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Editor

GROWTH OPPORTUNITIES FOR CHILE

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Growth Opportunities for Chile

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Table of Contents

Growth Opportunities for Chile: An Overview

Vittorio Corbo, Ricardo Gonzalez

1. Introduction

The last sixty years witnessed an important increase in world economic growth. This growth has been facilitated by the globalization process that started in the 1950s. The globalization surged from lowering barriers for trading goods and services, stimulating the exchange of ideas and the flow of people across the world. All this came as a result of technical advances in information, communication and transport technologies.

These technological advances and the ensuing globalization would not have meant anything if they had not been sustained by economic policies that gradually reduced barriers to trade in major regions in the world. Thus, along with the technological progress, the globalization process was sustained by the adoption of policies intended to raise trade openness and subsequent market-led reforms in developed as well as undeveloped countries. The integration of Europe in the fifties, the Chinese reforms that started in the late seventies, the fall of Eastern and Central Europe's communism and central planning at the end of the eighties, the collapse of the Soviet Union in 1991 and the process of reform in India that began the same year are all examples of how major regions moved away from state intervention towards more openness in order to reap the benefits the global economy had to offer.

The most remarkable cases of growth spurts in the last couple of decades have been China and India. The positive dynamics of growth in both countries have led them to regain the share of world output they had at the beginning of the twentieth century. In fact, the share of world GDP both countries had at the beginning of the nineteenth century was about 50 percent at Power Purchasing Parity (PPP) prices. Then, it fell to 20 percent at the start of the twentieth century and it kept on descending, reaching 8.7 percent at mid-century. The positive influence of globalization and market-led reforms adopted allowed these two countries to recover part of the ground lost as these two countries again account for 20 percent of world GDP in 2011.

The positive tailwind of world economic growth came to a halt with the recent financial crisis that has been the worst crisis affecting developed countries since the Great Depression. The recovery from this new crisis has been slow, which is not surprising as the deleveraging process of households and financial firms tends to be sluggish, unemployment rates are persistently high and the housing sector is still adjusting. Additionally, the sovereign debt crisis of several European economies has hit the world economy hard. Although, the short-term recessionary effects of policies intended to correct the excesses causing the crisis will keep growth low in advanced countries some years, world growth will suffer less as it will benefit from the positive outlook of emerging economies, especially China and India.

The positive perspectives of economic growth in China are justified by the high rates of savings and investment, its industrial base and innovation. On the other hand, India will benefit in the future from the growing trend in savings and investment, the adoption of better economic policies and its demography. Furthermore, both countries still have low per capita GDP records (China's per capita GDP is 8,387 in PPP, while India's per capita GDP is 3,663 in PPP in 2011), so there is still much room for these countries to catch up. Hence, the future prospects of both economies are the cornerstone of an optimistic outlook of world economic growth after the consequences of the crisis subside.

The growth of Emerging Asia, especially China, will benefit Chile as their demand for the primary goods that Chile exports to these markets will remain strong. The main challenge for Chile is managing the benign foreign environment by creating conditions for sustainable growth with less dependence on commodity exports and with more equity. Chile has to be prepared also for the downside of a slowdown in China's growth as the new government introduced policies to control credit growth and to change the composition of demand toward private consumption.

A high and sustainable growth requires an appropriate contribution of its main fundamental determinants. Theoretical and empirical studies of growth show that growth is the result of perspiration –growth of employment, and physical and human capital and inspiration– growth of productivity. Moreover, high and sustainable growth rates cannot be achieved without an important contribution of total factor productivity (TFP in short). Economic policies and institutions are two of the most relevant factors influencing incentives to hire labor and accumulate physical and human capital as well as stimulating productivity growth. Despite its transcendence, it is quite difficult to determine what economic policies and institutions are decisive to achieve a higher rate of growth for a sustained period of time.

In the following section, we selectively review the areas where reforms are needed to boost GDP growth in Chile. We then discuss the new research on growth and productivity in Chile introduced in this volume and summarize its main findings.

2. Where are the opportunities to increase Chile's growth today?

Instead of presenting another list of policies and institutions required to increase the rate of growth in Chile for a prolonged period of time, we draw on the general findings of the Growth Commission, led by Michael Spence, and on the specific recommendations for Chile in several OECD reports. The Spence report analyzes the experience of several countries in the postwar period that successfully sustained growth rates of 7 percent or higher for a long period of time –25 years or more. As organizing principles, the Growth Commission drew on the guidelines of growth theories proposed by academics in the past half century. Despite all the idiosyncrasies surrounding the analysis of these events, this Commission could narrow determinants down, identifying the most relevant characteristics accounting for high and sustainable growth rates.

Successful economies are characterized as countries that:

1. Take advantage of the opportunities offered by the global economy to improve the allocation of resources as consequence of more competition. This is especially relevant for small economies, which can benefit from economies of scale, allowing them to produce with lower costs, moreover if they can import more high-quality, low-cost inputs. Finally, the integration into the global economy helps in diffusing new ideas and technologies across countries, with the potential of incorporating them into new and old productive activities.

2. Achieve and sustain macroeconomic stability, which is relevant for all countries. A stable microeconomic environment enhances the informational content of relative prices, which contributes to reducing distortions in saving and investment decisions and provides certainty to the development of profitable projects with long gestation periods. It

also increases resilience to negative shocks and reduces the likelihood of economic crisis.

3. Use markets as a device to allocate resources efficiently, another feature that is relevant for all countries. This implies that an adequate regulatory framework is required to support and promote competition in all markets. More competition influences growth through its effects on efficiency and innovation.
4. Achieve high rates of saving and investment.
5. Promote the existence of a competent state that provides high-quality public services –including the management of the State, regulation framework and justice– and creates an environment supporting private endeavors by protecting property rights, encouraging contract enforcement, lowering barriers for entrepreneurs, among others.

One factor absent in this list is the role of education in affecting growth. Although it can be included in point 3 or in point 5, we prefer to analyze its role separately. Naturally, what is required in this issue is to improve the education people receive, especially the poorest groups of the population. More cognitive skills are crucial to develop new ideas, innovate and diffuse knowledge, which is required to adopt and develop technologies and thus increasing productivity and economic growth. By encouraging better education for the poor, income distribution should also improve.

Another feature that could have made it into the list above is industrial policy and the related policy of promoting tradable activities by weakening the currency. Both policies are rather controversial, so the Growth Commission was particularly cautious about promoting both policies. In the first case, the Commission acknowledged that it is difficult to select activities that should be promoted *a priori*, so it recommended that a thorough analysis be performed in order to properly assess what kind of industries require assistance. In the second case, weakening the currency may not be the best policy to encourage growth because it generates many distortions, mainly by taxing non-tradable industries and labor. Additionally, both policies encourage the appearance of rent-seekers looking to influence the government in order to appropriate rents derived from the assistance and as a byproduct hurting growth.

Where does Chile stand in these areas? With regard to the integration of the global economy, Chile has made important progress in contrast to neighboring countries by reducing unilateral import tariffs, lowering the maximum tariff rate to 6 percent and by signing preferential trade agreements with major countries, including the United States, the European Union, Japan and Canada. Reducing these artificial barriers is important to access new markets as the distance from these major markets acts as a natural barrier, hard to overcome. Perhaps the only two things where Chile has lagged in opening the economy are the costs of transport –still high partly because the inefficient management of ports– and the costs of engaging in international trade –although they are the lowest in the region, they are still high if we compare them with the costs incurred by successful traders in Emerging Asia.

In the financial openness area, Chile has an impressive record as well. A series of reforms –such as the practical elimination of capital controls, privatization and allowing foreign ownership in the banking sector and the pension reform which replaced the pay-as-you-go system for a fully-funded defined contribution system managed by private companies– have contributed to developing a more competitive and open capital market. Also, financial regulation and supervision have been strengthened in Chile after the financial crisis the country suffered in the 1980s. With this financial framework, the country has been able to attract financial flows from abroad without suffering the negative effects of fickle capital flows and the negative systemic effects they may exert on the banking sector.

On the macroeconomic front, Chile's framework is one of the most favorable in the world. This is the result of great institutional progress in the way monetary and fiscal policies are conducted. Regarding monetary policy, an independent and credible central bank, managing an inflation targeting scheme, complemented with a floating exchange rate, has been successful in lowering inflation towards industrial countries' level and its volatility –as a byproduct the volatility of GDP growth has also fell–, and real exchange rate misalignments have almost vanished.

On the other hand, fiscal accounts have been strengthened as public debt ratios have declined continuously in the last couple of decades, especially the external public debt, as the development of local bond markets has allowed the country to increase debt in domestic currency. An important institutional asset that Chile possesses is the fiscal rule, allowing the country to pursue an acyclical fiscal policy as Chile saves the extra revenue derived from commodity prices in times of boom to spend it in times of bust. In the meantime, the extra resources are invested in foreign stocks and bonds, cushioning the real exchange rate appreciation ensued in times of commodity booms. These improvements in the management of Chilean public finances have insulated the fiscal accounts from major negative foreign shocks. Despite this progress, Chile can still do more to advance in the management of public finances, by addressing some pitfalls in the design of the fiscal rule, increasing the efficiency of tax collection and evaluating public programs *ex ante* and *ex post*, among other policies in order to make fiscal accounts more sustainable.

Chile's integration into the global economy has increased the competition in tradable markets, improving the role of the market in allocating resources. The early elimination of price and interest rate controls, the enactment of specific laws promoting competition in services and public utilities run by the private sector have further improved the allocation of resources across all sectors. However, there is still room for further reform to improve the functioning of several markets and to promote the creative destruction of businesses. This process plays a central role in influencing growth of productivity and thus is a crucial factor in achieving a higher and sustainable growth. Moreover, two key variables sustaining the creative destruction are adoption and innovation of new technologies. Unfortunately, the creative destruction process is sluggish in Chile as barriers to start businesses are high –although they began to fall recently the cost of closing business is high– because bankruptcy is costly and severance payments for labor are high –and the access to credit markets for small and medium size firms is very limited. All in all, the poor regulation constraining creative destruction discourages adoption and innovation and thus, productivity growth.

In addition, rigid labor laws complicate the reallocation of labor: minimum wages distort the wage structure there are, low flexibility in working hours and high firing costs. These restrictions not only affect efficiency in the allocation of resources but also hamper employment opportunities for the low-skilled, poorly-educated population, especially young people and women from low-income house holds. For the transcendence of competition and the creative destruction process in enhancing efficiency, productivity and growth, many chapters contained in this volume address policies and regulations impairing the efficiency in several markets as we show below.

Saving and investment rates have grown in Chile over the last couple of decades as a result of the macroeconomic stability, the development of domestic financial markets and the instauration of the private pension system. In contrast to its Latin American counterparts, Chile's saving rate is high. However, the investment rate is low, similar to the regional average. In this area, Chile can do more to encourage investment in smaller firms. In fact, small firms keep on facing financial constraints, making them unable to reap the benefits the global economy has to offer. One of the chapters in this volume addresses this issue.

Finally, major reforms are required in the quality of government services, especially in public education and health services. Better public education, which is the education received by low income students, is crucial for increasing productivity and economic growth over a long period of time. Both public education and health suffer from the lack of resources and institutional weaknesses. These institutional problems induce poor incentives and lack of accountability, whose consequences are low-quality services provided inefficiently.

The institutional difficulties are more remarkable and evident in education. Although, much progress has been achieved in terms of coverage, Chile still ranks low in international achievement tests, even controlling for its income per capita. Despite recent results show a minor improvement, there is room for further reforms in this area to increase the level of cognitive skills of the population as a whole, especially those of students from low-income households. Additionally, a low human capital base is a serious handicap for adopting and designing new technologies, which impairs productivity growth directly. Thus, for its strong effects on income distribution, productivity and economic growth and for its interaction with other economic policies, education receives a lot of attention and thorough analysis in several chapters of this volume.

On the other hand, a detailed analysis focused exclusively on Chile was performed by the OECD in its Country Surveys. In these reports, the organization has identified six key areas were Chile lags behind its peers in the OECD, and where there is ample room for reforms that could raise productivity growth. These areas are: education, entrepreneurship, innovation, market competition, quality of public services, and the functioning of labor markets. Reforms in these areas have the potential of boosting productivity growth and thus contributing to higher output growth rates in the long-term. The chapters of this volume address most of these issues.

3. Overview of the volume

In the first section we have identified some areas where reforms are required to enhance efficiency, productivity and growth for a long period of time. We concluded that strong institutions, together with a regulation adequately suited to stimulate an efficient business environment, induces a better appropriation of the opportunities offered by integration into the world economy. The chapters of this volume address those areas using different approaches. Since many of these issues are interrelated, some topics are addressed in several chapters, but in complementary ways. The rest of this introduction summarizes the chapters of this volume and analyzes how reforms in such areas help to achieve high growth rates for a prolonged period of time.

3.1. WHY IS LATIN AMERICA POOR?

In this chapter, Daron Acemoglu discusses why Latin America is poor today in order to shed some light on Chile's long-term challenges to achieve economic development.

Acemoglu claims that small institutional differences can lead to large differences at critical junctures –periods when a big event takes place. When this logic is applied to Latin America, the divergence in terms of income per capita between North America and Latin America is explained by the extractive institutions the latter featured at the moment of decolonization. Extractive institutions include insecure property rights, forced labor systems and regulations preventing the functioning of markets. These institutions were set by the Spaniards when the colonization took place, which was possible because many indigenous societies featured a hierarchical structure, so the Spaniards replaced the old elite.

Extractive institutions generate growth, but in a rather unsustainable fashion because it does not emerge from the adoption of new technologies and creative destruction. Technical change can create political losers and for that reason, they use the political power they have in order to block such change. This is why the industrial revolution did not take place in Latin America in the XIX century. Furthermore, extractive institutions are persistent, even when the political regime changes. In such cases it could be possible that the new elite replaces the old elite, recreating the old system. This is the reason why Latin America could not catch up in the XX century.

The situation in North America was the exact opposite. Although, the settlers wanted to create extractive institutions, they could not. The decolonization process led to the strengthening of assemblies, which is a crucial feature of inclusive political institutions. Such institutions support the creation of inclusive economic institutions, including secure property rights for human and physical capital, law and order and resources are allocated using market devices with the support of State regulation. Societies having inclusive institutions embraced new technologies because no regulations prevented the adoption of technical innovations and elites could not control this process of industrialization, leading to sustainable growth in North America.

With regard to Chile, Acemoglu argues that Chilean economic institutions look good on paper, but more can be done to encourage entry to markets and entrepreneurship in order to increase the inclusiveness in economic growth. Chile also needs to strengthen its pluralistic political structure and to build it greater equality of income and access to education are required. When there are inequalities in both dimensions and politics is dominated by elite, a large fraction of the population feels alienated, which generates the perfect environment for the emergence of populist leaders. Under his view, Chile has advanced in political pluralism –as shown by the shifts in power from left to right in peaceful means– and income inequality has been declining, not by income redistribution, but by human capital formation. So, further progress in both political pluralism and income equality are the foundations for building the institutions Chile needs to move forward.

3.2. Economic and productivity growth

In this chapter, Corbo and Gonzalez estimate productivity growth for the recent years, and thus updating the estimations performed by previous studies. The analysis by the authors confirms that a productivity slump occurred in Chile, after 1998. Productivity growth fell during the Asian Crisis, and although it recovered somewhat in recent years, it never recovered the rates achieved during the “Golden Age” of Chile’s economic growth –from 1986 to 1997. Although TFP growth plummeted, GDP growth did not because capital accumulation has helped to sustain growth during the last decade, though at lower rates than those achieved in the pre-Asian Crisis years. Since capital accumulation undergoes decreasing returns, it will be increasingly hard for the country to sustain the actual level of GDP growth, which is lower than the rate achieved during the Golden Age.

To calculate productivity, Corbo and Gonzalez applied a novel method for the national literature studying growth in Chile. This methodology allows disentangling the role of the accumulation of technological-intensive capital from other forms of capital in accounting for GDP growth. These goods are Information and Communication Technologies (ICT) such as office and computational equipment (hardware), telecommunication equipment, and software. The authors find that the contribution of ICT capital to growth is sustaining GDP growth over the recent years. This was possible for two reasons: the increasing opening of the Chilean economy, allowing the country to import these high-tech goods from many countries at lower prices and the pronounced real appreciation that followed the sharp rise in terms of trade after 2004, further reducing the price of imports, encouraging the acquisition of new technologies.

This chapter advances two hypotheses trying to explain the deceleration of productivity growth since 1998: (1) poor productivity of a few large economic activities, enough to explain the aggregate productivity slump; and (2) high energy prices which reduces the utilization of energy -intensive capital, diminishing the productive capacity of the economy, productivity and growth. Corbo and Gonzalez introduce some modifications to the standard growth accounting to study both topics. Such modifications can be found in the international literature studying productivity and growth. The authors find evidence of the existence of both channels, but they cannot solely explain the decline of TFP growth.

Another exercise performed in this article is the calculation of reallocation among economic activities and their labor productivities. During the Golden Age, the average labor productivity growth was high in most economic activities and, at the same time, a substantial reallocation of workers took place towards high-productivity activities, further enhancing labor productivity and GDP growth in Chile. After 1998, the contribution of this reallocation to labor productivity was virtually zero, coinciding with a period of low aggregate productivity. This lower contribution of reallocation may be explained by labor market policies restricting the flow of workers towards high-productivity activities in an environment where post-crisis adjustments were needed. Micco and Repetto explore this and other related issues in their chapter on this volume.

Most reforms recommended by academics to enhance growth can be effective at the long term. In the short term, Corbo and Gonzalez argue that reforms to the labor market pointed to increasing the employment of young people and women can boost GDP growth. In fact, if Chile aims to reach the employability rates of OECD in five years, starting in 2012, employment would grow 2.6 percent per annum and thus, 780.000 persons would be added to the labor force, contributing a 1 percent gain on GDP growth per annum over the transition. Also, stimulating the employment of women and young people increases the accumulation of human capital of these groups through learning-by-doing and improves the income distribution.

3.3. Microeconomic reforms and competition in the electricity market

Galetovic, Hernandez, Muñoz and Neira –GHMN henceforth–, the authors of this chapter, hold that one of the reasons underlying Chile's low productivity growth post-1998 is the institutional and policy environment, including regulations, laws and institutions affecting the performance of any economic activities by obstructing the exchange of resources and hindering efficiency in voluntary transactions. Microeconomic reforms are policy changes aimed at overcome such barriers. In this sense, low productivity may occur as a result of bad microeconomic reforms or by uncorrected distortions. However, the critics of pursuing microeconomic reforms claim that they are difficult to implement and the payoff is rather small.

In contrast to this view, the authors of this chapter suggest that focusing on pursuing microeconomic reforms can generate large payoffs if performed thoroughly. To support this, GHMN calculates the benefits of implementing microeconomic reforms in the Chilean electricity market. For this purpose, GHMN set up a model for the electricity market in Chile, specifically the Central Interconnected System (CIS), which supplies electricity for about 92 percent of the population and accounts for 76 percent of total capacity. The supply is obtained by minimizing the expected private cost of supplying electricity, accounting for the costs of capacity, operation and outage for sixty years. In spite of its simplicity, this framework is remarkably detailed. The model includes assumptions about the weather –relevant for generating hydroelectricity–, the uncertainty in the price of fossil fuel, the supply of renewables, the costs of externalities arising from the emission of pollutants and the competition of firms in this sector. The results of this model are prices and consumption of electricity in Chile under different energy reforms, so it constitutes an adequate laboratory to experiment with policies regulating the electricity market.

In 1991, Chile and Argentina signed a protocol establishing the exports of natural gas from Argentina to Chile. Since natural gas was remarkably cheap, the capacity of the system expanded using combined-cycle gas turbines. However, Argentina began to cut gas exports to Chile in 2004 in increasing quantities over the following years. GHMN calculate what would have happened had this cuts not taken place. The authors find that GDP would have been permanently higher by 0.3%.

The second set of simulations evaluates the costs of delaying investments in the current situation, which result as a consequence of lobbying by environmentalists, red tape and other political restrictions retarding investments in new plants using hydropower or coal. GHMN calculate a rise in generation costs per MWh of almost 10% with no further hydropower development and a rise from US$64/MWh to US$70/MWh with neither hydro nor coal. The authors also find that the value added in the rest of the economy falls, depending on the case, by 20 or 25 percent of the increase in value added derived from the return of the Argentine natural gas to Chile.

The third set of simulations considers the effects of environmental policies. First of all, GHMN calculate that the current environmental regulation is quite effective because it has practically eliminated particulate material and substantially diminished SOx and NOx emissions. In fact, the authors estimate that under the optimal policy these emissions are slightly higher, suggesting that the current standards are severe.

Then, GHMN simulate the effects of a 20/20 policy –20 percent of electricity produced using non-conventional renewable energies in 2020–, finding that this policy increases the price of energy in the short- and long-term, engendering a loss in social surplus of about half of what was lost with the Argentine natural gas. In this sense, it is a bad policy. Other bad policies, according to the authors' calculations, are uncontrolled emissions and the red tape that delays investing in new hydropower and coal plants.

All in, the analysis of the electricity market performed by GHMN suggests that microeconomic reforms involve large estimated payoffs if a detailed analysis is performed in contrast to studies with more aggregated data. Moreover, a thorough analysis, as performed in this chapter, provides valuable information by identifying the benefits and costs, winners and losers of several policy options and helps to build consensus around the reforms with the largest welfare gains. Thus, it would be interesting that similar studies were performed for other industries. More on this point can be found in Gonzalez's chapter about the creation of an institution with enough capacity to perform such analyses.

3.4. Misallocation in the labor market and aggregate productivity

Micco and Repetto study the dynamics of the labor productivity dispersion across manufacturing plants. The authors find that dispersion of labor productivity rises in 2004 until the end of the sample in 2007. This means that since 2004 there are more low-productivity plants coexisting with high-productivity plants, which could be the result of policies allowing the survival of less efficient plants and reducing the flow of labor towards high-productivity plants, both generating a decline in overall labor productivity. This jump in dispersion is higher in plants within industries employing high-skilled labor more intensively. In a related exercise, Micco and Repetto calculate the speed of adjustment of manufacturing plants finding that plants have tended to adjust more quickly in recent years, however, plants employing high-skilled labor intensively adjust more slowly than the average plant. Both pieces of evidence suggest that labor market regulations affecting the employment of high-skilled labor complicate the adjustment of plants when they are hit by economic shocks, inducing a lower reallocation of workers towards high-productivity plants.

In another exercise Micco and Repetto find that the reallocation of workers has been productivity-enhancing in Chile, which means that labor has flowed from low-productivity plants to high-productivity plants. However, they also found that the contribution of this reallocation process to overall productivity growth has diminished since the Asian crisis, which is similar to the evidence found by Corbo and Gonzalez using all economic sectors.

The authors suggest that the lower reallocation of workers since the Asian crisis could be the result of higher energy prices, higher volatility of the real exchange rate or higher real interest rates as a consequence of the Asian crisis. Micco and Repetto find that macroeconomic volatility is correlated with the dispersion in labor productivity, especially in plants using energy more intensively in their productive processes and in plants engaged in international trade.

To assess the relevance of reallocation to manufacturing productivity growth, Micco and Repetto performed an interesting exercise: what happens if half of the workers employed in plants located at the bottom quintile of the productivity distribution are reallocated to plants located at the top quintile of the productivity distribution? They find that manufacturing productivity growth would increase by 17 percent.

3.5. Financial markets and economic growth

Diaz, Lefort and Morales –DLM henceforth– study whether depth, liquidity and sophistication of financial markets can foster productivity growth. According to DLM, there are a myriad of channels linking a developed financial market with higher productivity growth, such as encouraging technological innovation and higher accumulation of human capital, improving the allocation of savings and risk diversification, to name a few. In order to assess whether there is an empirical relation between financial development and productivity growth, DLM estimate a state-space model of TFP to account for the influence of unobservable variables on GDP and TFP dynamics. They find no evidence of such relation using various proxies for financial development: banking credit, market capitalization and stock market turnover. DLM claim that this lack of relation could be the consequence of low access to financial services and low liquidity of stock markets.

DLM find evidence that the financial access for small firms is still low. Banks charge larger spreads to these companies to compensate for the higher credit risk and the high costs involved in these operations. Furthermore, a high maximum legal rate, the lack of payments history and standardized financial statements and an insufficient amount of collateral, among other variables, complicate the access to external funds of smaller firms. DLM suggest that the use of simplified standardized financial reports and pools of collateral would improve the access to credit of small firms.

An established result in the international literature studying economic growth is that investor protection fosters growth at the long-term. However, DLM suggests that this is an area where there is ample room for improvements. There are information asymmetries contracting the supply of credit by unprotected investors and large investors also exploit these asymmetries retaining the control stakes in large companies, which reduces the liquidity in the stock market. The origin of these practices is the high ownership concentration present in Chile. DLM suggest some reforms to address this and other issues to enhance the functioning of Chile's capital market by increasing its transparency in terms of the amount, timing and quality of the information delivered and strengthening the governance structure of regulatory bodies.

Another area studied by DLM is the informational content of stock prices. Whether these prices convey information is important as it is a sign of how assets are being allocated. DLM provide evidence pointing to a null increase of informational content after the last reform of capital markets, MK3, showing that capital is not being allocated efficiently in the stock market. The authors suggest that there is some space for increasing informational content in stock prices. The main reform would be encouraging the participation of more financial agents, such as analysts, market makers and dealers, so they can be involved in the process of price formation and thus asset prices may reflect more information. This higher participation would also heighten the traded volumes, improving the liquidity of the capital market. However, high ownership concentration conspires against this. So a reform addressing this concentration would correct many of the current capital market's pitfalls in Chile.

3.6. Education and productivity

Beyer and Gallego explore the effect of human capital quality on economic growth, disentangling the mechanism through which human capital affects growth –capital accumulation or TFP growth. The authors argue that high quality of human capital is more relevant as countries approach the technological frontier. The evidence they provide in their paper support their hypothesis. The empirical results suggest that the quality of human capital affects TFP growth and consequently, output growth. Since Chile is slowly approaching the technology frontier, these results are relevant.

Then Beyer and Gallego study ways to increase the quality of human capital in Chile based on their judgment and reading of the literature. For further progress in this area, they identify four areas where urgent reforms are needed: (1) re-define the number of instruments aimed to increase the quality of human capital to simplify the regulation and align the incentives provided by different policy instruments; (2) adopt policies to increase the quantity and quality of pre-school education and strengthen the connection of this level with primary and secondary schooling; (3) provide incentives in the market for teachers to attract the most capable people to the teaching profession; and (4) adopt reforms in order to give more autonomy to schools and principals of public schools and to improve the selection process.

However, Beyer and Gallego conclude that the adoption and implementation of these reforms will not be enough to achieve long term economic development because the effects of improving the quality of human capital on growth are small. There are complementarities between education and the institutional framework, so other reforms should be adopted at the same time to boost Chile's productivity and income per capita.

3.7. Productivity and technological adoption

Fuentes and Mies study the contribution of technical adoption on productivity. The first question is why adoption instead of innovation. The answer is simply that adoption is more relevant for developing economies for catching up the technology frontier. Since adoption is one the relevant factors underlying productivity, it may help to explain differences in per capita income across the world.

According to Fuentes and Mies, Chile has made an exiguous effort to enhance its R&D investment. Controlling for its per capita GDP, the authors find that R&D expenditure, personnel involved in R&D activities and expenditure in licenses are below what the country should have according to its stage of development. Other determinants of R&D investment are the quality of institutions (property rights mostly), the quantity of human capital (higher education may encourage innovation) and financial development (funding for innovative projects). Once again, when controlling for these other indicators, Chile ranks below what it should according to these determinants. All in all, this evidence indicates that Chile is making an insufficient effort in R&D investment.

Then, the authors ask themselves, are R&D efforts crucial to increase productivity? Or are there other variables enhancing long-term growth? To answer these questions, Fuentes and Mies set up a model encompassing three insights from the theoretical literature of growth: (1) technology adoption is relevant for growth in developing countries and also helps to account for the cross-country income differentials; (2) there are policy interventions affecting R&D investment; and (3) human capital influences the ability of the country to absorb new technologies and thus, the capacity of adoption.

The reduced form of this theoretical setting is later estimated and their results applied to a simple calibration model oriented to explain productivity differences between Chile and US. The productivity gap is explained by the institutional environment to engage in R&D investments, microeconomic flexibility (reflecting how likely the availability of technologies is and the potential of adoption) and human capital (quality and quantity). In this accounting exercise, Fuentes and Mies find that the quality of human capital is the main factor accounting for the productivity gap in Chile, explaining sixty percent of the productivity gap with the US. The poor quality of the education in Chile reduces growth opportunities by reducing the incorporation of state of the art technology to the processes of production and by limiting innovation. Less than thirty percent of this gap is accounted for by institutional variables, which do not stimulate R&D investment enough in Chile.

Ultimately, if Chile wants to close the income gap with developed countries, it should encourage technology adoption and make serious improvements in the quality of the education given to its population. Hence, an educated workforce will contribute enormously to increase adoption, advancing in the catching up process and to set the stage for high quality innovation once the country reaches the technological frontier.

3.8. Political economy of distribution and growth

Schmidt-Hebbel studies the relation of income distribution and growth in Chile, approaching the issue from different angles. First, when performing an international comparison, Chile seems to have a small size of government according to its stage of development, however, he notes that this is so because a large share of pension and health expenditures as well as infrastructure (included in the other countries' figures) are privately financed in Chile, so they are excluded from traditional indicators. Thus, when including these expenditures, the government size is about right for its stage of development. Second, income concentration is high in Chile even when controlling for the current level of development.

To understand the current context, Schmidt-Hebbel sets up an endogenous growth model, augmented with political economy variables. The model features a median voter rule deciding over the income taxation preferred. The resources collected are spent in government consumption, useful for consumers, and services, which are useful for producers. The government also decides to levy a lump sum tax to the rich, which is given to poor households in a distortionary way, conditional on the distance of their income to the mean. All of these elements influence the size of the government and, ultimately, growth.

What is remarkable about this model is that it is successful in replicating current Chilean data. This allows Schmidt-Hebbel to perform several counterfactual exercises. The results implied by the simulations suggest that high income concentration hurts growth as stimulates the demand for public transfers which are possible by levying distortionary taxation only. Naturally, the composition of government spending matters: if it is focused on transfers, growth would be lower in contrast when it is allocated to productive services. In sum, this model outlines a positive interaction of income inequality and growth: more inequality heightens the demand for transfers, which is a form of unproductive public spending. This higher demand is met by raising distortionary taxation resulting in less growth. So, more income inequality implies less growth.

On the other hand, Schmidt-Hebbel elaborates a second model, although this is more stylized. This model illustrates the relation of political leadership, the policymaking process and the quality of institutions and policies. The analysis of the model implies that a country with a declining growth rate and deteriorating income distribution can move into a virtuous cycle by increasing the quality of its policymaking process, institutions and economic policies.

Finally, Schmidt-Hebbel concludes proposing several areas of reform in order to improve growth and income distribution. Many of these areas are addressed in this volume, such as education, labor market and technological innovation. Others like the control of crime, tax reform, entrepreneurship, environmental protection, regional integration and state and government reforms are beyond the scope of this volume. Despite the consensus about the areas in need of reforms, the adoption of policies addressing these issues faces political economy drawbacks. Chile needs to enhance the policymaking process and institutions to overcome these difficulties. These complications range from informational asymmetries about the benefits of reform (beneficiaries are poorly identified and informed), the distributional effects of reform (leading losers of reform to mobilize resources in order to block reforms) to a poor representation of community's interests in policymaking arenas. Hence, political reforms are necessary for Chile to begin to adopt productivity–enhancing and equity improving reforms and thus advance towards the long sought development.

3.9. An institutional arrangement for enhancing productivity growth

Productivity is declining over the recent years and income inequality has been stuck in high levels over the last couple of decades. Schmidt–Hebbel argues that improving the quality of the policymaking process and institutions would lead the country to a virtuous cycle featuring high growth and better income distribution. The final chapter, written by Gonzalez, hypothesizes that scarcity of technical skills within the Government and Congress and an insufficient involvement of the community in the process of policy design explain why complex, productivity-boosting reforms are not adopted.

To overcome the impediments identified, the Government set up ad hoc commissions to address the technical content of reforms. However, Gonzalez argues that despite being valuable for opening the discussion of policy reforms and for gathering experts, this approach is insufficient for several reasons: (1) in practice, not all points of view are effectively represented in the policy debate within these commissions; (2) at the moment of writing the final report, some interests had more influence on the outcome of this process than others; (3) as the President set the terms of reference, it is possible that potentially relevant topics end up being excluded from the analysis; (4) it is not clear how independent the final report from the government's own assessment is; and (5) the commissions could lack enough resources to perform their tasks efficiently.

Moreover, since ad hoc commissions operate from outside the legislative system, they are not subject of regulations, so their outcome is largely idiosyncratic, especially in terms of the participation of the community. Public involvement in policy design is very relevant today given the recent trend of social organizations expressing their demands in non–institutionalized forums. These forms of manifestation are relevant since they have the power to affect the formal policymaking process.

For bridging the technical capacity gap of the public apparatus and for creating links to stimulate public participation in reform design, Gonzalez proposes that an institution like the Australian Productivity Commission (apc) should be incorporated into the current policymaking process.

The apc is an independent institution aiming to advise the government on policies stimulating productivity growth by designing the technical content of reforms in economic, social and environmental issues. Its independence is established by law as well as the orientation to productivity because the latter is necessary to achieve higher levels of material wellbeing. The term of the commissioners does not overlap with the length of government, and therefore, the commission adds continuity to the policymaking process. This institution has been largely successful in promoting the adoption of productivity-enhancing reforms in Australia and the understanding of the costs and benefits of implementing such reforms.

Gonzalez highlights two elements about this approach. One is the focus on productivity. For economists, it is easy to conceive that enhancing productivity will ultimately lead to improvements in income growth and material wellbeing. However, it is less obvious for the rest of the community. However, the author discusses that centering the attention on productivity is useful because it provides an organizing principle for designing reforms oriented to achieve higher material welfare. In addition, social and environmental factors along with other relevant dimensions of wellbeing are considered at the moment of designing the reforms, giving a more complete assessment of welfare. In Australia, the law states that these other objectives must be taken into account when formulating policy reforms.

The second key point is the public consultation process. This is the channel where the community, all interested participants, can express their view and confront them in a debate. Particularly important is the research performed by the apc's technical staff, providing the proposals, the facts and the empirical evidence relevant for the reform design. These research skills contribute to strengthening the technical capacity of the state, easing the process of policy formulation. The results of this research are contained in ex ante evaluations performed by the apc at the moment of designing reforms, which are later contrasted with the viewpoints of the community. These evaluations are also useful to build support to the reform when discussed in Congress. The apc also performs ex post evaluations which are valuable for sustaining reform efforts in other areas.

However, Gonzalez discusses that the implementation of an Australian-style productivity commission in Chile is no panacea because the adoption of such institution will neither lead automatically to the adoption of reforms nor solve the problems of the political system. The reason is that the commission intervenes at the stage where policies are designed, not when these policies are approved and implemented, so there is little the commission can do in overcoming failures in those phases. Undoubtedly, reforms to the political system are strongly necessary and useful complement to the approach described by the author. However, if the board of the commission is representative and well –respected, this institution can partially overcome these problems and be a valuable help in the process of adopting productivity– boosting reforms.

3.10. Panel discussion

In the end of the conference, Daron Acemoglu, Ricardo Caballero, Vittorio Corbo, Jorge Marshall and Patricio Meller discussed the challenges the Chilean economy is facing to achieve economic development.

Acemoglu emphasized that specific institutions complement each other and if some dimension of the institutional framework is missing, it affects the functioning of other institutions or regulations. One example is the technology –education relation: if the quality and level of education is low, the price signals are not being sent and there is a significant slowdown in technology. The second point he made is that the quality of human capital, entrepreneurship, and R&D are crucial in Chile's stage of development in order to converge to the income per capita of advanced economies. The third point Acemoglu discussed is that inequality is very important for two reasons: (1) inequality really makes the growth process less broad based; and (2) a highly unequal society has greater distributional conflicts which creates instability. In this sense, he claims that it is important to deal with inequality, but not in a distortionary way, by increasing the quality of education, not through excessive redistribution since it is very ephemeral and introduces distortions that stops business creation, entrepreneurship and investment. The fourth point Acemoglu made is that Chile needs a real technocracy –with the appropriate checks imposed– to strengthen the State. His final point was that market access is important for a small open economy like Chile. He argued that industrial policy is a bad idea because the governments are not good at picking winners and it is a very political process. The right choice would be enlarging the market for companies with the potential of introducing skill-intensive technologies.

Meller expressed his skepticism about the calculations showing that the growth of TFP has been negative in the last decade. He thinks that something is happening with productivity in Chile and that productivity expansion is low, however, calculations of TFP growth do not give us a clue about what is going on and what needs to be done to increase productivity. Later, he argued that to increase productivity we should study the problem of economic sectors. He claimed that service sector is the economic activity with the largest gap in productivity because it is intensive in unskilled labor. However, he showed some concern about increasing the productivity of the services because it can reduce the competitiveness of Chilean economy if such services are not inputs in the production of tradable goods. The third point he made was that the structure of companies and the relationship between workers and management could influence productivity. He concluded by stressing that despite the agreement about the importance of human capital for growth, the bulk of the discussion is still focused on what happens to the quality of education at the school and tertiary levels, although today what happens with the quality of education before entering the school –from one to five years old– also matters. This problem is critical since any reform in this area will show results in twenty years at least.

Corbo began discussing that all national and international studies performed find that TFP growth has fallen significantly, reaching average negative rates over the last decade, no matter the method followed to calculate TFP. Later, he argued that Chile's limited ability to deal with foreign shocks affects productivity, partially because the labor market is quite rigid. When firms were recovering from the recession of 1998-1999, they suffered the shock of energy prices. High energy prices induce less utilization of capital, reducing output growth. He also discussed that the other two factors explaining the drop in Chile's TFP growth are high bankruptcy costs and poor regulation at the municipal level. Both complicate the entry and exit from markets and discourage entrepreneurship. Later, he suggested three areas that require urgent reforms: (1) education; (2) entrepreneurship; and (3) labor market. High quality education would improve income distribution of income and allow people access to more opportunities. Labor market restrictions worsen income distribution because less qualified employment is the most affected. Finally, Corbo concludes by arguing that Chile has a window of opportunity in the short term by increasing labor force participation, especially for women and young people. However, minimum wage hikes and the poor quality of education have conspired against higher participation. So incorporating them into the labor force, not only can reduce income inequality, but can encourage human capital accumulation through formal employment.

Marshall argued that focusing on TFP growth is not relevant because its dynamics are poorly understood. The focus of the attention should be on why there is still a large gap in income per capita between Chile and advanced nations and to close such gap, we should look at the fundamental causes proposed by Daron Acemoglu. Later, he referred to the lack of trust among citizens as one reason underlying the existing regulations in the labor market regulation. The bargaining between workers and employers prevents the building of trust, so workers keep demanding more regulation, increasing the rigidity of the labor market. Further progress in this area should consider this lack of trust. With regard to innovation, he revealed that the institutional framework promoting R&D has changed frequently in the past, changing the incentives to innovate. Moreover, collaboration between companies is crucial to innovate, but Chilean companies do not collaborate much. For both reasons, innovation does not take off in Chile. Finally, he concluded by saying that the performance of medium-size businesses is relevant to productivity growth. Small businesses are relevant for employment, but not for productivity. Chilean medium-size companies are family businesses, whose productivity is lower than Chile's average. The reason is that they do not open themselves, do not trust and have fear of creating alliances and interactions with other companies. These fears and suspicions are rooted into our institutions and the only possible way to move forward is improving Chile's institutional framework, especially the State, in order to provide the space where trust can be built upon.

In his intervention, Caballero connected the topics of growth with the international economic context, especially to the macroeconomic situations of China and the United States. In China, there is a clear intention to reorient growth towards domestic sector producing nontradables and Caballero does not think that this change has a great impact on China's growth because the relevance of the external sector is far less important than what the world thinks. He predicted that China will continue to grow between 8-10% for a while longer, although not without risk because it is difficult to sustain such growth. In the U.S., the mediocre recovery will take time, as an important part of the financial system vanished and there was a sharp fall in consumers' wealth. The Federal Reserve is working to offset both mechanisms using quantitative easing. Since this instrument is imperfect, the Federal Reserve will use it more intensively and more than is desirable, creating an inefficient excess of liquidity worldwide.

Chile's real exchange rate is the price that connects Chile's growth to the global context. The strong Chinese growth and the monetary policy followed by the Federal Reserve appreciates Chile's real exchange rate and will continue to do so for a while. These two forces produce what is generically known as "Dutch Disease". This external pressure can accelerate the process of technology adoption. But if this process of foreign capital inflows occurs very fast, it can destroy the export sector of the economy and may adversely affect the growth of exporters, which is very important for Chile's medium term growth. Since the real problem is the reallocation of resources, there are two types of policies to reduce this problem: (1) policies of setting spending levels and policies of expenditure redistribution; (2) policies that increase the quantity and quality of other factors of production. Differential VAT, industrial policies and interventions in the exchange rate market could also do the job but they create a series of perverse incentives and distortions.

On the other hand, Caballero thinks that increasing female labor participation is the most obvious margin to expand the quantity of productive resources. A third of the growth rate that Chile lost in recent years was due to the fall in employment growth. This can be completely reversed by increasing the contribution of labor to growth. The return of policies encouraging participation is high in the short term and in the medium term as well, because one of the great sources of education is employment.

Why is Latin America Poor?[1]

Daron Acemoglu

The reasons I will talk about why Latin America is poor are twofold. The first is that I have been working on the answer to such a question for the last several months with my longtime collaborator, James Robinson, for a book that will come out in the next calendar year, *Why Nations Fail: The Origins of Power, Prosperity, and Poverty*. The second reason for talking about this is that while I am not an expert on the Chilean economy, I believe it is useful to think about the long-term development problems of Chile in a broader, Latin American perspective. It would appear a little bit heretical here because Chile is much richer and more developed than the rest of Latin America, but there are commonalities between Chile and the rest of the region that come out of the analysis of Chile within the Latin American context.

There is a big disparity around the world in terms of income per capita. Most importantly for today's talk, most of Latin American countries are around the ten thousand or less in income per capita in PPP terms. North America is around the forty or fifty thousand range. So, Latin America is poor compared to North America and Western Europe, but compared to India or Sub-Saharan Africa, Latin America is doing well. So when we talk about Latin American countries, we are not talking about countries as big economic, political and social failures –although there are some exceptions in Central America and in the Caribbean– but they are not doing as well as one would think given the globalized world we live in, where technology can flow freely and most of these countries can trade. This is not a result one would expect based on basic economic models. This is part of the puzzle. The second thing to note is that Chile is doing better than the rest of South America.

How did we get here? This is well known, but I am saying this to set the scene. Angus Maddison's data –which is mostly based on guesstimates

[1] This paper is based on the transcript of a 2011 lecture by Daron Acemoglu on the book *Why Nations Fail*: *The Origins of Power, Prosperity, and Poverty* by Daron Acemoglu and James A. Robinson.

because there were not actual accounts back in 1000 AD– give a relatively accurate perspective of the evolution of average GDP per capita in Western Europe, Western Offshoots, Latin America, Asia and Africa from 1000 to 2000, although this data may exaggerate how early on Western Europe started growing. The general perspective is agreed upon by economic historians. The point I want to emphasize here is that until 1800 or mid-XVIII century, there were no large differences anywhere in the world, certainly not between Latin America and North America. According to Maddison, Western Europe was already pulling ahead by the XVIII century. Some people very strongly disagree with that. But even if you agree with Maddison, the gap between Latin America and Western Europe was not that huge in the middle of the XVIII century and the gap between the Western Offshoots, which is very much driven by the United States, and Latin America was almost trivial.

It is in the XIX century that the gaps started forming. In fact, if you compare specific countries to United States, say Mexico, and even in 1750 Mexico was ahead or level compared to the United States. It is in XIX century that the Unites States began pulling ahead. Of course, this is the well-known story of industrialization and commerce. In the XVII and XVIII centuries commerce was important for the development of Latin America, but the XIX century saw a new wave of economic activities, especially centered on trade and industrialized goods. That is what led to the breakneck pace of growth in the United States and that is something that the rest of American continent did not share. The same kind of industrial growth did not take place in most of Latin America. That is a proximate explanation for why Latin America did not grow first and later did not catch up.

The question that I am trying to address here is how we think of this divergence and this lack of subsequent convergence between different parts of America and different parts of the world. To do that, I will start discussing some stories from the beginning of England, the United States and Latin America at the early stages. I will present some vignettes to set the scene, and then I will introduce some concepts which I will try to use to bring the narrative up to the present.

The beginning of England for the story I am about to tell –considering that any point set as the beginning is arbitrary– and for the point I want to emphasize is the Glorious Revolution of 1668. It is a fairly radical change in economic and political institutions in Britain. Of course, this is the tail end of other major events that have been going on for several centuries, for example, the Magna Carta, the increasing power of Parliament throughout the xv and xvi centuries –which was very slight, but still notable– the political centralization under the Tudor period, the English Civil War and other conflicts between the monarchy and Parliament. But the Glorious Revolution is particularly notable because it was the major defeat of the absolutist project that James II was carrying out, before then by Charles II and Charles III, and power, economic and political, decisively shifted away from the monarchy to Parliament. What was particularly important was not the number of powers Parliament had to check against the monarchy and to set policies, for example, taxation and the approval of the raising of an army, but that Parliament itself began to represent a broad set of interests, such as people from industrial backgrounds and the merchants who made a lot of their money in the Atlantic trade. I will refer to that as pluralism.

This pluralism was particularly important in the subsequent political development of England and Britain as political power was not concentrated in a single group that headed the political decision making. Consequently, economic decisions were made by some type of coalition or by some agreement among different people or interests.

The reason I am emphasizing this is that this was the first time that something like this became the law of the land and consolidated in a way that was not done before.

The United States, whose colonization by the English started in the early xvii century, was not at first designed to be just like the Parliament. When the British sent the original colonization, the settlers, their plan for the United States was very different. What they wanted to do was to recreate a feudal system which had already disappeared in England. All the major colonial efforts were given to the landgraves by the Crown and the people who had the landgraves, for example, Lord Baltimore, were going to be the governor of these areas, they were going to have people called the "leet-men" underneath them, who had no rights, who had to work and produce output and they received little wages. But quickly the British realized that in North America things were going to be different.

In particular, the main theme was that the Europeans agreed to go there as leet-men. They did not want to go there to work for low wages in very harsh conditions; instead, they wanted to take the free land to work it for themselves. At first the companies that did the colonization effort, Virginia Company and Jamestown, tried to fight this. For instance, the governor and the deputy-governor of the Jamestown colony, Sir Thomas Gates and Sir Thomas Dale, promulgated draconian laws in order to prevent people from setting up their small holding of land or trading with Indians. The following text is from a law they passed in order to maintain control:

> "No man or woman shall run away from the colony to the Indians, upon pain of death.
> Anyone who robs a garden, public or private, or a vineyard, or who steals ears of corn shall be punished with death.
> No member of the colony will sell or give any commodity of this country to a captain, mariner, master or sailor to transport out of the colony, for his own private uses, upon pain of death".

As you can see, any offense is punishable by death and offenses are like running away from the colony to the Indians, trading with Indians, robbing the garden, which were all owned by the Virginia Company. So, this is a very draconian society they were trying to set up, much more draconian than was in England at the time.

But it failed. It had no chance of succeeding because there was not enough labor willing to work, too much land and too many other things to do. Running away from the company was punishable by death, but there was not any realistic power to enforce that law because there were not enough men empowered to capture people. The companies were very unsuccessful with this project. After 11 years, they realized that the project was not going to work, so they moved to an entirely different system. They went to a "headright system" giving all settlers 50 acres of land, so rather than people working as feudal servants, now they were going to be smallholders like small entrepreneurs. Later, the 50 acres were supplemented with more acres under different regulations. Then, these people would have grown their own crop and trade.

But economic rights were not enough. The settlers wanted political rights and quickly passed to a General Assembly structure and these were what underpinned the Constitution of the United States and the declaration of independence. This was not what the Virginia Company or other companies wanted to implement, but it was the reality in the ground.

What about Latin America? The Spaniards who colonized Latin America were no different than the British in that they had exactly the same project. The key thing, however, is that they encountered very different conditions. Here I picked one episode that shows how Spaniards tried to negotiate conditions they encountered. I am sure that there are similar stories for Chile, but I think this is the clearest one. These episodes are from the Juan Díaz de Solís colonization of the Río de la Plata in 1516 and Pedro de Mendoza's colonization of Buenos Aires. These were potentially great areas. But all of these efforts came to nothing because by and large, these environments were very similar to those Virginia Company was colonizing in North America. Essentially, what they found there were hunter-gatherer Indians, the Charruas and the Querendí. These people were not the kind of Indians they could force to work. Spaniards like the British wanted to be elite and have people as servants and slaves working and producing for them. They wanted the Charruas to produce food for them, but the Charruas fought them instead and put Solís to death shortly thereafter. There were not enough Charruas and they were fighting, so Spaniards quickly withdrew from Buenos Aires.

In 1537, Juan de Ayolas discovered the Guaraní in Paraguay. The Guaraní were different from the Charruas as they were settled, semi–sedentary and also had a hierarchical structure, like the Incas and Aztecs whom Pizarro and Cortes were colonizing. This hierarchical structure was exactly what the Spaniards wanted because they essentially replaced the elite of the Guaraní and they put the rest of the Guaraní to work to produce for them and pay tributes to them, so this area was one of the first the Europeans settled. The contrast is what Solís found in Río de la Plata, which was similar to what the Virginia Company found. This process was not conducive to the extractive institutions that the Spaniards tried to set up and they did not colonize that area for quite a while because they could not take over the hierarchical structure as they did with the Guaranís, the Incas and the Aztecs.

This is a capsule of the overall colonization and the development of institutions in Latin America. In some sense, for this whole period, you can tell several different types of stories. You can talk about how culture from South America differs from that of North America, where culture would refer to either the culture of the indigenous people or the culture and religion the Spaniards brought. You can talk about geography because there are some places that are quite tropical in Latin America. But when you think of overall development and these episodes, the crucial things were not the religion, the culture, the geography or the values that were being brought, but it was the method of colonization. What the Europeans wanted to do and impose was not very different and the cultures did not have much to do with what they were developing. One way of seeing it is that many of the parts that the Europeans colonized with the style that de Ayolas, Pizarro or Cortes managed were not very unsuccessful at first. They were very good at producing a lot of output and by the middle of the XVIII century, Mexico, Cuba, Jamaica and even Haiti were richer than the United States. It was not anything that prevented the production of output in a given geography or culture. Instead what I am going to emphasize is the role of institutions, where institutions are the set of regulations, broadly construed. This comes from Douglas North, who was one of the early people working in institutions and their role in economic history. He defines institutions as

> "…the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction".

This quotation captures the essence of institutions as they shape the incentives. The incentives that the Europeans set up in different parts of the world were very different and those will have crucial effects, as I will explain later, as we move forward.

One other perspective, which again I will return as I talk about today, is that policies and institutions matter, but the way they matter is that some policies and institutions are good for economic growth and some of them are bad. Some politicians do not get that high inflation is bad, they think it is good and that is why they keep pursuing high inflation. But again if you start from a historical perspective, what you realize is that this does not have much explanatory power. When you think of it, de Ayolas, Pizarro and Cortes did not set up these forced labor and repressive systems because they thought they were the good ones for the population they were colonizing and similarly, the Virginia Company did not set up the General Assembly because it thought it was better, it was forced to do so because they had the exact same plan of colonization as de Ayolas, Pizarro and Cortes, but could not do it. All of them had this particular plan in mind not because they were ignorant about what was good for the population they were colonizing, but because they had a particular objective to maximize their profits by hook or by crook and that was the crucial thing.

To make sense of this James Robinson and I suggest in the book some simple concepts. I have already introduced the main ideas of these concepts, so I will go quickly through this. Extractive economic institutions are essentially what de Ayolas was able to set up with the Guaranís, Cortes with the Aztecs and Pizarro with the Incas. They include: insecure property rights, in particular, the absence of property rights in labor that people have to sell; entry barriers and regulations preventing functioning of markets. Labor was being bought and sold even in the Spanish empire, but it was not in a free market, it was a forced labor system that essentially set the way you have to work like the *repartimento* or the *encomiendas*. To realize the potential of the market to allocate resources in the most efficient way one needs a *level playing field*. If only a very small fraction of the population is able to participate in market activities, it is not a truly inclusive, functional set of market institutions. Rather, similar to what we observe in the Caribbean plantation economies, but also in most of the places that the Spaniards colonized, this was a set of institutions empowering a small and narrow elite to rule politically and hold all the assets and all of the opportunities to trade, while the bulk of the population did not have such rights and opportunities.

Extractive economic institutions do not exist in a vacuum. They need extractive political institutions to support them. If you have a system in which you have something like pluralism –in which many different interests in the society are represented and they have political power– it will not go along with a system in which five or ten percent of the population hold all assets and force the rest to work. If the rest of the population has a political voice they are not going to set up this very unequal and unjust system. So, exploitative and extractive economic institutions need an extractive set of political institutions like the absolutism James II was trying to create in England that was defeated and political institutions are going to concentrate power in the hands of a few without any kind of checks and balances or pluralism.

In contrast to this are the inclusive economic institutions that are defined as the opposite of the extractive economic institutions. Here you have law and order, so people can have secure property rights for both human and physical assets, the markets are working, so the allocation takes place mostly through markets, although it might require some sort of regulation or state-support. By inclusive economic institutions I do not mean an extreme laissez faire world without state participation, in particular, the state providing infrastructure or public education might be important to develop this level playing field.

In general, inclusive economic institutions do not need to be supported by a different set of political institutions. If you have extractive political institutions in which power is concentrated in the hands of a few, they often try to change inclusive economic institutions, they are going to try to protect their own monopolies and their own property rights, and start violating other people's property rights. Inclusive economic institutions need to be supported by inclusive political institutions in which you have broad participation in the political decision making (pluralism) and real constraints and checks and balances on the exercise of power and, also related to pluralism, the rule of law, so the law is actually applied equally to all people. It is no coincidence that during the Glorious Revolution there were major reforms in the legal system as well.

The growth that took place in the xix century, in the context of the industrialization of North America and parts of Western Europe, was similar to growth under inclusive institutions because it was largely based on investment in new technology and machinery and new trading opportunities, with such opportunities being open to a broad cross-section of society. It was underpinned by relatively well-enforced property rights. It was harnessing the power of markets. Feudalism is a system that has many things wrong with it, but one is that it does not use the market because many things are done locally, without the allocation of talented people according to comparative advantage. And, it generated much greater broad-based participation. Very importantly, this involved a typical feature of growth under inclusive institutions: what the famous Austrian economist Joseph Schumpeter dubbed *creative destruction*. Namely, this was a process where old technologies were being destroyed and replaced by new and all old elites were being replaced by new.

This last point is particularly clear in the case of industrial growth in both England and the United States. The drivers of this growth were literally new men. They were new people who could come up the system because there was enough security in property rights and a level playing field for people like this to ascend. If you think of the many key figures of the British Revolution, they were not part of the elite. They could do this because the system did not block their path. In fact, the system made it very easy for them with secure property rights and patents and they could hire labor in relatively competitive markets.

The central question is why are these extractive institutions so prevalent throughout history and even today? In the process of developing answers to this question, I will also argue that the remnants of these extractive institutions are still influential in Latin America.

There is a logic underlying extractive institutions and again I will come back to the ignorance hypothesis. de Ayola, Pizarro and Cortes did not make a mistake setting up extractive institutions, they actually made the right choice for themselves –but at the expense of the rest of the society decolonized. We might disagree with their objectives of exploiting and killing millions, but that is what they wanted to do. In the same way, extractive institutions have logic. They are redistributing resources from a part of the population to another part and as long as the part that receives this redistribution is politically powerful that logic is also powerful. There is another part to that logic: extractive institutions are not creatively destructive as inclusive institutions are, or even when they permit growth, this is growth without creative destruction.

Of course, extractive institutions would not naturally produce very low output. This would not be in the interest of people who are setting up and dominating extractive institutions. So if you think of extractive institutions that were set up in the Caribbean, they were extremely efficient in making slaves work and produce sugar. That is why Cuba, Haiti and Jamaica were among the richest places at some point in time. The Potosí mine used forced labor and it was very effective in filling the coffers of the king of Spain and the pockets of the people who dominated it.

These two points about the logic under extractive institutions are important. To repeat, the first point is that it would be wrong to expect extractive institutions not to do well at all points in time. In fact, you can have growth under extractive institutions. But the second point is that this growth will be very different in nature from growth under inclusive institutions. It is not going to involve creative destruction. In fact, what defines extractive institutions is the fear of creative destruction. Extractive institutions, while generating growth, do not embrace new technologies as much, because they would bring creative destruction. Also, they would not reform themselves towards inclusive institutions, because again that would be associated with creative destruction.

Here it would be useful to have a broader notion of creative destruction than what Schumpeter defined, which was purely in the economics sphere. We should, instead, also consider creative destruction in the political sphere. Creative destruction in the political sphere's means that there will be political losers, people losing their political power and privileges, because of technological change and the process of economic growth. Recall that this is what happened in the Virginia Company: the officers of the company, the politically dominant group in the colony, were sidelined rapidly once economic change, especially inclusive economic change, started. This was in part because that society could not become a full smallholder society without some type of political empowerment of the smallholders. That is what the General Assembly did. That is why the smallholder settlers wanted to be ruled by such assemblies. Once the assemblies were there, the power of the elite was gone. They were political losers.

The problem with political losers is that those who currently hold power and expect to become political losers, as a result of creative destruction, technological change or institutional change, will often try to block it. This is one of the main reasons why extractive political institutions will not lead to sustained economic growth.

Thus growth under extractive institutions is not impossible. If you think about China today, growth under these types of institutions is feasible, and in fact, can take place very rapidly. The problem is that it will not translate into sustained growth unless it's accompanied by fundamental political changes. Sustained growth requires intense creative destruction, which extractive institutions cannot tolerate.

The final point I want to make before going to the applications of Latin America is the institutional change. I painted this picture of inclusive and extractive economic and political institutions and how they support each other. That sounds like a very stationary world. But the world we live in is very dynamic and institutions change all the time. How does change happen? By the same concepts that I already emphasized, but there are other aspects in which they play out which I will talk about. Conflict is pervasive. The conflict between the people who benefit from different sets of institutions is the driving force. But this conflict plays out differently during different periods of time. The concept that I find useful to think about this is the institutional drift, which is chosen in part to evoke the related notion of genetic or evolutionary drift. Genetic drift is the name given by biologists to the following situation: if you have two populations that are identical to start with, but they are in different locations so they are not interacting in a strong way. Then, because of small random perturbations, they are going to evolve differently. If you look at them in fifty years, you will likely not see any major differences. But if you look at them four hundred years, you will see some small and perceptible differences. In the same sense, the conflicts that exist between the people holding the political power, which they are trying to protect, and people who do not, in different societies these are going to lead to small differences over time, certainly not in a couple of years, but over the course of several decades or even centuries.

If you look at England and Spain in early xvii century, they are not all that different. Then, there is the institutional drift that makes them just a little bit different at the margin. They are not that different in the sense that they are both ruled by monarchs who had absolutist projects and to some extent, they were successful. In both cases, the absolutism is not extreme: there is the Parliament and there are courts in Spain. But there are some differences as the Parliament is a little bit stronger than the courts and as a result you have a very crucial difference as the Spanish king dominated all of foreign trade. In England, you have a similar system, but it is just a little weaker. If you think of how British trade was organized, almost all of it was under monopoly of the Crown. But crucially, the Crown was not able to monopolize the new world trade because there was this endogenous monopoly that was past and it was hard for the Crown to pass new monopolies. It is a small difference between Spain and England. But this small difference mattered because it had quite significant implications. When the big shock of the opening up of Atlantic trade routes hit and generated a myriad of new economic opportunities, its consequences played out very differently. In Spain, it filled the coffers of the king of Spain. In England, it enriched a lot of new traders in this non–monopolized environment. Those new traders who did not come from the elite and the companies were pirates that started the slave trade to the Americas.

The institutional change is the interaction between small institutional differences that exist and big shocks which we call critical junctures because in critical periods during which these big shocks hit, small differences lead to divergence similar to the divergence between Britain and Spain. In Spain, the Atlantic trade strengthened the Crown and in England significantly weakened the Crown, leading to the English Civil War and the Glorious Revolution. There is nothing deterministic about this and ex post we can talk about small differences that mattered. But, still there is this strong tendency of critical junctures leading to different outcomes depending on the institutions that they encountered. When the next big shock comes, you are going to have bigger changes because small differences will now be medium-sized differences.

Another critical juncture that many historians point to is the Black Death. According to the Neo-Malthusian theory of the decline of feudalism, the Black Death and the decline of population was the crucial factor in causing the end of the Feudalism and led to new institutional structures in England and even in France by the xvii century which made things very different. The argument goes that the Black Death, by reducing the population increased wages –data from Britain support this– and it became harder for the feudal lord to keep workers under his feudal relationship and people wanted to go to the cities where wages were even higher and they wanted more rights, and slowly the feudal relationships started to atrophy. But at the same time that the Black Death was hitting Western Europe, it was also hitting Eastern Europe, but led to a different result. There was no collapse of the feudalism, and in fact, over the next two centuries feudalism in the East got stronger. We do not know the wages in Eastern Europe, but certainly the feudal relationships became much stronger as the feudal dues became much onerous and secondly, serfdom was more radical in many ways. So, these are small differences that were shocked by big critical junctures. In summary, by the time the Black Death hit, Eastern and Western Europe were not that different, but there were already some perceptible differences, most importantly cities had already become more important in Western Europe than in Eastern Europe. There were present in Eastern Europe, but they were fewer in numbers and for opportunities, they were less important for people. The Black Death increased wages, especially in the cities and created much bigger opportunities for the cities in Western Europe than in Eastern Europe. So, again critical junctures and institutional divergence are important.

There is a set of events occurring in Latin America similar to the consequences of the Black Death in Eastern Europe. We had a big population collapse when the *conquistadores* came and brought their diseases. The population during the Black Death fell about fifty percent in many parts of Europe. The population collapse in South America was much more severe. If we expect the same type of competition for labor that happened in England, for example, which led to a sharp increase in real wages, then we should expect something similar in Mexico or in the Spanish Empire. In Mexico, where there are data for unskilled *repartimiento* workers and for textile workers, there is no increase in wages and if anything there is slight decline in wages. There should not be any surprise. It is the same story of a shock hitting a different set of institutions. The relevant institution here is the *repartimiento* system, a form of forced labor. The *repartimiento* workers were not trading their labor services in a free market, they were forced labor, so the wage was artificially set and if you did not like that wage, the elites used additional coercion in order to make you respond. When you have this coercion structure and the situation changes, you do not increase wages, you increase coercion. That is likely what happened in Eastern Europe as well.

Focusing again on the Americas, another big shock that hit was the decolonization, which was the event that strengthened the assemblies in North America. But the same kind of decolonization was also an important shock for Latin America, but it worked out very differently for most places because the independence was not a movement in order to increase the inclusiveness of institutions as it was largely in North America. For example, in Mexico the insurgence and rebellion against Spain and the Cadiz Constitution by the Mexican elite happened because they were afraid that the Cadiz Constitution would ban forced labor in the colonies, create more rights for the indigenous population and reduce their monopoly. Again, you see similar events playing out, but leading to even more divergence.

The industrial revolution was an endogenous event, most likely an outcome of economic and political institutions that were enshrined in the Glorious Revolution and the rapid process of commercial activity and innovation that went on in the XVIII century in Britain. For the rest of world, it was a big shock because all these industrial technologies were becoming available. But different places reacted very differently. North America was in the forefront of the societies that embraced these new industrial technologies and new people could come up and be the entrepreneurs driving the industrial revolution in the United States and they could do this because there were no regulations against entrepreneurship and there were no regulations that cemented the control of the elites. It was very different in Latin America as there was not this new entrepreneurial class different from the elite that could come forth and carry the industrialization process. You see the same thing within Europe as well. Eastern Europe and Spain reacted very differently to the industrialization opportunities.

So, why is Latin America still poor? Latin America did not benefit from the industrialization process at XIX century, but why it did not catch up? If extractive institutions were in place in Latin America temporarily, subsequently withering away, then the inclusive institutions, which were the facilitators of the industrialization in North America in XIX century, would have sprung up in Latin America in the XX century also, and Latin America would have caught up rapidly. But this of course did not happen. The reason is obvious: there is a vicious circle around extractive institutions, which I already hinted. Once you have these extractive institutions, they tend to persist because this set of institutions gives political power to people who have economic power and this scenario of people having economic and political power make the elites difficult to dislodge. So, it is the persistence of the same elite.

But this is not the only reason why extractive institutions persist. If you look at Mexico, today the people who dominate the society are very different from the people who dominated it during colonial times and the same is true in many African societies. The reason is that once you have extractive institutions, the challenges to the system are often from other groups trying to take commanding heights of the economy and monopolize political power for their own narrow benefit. If you are able to dislodge a particular elite that was able to benefit at the expense of society, if you become the new elite, why not do the same thing. The process of one set of elites replacing other elites recreating the system is another element of why extractive institutions are persisting. The transition to inclusive institutions is not very easy. This also comes with infighting to take control of power, which makes it very hard for political centralization that is necessary to build a system of law and order. This is what the German sociologist Robert Michaels called the iron law of oligarchy. There is an oligarchy recreating itself all the time, even after the regime changes.

I do not know the history of Chile as well as I should, but of course, Chile is not the country with the most extractive institutions in Latin America. If you look at Guatemala, the control of the same elite over time is incredible. The work of Arnold Bauer in the context of Chile in 1854, 1874, 1902 and 1918 shows that over fifty percent of senators and deputies were major landowners over those years. This is a pattern you have in many parts of Latin America: you see the same elites controlling the political power and land for long periods of time. This is not very conducive to industrialization.

Extractive institutions also influence the way business are carried out. If you look at how people make money today in Latin America the situation is actually very different. Carlos Slim, the wealthiest man in the world, is not part of the elite of xix century Mexico; he is entirely a self–made man. But if you look at the details about how he made his empire, it is very different from how Bill Gates built his fortune. Bill Gates' fortune is based on entrepreneurial growth, a small entrepreneurship that built up large. The institutions in the United States had to check Bill Gates at every stage so he could not build a monopoly, then he was fined and faced large barriers because there were fears that the Microsoft software was becoming a monopoly. On the other hand, Carlos Slim made his money thanks to a telecommunications monopoly in Mexico, which he bought for a cheap price, and he was able to keep the monopoly by using, for example, a loophole in the system where he could challenge anybody trying to enter into the market or any kind of challenges to his monopoly power. The U.S. system is more open to entrepreneurship. Big companies are very important in the U.S., but they have to compete against small entrepreneurs all the time and this is the reason why these big companies are very efficient.

If you look at parts of Latin America, things are much worse. Melisa Dell studied economic outcomes in the area around the Potosí *mita* in Peru and Bolivia. The Potosí catchment area was the zone where the mine was located and people located in the catchment area were coerced to work in the mine, and those outside the catchment area did not have forced labor obligations. The analysis of Dell shows a discontinuous change of economic outcomes when you cross to the borders of the catchment area. Today, a very long time after the forced labor system has been abolished, there are still places where forced labor was used extensively for long periods of time in conditions much worse. The effect of being in the catchment area seems to be about 25 percent lower income or consumption per capita.

This legacy of the colonial times is exhibiting itself in different ways. In Mexico it shows up itself as a new Lebanese-descendant like Carlos Slim becoming an entrepreneur and making his money thanks to monopoly power, that is still a remnant of old times, or the forced labor institutions in which people are totally cut out from the market. People around the catchment area are uneducated and growing the same crops as outside the catchment area, but they are not selling them anywhere because they do not have roads and access to the markets, so this is an entirely different environment in which they are living.

So, why is institutional reform proving so difficult? It is not because people are ignorant about the system they are enduring under, and that's why extractive institutions are persisting. Nor are they totally ignorant about what a more inclusive society would look like. Rather, it is that a more inclusive society, starting from extractive institutions, is very difficult to create. You see it in many different ways. If you look at mayors in many different parts of Brazil, it is the same families since 1890 still dominating. It is very difficult to break a system like that. It is not that these people are part of a mafia trying to dominate political power. It is just that once you have these extractive institutions, they create such inequalities, both politically and economically, that it becomes very difficult to overcome. Samuel Stone, a political sociologist, traced 46 presidents today –not in the 1900s– in Guatemala, El Salvador, Panama and Costa Rica to a single conquistador, Cristobal de Alfaro. This is the persistence of the same elite over time, which is rather remarkable.

But it is not just the same elite trying to dominate things, which I emphasized in the Mexican case. Rather, the system is changing, but even though it changes, it still remains extractive. Extractive institutions are re-creating themselves under different guises. In many ways, this is an illustration of the iron law of oligarchy which I have already discussed above.

One example of that is Colombia. In the mid–2000s, 35 percent of the Congressmen were allegedly –according to Salvatore Mancuso who was one of the leaders of the paramilitaries– elected by the support of the paramilitary. This means that 35 percent of the country is totally under lawlessness because it is paramilitary-controlled. You cannot have a normal development process when about a third of the country is outside law and order and property rights are extremely insecure. Of course, you have drugs in order to support this. Even before drugs became so important the ability of the Colombian state to project its power in the periphery of the country was limited. Part of the reason why in the catchment area of the Potosí mine is so backwards is because they have no rules and they are not under the control of the state overall.

This is not entirely separated from the despotism of populism in Latin America. One of the major problems in Latin America is populism. The surge of this movement is not illogical. It is not that people in Latin America are ignorant and they think that Chavez's economic policies in Venezuela or the Kirchner's in Argentina are the best thing. It is a quite understandable reaction to the same elite domination we were talking about. When there is great inequality, that is going to create a backlash and sometimes people will turn to the leaders they believe are really against the elite, even if these leaders are quite self-destructive for the economy. I think this is the best way of understanding populism in Latin America: it is quite related to the fact that there is great inequality and elite domination of politics.

With this situation, how do we move forward? It has to be on two counts. It has to be that economic institutions become more inclusive. On paper, the economic institutions in Chile are as good as one can expect. But there is much more that can be done in encouraging small entrepreneurship. Having property rights of a few companies is not the same as encouraging entry and creating a level playing field. The latter means that more people need to be part of the economic process. You cannot create a level playing field if the society is so unequal that large part of the society cannot get education and does not have the human capital to be the entrepreneurs and to grab the economic opportunities. That challenge is very important because that new blood of the economic system forces people like Bill Gates to do better for the society, to be innovative rather than make profits from government-supported monopoly power like Carlos Slim did in Mexico.

New business creation is very important and that requires the institutional guarantees that business is secure, but it also requires a pluralistic structure such that more people take part in both economic and political activities. One aspect of that pluralism is that it needs to have greater equality both in income, but also in access to education. Another aspect is that people should be able to have their voices heard politically, which will ultimately underpin economic opportunities open to a broad cross-section of society. Without that political pluralism, economic pluralism would ultimately disappear.

Building greater education is important for human resources in the import of technology in places all over Latin America including Chile, but it is also very important such that these people who have the additional education not only will be better employees, they are going to be the entrepreneurs who will create greater dynamism. But also it is central for a third reason, which is why I think it is difficult to create a purely pluralistic society. When there are great inequalities, as I have already mentioned, there is going to be a tendency for large parts of the population to feel alienated and go after populist leaders because they feel that the system is so unjust. I think that greater equality is important because it is what is going to cement the pluralism. Countries like Brazil and Chile, for example, made great strides towards pluralism. When you have several elections and power shifts from left to right peacefully, then this is the first major step towards political inclusiveness. You cannot have pluralism if political power cannot change hands or can only do so by a violent means. But as I have indicated above, true pluralism will also require some amount of equality of economic opportunity. What this implies is that if you have huge levels of inequality, then it would be very difficult to make pluralism work.

In this respect, there are promising signs in Latin America. When you look at Brazil, there are a lot of policies you can disagree with, but one of the things that the Brazilian politics has delivered over the last decade or so is the sharp decline in inequality. In Chile, data from a paper of Juan Eberhard and Eduardo Engel shows that inequality has been declining as well. So together with political pluralism, a declining inequality poses very well for the future in building the kind of institutions that can be the next stage for a middle income country to go forward towards higher income because this is going to be necessary for the import of technology and the entrepreneurship. It is particularly relevant because I think Eberhard and Engel argue fairly convincingly that the reason why inequality is been declining is not redistribution of income, but human capital formation. So human capital is becoming more abundant and that puts a greater pressure for wages and income to be equalized. This is the best way to reduce inequality.

Part of the reason why I am saying these developments are quite promising is that these changes leading to lower inequality and greater equality of opportunity are taking place mostly within the context of democratic politics, and in the process they are also strengthening democratic institutions. If they be consolidated and also open the way to new entrepreneurial dynamism building on this more inclusive environment –rather than self-destructive regulation and an anti– business policies as they have sometimes done in Latin America then they can also pave the way to a much more inclusive path of economic growth for which entire populations will tend to benefit.

As I have tried to argue, the roots of the economic, political and social problems of Latin America, Chile included, are institutional. The solutions are also institutional. What's more, these solutions are within the grasp of the current generations of many Latin American societies, making me quite optimistic about the prospects of much of Latin America.

Thank you.

Productivity and Economic Growth in Chile[1]

Vittorio Corbo, Ricardo Gonzalez

1. Introduction

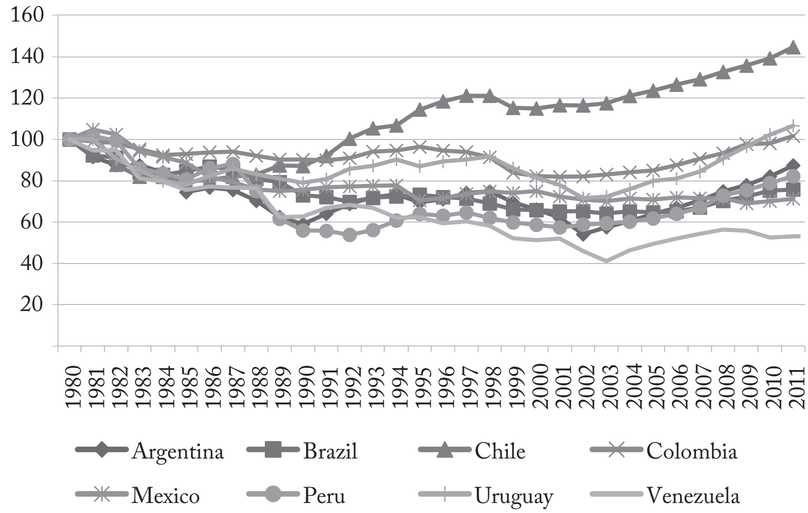
Chile experienced a very successful transformation in the last thirty years, allowing the country to attain major economic and social achievements as many substantial economic reforms were implemented to sustain macroeconomic balances, strengthening fiscal solvency, creating an autonomous Central Bank with a mandate to pursue price stability, promoting a sound financial system, substituting the underfunded and much abused defined benefit pension system by a privately–administrated, defined contribution pension scheme and creating a market economy, competitive and open to the global economy.

As a consequence, the results have been impressive. Chile has been the only middle size country in Latin America to have reduced its per capita income gap relative to advanced economies in the past thirty years (see Figure 1).

At the same time, the country has made major progress in its social indicators including poverty rate, child and infant mortality, life expectancy at birth and access to drinking water, sewerage and electricity. This progress has been mainly the outcome of high economic growth and has been assisted by government transfers adequately targeted to the poorest.

[1] We thank Claudio Aravena, Mariela Dal Borgo and Nanno Mulder for their help with the construction of ICT capital series for Chile, Claudia Hernandez for her assistance with the capital stock series, Juan Eduardo Chackiel for his help with tariff data and Andres Perez for his help with the *Encuesta de Ocupacion y Desocupacion*. We also thank Jorge Desormeaux M. for his editorial assistance. Any remaining errors are our own responsibility.

Figure 1: Chile's per capita gdp relative to advanced economies (1980=100).



Note: Per capita GDP is measured in PPP dollars.

Source: IMF, WEO, October 2012.

Furthermore, as has been illustrated during the global financial crisis of 2008-2009, the resilience of the Chilean economy has also improved substantially. When the crisis hit and foreign trade collapsed in late 2008 and early 2009, Chile was able to introduce aggressive countercyclical fiscal and monetary policies to cushion the impact of the external shock on GDP and on the most disadvantaged members of the society. This response was made possible by: (1) a strong macro-financial framework built in previous years, which includes a rule-based fiscal policy that has resulted in a single-digit gross government debt-to-GDP ratio; (2) an independent central bank, which has implemented a credible inflation-targeting framework with a flexible exchange rate that had brought inflation to the target, that is a trend value around the 3% annual; and (3) a strong financial system backed by appropriate regulation and supervision.

However, in spite of all this progress, the country has been showing some signs of lethargy in the past decade as the strong growth of the 90s has lost steam. In this paper, we provide updated evidence on GDP and Total Factor Productivity (TFP) growth –the broadest measure of how well an economy puts its resources to use– of Chile, strongly focused on the path followed by these two variables in the last decade. We apply the methodology outlined by Jorgenson and Stiroh (2000) to obtain TFP growth. As a by-product, we calculate the contribution of information technologies to output growth, which is quite relevant in times when the accumulation of information and communication technologies is becoming critical to speed the approach to the technological frontier. In Section 3, we present the details of the growth accounting we apply in this paper. In Section 4, we discuss the results of this exercise. We find that a large part of real GDP growth between the period 1985-2000 and 2001-2010 can be accounted for by TFP growth. Particularly relevant is the result that GDP growth has slowed over the last decade as a consequence of a slump in TFP growth. Several robustness checks confirm this view.

All these calculations are carried out using the old National Accounts (*Compilacion de Referencia 2003*). At the end of Section 4, we perform the growth accounting exercise using the new National Accounts (*Compilacion de Referencia 2008*). The new accounts calculate volumes using chained prices, instead of prices of a given year. Thus, volumes measured may change from previous reviews and may also induce important differences in GDP and capital stocks, and consequently in TFP growth. In spite of the differences, we still find that productivity has slowed over recent years at a similar average rate as the one found using the old National Accounts.

Later, we explore two possible reasons that could explain the poor performance of TFP growth over the last decade. The first concerns the dynamics of sectors in the Chilean economy. To be precise, if two or three economic activities, accounting for the lion's share of the economy, are experiencing a productivity slump, then this may explain the slowdown of TFP growth. Therefore, in such cases, economic policy should address the bottlenecks of these specific activities to enhance productivity and GDP growth. In Section 5, we perform a growth accounting exercise for each economic activity, and also, analyze the path followed by TFP in each sector. Furthermore, in a related exercise, we assess how the reallocation of workers between activities has stimulated growth, which occurs when employment flows toward high productivity activities.

The second argument involves the negative effects of the rise in the relative price of energy on output and productivity. But, why would an increase in energy prices be harmful to economic growth and productivity in the first place? In Section 6, we modify the conventional framework of growth accounting, in the spirit of Berndt and Wood (1984) and Berndt, Mori, Sawa and Wood (1991). In such a model, a growing path of the relative price of energy deteriorates capital services in a sustained fashion as some machines are employed less intensively and eventually, becoming idle, lowering the productive capacity of the economy. Not accounting for those price –induced changes in utilization rates would lead to an under–estimation of TFP growth rates when the energy price rises. Since the relative price of energy has risen sharply since the Asian crisis, we might expect an important negative effect of the rise in energy prices on GDP and TFP growth.

After analyzing the results of these growth accounting exercises, we focus on reforms to boost GDP growth. Usually, the discussion of such reforms involves policies whose effects will be perceived in the long-term. But, is there anything the country can do to raise output growth in the short-term? In Section 7, we argue that the answer to this question is a resounding yes. Chile can still enhance its short-term performance by adopting reforms encouraging labor force participation, in particular, the employment of young people and women. In this section, we present the calculations of how much growth these reforms can add and what policies should be adopted for such purpose.

Ultimately, Section 8 presents the concluding remarks of our study.

2. What do we know?

We review in this sub-section several papers that attempt to explain Chile's growth performance using a growth accounting framework-measuring TFP as a Solow residual –and using cross–country and time series regressions.

We study two branches of the literature. The first one provides estimates of TFP's contribution to growth using factors without any adjustment for the quality or the utilization of factors of production. This branch includes De Gregorio (1997), Coeymans (1999), Chumacero and Fuentes (2001), Corbo and Tessada (2001), Hofman (2001), Beyer and Vergara (2002), Fuentes, Larraín and Schmidt-Hebbel (2006), and De Gregorio (2006). In spite of their differences, these studies agree on the following point: the high growth rates the Chilean economy experienced from 1986 to 1997 were explained mainly by a jump in TFP growth and by capital accumulation. There are some discrepancies over the period chosen –we present the results in detail in Table 1, which is drawn from Schmidt–Hebbel (2001) and updated by us. For earlier periods, Chumacero and Fuentes (2001) estimate a high contribution of labor accumulation during the 60s.

The second branch, which includes the work of Roldos (1997), Gallego and Loayza (2002) and Fuentes, Larraín and Schmidt–Hebbel (2006), provides estimates of TFP's contribution to growth using inputs adjusted for quality. This is significant because it represents the substitution of heterogeneous inputs and is not related to the rate of technical progress. Since productivity is measured as a residual, TFP estimates, excluding adjustments for quality improvements, will incorrectly attribute the effect of such adjustments to TFP growth. As we might expect, these studies provide a more important role to capital accumulation and a less important role to TFP growth than studies of the first branch. However, Fuentes, Larraín and Schmidt-Hebbel (2006) provide an exception to this picture: their results show that growth performance after the debt crisis and before the Asian crisis can be explained mainly by TFP growth. This result may be due to the fact that they adjust capital only for utilization and not for quality.

The international literature has recently separated physical capital between Information and Communication Technology (ICT) and non-ICT capital, notably in Jorgenson and Stiroh (2000) and Oliner and Sichel (2000) for the US. This has made it possible to study the effect of the sharp decrease of ICT capital prices, which may have induced a change in the productive structure of the economy, on efficiency and economic growth. The lack of readily available data was the main reason why this analysis is missing in growth accounting exercises for Chile, although the issue could in principle be very relevant: the country's openness should allow it to take better advantage of the availability of new ICT capital and the decline in ICT prices that has taken place in the last decade.

Recently, however, Jorgenson and Vu (2007) and de Vries, Mulder, Dal Borgo and Hofman (2007) addressed this subject for Chile within a study of a larger set of countries. The former paper attempts to gauge the contribution of ICT investment and capital accumulation to world growth with a growth accounting framework applied to 122 countries. As one would expect, this extraordinary effort requires a massive amount of data that even they could not gather; therefore the authors employed several assumptions that made their estimates imprecise. According to Jorgenson and Vu (2007), the high growth rate of Chile from 1989 to 1995 is explained mostly by TFP growth. However, TFP contracted sharply during 1996-2006 (especially after the Asian crisis) even as Chile grew more than Latin America and the world as a whole, according to the authors' estimates. How is this possible? The answer appears to be factor accumulation. The increase in hours worked explains most of Chile's growth during 2000-2006, and is far above the labor growth rate of world's major economies. The same happens, to a lesser extent, with non-ICT capital accumulation. The contribution of ICT capital accumulation to Chile's growth is in line with that of G7 countries, but smaller than that of Developing Asia. This evidence suggests a serious "lack of inspiration" that is compensated by high rates of "perspiration" in Chile's recent economic performance.

De Vries, Mulder, Dal Borgo and Hofman (2007) employ specific country data sources to estimate a more precise contribution of ICT capital accumulation to Latin America's growth. Their results for Chile differ from those of Jorgenson and Vu (2007), presenting a less dramatic picture. From 1990 to 1995, physical capital accumulation explains the lion's share of Chile's economic growth. TFP growth rates are high, but contribute one percentage point less than ICT and non-ICT capital accumulation. While physical capital accumulation continues to be as relevant during 1996-2004, TFP contracts during 1995-2000 (possibly due to the Asian crisis) and increases slightly during 2000-2004. There is no continuous downward trend of TFP as in Jorgenson and Vu (2007), but the evidence nonetheless suggests that physical capital accumulation was the main driver of economic growth over the recent years.

The literature studying Chile's growth performance also includes time series and cross–country approaches. Time series methods are employed by Roldos (1997), Rojas, Jimenez and Lopez (1997), Coeymans (1999), Jadresic and Zahler (2000), Chumacero and Fuentes (2002) and Fuentes and Morales (2010). It is difficult to compare the results of these papers due to sharp differences in the empirical specifications and the methods employed to estimate them. However, each paper highlights the relevance of structural variables –such as trade and financial openness, structural reforms, monetary and fiscal policy and political rights– and cyclical variables –such as terms of trade– on growth. Cross-country approaches are employed by De Gregorio (1997), Barro (1999) and Gallego and Loayza (2002) to explain Chilean growth performance. The main result of these papers is that human capital and better monetary and fiscal policies explain most of Chile's growth performance[2].

[2] We refer the reader to Table 1 where we present in detail these and other results from previous literature.

The different growth accounting exercises described above agree on several points. TFP growth rates were higher in Chile over the "Golden Age", 1986-1997 period. TFP declined sharply following the Asian crisis, from 1998 to 1999[3]. After the Asian crisis, during 2000-2005, most studies agree that TFP stagnated and growth was mostly accounted for by physical capital accumulation. Thus, two questions arise: what explains this productivity slump? And what can be done to enhance TFP growth in the future? The following sections will sketch some answers to both questions.

3. The growth accounting framework

The most classical approach to studying economic growth is the growth accounting framework. The reason is simple: it offers an easy way to dissect growth into its proximate sources. There are two related methods to perform this dissection, according to the starting point chosen: (1) the aggregate production function, the method employed by Solow (1956) in his pioneer work on sources of growth; and (2) the production possibility frontier introduced by Jorgenson (1966) and employed by Jorgenson and Griliches (1967).

The approach followed by Solow starts with a neoclassical production function employing capital and labor to produce a single good, which is used to consume and to invest. This framework links economic growth to the accumulation of capital, to the use of labor and to technological progress. Technological progress is completely exogenous and Hicks-neutral: it affects the productivity of both capital and labor equally. That is why this term is called Total Factor Productivity (TFP) or Multifactor Productivity (MFP). As the contribution of TFP to growth is not directly observable, it can be estimated residually from data on GDP growth, capital growth and labor growth under the assumption of constant returns to scale and that factors are paid the value of their marginal product. The implicit calculation of TFP, following this framework, is known as the Solow residual.

[3] See Corbo and Schmidt-Hebbel (2011).

Table 1: Sources of Growth for Chile.

Study	Methodology	Time Period	Results
De Gregorio (1997)	Growth Accounting, Cross–country regressions	1975-1997 1960-1997	The GDP growth decomposition for 1990-1997 reports the following values (in parenthesis the change regarding 1975-89): GDP growth: 6.7% (3.4%); Physical capital contribution: 2.7% (1.7%); Labor contribution: 1.5% (–0.3%); and TFP contribution: 2.6% (2.1%).
Rojas, Jimenez and Lopez (1997)	Time Series Econometrics	1960-1996	The potential GDP growth decomposition using regression results for 1991-96 reports the following values (in parenthesis the change regarding 1961-96): GDP growth: 6.5% (2.7%); Physical capital contribution: 2.0% (0.4%); Labor contribution: 3.1% (0.8%); and TFP contribution: 1.4% (1.4%).
Roldos (1997)	Growth Accounting, Time Series Econometrics	1966-1995	The GDP growth decomposition adjusting for utilization and quality of inputs for 1991-95 reports the following values (in parenthesis the change regarding 1971-90): GDP growth: 7.5% (4.7%); Physical capital contribution: 4.1% (2.8%); Labor contribution: 1.9% (–0.5%); and TFP contribution: 1.4% (2.3%).
Barro (1999)	Cross–country regressions	1965-1995	Regression results are used to explain why Chilean per–capita GDP was 1.5% higher than the world average in the 1965-95 period. This is mainly due to the impact of two variables: relatively small government (0.8%) and fertility rates (0.6%).
Coeymans (1999)	Growth Accounting, Time Series Econometrics	1960-1998	The GDP growth decomposition for 1989-97 reports the following values (in parenthesis the change regarding 1961-98): GDP growth: 7.8% (3.7%); Physical capital contribution: 2.0% (0.8%); Labor contribution: 1.6% (0.1%); and TFP contribution: 4.2% (2.9%).
Jadresic and Zahler (2000)	Time Series Econometrics	1961-1998	Difference in per worker GDP growth in the 1990s with respect to the 1960s (2.5%) can be mainly explained by structural reforms (2.5%). Other factors that contribute to the increase are the reduction of inflation (0.7%) which is exactly offset by a reduction in political rights. Whereas the difference in growth in the 1990s with respect to the 1970s (4.6%) can be explained by lower inflation (4.5%), better structural policies (1.7%), and higher political rights (1.6%). The negative impact of higher foreign interest rates on growth compensates the above–mentioned impacts (–3.2%). In turn, higher political rights mainly explain the differences of the 1990s with respect to the 1980s.
Chumacero and Fuentes (2001)	Growth Accounting, Time Series Econometrics	1961-2000	Growth accounting exercises show that the growth rates of the sixties are mainly due to the accumulation of human (54%) and physical (37%) capital, while the booms of the mid-seventies and the one from 1985 until 1998 are mainly due to TFP growth (which increased its contribution from almost zero to rough one third of total growth).
Beyer and Vergara (2002)	Growth Accounting	1976-2001	The GDP growth decomposition for 1991-1995 reports the following values (in parenthesis growth decomposition for 1996-2000): GDP growth: 8.7% (4.1%); Physical capital contribution: 3.5% (3.6%); Labor contribution: 1.5% (0.5%); and TFP contribution: 3.7% (0.1%).

Study	Methodology	Time Period	Results
Corbo and Tessada (2002)	Growth Accounting	1951-1997	In the period of high growth (1986-97) roughly half of total GDP growth can be explained by TFP growth. While the increase of GDP growth (2.1% per annum) in 1996-97 was explained by a big jump in the contribution of capital accumulation (from 1.6% to 4.8% that compensates for a decrease of TFP of almost 1%).
Gallego and Loayza (2002)	Growth Accounting, Time Series and Cross–country Econometrics	1960-2000	The GDP growth decomposition adjusting for utilization and quality of inputs for 1986-2000 reports the following values (in parenthesis the change regarding 1960-85): GDP growth: 6.6% (4.1%); Physical capital contribution: 2.5% (1.5%); Labor contribution: 2.3% (0.8%); and TFP contribution: 1.9% (1.8%).
De Gregorio (2005)	Growth Accounting	1970-2004	The GDP growth decomposition for 1985-2004 reports the following values (in parenthesis growth decomposition for 1970-2004): GDP growth: 5.7% (3.8%); Physical capital contribution: 2.3% (1.7%); Labor contribution: 1.6% (1.2%); and TFP contribution: 1.7% (0.9%).
Fuentes, Larraín and Schmidt–Hebbel (2006)	Growth Accounting, Time Series Econometrics	1960-2005	The GDP growth decomposition adjusting for utilization of inputs and quality of labor for 1990-2005 reports the following values (in parenthesis growth decomposition for 1990-1997 and 1998–2005 respectively): GDP growth: 5.3% (7.1% - 3.1%); Physical capital contribution: 1.8% (1.6% – 1.6%); Labor contribution: 0.4% (1.1% - –0.5%); and TFP contribution: 3.1% (4.4% - 1.9%).
De Vries, Mulder, Dal Borgo and Hofman (2007)	Growth Accounting	1990-2005	The GDP growth decomposition adjusting for quality of inputs for 1990-2005 reports the following values (in parenthesis growth decomposition for 2000-2005): GDP growth: 5.5% (3.8%); Physical capital contribution: 3.3% (2.1%) –ICT: 0.6% (0.6%); Non-ICT: 2.7% (1.6%); Labor contribution: 1.3% (1.4%); and TFP contribution: 0.8% (0.3%).
Jorgenson and Vu (2007)	Growth Accounting	1989-2006	The GDP growth decomposition adjusting for quality of inputs for 2000-2006 reports the following values (in parenthesis growth decomposition for 1989-1995): GDP growth: 4.1% (7.6%); Physical capital contribution: 2.2% (2.4%) –ICT: 0.4% (0.3%); Non-ICT: 1.8% (2.1%); Labor contribution: 2.6% (1.8%); and TFP contribution: –0.7% (3.4%).
Fuentes and Morales (2010)	Growth Accounting, Time Series Econometrics	1963-2005	Using a latent variable approach to estimate the TFP growth, the authors estimate the following decomposition of GDP growth for 1990-2005 (in parenthesis growth decomposition for 1998-2005): GDP growth: 5.4% (3.4%); Physical capital contribution: 2.6% (2.5%); Labor contribution: 0.6% (–0.2%); and TFP contribution: –1.7% (0.3%).

Note: This table is drawn from Schmidt–Hebbel (2001) and updated by the authors.
Source: Own elaboration.

The production possibility frontier is similar to the Solow approach with one main difference, namely that capital and labor can produce two goods instead of one: consumption and investment goods, recognizing the potential substitution between investment and consumption goods. This distinction with the Solow approach was not very relevant until the introduction of Information and Communication Technologies (ICT) goods since they can be consumed as well as invested, thus the production of ICT capital goods is no longer a perfect substitute for other outputs.

Another relevant topic to address before implementing the growth accounting framework is the following: are flows or stocks the relevant variables to be included in the growth accounting exercise? The contribution of any given factor to production is the use of the input –e.g., number of hours worked, the number of machine hours involved in the production process measured by the flow of service value of the output it generates– that is to say, the value of their marginal product. However, as the marginal product is not observed, we can proxy them by their factor prices. This approximation is valid only if factor markets reflect the value of the marginal product as it happens in competitive product and factor markets, which is an assumption commonly made by the growth accounting literature. Therefore, accounting for the use of factor only does not provide an adequate estimate of the contribution to economic growth.

At this point we have considered inputs at the aggregate level, assuming they are homogeneous. However, there is a pervasive heterogeneity in factors of production. Aggregate capital services are composed of machines, buildings and vehicles with different depreciation patterns and rental rates, time-varying service lives and so on. Aggregate labor services are comprised of individuals with different ages, school attainment, cognitive capacity and skills, working different hours, whom of course receive different wages for their services. An appropriate measure of capital and labor services should be consistent with this fact; therefore we have to aggregate those inputs accordingly. The next section presents a method to aggregate heterogeneous inputs to construct an aggregate measure consistent with the framework.

Once we take into account the pervasive heterogeneity of input services, we should take into consideration that there is a potential substitution from low-quality to high-quality inputs at the unit level (i.e. plants and firms), which could be mistakenly attributed to technological improvement if we leave it in the Solow residual. In other words, the Solow approach cannot distinguish between productivity improvements *embodied* in the accumulation of inputs of different qualities and the *disembodied* technical progress measured as the Hicks neutral productivity, which is the proper measure of TFP.

The three previous implications were first drawn out by Jorgenson and Griliches (1967). This approach has been employed subsequently by many scholars and practitioners interested in productivity. Christensen, Cummings and Jorgenson (1980) analyze the sources of growth for the G7 countries (Canada, France, Germany, Italy, Japan, United Kingdom and United States) for the period 1960-1973. The main result was that productivity growth accounted for slightly less than a half of growth (measured as output per capita) in Canada and the United States, but more than half for the rest of the sample countries. This study was later updated in Jorgenson and Yip (2000), where the period under analysis was extended to 1960-1995. After 1973, the relevance of productivity growth fell considerably for G7 countries, virtually disappearing after 1989 for Japan and the US. The rest even experienced negative productivity growth rates. Furthermore, this approach is employed by the U.S. Bureau of Labor Statistics to estimate productivity for the US, it is the foundation of the EU-KLEMS program to construct productivity estimates for several countries and it is the groundwork behind the OECD manual on capital and productivity estimates (see OECD 2001 and OECD 2008).

Since 1995, growth accounting has been used to assess the contribution of ICT capital on economic growth. As ICT relative prices declined sharply after 1995, ICT capital may well have induced a change in the productive structure of the economy as firms switch to high-technology productive goods, increasing their efficiency and the pace of economic growth. Oliner and Sichel (2000) and Jorgenson and Stiroh (2000) were the first papers examining the resurgence of US growth under the scope of ICT capital accumulation. On the one hand, Oliner and Sichel (2000), using the Solow approach, concluded that ICT capital investment and industry productivity of the computer –producing sector were responsible for two-thirds of the rise in labor productivity during the late 1990s. On the other hand, Jorgenson and Stiroh (2000), using the production possibility frontier approach, found almost the same results. Recently, this approach has been adopted for Jorgenson and Vu (2007) who try to determine whether ICT investment is behind the resurgence of growth in the world. They found that ICT contribution to growth almost doubled from the 1989-1995 to the 1995-2000, when ICT relative prices dropped abruptly, but TFP continues to be the main engine of world economic growth. De Vries, Mulder, Dal

Borgo and Hofman (2007) use the same approach but different data for Latin America to assess the contribution of ICT investment to growth in the region. They found that this contribution is very low because the levels of ICT investment are far below from those found in the US and Europe.

Given the widespread use of these frameworks in the growth accounting framework, we adopt them in our study of Chile's output growth in the following subsections.

4. Sources of economic growth for Chile

The starting point of the analysis is the growth accounting framework of Solow (1957). We expand it to allow the inclusion of ICT capital and input quality indexes; therefore we calculate the contribution of input flow services to growth instead of input stocks.

The final homogeneous good is produced using capital and labor only according to the following Cobb-Douglas production function with constant returns to scale[4]:

$$(1) \qquad Y(t) = A(t)\, K(t)^{\alpha}\, L(t)^{1-\alpha},$$

where $A(t)$ is the Hicks-neutral technological progress or Total Factor Productivity (TFP), $K(t)$ represents aggregate capital services and $L(t)$ stands for aggregate labor services. Thus, the growth rate of output is:

$$(2) \qquad \Delta 1nY(t) = \Delta 1nA(t) + \alpha\Delta 1nK(t) + \Delta 1nL(t),$$

where growth rates are expressed as log differences[5] and α is the share of capital income in the value of production (under the assumption of constant returns to scale). $\Delta 1nY(t)$ represents the GDP growth rate, $\Delta 1nA(t)$ is the TFP growth rate, $\Delta 1nK(t)$ is the aggregate growth rate of capital services, $\Delta 1nL(t)$ is the aggregate growth rate of labor services. In Appendix A, we show that aggregate growth rates of both input services are weighted averages of heterogeneous types of inputs using their relative payments as weights. Finally, as is usual in the literature since Solow (1957), the rate

4 This production function is empirically validated in econometric estimations using the data employed in this paper. Those results are available upon request.

5 $\Delta 1nY(t) = 1nY(t) - 1nY(t-1)$.

of technological progress, $\Delta 1nA(t)$, is estimated as a residual. Subtracting the growth rate of hours in both sides of equation (3), we get the following expression:

$$(3) \quad [\Delta 1nY(t) - \Delta 1nH(t)] = \Delta 1nA(t) + \alpha\,[\Delta\, 1nK(t) - \Delta 1nH(t)] + (1-\alpha)\,[\Delta 1nL(t) - \Delta 1nH(t)],$$

where the term on the left-hand side is the average labor productivity, while on the right-hand side the first term is the contribution of TFP growth, the second term represents the contribution of capital deepening and the third term reflects the contribution of labor discounting the fraction due to hours worked, which is usually named labor quality by the academic literature.

The growth accounting exercise as presented in equations (2) and (3) requires a parametric estimation of the capital share α. The old National Account data reports a share of capital in national income equal to 50%. We follow Fuentes, Larrain and Schmidt-Hebbel (2006) in using a capital share equal to 40%, which is calculated as the 50% of National Accounts less the imputations coming from the income of independent workers. This also facilitates the comparison of our results with theirs.

Alternatively, we also carried out econometric estimations of a production function for the 1960-2008 period. First of all, we could not reject the hypothesis of constant returns to scale and after that, we impose a constant returns to scale restriction in our regression specification, obtaining an estimated capital share equal to 44% with a 95% confidence interval equal to (38%, 50%)[6]. Since both estimations, the 50% and 40%, lie inside the confidence interval, we are confident that the 40% figure is not significantly overestimating or underestimating the true share of capital.

The subsections 4.1 and 4.2 show the sources of both GDP growth and average labor productivity growth respectively, while subsection 4.3 assesses the relative plausibility of our estimates by contrasting our results with those found in previous works and also, by performing some robustness checks. All figures in this section are calculated using the new National Accounts (*Compilacion de Referencia* 2008). With regards to the old National Accounts, the new ones feature two main modifications: (1) changes in the measure of real volumes, moving from a fixed base year to a

6 These results are available upon request.

moving base year; and (2) changes in growth rates of several macroeconomic aggregates because new methods and sources of information were adopted. These changes were applied following the best practices suggested by international organizations such as the IMF, UN and OECD.

For our purposes, the major modification is the measure of volumes. Previously, volumes were built using prices of a base year as weights. In the new National Accounts, volumes are measured using chained prices, where weights are moving averages of past prices; hence this year's real volumes are obtained using previous year's prices. This form of calculation has the virtue of being continuously updated, instead of the prior methodology that becomes outdated as disparities between current and base year prices may exacerbate over time. The chained price method has already been implemented in all OECD countries but Mexico and it has also been adopted in Brazil and Colombia recently.

Naturally, this new measure of real activity may modify the results obtained by previous literature that uses fixed prices instead of the chained prices to measure volumes. GDP and capital stocks, which are constructed using real investment, may differ when using this new version of the National Accounts. In addition, the (aggregate) capital share of output can differ. However, we decide to use 40% for two reasons: (1) to facilitate the contrast with previous estimates, isolating the effect of volumes only on productivity growth; and (2) the econometric regression we performed at the beginning of this section confirms this number.

4.1. Sources of GDP growth

We start showing the results from the growth accounting exercise for Chile from 1960 to 2012 (Table 2), without considering the contributions of the accumulation of ICT capital because we can calculate such series only since 1985. Then, we present the sources of growth with the contribution of ICT capital from 1987 to 2012 (Table 3).

A simple observation of the calculations shown in Table 2 is enough to perceive that periods of high GDP growth feature high expansions of TFP. In fact, from 1960 to 1986, TFP growth was negative, on average, and the average GDP growth was lower than the growth experienced from 1987 onwards, characterized by an expansion of TFP of 0.8 percentage points, on average. However, this initial analysis hides an important heterogeneity about the paths followed by GDP and TFP within each set of years. This is the analysis that follows.

Table 2: Sources of growth 1960-2012.

	GD Growth	Contribution of Capital Services	Contribution of Labor Services	Contribution of tfp
1960–1973	3,4%	1,5%	2,3%	–0,3%
1974–1986	2,2%	0,7%	2,0%	–0,4%
1987–2012	5,5%	2,8%	1,9%	0,8%
1987–1991	7,0%	2,2%	2,8%	2,0%
1992–1997	7,6%	3,3%	1,8%	2,5%
1998–2003	3,1%	2,4%	1,4%	–0,7%
2004–2008	5,5%	3,0%	1,9%	0,5%
2009–2012	4,0%	2,9%	1,9%	–0,7%

Note: gdp and capital services are calculated using Central Bank of Chile's *Compilacion de Referencia 2008*. Labor services are calculated using ine's Employment Surveys. Services are obtained by adjusting stocks for quality as shown in Appendix A. Aggregate capital share equals 40%. Preliminary figures are employed since 2010.

Source: Authors' own calculations.

Table 3: Sources of growth 1987-2011.

	gdp Growth	Contribution of Non–ict Capital Services	Contribution of ict Capital Services	Contribution of Total Capital Services	Contribution of Labor Services	Contribution of tfp Growth
		(1)	(2)	= (1) + (2)		
1987-2012	5,5%	2,3%	0,9%	3,1%	1,9%	0,4%
1987-1991	7,0%	1,8%	0,5%	2,4%	2,8%	1,8%
1992-1997	7,6%	2,9%	0,9%	3,8%	1,8%	2,0%
1998-2003	3,1%	2,0%	0,7%	2,7%	1,4%	–1,1%
2004-2008	5,5%	2,2%	1,6%	3,8%	1,9%	–0,2%
2009-2012	4,0%	2,4%	0,5%	3,0%	1,9%	–0,8%

Note: gdp and capital services are calculated using Central Bank of Chile's *Compilacion de Referencia 2008*. Labor services are calculated using ine's Employment Surveys. Services are obtained by adjusting stocks for quality as shown in Appendix A. The details about the construction of ict capital services are explained in Appendix A, B and C. Aggregate capital share equals 40%. Preliminary figures are employed since 2010.

Source: Authors' own calculations.

GDP growth from 1960 to 1973 was higher than the rates achieved from 1974 to 1986, despite the fact that TFP growth was declining at barely the same average rate in both periods. It is clear from the figures in Table 2 that factor accumulation was sustaining output growth. During the pre-reform period (1960-1973), the contribution of capital to growth averaged 1.5 percentage points and the contribution of labor services was even higher (2.3 percentage points, on average), while the contribution of labor clearly surpassed the contribution of capital from 1974 to 1986 (2 and 0.7 percentage points, respectively). It is important to highlight that the latter period was characterized by far-reaching economic reforms that lasted until 1981, to be followed by a severe crisis in 1982-1983 and the adoption of a new set of reforms, whose effects were fruitful since 1985 onwards.

From 1987 to 2012 the picture was quite different: GDP growth rates jumped, almost doubling the average output growth achieved from 1960 to 1986 (2.8 percent). This dynamic performance was driven by an increase in TFP growth that moved from negative average growth rates to an expansion of 0.8 percent per annum on average. Another relevant factor was the upsurge in the contribution of capital services, almost triplicating the contribution from 1960 to 1986. Thus, capital services became the main driver of Chile's economic growth in the last twenty five years, accounting for more than half of average GDP growth. However, when we look at this period more carefully, we note that the jump in the contribution of TFP growth occurred from 1987 to 1997, a period of growth rates higher than 7 percent per annum on average. Unfortunately, this process of sustained GDP growth was interrupted suddenly by the Asian crisis at 1998-1999, whose effects on TFP growth were felt even five years after the crisis. But once the crisis effects subsided, productivity did not take off and TFP growth rates were expanding at rates far below from the pre-crisis years.

Toward the end of the last decade, Chile could not isolate itself from the effects of the Global Financial Crisis and Great Recession of 2008-2009. The country suffered large negative shocks from external sources as a sharp downfall of commodity prices and external demand for exports, along with a massive capital outflow. This situation required the country to deploy active fiscal and monetary policies to cushion the potential damage. As a result, GDP growth fell for a few quarters, between the last quarter of 2008 and the first half of 2009, but the magnitude of such decline was lower in contrast to previous recessions seen in this country. Also, as a consequence of the large shocks experienced in 2009, TFP growth fell sharply that year.

When the recovery was gaining strength, the earthquake of February 2010 interrupted this process, but only for a quarter. The reconstruction after the earthquake encouraged capital accumulation, which partially explains the high contribution of capital services in recent years, along with a favorable external environment to finance domestic investment projects.

With regards to labor services, 2010 and 2011 were years when their growth was impressive due to the expansion of formal employment. Part of this growth is surely explained by the recovery from the Great Recession and by the application of INE's new surveys of employment. However, employment did not keep this pace and its expansion fell during 2012. Along with the decline suffered during the Global Financial Crisis, the moderation of employment growth accounts for a contribution of 1.9 percent per annum, on average, the same average obtained from 2004 to 2008.

In what follows, we break down the contribution of total physical capital into its ICT and non-ICT components. Because ICT capital can be calculated accurately since 1985, we will analyze GDP and TFP growth from 1987 to 2012, putting aside the period from 1960 to 1986. We will also break down this period into five-year windows and focus on the events that could explain the dynamics of both input services and TFP. The results of this exercise are shown in Table 3.

From 1987 to 1991, a period in which Chile had recently recovered from the crippling Latin American Debt Crisis of 1982, that had resulted in a quantum jump in the unemployment rate, the contribution of labor dominates the picture (2.8 percent per annum), followed very closely by the contribution of capital and TFP growth, 2.4 percent and 1.8 percent per annum, respectively. TFP growth rates reached very high levels relative to precedent periods (see Table 2). From 1992 to 1997, the period with the highest average GDP growth of the time span under analysis, the contribution of capital services increased by 1.4 percent per annum relative to 1987-1991, becoming the main driver of growth. TFP growth increased from 1.8 to 2 percent per annum, on average, and the contribution of labor declined from 2.8 to 1.8 percent per annum. This period, from 1987 to 1997, represents Chile's best TFP performance, and is sometimes called Chile's "Golden Age" for its high sustained growth that allowed the country to duplicate its per capita income in ten years.

The following ten years following Chile's "Golden Age" were disappointing. The Asian Crisis hit the country particularly hard, decreasing average GDP growth per annum from 7.6 percentage points, on average, in the 1992-1997 period to 3.1 percentage points, on average, in the 1998-2003 period. The contribution of both labor and capital services declined significantly, from 1.8 percentage points to 1.4 percentage points per annum for labor and from 3.8 percentage points to 2.7 percentage points per annum for capital. TFP achieved a severe decline in this period, and did not recover during the 2004-2008 period as TFP stagnated until 2008, on average. Average GDP growth from 2004 to 2008 was 5.5 percentage points, substantially higher than the average of 1998-2003, even though TFP was not expanding at all.

After 2008, the Great Recession and an earthquake hit the country hard. Average GDP growth, from 2009 to 2012, declined in contrast to previous five years from 5.5 to 4 percentage points. However, the contribution of both input services remained strong. In fact, the contribution of capital services averaged 3 percent per annum and labor services contributed to output growth at the same rate of the previous five years, which is explained by a higher rate of employment creation, due to foreign and domestic cyclical factors, and not by a higher contribution of labor quality, which expanded at modest rates.

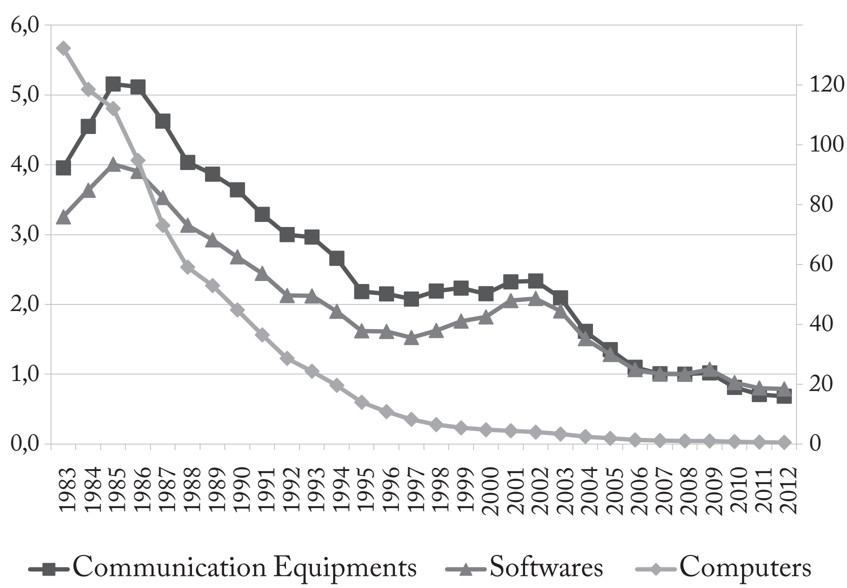
In all, the average GDP growth over the last twenty five years is explained mainly by the contribution of capital services. More recently, capital services are contributing to output growth at high rates and additionally, an important boost to GDP growth performance is also given by labor services, but only in recent years. Unfortunately, we cannot claim the same about TFP growth, which is declining at a faster rate. Therefore, factor accumulation, and specifically capital accumulation, has been the main driver of the Chilean growth process from 1987 to 2012. Jorgenson and Vu (2007) arrive at the same conclusion in their analysis of world economic growth. This contrast is relevant for our exercise because we apply the same methodology as these authors with differences about data involved.

Thus, the first lesson of this exercise is that years of high GDP growth were periods of high expansions of TFP, and, of course, if Chile wants to return to the path of sustained growth, the country must work on removing the factors constraining the growth of productivity.

The contribution of capital services shown in Table 3 is slightly different from its counterpart exhibited in Table 2. In fact, the contribution of capital services increases from 2.8 to 3.1 percentage points per annum for the 1987-2012 period when we break down the contribution of capital into its ICT and non–ICT components. This is a regular result in the international literature studying the role of ICT goods in the productive structure of the economy. In this model, if the price of a type of capital is falling, this means that the user cost is increasing, so its marginal productivity is high. Therefore the substitution toward this type of capital increases the contribution of capital to GDP growth. That was the situation in Chile from 1987 onwards because ICT relative prices declined sharply as it can be seen in Figure 2.

The impressive decline of ICT prices is explained not only by the downfall of ICT prices in the United States after 1995, but by other relevant factors as well. Since ICT capital goods are mainly imported from advanced countries, tariffs and the real exchange rate matter for the trajectory of ICT relative prices. Thus, the benefits of the sharp fall in the prices of ICT goods witnessed in the US at the mid-90s could be enjoyed in Chile if domestic tariffs as well as the real exchange rate do not reverse that declining trend. The figures of Table 3 suggest that Chile could reap the benefits of these cheaper relative prices.

Figure 2: ICT relative prices for Chile.



Note: The left vertical axis measures the evolution of the computer relative price. The right vertical axis measures the communication and software relative prices. Relative prices are ict Investment Deflators relative to Chile's gdp deflator. See Appendix A for details.

Source: Authors' own calculations.

From 1987 to 2003, the contribution of ICT capital services has been somewhat stable at a rate lower than the average figures between 1987 and 2012. This is related to the dynamics of ICT relative prices. When ICT prices began to fall in the U.S in 1995, Chilean tariffs were also falling but the real exchange rate was very high for a long period, therefore, the rapid decline of ICT prices in the US did not pass swiftly to the Chilean market. The Asian Crisis of 1998–1999 caused a sharp real depreciation, raising ICT prices further. But since 2004, Chile has undergone a period of prolonged real appreciation, making ICT imports cheaper and thus allowing the country to reap more fully the benefits of ICT capital services. This accounts for the increase in growth contribution of ICT capital from 0.7 between 1998 and 2003 to 1.6 percent per annum, on average, during 2004-2008. Since 2009, the contribution of ICT capital has been a 0.5 percent per annum, on average, influenced by the large real depreciation as a consequence of the Great Recession. However, such depreciation reversed and high contribution of ICT goods to output growth resumed in 2011 and 2012.

Therefore, the abrupt fall of ICT prices are explained by cheaper prices of ICT goods in the US and the increasing opening of the Chilean economy. This allowed substituting non-ICT technologies for ICT capital, helping to sustain high rates of capital accumulation and GDP growth.

4.2. Sources of average labor productivity growth

To complement the previous perspective about GDP growth, we now show the sources of average labor productivity (ALP) growth, which is an alternative view of the decomposition for GDP growth. Rearranging the decomposition given by equation (3), we can see that GDP growth is the result of the increase in hours worked and in ALP as it follows:

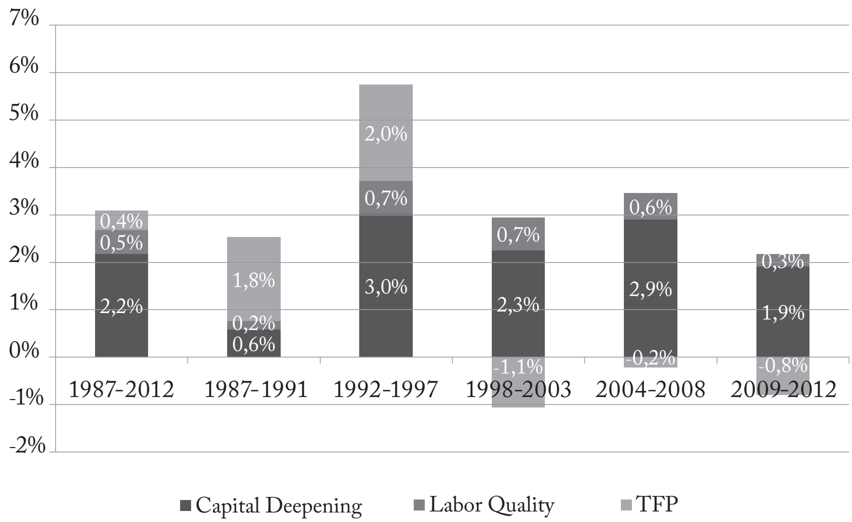
$$(4) \qquad [\Delta 1nY(t) - \Delta 1nH(t)] \equiv \Delta 1nALP(t)$$
$$\Rightarrow \Delta 1nY(t) = \Delta 1nALP(t) + \Delta 1nH(t)$$

A simple inspection of Tables 2 and 3 is required to note that ALP growth is the main driver of long-term economic growth. In Figure 3, we examine the changing composition of the factors determining ALP growth. These components are the growth of capital deepening, labor quality and TFP.

From 1987 to 2012, capital deepening explains the lion's share of ALP growth (about two thirds of the total) while the rest is accounted for by

TFP and labor quality at barely equal parts. This composition has not been constant over time: in the period of highest sustained growth, 1987-1997, TFP growth was the main driver of ALP growth. The opposite situation occurred from 1998 onwards, when ALP growth rates were lower while TFP was declining slowly until the Great Recession when the drop was steeper. The capital deepening effect contributed somewhat to ALP growth from 1987 to 1991, reaching a maximum contribution in 1992-1997. Later, the contribution of capital deepening fell close to the average between 1998 and 2003, moved upward from 2004 to 2008 and declined to levels below average from 2009 to 2012 due to the effects of the Great Recession. Finally, the contribution of labor quality experienced a jump of half a percentage point per annum after 1991, suggesting a substitution of employment toward workers of higher marginal productivities. Unfortunately, labor quality has not expanded significantly since 1991, growing at a stable pace of 0.7 percent per annum over our sample period, although it has not kept the pace because its contribution has declined somewhat over recent years.

Figure 3: Sources of labor productivity growth 1987-2012.



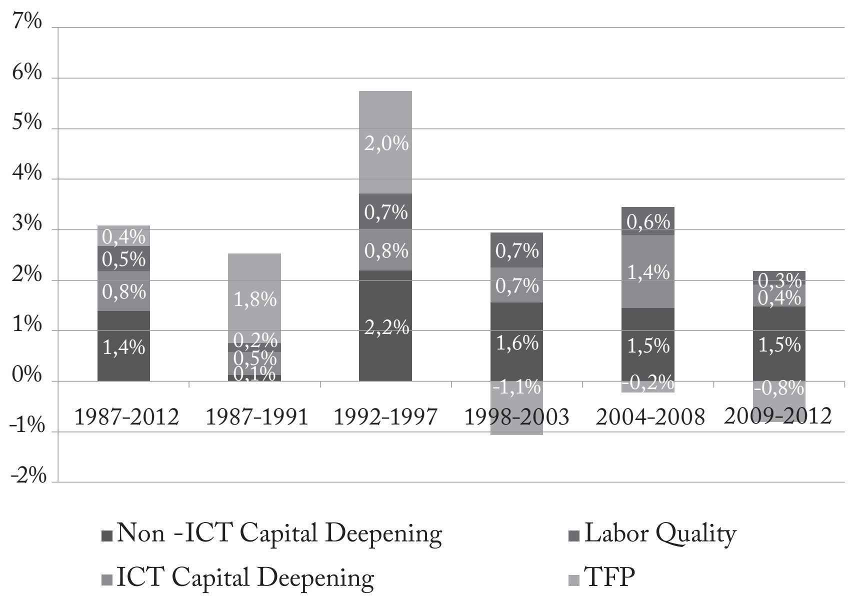
Note: Labor productivity growth is GDP growth minus the growth of total hours worked (employment times average hours worked). GDP growth, non-ICT and ICT capital deepening are calculated using Central Bank of Chile's *Compilacion de Referencia 2008*. Labor quality is calculated using Universidad de Chile's Employment Surveys. The details about the construction of ICT capital services are explained in Appendix A, B and C. Aggregate capital share equals 40%. Preliminary figures are employed since 2010.

Source: Authors' own calculations.

In Figure 4, we break down the contribution of capital deepening to ALP growth into its ICT and non-ICT components. More than a third of the contribution of capital deepening above is explained by ICT capital, with an increasing contribution to ALP growth, especially between 2004 and 2008. In contrast, after a sharp upsurge in the period of sustained growth, especially from 1992 to 1997, the contribution of non-ICT capital to output growth kept growing at a steady pace on average.

In sum, average labor productivity grew due to the "inspiration" effect of high TFP growth during 1987-1997, but later its growth was driven mostly by "perspiration". Labor quality jumped from 0.2 percentage points per annum in 1987-1991 to 0.7 percentage points per annum in 1992-1997, and it has kept this pace during the past decade, although it has lost steam in recent years. Capital deepening has gained relevance after the Asian crisis, thanks to the role of ICT capital deepening, because the contribution of the non-ICT component is still far below its pre-Asian crisis levels.

Figure 4: Sources of labor productivity growth 1987-2012: ICT and non–ict capital contributions.



Note: Labor productivity growth is GDP growth minus the growth of total hours worked (employment times average hours worked). GDP growth, non-ICT and ICT capital deepening are calculated using Central Bank of Chile's *Compilacion de Referencia 2008*. Labor quality is calculated using Universidad de Chile's Employment Surveys. The details about the construction of ICT capital services are explained in Appendix A, B and C. Aggregate capital share equals 40%. Preliminary figures are employed since 2010.

Source: Authors' own calculations.

4.3. Alternative estimations and robustness checks

In this subsection we discuss the similarities and disparities between our estimates and those found in previous literature. First, we contrast our growth accounting estimates, without the contribution of ICT capital, with two recent estimations to assess the magnitude of our calculated figures. Second, we contrast our results with the contribution of ICT capital with two recent international studies to assess the magnitude of the contribution of ICT capital services. And third, we discuss the robustness of our calculations to the other forms of quality and utilization adjustments, usually included by the national literature on this topic.

Table 4 presents the growth accounting performed by Fuentes, Larraín and Schmidt-Hebbel (2006) and our own calculations, with a slight adjustment from the figures we calculated previously in Table 2 to be discussed below. We employ the same breakdown of periods to ease the comparison among such figures. Under the heading of each panel in Table 4 we detail the adjustment of capital and labor specified by each study.

The results of Fuentes, Larraín and Schmidt-Hebbel (2006) are similar to our estimates for the 1960-1990 period, despite the fact that we use the new National Accounts and they use the old ones. Perhaps, the largest difference is the contribution of labor and consequently, TFP growth between 1974 and 1989. Since the '90s, the period of high GDP growth, their estimates of the contribution of capital and labor are lower than our results, implying higher rates of TFP growth. In spite of the big quantitative disparities with this work, these calculations provide the same qualitative results: periods of high GDP growth are also periods of higher rates of TFP expansion.

The methodological differences with Fuentes, Larraín and Schmidt-Hebbel (2006) lie mainly in the calculation of the contribution of capital, particularly in the aggregation method of heterogeneous types of capital and in the adjustment for utilization[7]. In our paper, as in Jorgenson and co-authors, the aggregation of capital services is carried out using user weights and a Törnqvist quantity index. In contrast, the Fuentes, Larraín and Schmidt-Hebbel (2006) equally weight different types of capital, failing to

[7] There are also differences in the calculation about the contribution of labor. Such disparities come from the construction of the labor quality index. We refer the reader to Appendix A for an analysis of the differences of the method we employ to estimate labor quality with those found in the national literature.

capture the (potential) substitution among heterogeneous types of capital with different characteristics (e.g. average service lives, depreciation rates) and different marginal products. If the price of a type of capital is falling, then the user cost is increasing and its marginal productivity is high; therefore the substitution toward it increases the contribution of capital to GDP growth.

Another issue related to the use of the Törnqvist index is the use of time-varying shares to weight different types of capital, increasing the contribution of capital. In Table 4, we present our decomposition results applying the weights calculated for 2008 (the reference year of the new National Accounts) to the whole sample. Once again, results do not change much in contrast to our main calculations, including time-varying shares, shown in Table 2.

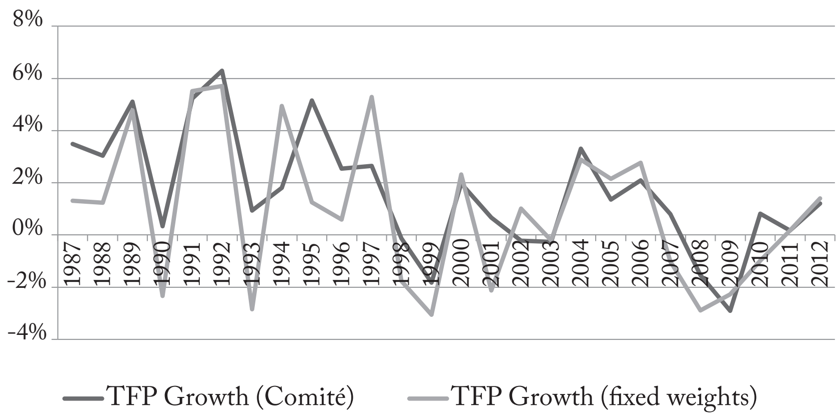
Table 4: Contrasting Growth Decompositions.

	GDP Growth	Contribution of Capital Growth	Contribution of Labor Growth	Contribution of TFP Growth
Fuentes, Larraín and Schmidt–Hebbel (2006)				
Measure: capital adjusted for energy consumption rate and employment adjusted for hours and wages				
1960-1973	3.1%	1.6%	1.4%	0.2%
1974-1989	2.9%	0.9%	2.9%	–1.0%
1990-2005	5.3%	1.8%	0.4%	3.1%
1990-1997	7.1%	1.6%	1.1%	4.4%
1998-2005	3.1%	1.6%	–0.5%	1.9%
Authors' own elaboration				
Measure: Tornqvist index (with fixed weights) for capital and employment using marginal productivity as weights				
1960-1973	3,4%	1,4%	2,2%	–0,1%
1974-1989	3,3%	0,7%	2,3%	0,3%
1990-2005	5,5%	2,7%	1,0%	0,6%
1990-1997	7,1%	3,1%	1,2%	0,5%
1998-2005	3,9%	2,3%	0,9%	0,6%
2006-2012	4,3%	2,8%	1,5%	0,4%

Note: Results of Fuentes, Larraín and Schmidt-Hebbel (2006) were taken directly from their paper.
Source: Authors' own calculations.

Figure 5 shows the path of TFP growth calculated by Comite Consultivo del PIB Tendencial (2013) (TFP growth, Comite) and TFP growth calculated using Tornqvist index with fixed weights to aggregate capital services (TFP growth, fixed weights), which is the same decomposition we show in the lower panel of Table 4. On average, TFP growth calculated by the Comite is higher than our average TFP growth, presumably because Comite's estimations fail to account for the heterogeneity of capital goods and gains of the substitution towards high-productivity types are attributed to TFP instead to capital services. Although this aggregation method is absent in the national literature discussed in this paper, differences turn out to be small in terms of the dynamics implied by such procedure.

Figure 5: Contrasting Paths of TFP Growth.



Note: TFP growth (Comite) depicts the path of TFP growth calculated by Comite Consultivo del PIB Tendencial (2013). TFP growth (fixed weights) depicts the trajectory of TFP growth calculated employing Tornqvist index with fixed weights to aggregate capital services and employment is aggregated using marginal productivity as weights. GDP and capital services are calculated using Central Bank of Chile's *Compilacion de Referencia 2008*. Labor services are calculated using INE's Employment Surveys. Services are obtained by adjusting stocks for quality as shown in Appendix A. Aggregate capital share equals 40%. Preliminary figures are employed since 2010.

Source: Authors' own calculations.

As in the Solow method, both Fuentes, Larraín and Schmidt-Hebbel (2006) and Comite's (2013) include utilization adjustments in their estimates of capital because changes in the use of the capital stock along the business cycle cannot be attributed to TFP. Although the framework of Jorgenson and co-authors does not contemplate these types of adjustments, we are sympathetic to them. We used both measures of capital utilization adjustments, namely energy consumption and unemployment rates, and we found small quantitative differences with the results reported here[8].

Since previous studies for Chile did not take into account the specific contribution of ICT capital to GDP growth, we have to resort to a few international studies that calculate such contribution for Chile. These papers also apply the same methodology as we did, so any remaining disparity lies on data sources. In Table 5, we exhibit the results of two international studies. To compare our results with those studies, we have adjusted their figures to match official GDP growth rates and also, we break down the periods as these papers did.

The results of Jorgenson and Vu (2007) are similar to ours, as we can see in Panel A of Table 5: the contribution of non-ICT capital is virtually the same over the relevant periods, but the contribution of ICT capital is lower than our estimates. We attribute this discrepancy to differences in data sources: Jorgenson and Vu use expenditure figures to calculate ICT capital, while we use industrial import, export and production data to apply the commodity-flow approach. Another source of difference is the method employed to build ICT prices (see Appendix A for details).

Despite differences in the calculation of ICT capital series, the main disparity lies in the contribution of labor. Jorgenson and Vu employ international sources for hours worked, while we use official data for hours worked and for the construction of the labor quality index. Naturally, these differences pass-through to the estimation of the contribution of TFP: Jorgenson and Vu estimate a severe contraction in productivity after 1996 while we calculate modest growth rates since that year.

In Panel B of Table 5 we contrast the results for Chile of De Vries, Mulder, Dal Borgo and Hofman (2007) against ours. The contribution of non-ICT capital is higher than our estimates, but the contribution of ICT capital is roughly the same. We attribute the discrepancy to the construction of ICT deflators; specifically, the shares that weight the growth of each type of capital. In addition, the contribution of labor is lower than our estimates because of differences in data sources, and once again, all these disparities imply different dynamics of TFP growth.

We previously showed that our estimates for the contribution of labor are very similar to those found by previous studies for Chile. Our

8 These results are available upon request.

results on the contribution of ICT capital growth are supported by recent international evidence. Hence, both pieces of evidence make us confident about the reliability of the magnitudes we found in our growth accounting exercises.

Table 5: Other Estimations of Sources of Growth with ICT Capital.

	GDP Growth	Contribution of Non–ICT Capital Growth	Contribution of ICT Capital Growth	Contribution of Labor Growth	Contribution of TFP Growth
	Panel A: Jorgenson and Vu (2007) *				
1989-1995	7,6%	2,1%	0,3%	1,8%	3,4%
1996-2000	4,5%	2,9%	0,5%	1,7%	–0,5%
2001-2006	4,8%	2,0%	0,5%	3,0%	–0,8%
	Authors' own elaboration				
1989-1995	7,6%	2,5%	0,7%	2,3%	2,1%
1996-2000	4,5%	2,7%	1,0%	0,7%	0,1%
2001-2006	4,8%	1,8%	1,1%	1,5%	0,4%
	Panel B: De Vries, Mulder, Dal Borgo and Hofman (2007) *				
1990-2004	5,5%	2,7%	0,6%	1,3%	0,8%
1990-1995	7,2%	3,0%	0,4%	1,4%	2,4%
1996-2000	4,5%	3,3%	1,0%	1,1%	–0,8%
2001-2004	4,2%	1,7%	0,6%	1,5%	0,3%
	Authors' own elaboration				
1990-2004	5,5%	2,3%	0,8%	1,6%	0,7%
1990-1995	7,2%	2,5%	0,7%	2,3%	1,7%
1996-2000	4,5%	2,7%	1,0%	0,7%	0,1%
2001-2004	4,2%	1,6%	0,7%	1,9%	–0,1%

Note: Under the headings "Authors' own elaboration" we provide our estimations using our data and methods for the relevant period to ease the comparison with previous literature.

* Figures have been adjusted to match official GDP growth rates.

Source: Authors' own calculations.

The main lessons drawn in this section are that years of high output growth are years of high productivity growth and the deceleration of GDP growth witnessed in the last decade is the result of a deteriorating productivity. Both results are not artifacts derived from the utilization of the new National Accounts in all calculations. Naturally, differences in the way volumes are calculated (chained prices versus previous fixed prices of the base year) generate differences in figures, mostly when we break down the analysis into subperiods; however, such discrepancies turn out to be small enough to keep the main results unchanged[9].

5. Productivity analyses at the sector level

In this section, we explore what is behind the aggregate evolution of TFP growth. Particularly, the focus is on the productivity growth of all economic sectors comprising the aggregate economy. Two complementary exercises are performed in this section, based on two related, but different concepts of productivity. The first exercise is a decomposition of aggregate labor productivity into its sectorial components, allowing us to assess the evolution of labor productivity across economic sectors, the flows of workers between sectors –what we call later structural change– and the contribution of both to account for the aggregate labor productivity. However, this approach does not take into account the contribution to value added from capital accumulation. In the second exercise, we calculate TFP growth for each economic sector using a modified version of the growth accounting method outlined in Section 4. This methodology takes into account both capital and labor contributions to the growth of value added for each sector. Using the TFP of each sector, we build an aggregate TFP, which is then contrasted with the TFP calculated in Section 4.

This section begins with a description of the data employed, their sources and a brief analysis of dynamics of the value added of all economic sectors, from 1987 to 2011. It then continues with the decomposition of aggregate labor productivity and finalizes with the growth accounting of all sectors.

9 The Central Bank of Chile arrives to the same conclusion, although using a very different method. See Central Bank of Chile (2012), Box V.1 in page 39 of the Informe de Política Monetaria.

5.1. Data description

Sectors are defined at one digit ISIC classification. These sectors are: (1) Agriculture, Forestry, Hunting and Fishing (hereafter, Agriculture); (2) Mining and Quarrying (hereafter, Mining); (3) Manufacturing Industry (hereafter, Manufacturing); (4) Electricity, Gas and Water (hereafter, Public Utilities); (5) Construction; (6) Wholesale and Retail Trade, Hotels and Restaurants (hereafter, Commerce); (7) Transport and Communications (hereafter, Transport); (8) Finance, Insurance, and Business Services (hereafter, Financial Services); and (9) Community, Social, Personal and Government Services (hereafter, Social Services). Two sectors have been excluded from the analysis because capital or employment data are not calculated by the official sources. These sectors are Housing Services and Public Administration. Data of value added come from several reviews of the National Accounts, published by the Central Bank of Chile. Employment data are calculated by the National Institute of Statistics (its Spanish acronym is INE) and capital series are calculated by Henriquez (2005) and published by the Central Bank of Chile.

The most serious weakness of sectorial data lies in the capital series. Henriquez (2005) explains the method employed to construct the capital data of all economic sectors. Recent updates by Henriquez allow the use capital series from 1996 to 2010, which excludes most of the best years of the Chilean economy –the recovery of the Latin American Debt Crisis and the "Golden Age". For that reason, we would like to have a longer data. Vergara and Rivero (2006) extended the capital data backwards until 1986 for six sectors[10]. We employ their capital data, between 1986 and 1995, for Manufacturing, Public Utilities, Construction, Commerce, Transport and Financial Services. Therefore, the growth accounting for these six economic sectors covers the period 1986–2011 and for the other sectors covers the period 1998-2011.

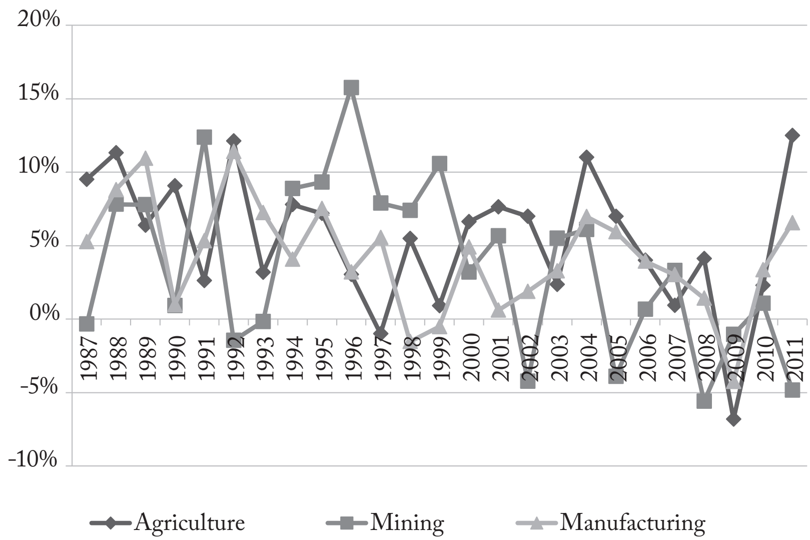
Figure 6 (Panels A to C) exhibits the evolution of growth rates of value added of all economic sectors. A simple observation of these three panels shows how disparate growth performances are across sectors and over time. Those differences could originate by idiosyncratic shocks in

[10] We refer the reader to Vergara and Rivero (2006) for an extensive analysis of the method employed to extend the capital stock backwards. The sectors excluded from this extension are: Agriculture, Mining, and Public Services. For these three sectors, the accounting procedure will start in 1996.

some cases, whose effect might (or not) disappear in the aggregate, depending on the correlation with shocks affecting other sectors. It could be the case that a negative shock in one sector might be offset by a positive shock in another sector, and then aggregate GDP growth would not be affected at all. As it can be expected, large shocks are harder to offset, and therefore larger shocks are more likely to influence the path of aggregate GDP growth. In this sense, a careful analysis of sector-level dynamics can shed some light about the performance of the aggregate economy.

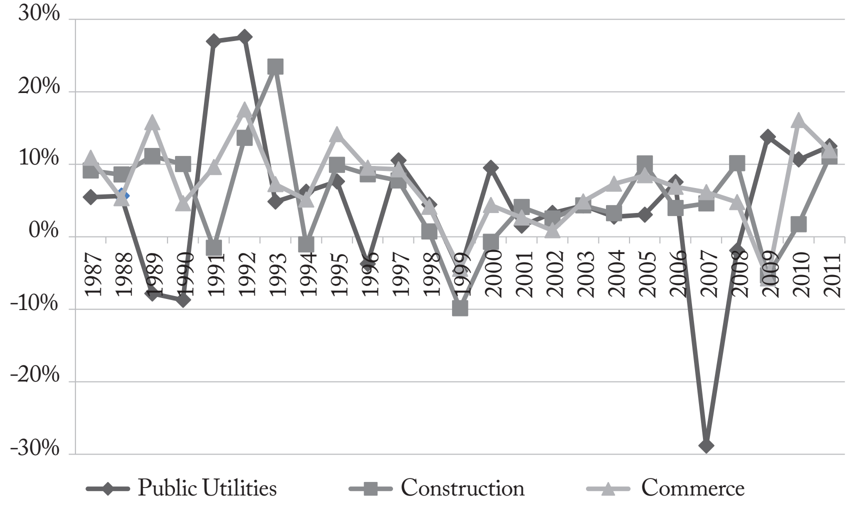
Perhaps, the most striking feature observed in Panels A to C in Figure 5 is the sharp drop in value added of Public Utilities that occurred from 2007-2008 (see Panel B in Figure 6). This steep decline of about 30% in that year is associated to the substitution of natural gas for fuel oil and coal as inputs in the generation of power, whose costs were substantially higher than the price of natural gas. The reason underlying this substitution was the growing reduction in natural gas imports from Argentina, which came to a virtual halt in 2008. Another reason contributing to this abrupt decline was a drought that affected the country, which adds to the steep rise in marginal costs of generating power.

Figure 6 – Panel A: The evolution of growth at the sector level.



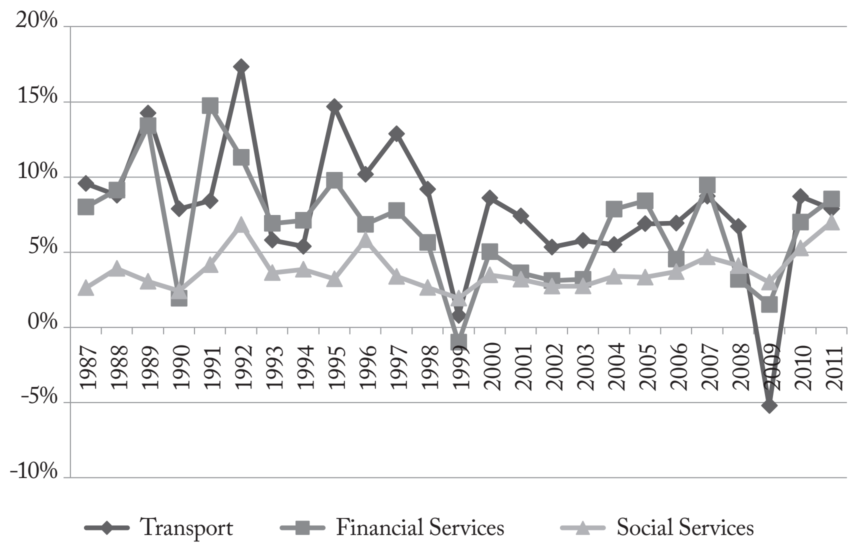
Source: Authors' own calculations.

Figure 6 – Panel B: The evolution of growth at the sector level.



Source: Authors' own calculations.

Figure 6 – Panel C: The evolution of growth at the sector level.



Source: Authors' own calculations.

As we claimed above, large shocks can influence the aggregate economy. In this case, the sharp drop in value added of Public Utilities was the result of higher costs derived from the forced substitution toward pricier inputs, induced by exogenous shocks, such as that Argentina did not honor the agreement signed with Chile and the fluctuations of weather. To confront the rise in marginal costs, prices increase, which could have a large impact on the rest of the economy. It could be the case that the steep rise of the price of electricity may induce substitution toward relatively cheaper sources of energy, increasing the costs of production in other sectors and affecting the economy as a whole. We postpone the estimation and analysis of the effects of energy price shocks on growth and productivity to Section 6.

From 1986 to 1991, the period of recovery from the Latin American Debt Crisis of 1982, all sectors performed very dynamically, reaching high growth rates (an un-weighted average of 7% per annum). Over these years, Agriculture and the cyclically related sectors of Construction, Commerce, Transport and Financial Services took the lead of the growth process, while Social Services and Public Utilities were expanding at modest rates, lower than the average. Particularly striking is the performance of Public Utilities. The latter sector suffered the effects of two negative shocks for two years (1989-90): a sharp rise in the price of fuel oil and coal, and a drought that negatively affected the generation of hydroelectric power. These shocks were largely transitory as value added bounced back from the poor performance the following years.

From 1992 to 1997, the best years of aggregate GDP growth in Chile, all sectors kept expanding at even higher growth rates than the preceding five years. In fact, the un-weighted average growth was 8% per annum over those years. Public Utilities and the cyclically related sectors of Construction, Commerce, Transport and Financial Services benefited from their higher than average growth rates, while Public Services experienced modest (lower than average) growth rates again.

As we discussed in Section 4, the ten years following Chile's "Golden Age" years were disappointing in terms of GDP and TFP growth. The un-weighted average growth fell from the stunning average of 8 percent per annum in 1992–1997 to 3.1 percent per annum in 1998-2003. Afterwards, the (un-weighted) average expansion of these sectors was 4.1 percent per annum in 2004-2008 and 4.4 percent per annum in 2009-2011.

Construction was by far the sector most seriously affected by the Asian crisis. Commerce and Public Utilities also suffered declines in value added, but such drops were lower in magnitude in contrast to Construction. On the other hand, Agriculture and Mining kept expanding at high rates during the Asian crisis, partly because Chile's terms of trade did not decline as industrial countries' demand for commodities was still growing during this crisis[11].

The recovery from the Asian Crisis lacked strength. In fact, the (un-weighted) average growth of these sectors was 4.1 percent per annum, from 2004 to 2008, far from the average expansion of 7 percent per annum during the recovery of the crippling Debt Crisis of 1982. Some sectors grew at high rates, although somewhat lower than the growth rates achieved from 1987 to 1997. These sectors were Construction, Commerce, Transport and Financial Services. In contrast to this slightly positive picture, Public Utilities and Mining registered poor performances. On the one hand, the growth rate of Public Utilities fell because of the shortage of natural gas and droughts affecting the country that we discussed above. On the other hand, the growth in value added of the Mining sector dropped in 2005 and 2008, because terms of trade worsened, in particular, the price of copper declined during both years, especially in 2008, when a massive downfall of world demand for commodities, at the onset of the Great Recession, implied a severe fall in the copper prices.

Copper price kept at low levels, relative to the recent trend level, in 2009. Later, this price recovered and resumed the growing path it had prior to the Great Recession. However, this was not enough to boost an expansion of the Mining sector since costs are growing fast, especially the cost of energy. Therefore, this sector kept growing at rates lower than the 4.4 percent per annum, the (un-weighted) average from 2009 to 2011. In contrast, the bounce back from the Great Recession is accounted for by the dynamical performance of Commerce, Financial Services, Public Utilities and Social Services, whose rates of expansion were faster than the average.

5.2. Labor productivity and structural change

In Section 4, we showed that GDP growth can be decomposed into the change of hours worked and the Average Labor Productivity per hour worked (ALP). In that section, we analyzed the determinants of ALP growth and the changing relative importance of such determinants over

11 In fact, terms of trade of several countries in Latin America improved during the Asian Crisis. See Corbo and Schmidt–Hebbel (2011).

time. It was clear then that ALP growth is the main driver of aggregate GDP growth. In this section, we pursue a different but complementary exercise: we try to account for ALP growth using sectorial ALP growth rates and the share of workers employed in each sector. The idea here is to calculate the contribution of both the growth of sectors themselves and the reallocation of workers between activities to aggregate ALP growth.

This approach was employed by Pages (2010) with the aim of studying the productivity of economic sectors for Latin America and by McMillan and Rodrik (2011) for several countries across the world. Both studies find that, in Latin America, workers tend to move from high to low productivity activities. On the one hand, Pages (2010) claims that the first stage of development, the migration of workers from agriculture to manufacturing was successfully achieved in the region; however, the second stage, which implies labor flowing from industries with high productivity to low productivity services, was the main culprit behind the lagging productivity performance in Latin America.

On the other hand, McMillan and Rodrik (2011) point out that globalization and labor market rigidities are the most prominent features promoting a growth-reducing structural change. The progress made in the region in opening up to trade has increased the reliance of Latin American countries on the performance of commodities and raw materials in international markets, which are very capital-intensive and high-productivity sectors, so there is not much room to absorb labor released from other sectors in such activities.

Aggregate ALP is defined as:

(5) $$\left(\frac{Y}{L}\right) \equiv \sum_{i=0}^{N} \theta_{i,t} \left(\frac{Y}{L}\right)_{i,t}$$

where the left-hand side is the aggregate ALP calculated as the aggregate value added per worker employed. We use employment instead of hours worked because there are no data of hours worked for sectors[12]. The right-hand side is the weighted average of all economic sectors' ALP. The

[12] Note that using hours worked on aggregate data and not in sectorial data will break the identity. Implicitly, we are assuming that there is not much variation of hours worked across sectors, which is not a restrictive assumption as Chile's labor code does not allow much flexibility in hours worked.

relevant weight, $\theta_{i,t}$, is the fraction of labor employed in sector *i* over total employment in year *t*. Then, we can define ALP growth as follows:

(6) $$\Delta \ln\left(\frac{Y}{L}\right)_t \equiv \sum_{i=0}^{N} \theta_{i,t-1}\, \Delta \ln\left(\frac{Y}{L}\right)_{i,t} + \sum_{i=0}^{N} \left(\frac{Y}{L}\right)_{i,t} \Delta\theta_{i,t} + \sum_{i=0}^{N} \Delta\theta_{i,t}\, \Delta \ln\left(\frac{Y}{L}\right)_{i,t}$$

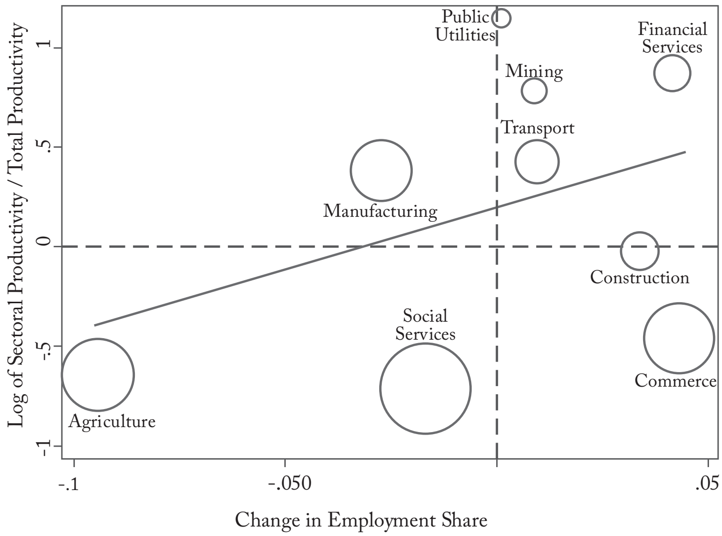
where the first term on the right hand side is the within component, representing the contribution of growth in ALP of all economic sectors, holding the (beginning of period) labor share constant. The second term is what McMillan and Rodrik (2011) call the structural change, which is defined as the contribution of the change in labor share, holding (end of period) ALP constant. If this term is positive it reflects a general movement of workers towards high-productivity activities, and the opposite when the term turns out to be negative. Finally, the third term is the cross component, which reflects the contribution of change in both ALP and labor share. Usually, this term is small, so it will be discarded in the following analysis.

A first impression about the structural change the Chilean economy has suffered, between 1987 and 2011, can be assessed by looking at the correlation between sectorial productivity and change in employment shares in Chile, which is depicted in Figure 7. The horizontal axis measures the change in the share of labor employed in a given sector, from 1987 to 2011. A positive (negative) change means that labor increased (decreased) from 1987 to 2011. The vertical axis measures the logarithm of sectorial ALP to aggregate ALP in 2011. A positive (negative) value means that ALP of a given sector is higher (lower) than the aggregate ALP. Finally, larger (smaller) circles mean a high (low) share of labor of a given sector in 1987.

Figure 8 exhibits many interesting patterns. First, Agriculture and Social Services had the larger shares of labor in 1987 as the size of the circles imply. Both sectors are located in the lower quadrant of the left. This means that labor flowed away from these sectors, but to where? These workers mostly flowed to Commerce, Financial Services and Construction. Second, since Agriculture and Social Services are two sectors of relatively low (labor) productivity, aggregate productivity rises when the workers flow to Financial Services because this sector is a relatively high-productivity activity, but the opposite happens when workers move to Construction and Commerce, two sectors of lower than average labor productivity. Third, note that Commerce was already employing a large share of labor in 1987. So the share of labor employed in Commerce has continuously increased over the years, which tend to reduce (labor) productivity if the contribution of additional labor is low. This could be one of the reasons that explain why ALP of this sector is lower than the average.

The three facts cited above deliver a mixed picture about aggregate productivity. From 1987 to 2011, there has been some movement of workers toward high-productivity activities, but the opposite has taken place as well. The line depicted in Figure 7 represents the correlation between relative ALP in 2011 and the change in labor shares from 1987 to 2011. This correlation is positive, but not significant, which means that the reallocation process has only weakly increased relative ALP.

Figure 7: Relative labor productivity and change in employment of sectors.

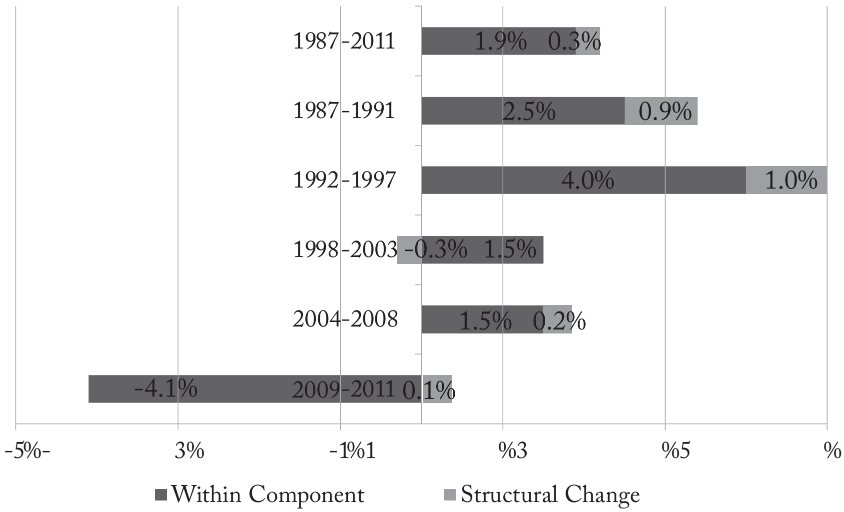


Note: The horizontal axis measures the change in the employment share of a given sector between 1987 and 2011. A positive value implies that labor increased in that sector over these years. The vertical axis measures the logarithm of sectorial ALP to aggregate ALP in 2011. A positive value means that ALP is higher in a given sector than the aggregate ALP in 2011. The size of the circle indicates the share of labor employed in a given sector in 1987.

Source: Authors' own calculations.

Another interesting fact observed in Figure 7 concerns Manufacturing. This is the only sector located in the upper quadrant of the left. This means that its (labor) productivity is higher than the aggregate ALP, but its share of labor has reduced, in other words, employment has been flowing away from this sector. This fact is consistent with the recent theories of international trade. When the economy opens itself to foreign competition, manufacturing firms compete with high-productivity firms from foreign countries. This competition is so intense that low-productivity domestic firms are driven out of the market and the labor they employed is free to move to other sectors or firms within this sector. In the end, high-productivity firms continue producing in the market, increasing the relative productivity of the sector as a whole. This story is fully consistent with the pattern observed in Figure 8.

Figure 8: Decomposition of alp growth 1987–2011.



Note: The figures are the compound average growth rate over the years of reference. Each component is calculated according to equation (6).

Source: Authors' own calculations.

Finally, note that Mining and Public Utilities seem to be very productive activities, in relative terms. They are both located in the upper quadrant of the right, which implies a high relative productivity. If the reallocation process is directed toward both sectors, aggregate ALP should rise. However, both sectors are very capital-intensive, and not labor intensive. Therefore, these two sectors cannot absorb the labor freed by the other sectors. In fact, from 1987 to 2011, both sectors almost did not increase the share of labor employed in their productive processes.

Table 7 exhibits the contribution of each sector to aggregate ALP growth from 1987 to 2011, the within component, which reflects the contribution of the ALP growth of a given sector to the aggregate ALP growth, and the structural change term, which reflects the contribution of the reallocation of workers to aggregate ALP growth. Sectors are ranked according to their total contribution to account for the aggregate ALP growth. The sectors contributing the most to the aggregate labor productivity are Commerce, Financial Services and Commerce. This contribution is explained mostly by the structural change term as the within component is close to zero. In contrast, the sectors contributing the least are Agriculture, Manufacturing and Social Services, whose structural change contribution is negative, at the same time that their labor productivity grew the most.

TABLE 7: CONTRIBUTION OF SECTORS TO AGGREGATE ALP GROWTH 1987-2011.

Economic Activity	Within Component	Structural Change	Total
	(1)	(2)	(1) + (2)
Commerce	0.4%	1.5%	1.9%
Financial Services	0.0%	1.6%	1.6%
Construction	0.0%	1.2%	1.2%
Transport	0.2%	0.4%	0.6%
Mining	0.0%	0.4%	0.4%
Public Utilities	0.0%	0.0%	0.0%
Social Services	0.3%	–0.6%	–0.3%
Manufacturing	0.3%	–1.0%	–0.7%
Agriculture	0.9%	–3.1%	–2.2%
Total	2.1%	0.4%	2.5%

Note: The figures represent the contribution of each sector to the compound average growth rate of aggregate ALP, between 1987 and 2011. Each component is calculated according to equation (6).

Source: Authors' own calculations.

The facts outlined above are explained by the flow of workers within the economy. The three sectors located in the lower part of Table 7 –Agriculture, Manufacturing and Social Services– shrank in terms of employment, as it can be seen in Figure 7. This is the reason why their contribution of structural change is negative. The workers previously employed in these three sectors were reallocated toward sectors located in the upper part of Table 7 –Commerce, Financial Services and Construction– which is why their contribution of structural change is higher. However, additional workers employed in these sectors reduce labor productivity when their contribution to output is low. This seems to be the case for Financial

Services and Construction as the within component of both sectors, which captures labor productivity growth of each sector, has been nil in the 1987-2011 period. Thus, the performance of Commerce is particularly remarkable, since it absorbed a relevant part of the employment from other sectors, and its labor productivity grew over these years, which implies that the contribution of additional employment to output has been high in this sector. Other sectors recording an expansion of the within component, that is, a positive growth in labor productivity, have been Agriculture, Manufacturing and Social Services, which is mainly explained by their reductions of the workers employed in their productive processes. Finally, note that Mining and Public Utilities contribute only slightly to aggregate ALP growth. Both sectors, despite their relatively high levels of (labor) productivity (see Figure 8), have not experienced major changes in their productivity levels and they also have not increased the labor employed in their production because these sectors are capital-intensive as we discussed above.

Figure 8 exhibits the decomposition of aggregate ALP growth into the within component and structural change components, according to equation (6), from 1987 to 2011. Over these years, the average growth of aggregate ALP was 2.2 percent per annum. The lion's share is explained by the ALP growth of individual sectors, while the contribution of the structural change was only 0.3 percent per annum. However, there is substantial heterogeneity within this period. As in Section 4, we break down this period into windows of five years.

From 1987 to 1991, time of the recovery from the Latin American Debt Crisis of 1982, aggregate ALP grew 3.4 percent per annum, on average. This performance is explained by the growth in labor productivity of many sectors and a substantial reallocation of workers toward high-productivity sectors. Perhaps, this phenomenon could be part of a Schumpeterian process that began with the crisis in 1982. The Debt Crisis drove low-productivity activities out of the market, generating a reallocation of workers from those activities to the ones that survived the crisis, high-productivity activities. In this sense, the process of reallocation, propelled by the crisis, was still developing.

The following five years, average ALP growth was the highest of the period under analysis. Labor productivity expanded 5 percent per annum. 4 out of 5 percent of average ALP growth from 1992 to 1997 is explained by the stunning performance of growth of all economic sectors. The contribution of the reallocation of workers kept on growing at a similar rate than the five years preceding.

This positive scenario reversed the following decade. The Asian Crisis hit the country particularly hard as aggregate ALP declined from the 5 percent per annum of the preceding five years to 1.5 percent per annum in 1998-2003 and in 2004-2008. The contribution of both within and structural change declined sharply. ALP growth of all economic sectors fell abruptly to less than a half of the (weighted) average growth of the preceding decade, from 1998 to 2008. The contribution of the structural change was negative in 1998-2003, but later reversed to a growth of small magnitude in 2004-2008.

The negative contribution of the reallocation of workers makes sense in light of the reverse-liquidationist view of recessions[13]. In such recessions, high-productivity activities, requiring high levels of external financing for their operation, are driven out of the market because they cannot get funds to keep on producing as financial markets are suffering a domestic liquidity shortage. Thus, workers from failing firms flow toward the surviving ones, which are not necessarily the most productive firms, shrinking the aggregate productivity of the economy.

In 1998, Chile suffered a massive liquidity shortage caused by the sharp increase in domestic interest rates and a sudden stop of capital inflows. The evidence shown in Figure 8 exhibits a negative contribution of reallocation of workers to aggregate ALP growth. So, it is perfectly possible that some high-productivity activities, requiring external financing for their operation, were driven out of the market because they could not get credit, while some lower productivity activities with access to sources of funding survived and attracted the labor coming from shrinking sectors, depressing productivity even further. This is not conclusive evidence about the presence of this phenomenon, but at least the facts discussed in this section match the implications of the reverse-liquidationist view of recessions.

The recovery from the Asian Crisis was not similar to the aftermath of the Debt Crisis. The (weighted) average of ALP growth of all economic sectors kept growing at low rates (1.5 percent per annum, on average, from 2004 to 2008) and the contribution of the reallocation of workers was a third of the rates experienced in the recovery from the Debt Crisis. Later,

13 See Caballero and Hammour (2005).

the Great Recession affected the country at the end of 2008 and half of 2009. The sharp drop of commodity prices and the recession ensued in Chile generated an important decline in growth of all economic sectors. In fact, the average of compound ALP growth was 4 percent per annum, which is almost fully explained by the massive decline in ALP growth of all economic sectors.

In all, the deceleration of (labor) productivity growth, which began in 1998, is explained by a lower growth in productivity of all economic sectors and a lower contribution of the reallocation of workers toward high-productivity sectors. Particularly relevant is the latter point. One could be tempted to conclude that the reallocation of workers toward high-productivity activities is completed in Chile, as in high income economies[14], so the contribution of this term will be lower from this time on. Alternatively, a skeptical interpretation of this fact is that the low contribution of the structural change is result of labor market inflexibilities, hindering the flow of workers toward the most productive employments. In this sense, policies oriented toward increasing the flexibility of the labor market could contribute to enhance the reallocation of workers and then, increase its contribution to account for a higher aggregate ALP growth, the main driver of GDP growth.

A different view about the decline in the contribution of the structural change to labor productivity growth concerns the scarcity of skilled labor. High-productivity sectors tend to be capital-intensive and therefore, they demand workers capable of managing new technologies. Unskilled workers, lacking an adequate mix of skills, are not capable of working in these sectors and will move to labor –intensive sectors, such as Construction and Commerce, requiring fewer skills. Thus, a growth-enhancing structural change is hindered by the scarcity of skilled workers and by the failure of the educational system in providing such skills to the population as a whole. However, this argument definitely deserves more research to assess its quantitative plausibility.

5.3. Growth accounting at the sector-level

The growth accounting method of Section 4 can also be applied to economic sectors. However, part of the data required by this procedure is

14 See McMillan and Rodrik (2011).

not available at sector-level. So, we adjust the procedure outlined in that section to reflect the availability of sector-level data.

This exercise has been performed before by Vergara and Rivero (2006). These authors apply the growth accounting framework to economic sectors in Chile over the period 1986-2001. The focus of their analysis is to present new evidence about TFP growth rates for economic sectors. Our focus, instead, is the sharp deceleration of aggregate TFP growth, witnessed in Chile since 1998. Particularly, we are interested on finding whether the performance of some sectors is responsible for the slump in productivity growth in Chile.

This section begins with the simplifications introduced into the analysis of Section 4 in order to meet data constraints. Then, we present the contribution of capital, labor and TFP to account for the growth of value added for all economic sectors and also discuss their respective productivity performances. Finally, we calculate an aggregate TFP growth rate as a weighted average of sector TFP growth rates. The measure thus obtained is contrasted later with the aggregate TFP computed in Section 4 to identify the economic sectors behind the declining path of productivity growth.

5.3.1. Methodology

As in Section 4, we assume that a Cobb-Douglas production function represents the productive process of each economic sector. The factors of production are capital and labor. Value added is the measure of output employed. As in previous sections, TFP represents a Hicks-neutral productivity shock, which means that affects equally the productivity of both factors.

In Section 4, we calculated capital services using the heterogeneous contribution of several types of capital. These data are not available at sector level, so we assume that all capital units employed are homogeneous. Thus, we discard the use of the Törqnvist index we employ in Section 4 to aggregate different types of capital. In Appendix A, we discuss that this aggregator is also a measure of capital quality; therefore, we do not adjust capital for quality[15].

[15] Vergara and Rivero (2006) also discard a quality adjustment for capital. The authors adjust capital for utilization, applying the employment rate for each sector relative to a measure of natural employment rate, which varies across sectors. We do not adjust capital for utilization to be consistent with the method applied in Section 4.

In Section 4, we calculated labor as the product of employment and average hours worked. However, hours worked for economic sectors are not available; therefore, labor is measured as employment. The implicit assumption here is that average hours worked does not change across sectors; therefore, differences in total hours worked are completely driven by differences in the number of employed agents at each economic sector[16]. In Section 4, we assume that workers are heterogeneous and empirically, we measure such heterogeneity using a labor quality index. In this section, as a consequence of data constraints, we assume that workers are homogeneous within sectors, but we allow some heterogeneity among workers across sectors. For that purpose, we adjust labor by a quality index calculated as the average wage of each economic sector relative to a general wage index. This index varies also over time. Data on wages are taken from INE.

The key parameter of the Cobb-Douglas production function is the labor or capital share. As is usual, we calculate the labor share because it is easier to compute. Table 8 exhibits the labor share calculated and those computed by Vergara and Rivero (2006) for contrasting purposes.

Table 8: Labor income shares by economic sector.

	Vergara and Rivero (2006)	Corbo and Gonzalez (2012)
Agriculture	—	37.1
Mining	—	18.8
Manufacturing	41	30.2
Public Utilities	23	13.5
Construction	37	65.0
Commerce	73	63.2
Transport	59	35.1
Financial Services	56	45.3
Social Services	—	71.3

Note: The labor shares calculated by Vergara and Rivero (2006) were taken directly from their paper.
Source: Authors' own calculations.

16 This assumption is not as restrictive for the case of Chile as it appears at first sight because there is not much variation of hours worked across sectors as Chile's labor code allows little flexibility in hours worked.

Differences between these two sets of labor shares are very sharp. These discrepancies rely on the source of data. Vergara and Rivero calculate labor shares using data on employment and wages from INE as a share of value added from the old National Accounts and adding a 14% for each case, so when the sector-level shares are aggregated, they are consistent with the aggregate labor share calculated by Minister of Finance (2004). In contrast to these authors, we calculate labor shares as the ratio of total remunerations to value added for each economic sector. Data for these calculations were taken from the Income Accounts of the old National Accounts (*Compilacion de Referencia 2003*)[17].

5.3.2 Accounting results

Table 9 shows the results of the growth accounting applied to each economic sector. At the beginning of Section 5, we discuss that capital series are available since 1996. However, Vergara and Rivero (2006) extended the capital series backward for all sectors, but Agriculture, Mining, and Public Services. We employ their extension of capital series, so the growth decomposition begins in 1987 for all sectors but these three.

TABLE 9: GROWTH ACCOUNTING AT THE SECTOR LEVEL.

	Value Added Growth	Contribution of Capital Growth	Contribution of Labor Growth	Contribution of TFP Growth
	Agriculture			
Labor Share:	37.1%			
1998-2011	4.7%	2.2%	0.2%	2.3%
1998-2003	5.0%	2.0%	0.3%	2.7%
2004-2008	5.4%	2.2%	–0.3%	3.4%
2009-2011	2.7%	2.3%	0.6%	–0.2%
	Mining			
Labor Share:	18.8%			
1998-2011	1.7%	6.7%	2.0%	–7.0%
1998-2003	4.7%	6.4%	–0.2%	–1.5%

[17] It should be noted that by the time Vergara and Rivero (2006) was written, Income Accounts were not available.

	Value Added Growth	Contribution of Capital Growth	Contribution of Labor Growth	Contribution of tfp Growth
2004-2008	0.1%	6.7%	1.7%	–8.3%
2009-2011	–1.6%	7.4%	6.9%	–15.9%
	Manufacturing			
Labor Share:	30.2%			
1987-2011	4.2%	4.4%	0.8%	–1.0%
1987-1991	6.3%	2.6%	2.8%	0.9%
1992-1997	6.5%	7.5%	0.7%	–1.7%
1998-2003	1.4%	2.9%	–0.2%	–1.3%
2004-2008	4.3%	4.7%	0.6%	–1.0%
2009-2011	1.9%	3.2%	0.5%	–1.8%
	Public Utilities			
Labor Share:	13.5%			
1987-2011	4.5%	3.1%	0.6%	0.8%
1987-1991	4.3%	3.3%	0.0%	0.9%
1992-1997	8.8%	5.2%	0.7%	2.9%
1998-2003	3.1%	–0.7%	–0.5%	4.3%
2004-2008	–3.5%	5.9%	1.5%	–10.9%
2009-2011	12.3%	1.4%	2.6%	8.3%
	Construction			
Labor Share:	65.0%			
1987-2011	5.6%	1.1%	4.0%	0.5%
1987-1991	7.5%	–1.9%	11.3%	–1.9%
1992-1997	10.4%	4.1%	3.3%	3.0%
1998-2003	0.2%	–0.3%	–0.2%	0.7%
2004-2008	6.4%	2.4%	4.5%	–0.5%
2009-2011	2.5%	0.6%	1.2%	0.7%
	Commerce			
Labor Share:	63.2%			
1987-2011	7.1%	3.5%	1.5%	2.1%

	Value Added Growth	Contribution of Capital Growth	Contribution of Labor Growth	Contribution of TFP Growth
1987-1991	9.3%	4.5%	2.1%	2.7%
1992-1997	10.5%	4.8%	2.4%	3.3%
1998-2003	2.1%	3.3%	1.1%	–2.3%
2004-2008	6.7%	1.5%	–0.4%	5.6%
2009-2011	7.4%	2.7%	3.1%	1.6%
	Transport			
Labor Share:	35.1%			
1987-2011	7.9%	7.0%	1.5%	–0.6%
1987-1991	9.8%	5.4%	2.5%	1.9%
1992-1997	11.0%	9.2%	1.3%	0.5%
1998-2003	6.2%	4.8%	1.7%	–0.3%
2004-2008	7.0%	9.5%	1.5%	–4.0%
2009-2011	3.8%	5.2%	0.2%	–1.6%
	Financial Services			
Labor Share:	45.3%			
1987-2011	6.7%	3.9%	2.4%	0.4%
1987-1991	9.4%	–1.5%	4.0%	6.9%
1992-1997	8.3%	5.4%	3.6%	–0.7%
1998-2003	3.3%	3.9%	2.0%	–2.6%
2004-2008	6.7%	7.5%	1.0%	–1.8%
2009-2011	5.7%	3.7%	0.5%	1.5%
	Social Services			
Labor Share:	71.3%			
1998-2011	3.7%	1.5%	2.2%	0.0%
1998-2003	2.8%	1.4%	2.8%	–1.4%
2004-2008	3.8%	1.4%	0.3%	2.1%
2009-2011	5.1%	1.6%	4.3%	–0.8%

Note: GDP and capital are calculated using Central Bank of Chile's *Compilacion de Referencia 2003*. Labor is calculated using INE's old Employment Surveys. Labor is adjusted for quality using the average wage of each economic sector relative to a general wage index. Capital is not adjusted for quality. Preliminary figures are employed since 2009.

Source: Authors' own calculations.

Mining exhibits the worst performance in terms of TFP growth. From 1998 to 2011, TFP growth declined 7 percent per annum on average. This sharp deceleration obeys very specific reasons. First, the volumes of production fluctuate with the price of copper, which is determined in international markets. Although this price has achieved unprecedented levels since 2003, the growth rate of the price has varied wildly, transferring the volatility of commodity markets to volumes produced. Second, a higher price of copper stimulates the demand for inputs required by Mining. As this sector is capital-intensive, high copper prices have boosted the accumulation of capital, which has been steady at rates higher than 6 percent per annum over these years. However, this higher demand for inputs ends up increasing their prices over time, shrinking its value added. Third, the price of copper suffered a large drop at the onset of the Great Recession, sharply reducing the volumes produced. Later, the copper price recovered and the growth rates of valued added bounced back, but not enough to offset the large decline of 2008-2009, partially because high prices of inputs put substantial downward pressure to value added. For that reason, value added fell 1.6 percent per annum in this period, and since capital and labor were growing over these years, TFP dropped sharply.

Other poor performers in terms of TFP are Manufacturing and Transport. TFP growth fell 1 and 0.6 percent per annum, on average, in 1987-2011, respectively, although their productivities did not decline steadily over these years. In fact, the constant drop in TFP began in 1992 for Manufacturing, while the TFP of Transport falls at different rates since 1998 and at a faster rate since 2004. Another interesting fact about these two sectors is that the contribution of capital growth is the main driver to account for their growth rates, and, moreover, those capital contributions are also higher than what we find in other economic activities, which is a common feature among the productivity-lagging sectors.

On the other side of the spectrum, we find Commerce and Agriculture. These two sectors are the top performers in terms of TFP growth. TFP growth expanded 2.1 percent per annum, on average, in 1987-2011 for Commerce and 2.9 percent per annum, on average, from 1998 to 2011 for Agriculture. Their good performance has rather different sources. As we claimed above, the last twenty five years featured a substantial migration of workers from agriculture to other sectors of the economy. This explains the fact that the contribution of labor to the growth of value added is small for Agriculture, the smallest of all economic sectors. In addition, the share of total value added of Agriculture is about the same in 2011 as it was in 1986. This means that the production of this sector is expanding at a close rate to the aggregate economy, with a little bit more of capital –the contribution of capital to growth of value added has been 2.2 percent per annum, on average, from 1998 to 2011, which is one of the lowest of all economic sectors–, and barely the same amount of employment. So, achieving high rates of growth with a minor expansion of capital and labor is only possible if a true increase in productivity takes place.

This is in stark contrast with Commerce. This sector was one of the activities that attracted labor flowing from Agriculture. The growth of value added was high from 1987 to 1997, accounted for by high rates of growth of capital, labor and productivity. This process was interrupted in 1998 until 2003, a period in which capital and labor grew at slower rates, but TFP dropped sharply, which accounts for the severe decline in growth of value added over those years. Later, Commerce would recover high rates of growth, although lower than those seen in the Golden Age of the Chilean economy, but this time growth was not accounted for mostly by the accumulation of production factors, but by high growth of TFP. In all, despite the fact that Commerce and Agriculture had a similar good performance in terms of TFP, growth dynamics and their sources differ substantially.

Construction and Financial Services are other sectors in which TFP grew, but at slower rates than Agriculture and Commerce. The growth of value added of Construction averaged 5.6 percent per annum in 1987-2011. Financial services expanded 6.7 percent per annum, on average in the same period. The growth of both sectors is accounted for by a similar contribution of TFP –0.5 and 0.4 percent per annum, on average, from 1987 to 2011 for Construction and Financial Services, respectively–, but by different contributions of factors: labor accounts for the lion's share of growth of Construction and capital accounts for most of the expansion of Financial Services. Note that the contribution of labor in both sectors is very high in contrast to the other sectors, especially in Construction. The reason is that both sectors are labor-intensive and, therefore, they have the potential to absorb the labor that flowed from Agriculture and Manufacturing, which could explain this fact.

The value added of Public Utilities grew 4.5 percent per annum, on average, in 1987-2011. This is a capital-intensive sector and for that reason, it is unsurprising that the growth of value added is accounted for by a large contribution of capital (3.1 percent per annum, on average) and a small contribution of labor (0.6 percent per annum, on average), which is lower than the contribution of TFP (0.8 percent per annum, on average). Although the average performance of TFP seems to be good, this average hides substantial heterogeneity within this period. In fact, TFP growth is closely tied to climate conditions, in particular, droughts that recurrently affect the country. These droughts squeeze the value added of electricity generation as hydropower plants substitute the hydro component for fuel oil, increasing their cost of production and shrinking value added. The droughts Chile has suffered in the past twenty five years occurred in 1986, 1990-1991, 1996, 1998-1999, 2007-2008 and 2010-2011, and affected one or several regions, mainly in Chile's south-center zones. But perhaps the most severe shock to this sector was the sudden stop of natural gas imports from Argentina in 2004 that we discussed at the beginning of Section 5. This shock plus a sharp and continuous increase in oil prices and droughts affecting the country were the contributing factors to a sharp drop of the value added and TFP between 2004 and 2008.

Finally, the growth of Social Services averaged 3.7 percent per annum between 1998 and 2011. This growth is accounted for by labor mostly and a small contribution of capital since this sector is labor-intensive. TFP did not grow over these years, on average. Although TFP grew 2.1 percent per annum in 2004-2008, TFP declined in periods that included the Asian Crisis and the Great Recession, which were years when labor expanded sharply in this sector.

5.3.3. Aggregate TFP

In this part of the section, we aggregate the TFP growth of all economic sectors into one indicator reflecting the average performance in terms of productivity. For the aggregation, we use as weights the shares of value added in 2003, since this is the base year in the old National Accounts (*Compilacion de Referencia 2003*). Manufacturing is the largest sector in terms of value added, representing 19 percent of total value added in 2003, which is somewhat lower than the share it had in 1986 (23 percent). The second largest sector is Financial Services, whose share of value added is

18 percent, higher than the share in 1986 (15 percent). It is interesting to point out that the declining trend of the share of Manufacturing and the growing trend of Financial Services continued along the 2000s and consequently, Financial Services took the top spot in terms value added. Other important sectors are Social Services (14 percent), Commerce (11 percent), Transport (11 percent), and Mining (10 percent). The activities with the lowest shares of value added are: Construction (8 percent), Agriculture (6 percent), and Public Utilities (3 percent).

Not only had the share of value added of Manufacturing declined over the years, but the share of Social Services fell too, from 19 percent in 1986 to 14 percent in 2003, which is about the same as in 2011. In contrast, Financial Services and Transport have increased their relative importance in terms of value added, going from 15 to 19 percent in the former sector and from 7 to 12 percent in the latter. Other sectors suffered (if anything) milder changes.

If these changes in the productive structure are relevant quantitatively, we might be over –or under– representing some economic activities when we use fixed weights, which could overstate or understate the aggregate TFP thus calculated. Therefore, we face two choices regarding the weights employed to build the aggregate TFP growth: (1) using fixed weights, calculated for 2003; or (2) using time-varying shares.

Another problem we face for the calculation of the aggregate TFP is that we cannot calculate TFP since 1987 for some sectors –Agriculture, Mining and Social Services– because capital series were not available. In addition, we also exclude Public Utilities in some calculations because the erratic behavior of its TFP growth, strongly related to exogenous events such as hydrology and the foreign price of fuel oil and coal. Note that we are also excluding Mining, so the aggregate TFP ruling out these four sectors does not include any potential effect of terms of trade and hydrology shocks on productivity and thus, it is a more transparent and genuine measure of productivity growth. In all, one indicator will include only five economic sectors, namely, Manufacturing, Construction, Commerce, Transport and Financial Services. Other indicators will include the six sectors with data from 1986 until 1996 and all sectors since 1996. We re-calculate the weights to add up to one in the cases we employ a subset of economic activities for our calculations.

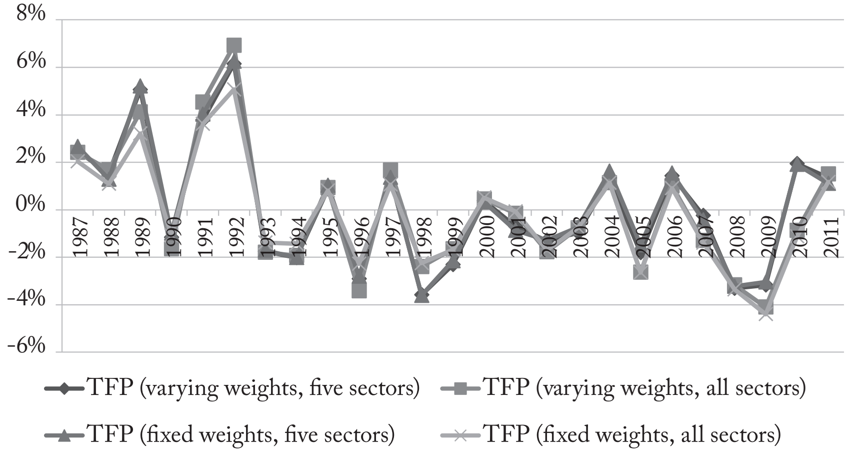
Figure 10 exhibits four indicators of aggregate TFP growth. These four indicators represent combinations of several choices we face: (1) fixed weights and five sectors; (2) time-varying weights and five sectors; (3) fixed weights and all sectors; and (4) time-varying weights and five sectors.

From the simple inspection of Figure 10, we can note that there is not much difference between fixed and time-varying measures. In fact, the difference between both measures is 0.1 percent per annum on average in 1987-2011. This means that changes in the shares of value added tend to offset each other over time, and thus, these changes do not contribute to accounting for the performance of aggregate TFP growth. In the following analyses, we study the evolution of the indicator calculated using fixed weights to isolate the contribution of different sectors to aggregate TFP.

Between the indicator including five and all sectors there are some differences. Aggregate TFP growth using five sectors is 0.4 percentage points higher, on average, than the indicator including all sectors. The largest discrepancies occur in 1998, 2005, 2007, 2009 and 2010, where the difference between these two indicators is greater than 1 percentage point. In 1998, TFP of Manufacturing declined 6 percent points, and therefore, the indicator that puts more weight on this sector (the indicator of five sectors in Figure 9) shows a sharper drop. In 2005, TFP of Mining and Public Utilities fell abruptly (13 and 5 percentage points respectively), which explains why the growth of the indicator including all sectors shows a larger decline than the indicator using five sectors. In 2007, the difference obeys the inclusion of Public Utilities, whose TFP contracted by 37 percentage points. Finally, between 2009 and 2010, the discrepancy is explained by the performance of Mining, whose TFP dropped sharply in both years, product of the plunge in the price of copper between mid-2008 and mid-2009 and the higher costs that squeeze value added.

Table 10 exhibits the aggregate TFP growth using all sectors and five sectors, and the TFP calculated in Section 4, with and without ICT capital. Levels of growth rates differ as one might expect, but tend to coincide in terms of dynamics. Furthermore, note that aggregate TFP growth and sector-weighted average TFP growth do not necessarily have to match, because capital and labor shares are not the same for each sector and for the aggregate economy. The same happens with capital and labor growth. So, these two sources of disparities render a perfect match between aggregate TFP growth and sector –weighted average TFP growth quite unlikely. However, despite the quantitative differences, the deceleration of TFP growth that began in 1998 and went along until 2011 is present in all indicators of aggregate productivity.

Figure 9: Aggregate TFP growth.



Note: These indicators are weighted-averages of TFP growths calculated for five sectors (Manufacturing, Construction, Commerce, Transport and Financial Services) or all sectors. Weights are the shares of each sector over total value added. Fixed weights are the shares calculated in 2003. To obtain TFP for each sector, GDP and capital are calculated using Central Bank of Chile's *Compilacion de Referencia 2003*. Labor is calculated using INE's old Employment Surveys. Labor is adjusted for quality using the average wage of each economic sector relative to a general wage index. Capital is not adjusted for quality. Preliminary figures are employed since 2009.

Source: Authors' own calculations.

TABLE 10: COMPARISON OF AGGREGATE TFP GROWTH.

	VALUE ADDED-WEIGHTED TFP (ALL SECTORS)	VALUE ADDED-WEIGHTED TFP (FIVE SECTORS)	TFP W/O ICT GOODS	TFP WITH ICT GOODS
1987-2011	–0.2%	0.2%	0.5%	0.4%
1987-1991	1.8%	2.4%	2.2%	2.0%
1992-1997	0.3%	0.4%	3.2%	2.9%
1998-2003	–1.0%	–1.4%	–0.8%	–1.0%
2004-2008	–1.1%	–0.4%	0.1%	0.0%
2009-2011	–1.5%	0.0%	–4.4%	–4.0%

Note: Value added–weighted TFP is a weighted average of TFP growths of all sectors and five sectors (Manufacturing, Construction, Commerce, Transport and Financial Services). Weights are the shares of each sector over total value added in 2003. TFP growth with and without ICT goods are calculated in Section 4.

Source: Authors' own calculations.

Between 1987 and 1991, aggregate TFP growth reached the highest levels of the last twenty five years in Chile as we discussed in Section 4. The same happened with the sector –weighted average TFP growth of all and five sectors, which is 1.8 and 2.4 percent per annum, on average, respectively. Both indicators are close to the TFP obtained using aggregate data. The difference is 0.4 or 0.2 percentage points more or less on the indicator under analysis. As it is shown in Table 9, Financial Services, Commerce and Transport supported the expansion of productivity levels in this period.

An important difference in growth rates lies in 1992-1997. TFP growth obtained using aggregate data suggests this was a period of a sustained productivity expansion –in fact, there is an average expansion of productivity of 3.2 and 2.9 percent per annum using aggregate TFP growth without and with ICT goods respectively–, but the weighted average of sector TFP growth suggests a mild productivity expansion of 0.3 and 0.4 percent per annum, on average, for five and all economic sectors respectively. This result is mainly driven by the performance of Manufacturing and Financial Services because these two sectors suffered large drops of productivity growth in this period (the average decline was 1.7 and 0.7 percent per annum, respectively, see Table 9) and they are the two largest sectors of the Chilean economy.

One possible explanation that accounts for this discrepancy between aggregate and sector figures is that aggregate data overstate the contribution of some sectors going through expansions of productivity, but whose shares of total value added, a measure of the size relative to the total economy, are small. This is the case of Commerce and Construction. However, once we weight their TFP growth for their relative size, this effect tends to disappear. Note that the indicator including all sectors is calculated using six sectors only between 1987 and 1996. The sectors included account for two thirds of total value added. Therefore, the three excluded sectors should have experienced very high TFP growth rates in order to account exactly for the aggregate figure, which seems quite unlikely. Since we do not have information of these three sectors, we cannot assess if the other sectors account for the difference. Moreover, one should keep in mind that these indicators will tend to differ because of divergences in terms of capital and labor shares between sectors and the aggregate economy, making the task of unveiling this difference increasingly hard.

Discrepancies in TFP growth tend to reduce in 1998-2003. The decline of TFP growth obtained using aggregate data is 0.8 and 1 percent per annum without and with ICT goods respectively and 1 and 1.4 for the weighted average of TFP growth of all and five sectors respectively.

Although, this period includes the Asian Crisis, the worsening of terms of trade and droughts, not all sectors suffered a fall in productivity growth. Agriculture, Public Utilities and Construction had large expansions of productivity, but since they account for a minor fraction of total value added, the productivity growth of these sectors did not affect aggregate growth substantially.

Divergences reappear in 2004-2008 as TFP obtained using aggregate data barely grew, but the weighted averages of TFP declined 1.1 and 0.4 percent per annum, on average, using all and five sectors respectively. Agriculture, Commerce and Social Services are the only sectors with a growing TFP in this period (see Table 9). But the remaining sectors, 70% of total value added, suffered massive declines in productivity growth. Therefore, it could be the case that aggregate figures are overstating the performance of these three good sectors, masking the poor panorama of productivity for the rest of the economy, although the same precaution we took while interpreting divergences for the period 1992-1997 apply here as well.

Differences are larger in 2009-2011. TFP using aggregate data fell more than 4 percent, while the decline using the indicator including all sectors suffered an average decline of 1.5 percent per annum, average TFP growth using five sectors do not exhibit such sharp drop;; instead, it shows a stagnation. This discrepancy could be explained by the performance of Mining, a sector that underwent an abrupt drop of TFP growth in this period.

So are there sectors accounting for the productivity slump since 1998? The evidence shown in Table 11 will help to answer the question. There are several things to notice. First, TFP growth drops sharply on average in all sectors when we contrast the average of 1998-2011 with the average of 1987-1997. This is unsurprising as the period of 1998-2011 includes two recessions and the period of 1987-1997 features none. However, 1998-2011 also includes the recovery from these two recessions and if such recoveries were as strong as the recovery from the Latin American Debt Crisis of 1982, differences would be smaller.

Second, the relative large sectors of the Chilean economy are poor productivity performers. Even in the Golden Years in terms of GDP growth, the TFP growth of Manufacturing, the larger sector, was declining and since 1998, the speed of decline accelerated further. However, the difference between the evolution of TFP in 1987-1997 and in 1998-2011 was smaller in contrast to other sectors, so the productivity performance of this sector cannot account for the productivity slump by itself. Financial

Services, the second largest in 2003 and the largest sector of the Chilean economy currently, suffered the sharpest decline in productivity among all sectors. This sector moved from an average expansion in productivity of 2.4 percent per annum in 1987-1997 to an average decline of 1.4 percent per annum in 1998-2011, which is not the worst performance in this period, but it is the largest fall in TFP growth. Another sector that went through an abrupt fall in TFP is Transport. This sector experienced an average growth of TFP of 1.1 percent per annum in 1987-1997 and a decline of 1.9 percent per annum, on average, in 1998-2011.

Table 11: The sectorial origin of the TFP slowdown.

Economic Sector	Shares of Value Added	Average TFP Growth 1987-1997	Average TFP Growth 1998-2011	Difference
Agriculture	6%		2.3%	
Mining	10%		–7.0%	
Manufacturing	19%	–0.5%	–1.3%	–0.8%
Public Utilities	3%	2.0%	–0.3%	–2.3%
Construction	8%	0.8%	0.2%	–0.5%
Commerce	11%	3.1%	1.4%	–1.7%
Transport	11%	1.1%	–1.9%	–3.0%
Financial Services	18%	2.8%	–1.4%	–4.2%
Social Services	14%		0.0%	

Note: Shares of each sector over total value added are computed in 2003. To obtain TFP for each sector, GDP and capital growth are calculated using Central Bank of Chile's *Compilacion de Referencia 2003*. Labor is calculated using INE's old Employment Surveys. Labor is adjusted for quality using the average wage of each economic sector relative to a general wage index. Capital is not adjusted for quality. Preliminary figures are employed since 2009.

Source: Authors' own calculations.

Manufacturing, Financial Services and Transport account for about half of the value added of the Chilean economy. Therefore, their TFP performance is crucial to explain the evolution of aggregate TFP. In fact, if the TFP of these three sectors would have kept growing at same average rate as in 1987-1997, aggregate TFP would have not decline in 1998-2011, measured in the indicator that includes all sectors. Precisely, in this case, aggregate TFP would move from declining 1.1 percent per annum, on average, in 1998-2011 to record an average expansion of 0.1 percent per annum. Thus, if the TFP of these three sectors have not slowed, aggregate

TFP and GDP would have been 1 percent per annum higher, on average, for 13 years.

In all, the poor performance in terms of productivity of three sectors, Manufacturing, Financial Services and Transport, account for a large part of the decline in aggregate TFP growth over the last decade. However, the slowdown in TFP is a widespread phenomenon, affecting all economic sectors. Thus, if these three sectors had kept the pace of 1987-1997, aggregate TFP would have slowed anyway in 1998-2011, in contrast to 1987-1997, but it would not have declined.

6. Shocks to energy prices and productivity growth

The growth accounting evidence of Section 4 illustrated the poor performance of TFP growth at the aggregate level for Chile since 1998. This is not an artifact of aggregate figures as the growth accounting of economic sectors also shows a severe slowdown of TFP for the some relevant sectors of the Chilean economy.

During the last decade, the price of energy has increased sharply. Figure 10 depicts the evolution of both the electricity tariff and an energy price index. Both prices are defined relative to economy-wide prices. The electricity tariff reported is the base price of energy applied in the Sistema Interconectado Central (SIC) in April of each year. The energy price index is a weighted average of energy prices relevant for Chile, according to their weight in the energy matrix. The energy sources considered are fuel oil, coal and electricity[18], which account for around a 70% of the energy matrix in 2008[19].

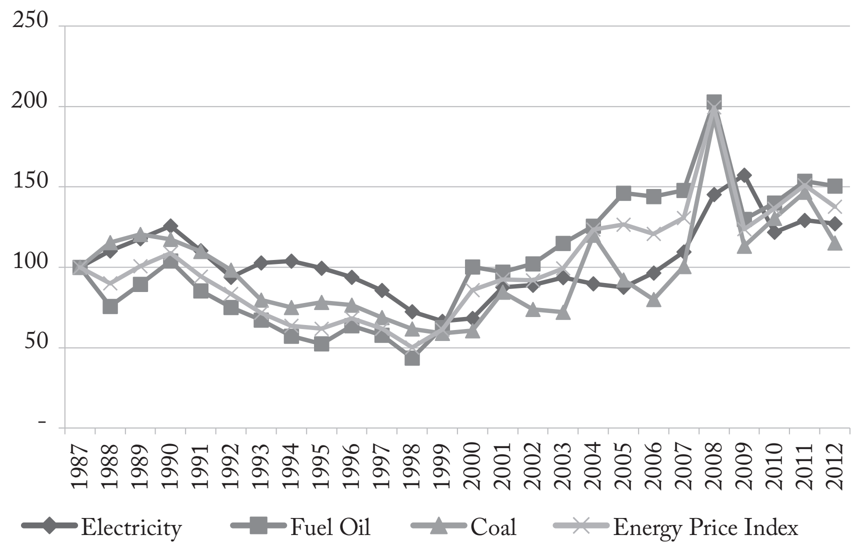
By studying Figure 10, two interesting facts emerge. The first fact is the dramatic fall of energy prices between 1987 and 1998. The relative price of energy accumulated an impressive decline of 50 percent in that period. Since the productive structure of the Chilean economy is intensive in the use of fuel oil and, in a lesser extent, coal, the dynamics of the energy price

18 We exclude firewood and natural gas in our calculations because reliable data for firewood prices are not available and natural gas is only available in few regions of the country; hence, it is not representative nationwide.

19 We use the West Texas Intermediate (WTI) price of petroleum as the reference price of fuel oil in Chile, and, in the case of coal, we use the price of the Australian coal as reference, both taken from IMF's International Financial Statistic (IFS). These figures are converted to Chilean pesos using the Chilean nominal exchange rate.

is mainly given by the evolution of these two foreign sources of energy. As it can be seen in Figure 10, the relative price of fuel oil declined 66 percent between 1987 and 1998, which partially explains why the relative price of energy fell. The other part is accounted for by the downfall in relative prices for coal and electricity. The relative price of coal fell 38 percent, while the real electricity tariff declined 27 percent over those years. It is clear that the decline of the price of foreign sources of energy is the most relevant factor to account for the fall in energy prices in Chile from 1987 and 1998.

Figure 10: The evolution of energy relative prices in Chile.



Note: The graph presents the evolution of the relative price of electricity, fuel oil, coal and the energy price index. All series are expressed relative to the GDP deflator. 1987=100.

Source: Authors' own elaboration based on data from Central Bank of Chile, Comision Nacional de Energía and IMF.

The fall of the relative price of electricity was not a monotone process. In fact, between 1987 and 1990, this price increased 25 percent in real terms. Perhaps, this could be related to the rise of the other energy prices and a drought between 1989 and 1990. Both factors contributed to raising the marginal cost of generating electricity and its price. Subsequently, the prices of foreign energy sources declined and the drought ended. From 1992 to 1994 the price of electricity was fairly stable around the level achieved in 1987. Since 1995 until 1999, this price fell steadily due to an agreement between Chile and Argentina, allowing Chile to import natural gas from Argentina. At the new international prices, Chile could generate electricity at low cost in contrast to preceding years, when power generation used fuel oil and coal as inputs. This encouraged the construction of combined-cycle power plants with the ability to operate using natural gas or fuel oil. This accelerated growth of plants generating power using natural gas instead of fuel oil contributed to an even larger decline in electricity prices.

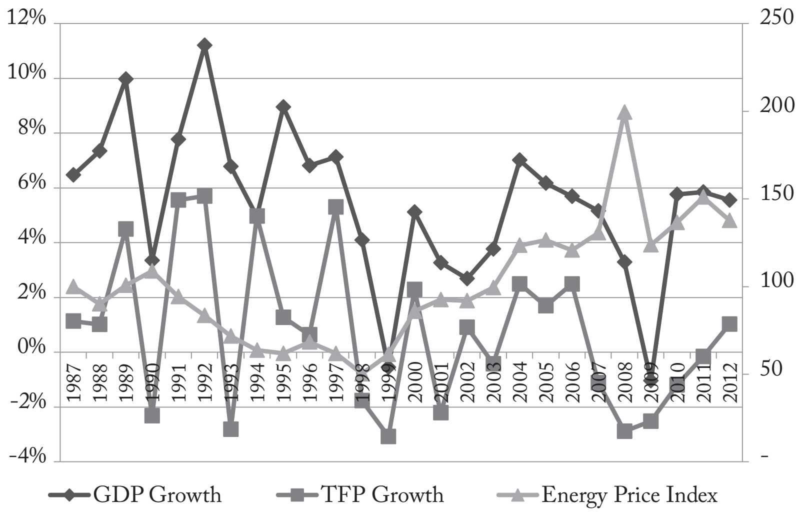
The second striking fact we observe in Figure 10 is the steepness of the upward trend of energy prices after 1999. This growing evolution of energy prices has its roots in domestic and international causes as well. Starting in 2004, Chile began to suffer successive cuts of natural gas imported from Argentina. The reason was simple: Argentinean authorities had fixed the dollar price of electricity and natural gas at such a low level that, along with a high rate of inflation that eroded both prices in relative terms, discouraged further investments in power generation and production by private companies. At the same time, the demand for energy kept growing in Argentina, generating increasing excesses of demand for electricity and natural gas over time. As companies were forced to supply the local market with the shrinking supply of gas, they began to gradually diminish the gas exported to Chile, coming to a complete halt in 2009. Combined-cycle power plants began to generate power using fuel oil, increasing the marginal costs of production, even more after the rising trend of commodity prices, fuel oil especially, that started in 2003 and ended abruptly in July 2008, at the onset of the Great Recession.

Furthermore, the scarcity of natural gas was not foreseen in the contracts between power generation plants and their customers; therefore, plants could not adjust the price they charged and their margins plummeted. This fact explains the dramatic fall in value added and TFP growth of Public Utilities that began in 2004, shown in Section 5. To correct the situation, the government enacted a law –named *Ley Corta II*– that allowed the prices, established in contracts, to follow the marginal costs more closely, which contributed to relieve the tumbling electricity sector.

To make things worse, the country had to bear some droughts in zones where hydroelectric power plants were located and for several years within the last decade: 1998-1999, 2007-2008 and 2010-2011. These droughts decreased the levels of water reservoirs, reducing the production of hydroelectricity, which represents 37% of energy production at total capacity in 2008[20]. Climatic volatility, the scarcity of natural gas and the super-cycle of commodity prices put an enormous pressure to the national system of power generation and they all contributed to explain the rising path of energy prices witnessed in the last decade in Chile.

Figure 11 depicts the path followed by GDP growth, TFP growth –calculated in Section 4– and the relative price of energy. There is a clear negative correlation between the price of energy and GDP and TFP growth rates: when this price rises, GDP and TFP growth slows. In fact, the simple correlation of the relative price of energy and GDP growth is -0.14, and with TFP growth, the correlation is -0.25, between 1987 and 2012. Over the best years of economic growth in Chile, the relative price of energy declined almost monotonically. Since 1998, energy prices began to rise and this growing trend continued until the end of the sample, and as counterpart, GDP and TFP growth rates slowed and have never reached the levels achieved during 1987-1997 period.

Figure 11: Energy prices, gdp and tfp growth in Chile.



Note: The figure presents the path followed by GDP and TFP growth rates (left axis) and the relative price of energy (right axis, 1987=100). The relative price of energy is a consumption-weighted average of fuel oil, coal and electricity prices relative to GDP deflator. This series of TFP was calculated without the contribution of ICT capital (see Section 4 for the details).

Source: Authors' own elaboration.

[20] Note that before the shortage of natural gas in Chile, hydroelectric energy represented 60% of the energy matrix. After that restriction and successive droughts, companies started to produce energy using fuel oil more intensively instead of natural gas.

It seems that, at least as a timing coincidence, the evolution of energy prices are related to the GDP and TFP slowdown of the last decade. But why would a rise in energy price reduce GDP and TFP growth in the first place? Well, energy is consumed mainly for industrial and mining activities. In fact, according to data published by the *Comision Nacional de Energía* in 2008, 51 percent of the total consumption of fuel oil in the country is consumed by transport activities and 20 percent by industrial and mining activities, while 66 percent of electricity is consumed by the latter two economic sectors. The remaining fraction is consumed by commerce, public and residential users. Hence, energy price increases could seriously affect the performance of some of the main economic activities of Chile[21].

What we have done up to this point is to suggest the potential link between the rise of energy prices and the deceleration of GDP and TFP growth rates. Note that we are not claiming that the rise of energy prices is solely responsible for a slowdown of GDP growth; instead we are suggesting that energy prices could be one factor underlying the poor performance of output and productivity growth in Chile over the last decade. Surely, there are other factors as well. Thus, the objective of this section is to provide some evidence in order to discover whether the growing path of energy prices could be an additional factor responsible for the productivity stagnation of the past decade.

The effect of energy price shocks on GDP and productivity growth has been studied extensively in the international literature, following the worldwide shocks to oil prices in 1973 and 1979. We draw on this literature to study this topic for Chile. We specifically draw on the work of Berndt and Wood (1984) for the US and UK manufacturing sectors and the study of Berndt, Mori, Sawa and Wood (1991) for US and Japan manufacturing industries. Basically, their model assumes that capital and energy are complementary factors in the production of output. Thus, when the firm decides to accumulate more capital, it is implicitly choosing an energy-efficiency relation for the productive process because each machine uses a certain amount of energy. At the moment of deciding to buy a given capital unit, the relation of energy-efficiency is fully flexible, but once the machine is bought, it becomes fixed. The firm cannot modify the quantity

[21] Note that transport, industrial and mining activities suffer abrupt declines in TFP growth since 1998 and the former two sectors account for an important part of the total value added of the Chilean economy. Thus, it could be the case that this sharp rise in energy prices is related to the productivity slowdown through the influence in these sectors.

of energy used in operation for a given machine. However, firms can adjust the intensity of the utilization of already installed machines. The academic literature named this kind of technology as putty-clay. Therefore, an energy price shock generates a change in the utilization intensity of different vintages of capital, according to its energy-efficiency factor –in particular, reducing the operation of energy-inefficient machines–, affecting the aggregate capital services and measured TFP growth, calculated as a Solow residual.

The national literature has also studied the effects of energy shocks on GDP and TFP for Chile, although, in most cases, electricity is the only energy input considered. Echavarría, García-Cicco and Soto (2009) calculate the effect of electricity price shocks on TFP, at the aggregate level, using an extended semi-structural production function, in which hours worked and capital stocks are combined using a Cobb-Douglas function, which are then combined once again with electricity consumption using a CES production function. In their model, the effect of energy shocks on TFP crucially relies on the elasticity of substitution between value added –the combination of capital and labor– and electricity. Also, as an extension exercise, the authors add to the model a capital depreciation function depending on the relative price of electricity, which is a simple way of capturing the effects of energy prices on capital utilization adjustments. The authors calculate, for the period 2005-2008, that potential growth would have been 0.3 percentage points higher, on average, and around 0.7 percentage points higher in the second quarter of 2008 if the price of energy had been the period average.

Another study that involves the relation of electricity prices and productivity is that of Alvarez, García and García (2008). The authors show that higher electricity prices lower the growth of labor productivity in Chile's manufacturing industries, using their econometric estimations for the period 1992-2005. Their estimated parameters suggest that a 10 percent increase in energy prices slows industry-level TFP growth around 1 percentage point in the short-run and 2 percentage points in the long-run. The authors also study whether this effect varies according to plant size and the utilization intensity of energy. They find that the decline in labor productivity growth after an energy price increase is larger for plants operating in more energy-intensive industries and for bigger plants.

Another related paper is by Blümel, Espinoza and Domper (2009). The authors assess the link of energy prices and economic growth using cointegration and error correction methods. As a proxy of energy prices, they calculate a weighted index of fuel oil, coal and electricity prices, as we do. The authors estimate a fall in GDP growth of 2 percentage points in the long-term if energy price doubles, although they did not find any significant effect of the energy price on output growth in the short term.

The rest of this section begins with a brief discussion about the framework employed to analyze how the rise of energy prices affects productivity[22]. Then, we describe the data to be incorporated later into a modified version of the growth accounting, outlined in detail in Appendix D, and discuss the results of this exercise.

6.1. What is the connection between energy shocks and productivity?

The international literature studying the worldwide productivity slowdown and its relation with the energy price shocks –occurred in 1973 and 1979– claim that the main channel of influence of energy prices on productivity is through capital services. This literature began by studying empirically the relation of energy consumption and capital stocks in the production function. Hudson and Jorgenson (1978) and Berndt and Wood (1979) found independently that capital and energy are complements in production, which means that capital requires energy to operate properly. Hence, high energy prices encourage a substitution of labor for capital because capital becomes relatively more expensive than labor. Since this substitution results in an increase in labor use, the rise of energy prices reduces (labor) productivity growth.

However, according to Nordhaus (1980, 1982) and Baily (1981), the story of the last paragraph is incomplete. On the one hand, Nordhaus (1980) claims that the previous argument ignores a key issue regarding the relation of energy and capital: the embodied nature of energy use, which means that once capital stock has been installed, the amount of energy it needs is fixed and it cannot be changed without substantial modifications of capital stocks. For that reason, no matter how hard the economy is hit by a negative energy shock, machines cannot change the quantity of energy employed for operation. However, the utilization of the machines can be adjusted, which means that if a given capital unit is using more

[22] The formal presentation of the framework employed in this paper to assess the effect of energy prices on productivity is explained in detail in Appendix D.

energy than other units, it is optimal to use it less intensively at the onset of a sharp rise of energy prices.

On the other hand, the point stressed by Baily (1981) is that official data on capital stock cannot capture any effect of a rise in energy costs because capital stocks are built using the Perpetual Inventory Method, which considers fixed retirement and depreciation patterns. It ignores any factor inducing a change on the utilization rates of capital, such as energy price shocks. Thus, an indicator of capital services, considering the energy price-induced change on utilization rates, instead of capital stocks, has to be employed in the growth accounting framework to account for the effect (if any) of the energy price fluctuations on productivity growth.

Berndt and Wood (1984) build an empirical model, taking into account both considerations. They use simulation methods to address the effect of energy price changes on productivity growth. Their model assumes that capital and energy are complements in production, with an elasticity of substitution governing this relationship. Moreover, the technology is putty-clay, which means that capital is fully flexible *ex ante*, but immutable once it has been installed. So a high cost of energy implies a change in the utilization rate of capital vintages according to the vintage's energy-efficiency relation: energy-efficient machines will be used more intensively and energy-inefficient machines will be used less intensively or discarded when the relative price of energy grows sharply. This shock reduces the growth rate of capital services, because the utilization of some capital units falls.

In this model, the relevant price of energy is relative to the price of capital goods that employ energy for the operation: machinery, vehicles and electronic equipment. Hence, when the cost of energy relative to capital is increasing, the utilization rates of capital, induced by fluctuations in energy prices, declines, reducing aggregate capital services. This adjustment of capital services defines a new Solow residual, as measure of TFP growth, which differs from the traditional calculation of TFP. In a scenario of substantial hikes in energy prices, this new TFP would be higher than the one traditionally measured because capital services would be lower, *ceteris paribus*[23].

[23] Although this is probably not the argument that closes the controversy, the framework employed is very attractive since it fits nicely into the growth accounting framework outlined in this paper. This will be clear in this section below. Furthermore, it is not the point of our paper to discuss the relative success of this or other arguments to account for the productivity slowdown in the US during the 1970s.

The crucial parameter that governs the quantitative relation between rises to the relative price of energy and TFP is the *ex ante* elasticity of substitution between energy and capital. This parameter influences how the utilization rates of capital vintages change when the relative price of energy fluctuates.

In this section, we employ a model with these features to address the link between energy prices and productivity. Before restating the growth accounting equations, we remark that the mechanism just described is more plausibly applied to machinery and equipment than to residential and non-residential structures. Thus, the rise in energy costs will affect a fraction of capital services only[24].

In Section 4, we decompose the growth rate of output into its sources as follows:

$$(7) \qquad \Delta 1nY(t) = \Delta 1nA(t) + \alpha\Delta 1nK(t) + (1-\alpha)\Delta 1nL(t),$$

where the growth rates are expressed as log differences, α is the capital income share in valued added (under the assumption of constant returns to scale), $\Delta 1nY(t)$ represents the GDP growth rate, $\Delta 1nA(t)$ is the TFP growth rate, $\Delta 1nK(t)$ is the aggregate growth rate of capital services and $\Delta 1nL(t)$ is the aggregate growth rate of labor services. Both aggregate growth rates of input services are weighted averages of heterogeneous types of inputs using their relative payments as weights (as shown in Appendix A). Capital services in equation (7) include residential structure, non–residential structure and machinery and equipment. Disaggregating the aggregate capital growth rate into these components gives

$$(8) \qquad \Delta 1nY(t) = \Delta 1nA(t) + \alpha\,[\upsilon_{R,t}\Delta 1nK_{R,t} + \upsilon_{NR,t}\Delta 1nK_{NR,t} + \upsilon_{M,t}\Delta 1nK_{M,t}] + (1-\alpha)\Delta 1nL(t),$$

where $\upsilon_{i,t}$ is the share of capital income that capital i holds in period t, where $i{=}R$ represents residential structure, $i{=}NR$ represents non–residential structure and $i{=}M$ represents machinery and equipment[25]. Now, the utilization–adjusted TFP growth rate is obtained using machinery and equipment figures, adjusted for the price–induced change in utilization rate:

[24] This is the same assumption made by Berndt, Mori, Sawa and Wood (1991) and based on the casual observation that other types of capital do not use energy as inputs to function properly.

[25] The exact expression of the shares of capital income is provided in Appendix A.

(9) $$\Delta 1nY(t) = \Delta 1nA^*(t) + \alpha\,[\upsilon_{R,t}\Delta 1nK_{R,t} + \upsilon_{NR,t}\Delta 1nK_{NR,t} + \upsilon_{M,t}\Delta 1nK^*_{M,t}] + (1-\alpha)\Delta 1nL(t),$$

where the star superscript means that the figure has been adjusted by utilization. Subtracting equation (8) from (9) results the following expression:

(10) $$\Delta 1nA^*(t) - \Delta 1nA(t) = \alpha\upsilon_{M,t}\,[\Delta 1nK^*_{M,t} - \Delta 1nK_{M,t}] = -\alpha\upsilon_{M,t}\Delta 1nB_{M,t},$$

which relates both the utilization-adjusted and the traditional TFP growth rates with the change of the aggregate utilization rate, . Although the exact expression of the aggregate utilization rate is derived in Appendix D, where we explain the full model in detail, we will discuss its determinants here. The change in the utilization rate of capital services depends on the interaction of the elasticity of substitution between capita and energy and the expected path of the relative price of energy. A sharp rise in the relative cost of energy encourages a decline in the use of the vintage suffering the rise, relative to older vintages not affected by those energy shocks. This change depends on the substitution across vintages. If there is little substitution, the adjustment will be sluggish and the effects on productivity will be spread over many years. The opposite will happen when substitution is high.

The other relevant factor affecting the utilization rate of capital services is the expected path of the relative price of energy. The reason is that since investment is a forward-looking decision, the firm has to forecast the full path of expected costs of capital relative to energy to decide how much capital wants to use in the productive process. If expected path of future prices of energy is increasing, the firm has the incentive of using older capital vintages more intensively, instead of newer vintages, which reduces the growth of capital services and its contribution to GDP growth.

In sum, in this model a rise in energy costs will reduce the utilization rate of energy-inefficient machines, reducing aggregate utilization of capital and the contribution of capital services to GDP growth. In such case, the adjusted TFP growth rate will be higher than the traditional calculation.

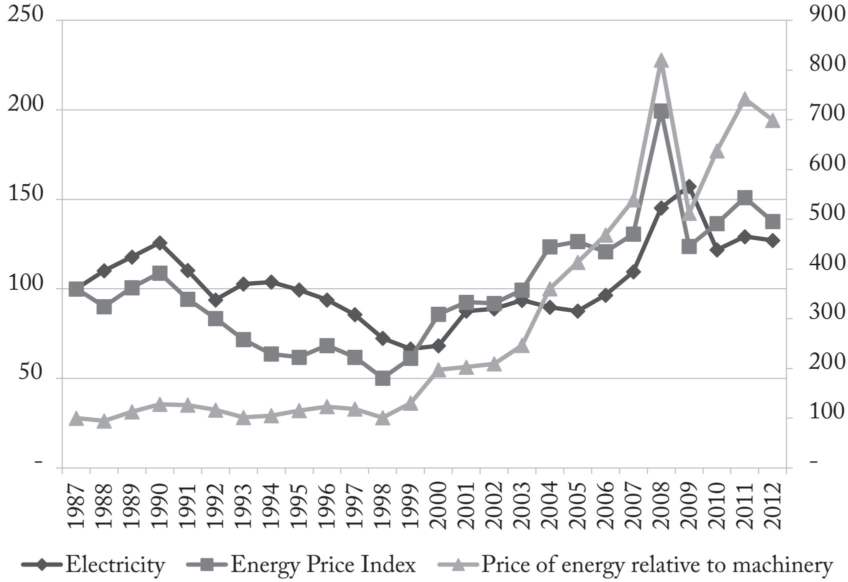
6.2. Growth accounting including the effect of energy price shocks

In this section, we will simulate the model outlined above. One of the key inputs of the model is the path of expected relative prices of energy. This requires specifying the expected path of the relative price of energy at each point of time, which is a very complex problem. To reduce the complexity of the issue, Berndt, Mori, Sawa and Wood (1991) assume that, starting from the effective relative price, future prices grow at a constant rate. This is mathematically equivalent to using the effective price of energy relative to capital as a proxy of the present value of future relative prices. We will also adopt that assumption in this paper. Although this approach seems to be a little bit coarse at first sight, it is a very valuable first approximation to analyze the effects of energy prices on productivity.

Figure 12 depicts the evolution of the price of energy relative to the price of machinery. This is equivalent to the expected discounted relative price of energy under the maintained assumption of constant growth of such prices. This relative price is constructed as the ratio of the energy price index over a deflator of machinery and equipment investment. In Figure 13, we also include the price of electricity and energy relative to the GDP deflator to contrast the relative price relevant for the model with prices, whose observation is more direct. A simple inspection of this relative price reveals an interesting pattern: during the best years in terms of GDP and TFP growth rates –between 1987 and 1997, the Golden Years of the Chilean economy– the relative price of energy was low and fairly stable, which was followed by years of increasing relative energy prices, especially from 2002 to 2008, when the growing trend accelerated further, coinciding with years of stagnation and decline in productivity growth. In 2009, a substantial decline of this price occurred, whose origin was discussed at the beginning of this section. However, in 2010, the growing path of the relative price of energy resumed, potentially affecting productivity growth further.

Note that the relative price of energy rises if the price of energy increases or if the price of capital decreases. After 2000, both occurred: energy prices went up as we documented previously in this section and the price of machinery and equipment declined sharply. Chile imports machinery and equipment and therefore their price was influenced by the real appreciation that occurred over those years and Chile's openness to trade, through a further reduction in the maximum import tariff and the signing of Preferential Trade Agreements.

Figure 12: The evolution of price of energy relative to machinery.

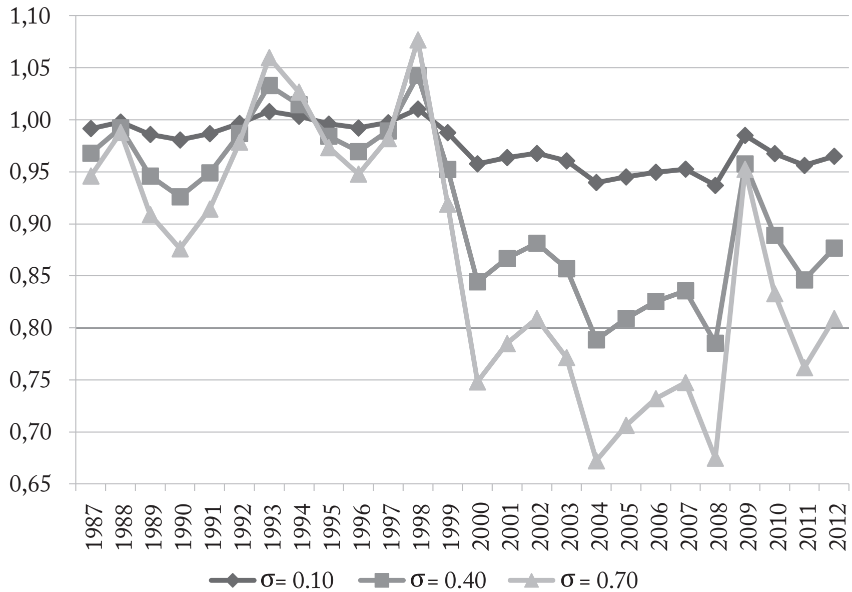


Note: The prices of electricity and energy are measured relative to a GDP deflator (left axis, 1987=100). The price of energy relative to capital is the energy price index relative to the deflator of investment in machinery and equipment investment (right axis, 1987=100).

Source: Authors' own elaboration.

Another key parameter of this model is the elasticity of substitution between energy and capital. In Figure 13, we depict the path of utilization rates of machinery and equipment induced by the fluctuation of the price of energy relative to machinery in Chile since 1987 for three values of the elasticity of substitution (σ). As was expected, the pattern of utilization rate follows closely the path of the fluctuations of the relative energy price. Specifically, when energy is relatively cheap, there is an intense utilization of capital services –utilization rate above 1–, while the opposite occurs when the price of energy rises. In fact, there is some over-utilization between 1991 and 1998, the Golden Years of economic growth in Chile. Undoubtedly, the contribution of capital services to GDP growth would have been lower if energy prices had been higher.

Figure 13: Energy price-induced utilization rates of capital in Chile.



Note: The utilization rates have not been adjusted for the income share of machinery and equipment over total capital. σ represents the *ex ante* elasticity of substitution between capital and energy.

Source: Authors' own elaboration.

As the price of energy began to rise in 1999, the utilization rate started to decline. The utilization recovered from low levels post-crisis, but again began to fall along the following decade. Note that when the elasticity of substitution is high the over –utilization is higher and the under–utilization is lower in contrast when σ is low. When this elasticity is high, the technical relation between capital and energy is more flexible; thus, changes in prices induce swift adjustments to the utilization intensity rate of capital and larger TFP fluctuations. This is the situation when a Cobb-Douglas production function is assumed, in which case σ equals one. However, if σ is substantially less than one, the use of a Cobb-Douglas function would be inducing a larger effect of energy prices on capital services and TFP than it should.

In Figure 13, we contrast the magnitude of the fluctuations in utilization rates for high and low elasticities of substitution between capital and energy. When the elasticity of substitution is low, the utilization rate suffers mild fluctuations in spite of the sharp rises in relative energy prices in contrast to changes in the utilization of capital when σ is larger. When σ is low the technical relation between capital and energy is not so flexible in the short-term; therefore, the adjustment to energy price shocks is not instantaneous, which is the case when σ is high or when the Cobb-Douglas is assumed. Instead, the effect of such fluctuations on capital services and TFP is sluggish and spreads over time. In all, the downfall produced in capital services when the energy price rises would be higher when σ is high, and then, the measured TFP growth would be higher.

Another two parameters, relevant for our calculations, are the depreciation rate and the service life of machinery and equipment. Both variables are important since they affect the number of years before a machine is replaced and thus they also influence the decision to invest on capital, besides energy prices. To isolate the effect of the energy price fluctuations on capital services, we assume that the depreciation rate and the service life of machinery and equipment are constant and do not vary according to the year of investment. The depreciation rate we assume is 11.5%, a standard figure employed by the international literature of growth accounting[26], and the service life will be equal to 11 years and will not vary over time[27].

In Table 12, we contrast the resulting TFP growth, adjusted by the change in utilization rate induced by fluctuations of energy prices, with the estimations of TFP growth of Section 4. Adjusted-TFP is calculated for three different elasticities of substitution between capital and energy: 0.1, 0.4 and 0.7. The first thing to notice from Table 12 is that there are slight discrepancies, on average, between the adjusted and unadjusted figures in 1987-2012. However, there are some differences when we look closely at the figures of Table 12. Such discrepancies come from marked swings in the price of energy relative to machinery. In such case, adjusted and unadjusted figures of TFP growth tend to differ, according to the elasticity of substitution between capital and energy.

When we discussed the evolution of energy prices relevant for Chile, we observed that the relative price of energy seems fairly stable between 1987 and 1997, in contrast to the sharp fluctuations, mostly upswings, in

26 See Jorgenson and Vu (2007).

27 A sensibility analysis was performed in order to assess how the adjustment on the utilization rate of capital varies according to different and possible values of the service life. The values tested were 14, 15, 16 and 18, which are the figures calculated by Henriquez (2005) for several groups of years. We did not find any significant difference between these calculations and the results presented in the main text.

1998-2012 (see Figure 12). This explains the little difference we calculate for those years among all indicators. When σ is 0.10, the average adjusted TFP growth is equal to the average unadjusted figure in 0.1 percentage point in 1987-1997. When σ is 0.4, TFP growth is slightly lower than the traditional indicator of TFP, on average, between 1987 and 1997, in contrast to the situation when When σ is 0.7 in which case the average TFP growth is marginally higher than the traditional calculation of TFP in 1987-1997.

TABLE 12: CONTRASTING TFP GROWTH RATES.

	Adjusted TFP Growth (σ = 0.1)	Adjusted TFP Growth (σ = 0.4)	Adjusted TFP Growth (σ = 0.7)	Unadjusted TFP Growth
1987-2012	0.8%	0.9%	0.9%	0.8%
1987-1991	2.0%	2.0%	2.1%	2.0%
1992-1997	2.5%	2.4%	2.3%	2.5%
1998-2003	–0.6%	–0.3%	–0.1%	–0.7%
2004-2008	0.7%	1.0%	1.2%	0.5%
2009-2012	–0.7%	–1.2%	–1.7%	–0.7%

Note: "Adjusted TFP growth" includes the energy price-induced change in utilization rate of capital services, according to the ex ante elasticity of substitution specified in parenthesis. The "Unadjusted TFP growth" is TFP growth, without ICT capital goods, calculated in Section 4. GDP and capital services are calculated using Central Bank of Chile's *Compilacion de Referencia 2008*. Labor services are calculated using INE's Employment Surveys. Services are obtained by adjusting stocks for quality as shown in Appendix A. Aggregate capital share equals 40%. Preliminary figures are employed since 2010.

Source: Authors' own calculations.

The relative price of energy increased steadily in 1998-2012, inducing a reduction of the utilization of capital and the contribution of its services to GDP growth. These are the years in which we calculate larger differences. Between 1998 and 2003, the deceleration of TFP growth was larger using the unadjusted figures than those adjusted for changes in utilization induced by energy prices, along with a high elasticity of substitution between capital and energy. In fact, the unadjusted decline of TFP was 0.7 percentage points, on average, while the drop of adjusted TFP was just 0.3 and 0.1 percentage points, on average, when σ equals 0.40 and 0.70, respectively (see Table 12). Over these years, the relative price of energy began to rise, reducing the utilization of capital services and inducing a higher TFP growth, or in this case, generating a lower decline in TFP growth.

Note that the adjustment is larger when the substitution between energy and capital is higher. The reason is the speed of the adjustment implicit in the technical relation between these two factors of production. A higher elasticity of substitution implies a faster decline in the utilization of capital, when the relative price of energy rises, inducing a sharper and instantaneous fall in TFP. In contrast, when the elasticity of substitution is lower, the adjustments in the utilization of capital and the fall in TFP are smoother and spread over time.

The price of energy relative to capital expanded faster in 2004-2008 than the preceding years, which reduced the utilization and contribution to growth of capital services further, elevating the adjusted TFP growth in contrast to the unadjusted measure. The average difference is 0.5 percentage points when σ equals 0.40 and 0.7 percentage points when σ equals 0.70 (see Table 12). Again, the adjusted TFP growth calculated using a higher elasticity of substitution generates a larger expansion because the decline in the utilization rates of capital services is sharper when the technical relation between capital and energy is more flexible. This generates a larger fall in the contribution of capital services to GDP growth and thus, adjusted TFP growth turns out to be larger than the traditional TFP.

Between 2009 and 2012, the evolution of the relative price of energy is mixed: in 2009, this price fell abruptly since commodity prices declined sharply at the onset of the Great Recession and subsequently, this price resumed the growing trend of preceding years. This somewhat erratic path complicates the analysis of the average performance of TFP because the utilization of capital services rises sharply and later declines, although with a lesser strength. In this case, the decline of the relative price of energy was larger than the rise in this price in absolute value, and that is why the average drop in adjusted TFP growth results larger than the average unadjusted TFP, mostly so when the elasticity of substitution is relatively high.

Then, how much would have TFP grown if the relative price of energy had increased less? Since 1999, the price of energy relative to the price of machinery –the relevant price of the model outlined above– has increased 17 percent, on average. Using the model of this section, we simulate how high TFP growth would have been if the relative price of energy had increased 10 percent, on average, in 1999-2012[28]. Of course,

[28] This 10 percent increase is the average growth rate of the price of energy relative to the price of machinery in 1987–2012.

the answer depends on the elasticity of substitution between capital and energy. When σ equals 0.1, an increase of 10 percent of the relative price of energy, instead of the effective 19 percent, would have generated no gain in TFP growth between 1999 and 2012. When σ equals 0.4, however, this gain would have been 0.15 percentage points per annum, on average, in the same period and when σ is 0.7 the gains would have been 0.36 percentage points per annum, on average, over those years.

The gains of higher TFP we calculate are somewhat lower than the estimates found by Echavarría, García-Cicco and Soto (2009) using a very different methodology. These authors use a semi-parametric approach of a general equilibrium model where the production function is such that the elasticity of substitution is between value added –a Cobb-Douglas function of labor and capital– and energy consumption. This model is estimated using quarterly data and the only source of energy considered is electricity. The authors estimate a TFP growth rate 0.5 and 1.3 percentage points higher, on average, than traditional estimation of TFP in 2005–2008 if the price of electricity would have been at the average level of their sample. The exact value of this gain in TFP depends on the elasticity of substitution between value added and energy. In contrast, we employ a CES function between capital and energy –which is a natural assumption according to Bruno (1984)–, so the elasticity of substitution is defined between capital and energy. This composite is later combined with labor using a Cobb-Douglas function. We use annual data and the following energy sources included in the price index: fuel oil, electricity and coal. If the relative price of energy grows at the average rate of the sample (1987-2012), TFP growth would have been between 0 and 0.36 percentage points higher per annum, on average, between 1999 and 2012.

Although it is clear that if the relative price of energy had grown less sharply, TFP growth would have been higher, these gains are not high enough to reverse the declining trend in TFP growth since 1998. In all, the rise of energy prices cannot fully account for the slowdown of productivity in Chile.

7. Opportunities to increase growth in the short-term

It is usual that all recommendations of policies to encourage growth aim to boost GDP growth at the long-term. In fact, all chapters on this volume discuss growth-enhancing reforms with such feature. But is there anything the country can do to improve its short-term performance? Our answer is a resounding yes. Chile can still stimulate GDP growth in the short-run by adopting reforms aimed to increase the labor force participation, in particular, by encouraging the employment of young people and women.

For improving the welfare of the current generation, the main opportunities lie on elevating the population's employment rates. The rate of labor force participation of people between 15 and 64 years old was 64.8% in 2010 and 66.2% in 2011, lower than the OECD's, which was equivalent to 70.5% in 2011. This situation is troubling especially for young people and women with low levels of human capital and for the poorest members of society. In fact, in 2011 the rate of labor force participation of young people between 15 and 24 years old was 37.5% contrasting with the 47% of OECD countries. In 2011, this situation marginally improved as the labor force rate of young people reached 38.4%, but the country is still far from reaching OECD levels. While the participation of women in the labor force was 51.8%, ten percentage points lower than the OECD's level in 2010. In 2011, this rate went up to 53.9%, which is an important advance, but still below from the level of OECD countries (61.8% in 2011).

Chile's employability rate –the ratio between employment and population over 15 to 64 years old– was 59.3% in 2010 and 61.3% in 2011. Although, it increased 2 percentage points, it is unsurprising that this ratio is below the OECD level, which was equivalent to 64.8% in 2011. This difference of 3.5 percentage points implies that there is a chance to increase employment in about 700.000 workers in Chile, beginning in 2012, with growth-enhancing effects for some years to come. In fact, the OECD employment rate can be achieved in 2015 if employment grows at 2.3 percent per annum, on average, starting in 2012. This is equivalent to creating 175,000 new jobs per year, from 2012 to 2015. In such a case, GDP growth would gain 0.8 percentage points per annum more, on average, in contrast with the average GDP growth obtained by keeping the employability rate constant at 61.3%, ceteris paribus.

To achieve this 0.8 percent gain in growth, every year for four years, it is necessary to advance the reform of policies and institutions that stimulate the attractiveness of entering the formal labor force and to encourage the employment creation. What type of policies and institutional reforms may contribute to increase the employability rate? The *Consejo Asesor Presidencial Trabajo y Equidad* suggests:

1. Grant an income subsidy to increase the employability of the poorest population.
2. Increase the labor participation of women through parental-leave subsidies, increase the financial resources for nurseries, encourage telecommuting and the re-entry of mothers to the labor market.
3. Create special programs of training and formation for young people, women and adults of high labor and social vulnerability, favoring their entry to the labor market.
4. Reform the current system of severance payments and improve the unemployment insurance model.
5. Create a market of labor intermediation, based on a system of differentiated bonds according to a worker's vulnerability.
6. Adopt age-contingent minimum wages.

In the same vein, the OECD recommends that Chile:

1. Adopt policies favoring human capital accumulation.
2. Strengthen the conditions of labor utilization.
3. Facilitate part-time jobs and telecommuting, because the prevalence of part-time jobs among the women in Chile is lower than the OECD's average.
4. Adopt social protection policies aimed to promote employment.
5. Ease access to child-care facilities.

Note that policies to increase employment in the short term not only are important because of their gains in economic growth in the near-term, but because higher employability in the formal labor market will also contribute to improve income distribution and the quality of human capital, through the possibility of simply having a job and on-the-job training.

8. Concluding remarks

In this paper, we have provided evidence about GDP and TFP growth performance in Chile, applying the methodology of Jorgenson and Stiroh (2000) in order to assess the contribution of ICT capital goods to output growth, and of course, to calculate TFP growth and study its dynamics, especially between 1987 and 2012. All of these calculations are based on the new National Accounts, in which volumes are measured using chained prices. We found that the performance of the Chilean economy is accounted for mainly by the contribution of capital services in the last twenty five years. Within capital services, particularly remarkable is the role played by ICT goods, whose accumulation is actually sustaining GDP growth since 2004. Over these years, Chile lived a period of prolonged real appreciation and a deepening of trade openness by the signing of Preferential Trade Agreements that kept import tariffs at low levels. All these contribute to making ICT imports cheaper and thus allowed the country to reap the benefits of the accumulation of new technologies.

In recent years (2009-2012), capital services are contributing to output growth at high rates, and at same time, an important boost to GDP growth is also given by labor services, whose origin is a strong expansion of formal employment, although it began to moderate its dynamics in 2012. Unfortunately, TFP growth has been declining since 1998 and has virtually stagnated in the last decade.

Another relevant observation from the growth accounting exercise of Chile is that years of high GDP growth were periods of high expansions of TFP. This explains why, despite factors of production being accumulated at a high rate over recent years, GDP growth is not achieving the rates witnessed in the Golden Years. Of course, if Chile wants to return to the path of sustained growth, the country must work on removing the factors constraining the growth of productivity.

Then we explore two hypotheses that could explain the deceleration of productivity since 1998. The first concerns the performance of economic sectors. If two or three economic activities, accounting for the lion's share of the economy, are experiencing a poor productivity performance, then they can account for a large fraction of the productivity deceleration. The second hypothesis is related to the effect of a sustained rise of energy price rises on GDP and TFP growth. In particular, a growing path of energy prices deteriorates capital services in a sustained fashion as some machines are employed less intensively –becoming idle eventually– and lowering the economy's productive capacity. As the relative price of energy has risen sharply since 1998, this shock may have sizeable effects on output and productivity growth.

When we analyze labor productivity growth at the sector-level, we find that the slowdown in aggregate (labor) productivity is accounted for by a lower growth in productivity of all economic sectors and a lower contribution of the reallocation of workers toward high-productivity sectors. During the Golden Years of the Chilean economy, the contribution of such reallocation was high. Thus one explanation underlying the decline in aggregate productivity is the low reallocation of workers toward high-productivity sectors. This could be the consequence of labor market inflexibilities, hindering the flow of workers toward most productive employments or it could be the result of the scarcity of skilled labor, required in high-productivity activities, that forces unskilled workers, a large fraction of the population, to flow toward low-productivity sectors. Further research is required at this point to assess the plausibility of these two arguments.

The growth accounting applied to the economic sectors of Chile shows a decline in TFP of all economic activities since 1998. However, some sectors suffered more abrupt falls in TFP growth than others between 1998 and 2011. This is the case of Financial Services and Transport. In addition, the TFP of Manufacturing is declining since 1992, although at varying rates. These three sectors account for about half of the total value added of the Chilean economy, so they can certainly account for a large part of the decline in aggregate TFP growth. If TFP growth of three sectors had kept the pace of 1987-1997, aggregate TFP would have slowed anyway in 1998-2011, in contrast to the ten preceding years, but it would not have declined, and aggregate TFP and GDP growth would have been 1 percent per annum higher, on average, for 13 years. This is a large difference.

In Section 6, we outlined a modified version of the growth accounting framework that includes the effect of energy prices on productivity. Rises in energy prices encourages a decline in the utilization of capital services, reducing the productive capacity of the economy and increasing the TFP growth in contrast to the traditional calculation. The fall in the contribution of capital services depends on the elasticity of substitution between capital and energy. We perform several simulations for different values of this parameter. We found that a higher elasticity of substitution generates sharper and instantaneous changes in the utilization of capital and TFP as the relation between capital and energy is more flexible. In contrast, when this parameter is low, such fluctuations tend to be smoother and spread over time. The key price of this model is the price of energy relative to the price of machinery. Such price increased 17 percent, on average, in 1999-2012. We simulate the effects of an average rise of 10 percent in the same period. We found that TFP growth would have been between 0 and 0.36 percentage points per annum higher, on average, between 1999 and 2012, depending on the exact value of the elasticity of substitution between energy and capital. Further research is required to pin down the value of this parameter. Although these gains are important, they are not high enough to fully account for the slowdown of aggregate TFP in Chile.

Finally, we proceeded to analyze what economic policies Chile should adopt to boost the pace of GDP growth in the short-term. This set of reforms should be aimed at increasing the employment of young people and women. If the country plans to reach the employability rates of OECD countries in 2015 by adopting such policies, then, employment must grow 2.3 percent per annum, beginning in 2012. Thus, 700.000 persons would join the labor force between 2012 and 2015, generating a gain of 0.8 percent per annum of higher GDP growth in each one of these years.

In all, Chile has a great opportunity to improve its performance as the distance to the productivity frontier of advanced economies is still significant. To seize this opportunity, the country needs to return to the path of high GDP growth in a sustainable way and the best way of doing it is by boosting productivity. This way Chile can close its per capita income gap with advanced economies and take the first step toward the long sought development.

References

Alvarez, R., A. García and P. García (2008). "Shocks de Energía y Productividad en la Industria Manufacturera Chilena". Working Paper 482. Central Bank of Chile.

Baily, M. (1981). "Productivity and the Services of Capital and Labor". Brookings Papers on Economic Activity, Vol. 1981, No. 1 (1981), pp. 1–65.

Beyer, H. and R. Vergara (2002). "Productivity and Economic Growth: The Case of Chile". In N. Loayza and R. Soto (edts.), Economic Growth: Sources, Trends and Cycles, Santiago: Central Bank of Chile.

Berndt, E. and D. O. Wood (1979). "Engineering and Econometric Interpretations of Energy-Capital Complementarity". American Economic Review, Lxix (June 1979), 342–54.

Berndt, E. and D. O. Wood (1984). "Energy Price Changes and the Induced Revaluation of Durable Capital in us Manufacturing During the opec Decade". mit Energy Laboratory Working Paper No. 84-003. Cambridge, Mass., March.

Berndt, E., S. Mori, T. Sawa and D. O. Wood (1991). "Energy Price Shocks and Productivity Growth in the Japanese and U.S. Manufacturing Industries". In C. R. Hulten (editor) Productivity Growth in Japan and the United States. University of Chicago Press.

Blümel, G., R. Espinoza and M. L. Domper (2009). "Crecimiento Economico, Precios de la Energía e Innovacion Tecnologica". Manuscript.

Bruno, M. (1984). "Energy Raw Materials, Profits, and the Productivity Slowdown". The Quarterly Journal of Economics, Vol. 99, No. 1 (Feb., 1984), pp. 1-30.

Caballero, R. J. and M. Hammour (2005). "The Cost of Recessions Revisited: A Reverse-Liquidationist View", Review of Economic Studies 72, April 2005, 313-341.

Central Bank of Chile (2012). "Informe de Política Monetaria". June 2012.

Christensen, L. R., D. Cummings, and D. W. Jorgenson (1980). "Economic Growth, 1947–1973: An International Comparison". In New Developments in Productivity Measurement and Analysis, eds. John W. Kendrick and B. Vaccara, 595-698. Chicago, IL: University of Chicago Press.

Chumacero, R. and R. Fuentes (2002), "On the Determinants of the Chilean Economic Growth", Working Paper 134. Central Bank of Chile.

Coeymans, J. E. (1999) "Ciclos y Crecimiento Sostenible a Mediano Plazo en la Economía Chilena". Cuadernos de Economía 36 (107).

Consejo Asesor Presidencial Trabajo y Equidad (2008). “Hacia un Chile Mas Justo: Trabajo, Salario, Competitividad y Equidad Social”, Informe Ejecutivo.

Comite Consultivo del pib Tendencial (2010). “Acta de Resultados Comite Consultivo del pib Tendencial”. Ministerio de Hacienda. Direccion de Presupuestos.

Comite Consultivo del pib Tendencial (2011). “Acta de Resultados Comite Consultivo del pib Tendencial”. Ministerio de Hacienda. Direccion de Presupuestos.

Corbo, V. and J. A. Tessada (2002), “Growth and Adjustment in Chile: A Look at the 90s”. In N. Loayza and R. Soto (edts.), Economic Growth: Sources, Trends and Cycles, Santiago: Central Bank of Chile.

Corbo, V. and K. Schmidt-Hebbel (2011), “The International Crisis and Latin America: Growth Effects and Development Strategies”, in M. Haddad and B. Shepherd (editors): Managing Openness: Trade and Outward-Oriented Growth after the Crisis, The World Bank, Washington, DC.

De Gregorio, J. (1997), “Crecimiento Potencial en Chile: Una Síntesis”, in Morande, F. and R.Vergara (eds.) (1997), Analisis Empírico del Crecimiento en Chile. Centro de Estudios Publicos-ilades/Georgetown University, Santiago.

De Gregorio, J. (2005). “Crecimiento Economico en Chile: Evidencia, fuentes y perspectivas”. Estudios Publicos, 98 (Otoño).

Echavarría, G., J. García-Cicco and C. Soto (2009). “Productividad Total de Factores, Costo de la Energía y Producto Tendencial”, Minuta Informe de Política Monetaria, December 2009, Central Bank of Chile.

Fuentes R., M. Larraín and K. Schmidt-Hebbel (2006). “Sources of Growth and Behavior of tfp in Chile”. Cuadernos de Economía, 43 (127), pp. 113-142.

Fuentes R. and M. Morales (2010). “On the Measurement of Total Factor Productivity: A Latent Variable Approach”. Macroeconomic Dynamics, Published online by Cambridge University Press 22 Mar 2010.

Gallego, F. and N. Loayza (2002). “The Golden Period for Growth in Chile. Explanations and Forecasts”, in Loayza N. y R. Soto eds., Economic Growth: Sources, Trends and Cycles, Santiago: Central Bank of Chile.

Henríquez, C. (2008). “Stock de Capital en Chile (1985-2005): Metodología y Resultados”. Studies in Economic Statistics N° 63, Central Bank of Chile.

Hudson, E. A. and D. W. Jorgenson (1978). “Energy Prices and the us Economy, 1972-76”. Natural Resource Journal (October 1978), 877-97.

ine (2006), “Cuenta Satelite de Tecnologías de Informacion y Comunicacion en Chile”. Agenda Digital.

Jadresic, E. and R. Zahler. (2000). “Chile’s Rapid Growth in the 1990s: Good Policies, Good Luck, or Political Change”. imf Working Papers 153, August.

Jorgenson, D. W. (2005). "Accounting for Growth in the Information Age", in Philippe Aghion and Steven Durlauf (eds), Handbook of Economic Growth, 1A, Amsterdam: North-Holland, pp. 743-815.

Jorgenson, Dale, Frank Gallop and B.M. Fraumeni (1987) "Productivity and U.S. economic growth", Harvard University Press: Cambridge MA.

Jorgenson, D. W. and Z. Griliches (1967). "The Explanation of Productivity Change". Review of Economic Studies 34 (99), July, pp. 249-80.

Jorgenson, D. W. and K. J. Stiroh (2000). "Raising the Speed Limit: U.S. Economic Growth in the Information Age". Brookings Papers on Economic Activity 1.

Jorgenson, D. W. and K.Vu (2007). "Information Technology and the World Growth Resurgence", German Economic Review, Vol.8, Issue 2, May 2007, pp. 125-145.

Jorgenson, D. W. and E. Yip (2000). "Whatever Happened to Productivity Growth?" In New Developments in Productivity Analysis, eds. Charles R. Hulten, Edwin R. Dean, and Michael J. Harper, 509–540. Chicago, IL: University of Chicago Press.

McMillan, M. and D. Rodrik (2011) "Globalization, Structural Change, and Productivity Growth".. Manuscript. Harvard University.

Ministry of Finance (2004). "Resultados del Comite Consultivo del pib Potencial",; Direccion de Presupuestos.

Nordhaus, W. D. (1980). "Oil and Economic Performance in Industrial Countries", Brookings Papers on Economic Activity, Economic Studies Program, The Brookings Institution, vol. 1980(2), pp. 341–399.

Nordhaus, W. D. (1982). "Economic policy in the face of declining productivity growth", European Economic Review, Elsevier, vol. 18(1), pp. 131–157.

Organization for Economic Co-Operation and Development, (2001). "Measuring Capital-oecd Manual: Measurement of Capital Stocks, Consumption of Fixed Capital and Capital Services". oecd Publishing.

Organization for Economic Co-Operation and Development, (2008). "oecd Information Technology Outlook 2008". oecd Publishing.

Pages, C. (2010). The Age of Productivity: Transforming Economies from the Bottom Up. Development in the Americas. Inter-American Development Bank, Washington D.C.

Perez, J. (2003). "Stock de Capital de la Economía Chilena y su Distribucion Sectorial". Working Paper N° 233, Central Bank of Chile.

Rojas, P., E. Lopez and S. Jimenez (1997). "Determinantes del Crecimiento y Estimacion del Producto Potencial en Chile: El Rol del Comercio Internacional", in Morande, F. and R.Vergara (eds.) (1997), Analisis Empírico del Crecimiento en Chile. Centro de Estudios Publicos-ilades/Georgetown University, Santiago.

Roldos, J. (1997). "El Crecimiento del Producto Potencial en Mercados Emergentes: El Caso de Chile", in Morande, F. and R. Vergara (eds.) (1997), Analisis Empírico del Crecimiento en Chile. Centro de Estudios Publicos – ilades/Georgetown University, Santiago.

Schmidt-Hebbel, K. (2001). "Chile's Growth: Resources, Reforms, Results". Manuscript. Central Bank of Chile.

Schreyer, P. (2001). "Productivity Manual: A Guide to the Measurement of Industry-Level and Aggregate Productivity Growth", Paris: Organization for Economic Co-Operation and Development, March.

Solow, R. M. (1956). "A Contribution to the Theory of Economic Growth",, Quarterly Journal of Economics, 70 (1), February, pp. 65-94.

Timmer, M. P. and B. Van Ark (2005) "Does Information and Communication Technology Drive eu-us Productivity Growth Differentials?" Oxford Economic Papers, 57(4): 693-716.

Vergara, R. and R. Rivero (2006). "Productividad Sectorial en Chile: 1986-2001". Cuadernos de Economía 43 (May): 143-168.

Appendix A: Measuring capital and labor services

A.1. Measuring capital services

A.1.1. ICT capital

Following Jorgenson and Stiroh (2000), we consider three types of ICT capital stocks: office and computational equipment (hardware), telecommunication equipment, and software. The classification of ICT goods comes from the OECD (2008). However, the Chilean National Accounts do not split their "Machinery and Equipment" series into these three elements, and it is impossible to separate them into these categories due to the method employed to construct them. We need to build a real investment series first, and then, use it to build capital stocks.

The investment series for ICT capital is constructed using the commodity flow approach, following Timmer and Van Ark (2005). This method builds on the fact that domestic supply equals domestic use at any moment of time. Thus, ICT goods supply, derived from domestic production and net imports, equals consumption and investment of ICT goods. If we rule out the consumption, investment is defined as follows:

$$(11) \qquad I_{i,t} = (Q_{i,t} + M_{i,t} - X_{i,t}),$$

where $I_{i,t}$ is investment in ICT good i, $Q_{i,t}$ is domestic production, $M_{i,t}$ are imports and $X_{i,t}$ are exports[29]. Unlike data on investment, detailed data on import and export of ICT goods is readily available in 1983-2011, from the UN Comtrade database. Detailed production data are available from the UNIDO database through successive matches of product classifications[30]. Thus, time series of domestic supply at local currency prices are obtained for each ICT asset between 1983 and 2011. Investment in ICT goods is available in 2004 from INE (2006), which presents a detailed ICT supply-

[29] Note that levels of these numbers may not coincide with the actual ones. The procedure described below is performed to match the actual levels with those estimated.

[30] Please, refer to Appendix C where we explain in detail which goods are considered as ICT goods and how we use concordance tables of product classifications to extend data backwards.

use table. Therefore, estimates of ICT investment are calculated using the domestic supply adjusted by the amount of investment per Chilean peso of domestic supply in 2004 as follows:

$$(12) \qquad I_{i,t} = \frac{I_{i,2004}}{Q_{i,2004} + M_{i,2004} - X_{i,2004}} (Q_{i,t} + M_{i,t} - X_{i,t}),$$

The nominal series of investment obtained has to be deflated to construct the constant price series used to calculate capital stocks. Ideally, investment series should be deflated by a hedonic index reflecting the different qualities of ICT goods. However, there is no such index available for Chile. A solution is to use the US hedonic index, adjusted accordingly to the Chilean context. According to Schreyer (2001), there are three possible methods to do this: (1) use the US price index in US dollars, which is useful when the nominal variations of ICT goods' prices are the same in both countries; (2) adjust the US hedonic index for Chilean inflation relative to US inflation; and (3) adjust the US index using the nominal exchange rate, which assumes that the law of one price holds for ICT goods.

In contrast to Schreyer (2001), we construct a different price index, which is more suited to a small open economy importing capital goods like Chile. A local firm that wants to import technology from a foreign country needs to adjust the foreign price (let us say the U.S. price) by the corresponding tariff (*tariff*), the trade markup (*markup*) and the nominal exchange rate (*NER*) to obtain the domestic price. Thus, the nominal Chilean ICT price index is defined as:

$$(13) \qquad P^{CHL}_{ICT,t} = P^{US}_{ICT,t}(1 + tariff_t)(1 + markup)NER_t \ ,$$

and expressed in terms of a base year (2003), it is defined as

$$(14) \frac{P^{CHL}_{ICT,t}}{P^{CHL}_{ICT,2003}} = \frac{P^{US}_{ICT,t}(1 + tariff_t)NER_t}{P^{US}_{ICT,2003}(1 + tariff_{2003})NER_{2003}},$$

where we have assumed that trade markups do not change over time.

Tariffs are the simple arithmetic average of the applied tariff rate, which does not vary across ICT goods since ICT-specific tariffs are not available for the period we study. NER is simply the annual average value of Chilean peso/US dollar exchange rate. Note that the index expressed in equation (14) not only tracks the evolution of the US ICT hedonic price index, but also changes in tariffs and in exchange rates.

According to the international literature studying these topics, these harmonized price indices are the appropriate tool to convert ICT capital investments of different vintages into a common efficiency-weighted unit. Once we have estimated the ICT capital investment series, we can construct the ICT capital services. In Appendix B we explain how we construct them in a way that is internally consistent with the construction of non-ICT capital services, following international standards.

A.1.2. Non-ICT capital

We consider three types of non-ICT capital stocks: residential, non-residential and machinery and equipment (M&E). The latter category includes some ICT capital stocks, so we subtract the ICT investment from M&E investment, and the resulting investment series is used to construct the capital stock of M&E. Henríquez (2008) estimates the capital stock for these three types of assets for Chile using the Perpetual Inventory Method (PIM) –the same we use below to construct ICT capital stocks– for the 1985-2005 period initially, but later, these stocks have been continually updated until 2010. The capital stock used in previous studies (for instance, Fuentes, Larraín and Schmidt-Hebbel 2006) was developed by Perez (2003). Henríquez's (2008) capital stock levels differ from Perez's (2003) due to the assumption of assets' time-varying service lives, which is quite relevant according to the definition given above. Thus, in our perspective, the measure employed in this paper is a better measure of capital stock than the one used in previous studies.

A.1.3. Calculating capital services

The methodology to estimate the flow of capital services follows Jorgenson and Stiroh (2000), and it simply states that capital services are the average of the stock available at the end of the current and prior periods:

$$(15)\ K_{i,t} = \frac{1}{2}\left(S_{i,t} + S_{i,t-1}\right).$$

The growth rate of aggregate capital services is defined as a share–weighted average of the growth rate of each type of asset:

$$(16)\ \Delta 1nK_t = \sum_i \bar{\upsilon}_{i,t}\, \Delta 1nK_{i,t},$$

where

$$(17)\ \bar{\upsilon}_{i,t} = \frac{1}{2}\left(\frac{c_{i,t}K_{i,t}}{\sum_i c_{i,t}K_{i,t}} + \frac{c_{i,t-1}\,K_{i,t-1}}{\sum_i c_{i,t-1}K_{i,t-1}} \right),$$

is the value share of capital income, which varies according to the type of capital asset and over time. $c_{i,t}$ is the cost of capital, which is defined as:

$$(18)\ c_{i,t} = (1 + r_t)P_{i,t-1} - (1 - \delta^i)P_{i,t},$$

where r_i is the nominal interest rate, $P_{i,t}$ is the acquisition price of capital asset i in period t and δ^i is the depreciation rate for the capital asset i. Alternatively, equation (18) can be rewritten as

$$(19)\ c_{i,t} = (r_t - \pi_t)P_{i,t-1} + \delta^i P_{i,t},$$

where π_i represents the capital gains (if positive) of an asset acquisition. Since the acquisition prices of each asset are not available, we use investment deflators instead, which is a usual assumption in the international literature.

A.2. Measuring labor services

Labor is defined as the total number of hours worked in the economy. This figure is comprised by the average number of hours worked per week[31] and the number of workers currently employed in the country[32]. However, it is an incomplete measure of labor services because it does not account for changes in the skill composition of workers over time, such as educational attainment and work experience. Adjustment for such attributes would provide a more accurate measurement of labor services. In the absence of these adjustments, more rapid output growth due to a rise in skills of the labor force is captured by the TFP growth, and not attributed to labor.

31 Source: Encuesta de Ocupacion y Desocupacion en el Gran Santiago, University of Chile.

32 Source: Indicadores de Empleo, National Institute of Statistics.

Jorgenson, Fraumeni and Gallop (1987) developed an index of labor quality, based on the heterogeneity of workers and their different labor productivities. We follow their procedure to build this index. The data source to elaborate the index is the *Encuesta de Ocupacion y Desocupacion en el Gran Santiago* (University of Chile). We choose to classify workers into four dimensions of heterogeneity: sex (male; female), age (16-17; 18-24; 25-34; 35-44; 45-54; 55-64; 65+), educational attainment (Basica; Media Científico–Humanista; Media Tecnica-Profesional; Superior, which groups studies in professional institutes and in university) and employment class (Employees; Self-employed and unpaid). Therefore, we split the working population into 112 (= 2 x 7 x 4 x 2) types of workers. Each cell represents one of the 112 different categories of workers. We compute the mean of hours worked and wages for each cell and then calculate the growth rate of aggregate labor services, defined as a share-weighted average of the growth rate of each type of worker, $j = 1, \ldots, 112$:

$$(20)\ \Delta 1nL_t = \sum_i \omega_{j,t}\, \Delta 1nL_{j,t},$$

where $L_{j,t}$ represents the hours worked by worker category j at time t and

$$(21)\ \bar{\omega}_{j,t} = \frac{1}{2}\left(\frac{w_{j,t}L_{j,t}}{\sum_i w_{j,t}L_{j,t}} + \frac{w_{j,t-1}L_{j,t-1}}{\sum_i w_{j,t-1}L_{j,t-1}}\right),$$

is the value share of labor income and $w_{j,t}$ is the real wage for worker j at time t. We define the aggregate labor quality index, $q_{L,t}$, as the difference between weighted and un-weighted growth in labor hours,

$$(22)\ \Delta 1nq_{L,t} = \Delta 1nL_t - \Delta 1nH_t,$$

where

$$(23)\ \Delta 1nH_t = \sum_j \Delta 1nL_{j,t},$$

is the un-weighted sum of labor hours. This index captures potential substitution among heterogeneous types of labor with different characteristics and marginal productivities.

The computation of this index is quite common in international literature following the work of Jorgenson and co-authors. However, we are not aware of any paper computing this index for Chile. Roldos (1997) and Fuentes, Larraín and Schmidt-Hebbel (2006) calculate a similar index using a proxy of the long-term wage as a (fixed) share –instead of the Törnqvist aggregator we employ– to weight the relative labor force (instead of the hours worked) that belongs to certain educational groups, which is the only dimension of heterogeneity in their framework.

APPENDIX B: CONSTRUCTION OF CAPITAL STOCKS

Once we have investment data for individual assets, we can build the capital stock series for each asset. The capital stock of asset i in period t, $S_{i,t}$, is defined as:

$$(24)\ S_{i,t} = \sum_{j=0}^{M_i} I_{i,t-j} g_{i,t-j} d_{i,t-j},$$

where $I_{i,t}$ is the real investment in asset i in period t, M_i is the maximum service life, $g_{i,t-j}$ is a survival function (one minus the retirement function) that gives the proportion of assets of age $t-j$ still in service at time t and $d_{i,t-j}$ is the depreciation pattern, or equivalently, the age-efficiency profile. The retirement function specified for every asset is a bell-shaped distribution function. A usual specification for the retirement function is the Winfrey S3 curve, whose main feature is that asset retirements are concentrated in the average service life of the asset, although the asset is not fully retired by that date. The Winfrey S3 has the following form:

$$(25)\ F_T = 15.610\ 1 - \left(\frac{T^2}{100}\right)^{6.902},$$

where F_T is the fraction that is retired because it ceases to be productive over the T decile, calculated around the average service life. For example, if the average service life of a given asset is five years, the second (fourth) year –the sixth (second) decile of the average service life– after the acquisition of this asset, 1.4% (23.6%) of the asset is retired.

For the depreciation rate, we assume a linear pattern with a slight modification, to take into account the retirements of assets over the service life of a given asset. Thus, depreciation is defined as follows:

$$(26)\ d_{i,t-j} = 1 - \left(\frac{t}{E_{i,t-j}}\right),$$

where t is the asset age and $E_{i,t-j}$ is the expected life of investments made in $t-j$ that remain to be retired in time t [33].

Despite its complexity, equation (24) simply states that capital stock is the weighted sum of past investments, where weights are derived from the relative efficiency profile of capital of different vintages. However, $S_{i,t}$ represents the installed capital stock of a given asset, not the flow of services, $K_{i,t}$, which is the relevant variable to be considered. As claimed by Jorgenson and Stiroh (2000), this distinction is not crucial at the level of individual assets, but becomes relevant when it comes to aggregate them because their heterogeneity.

33 Note that $E_{i,t-j}$ is not the average service life of the asset in this setting. Both concepts differ when asset retirements are allowed because the asset is not fully retired when it reaches the average service life. Of course, if we assume a simultaneous exit of the asset, instead of the bell–shaped retirement function, both concepts will coincide.

Appendix C: ICT Goods Classification

Detailed data on import and export of ICT goods are readily available from the UN Comtrade database, for the period 1983-2011. Detailed production data are available from the UNIDO database through successive matches of product classifications. The classification of ICT goods employed in this paper is taken from the OECD (2008), which classifies ICT goods into several groups. For our analysis, we re-group the categories of the OECD classification into a broader concept of ICT goods, trying to match these groups with the classification employed by the international literature on growth accounting (e.g. Jorgenson and co-authors): computers, communication equipment and software.

- Computers are comprised by the following categories of goods, defined according to the SITC Rev 3 classification:
- Electronic data processing equipment: 752.1, 752.2, 752.3, 752.6, 752.7, 752.9, 759.9.
- Office equipment: 751.1, 751.2, 751.3, 763.3, 763.8, 759.1.
- Control and instrumentation: 778.7, 874.1, 874.2, 874.3, 874.4, 874.5, 874.6, 874.
- Electrical and Mechanical Components: 771.1, 771, 772.2, 772.3, 772.4, 772.5, 776.2, 776.3, 776.4, 776.8, 778.6.

Communication equipments are comprised by the following categories of goods, defined according to the SITC Rev 3 classification:

- Radio communications (including mobiles) and radar: 764.3, 874.1.
- Telecommunications: 764.1.
- Consumer equipment: 761.2, 762.1, 762.2, 762.8, 763.3, 881.1, 885.3, 885.4, 885.7, 898.2.
- Components: 764.2, 764.9, 898.4

Software is comprised of the following categories of goods, defined according to the HS 1996 classification:

- 852431: discs, recorded, for laser reading systems, for reproducing phenomena other than sound or image.
- 852439: discs, recorded, for laser reading systems, for reproducing sound and image or image only.
- 852440: magnetic tapes, recorded, for reproducing phenomena other than sound or image.
- 852491: recording media (excluding those for sound or image recordings, discs for laser reading systems, magnetic tapes, cards incorporating a magnetic stripe and goods of Chapter 37).
- 852499: recorded media for sound or image reproducing phenomena, including matrices and masters for the production of records (excluding gramophone records, discs for laser reading systems, magnetic tapes, cards incorporating a magnetic stripe and goods of Chapter 37).

We use Jon Haveman's concordance tables to match the aforementioned product classifications with earlier product classifications and thus extending data backwards to the SITC Rev 2 classification, which covers more years in the past. Although, we could have extended data backwards to the SITC Rev 1 classification, we think this classification is too coarse for our purpose of identifying ICT goods; therefore we did not apply it here.

APPENDIX D: THE EFFECT OF ENERGY PRICE SHOCKS ON PRODUCTIVITY GROWTH: THE ANALYTICAL MODEL

In this section, we present the analytical model, following the work of Berndt, Mori, Sawa and Wood (1991). This methodology assumes that aggregate capital service is comprised by the sum of several vintages of surviving capital. In this context, surviving capital is the stock that has not fully depreciated and it has not reached its maximum service life. Hence, aggregate capital can be represented as:

$$(27)\ K_t = \sum_{\tau=0}^{T} (1-\delta)^{\tau} I_{t-\tau} = \sum_{\tau=0}^{T} K_{t,t-\tau},$$

where δ is the constant depreciation rate of machines, T is the service life of capital, measured in years, and $I_{t-\tau}$ is the real investment made in time $t-\tau$, then $t-\tau$ represents the corresponding vintage, in other words, it represents the year the machine was purchased. Thus, the aggregate capital service is defined as the sum of all capital vintages, $K_{t,t-\tau}$.

On the one hand, firms have to choose the utilization rate of each capital vintage, so aggregate capital services adjusted by utilization changes induced by fluctuations of energy prices are defined as follows:

$$(28)\ K_t^* = \sum_{\tau=0}^{M_i} e_{t-\tau} K_{t,t-\tau},$$

where $e_{t-\tau}$ is the aggregate utilization intensity of each capital vintage $t-\tau$.

On the other hand, each capital vintage embodies an energy-efficiency relation, which is set *ex ante*, when the firm is taking its decision about capital investment; in other words, before capital is acquired. This investment decision is forward-looking because it considers the profile of the expected price of energy relative to capital during the full service life of the capital and its depreciation pattern. If we assume a CES production function, combining capital and energy, in order to allow an *ex ante* substitution between energy and capital –which is the empirical relevant form according to the evidence discussed in Section 6–, the energy-efficiency relation is given by[34]

$$(29)\quad 1nF_t = 1\text{n}\left[\frac{E}{K}\right]_t = 1\text{n}a - \sigma 1\text{n}\left[\frac{P^*_E}{P^*_K}\right]_t,$$

where F_t is the energy-efficiency factor, E/K is the energy to capital ratio, ln$a$ is a constant, σ is the *ex-ante* elasticity of substitution between energy and capital and P^*_E/P^*_K is the discounted relative price of energy, which is defined as

$$(30)\quad P^*_{EK,t} \equiv \left[\frac{P^*_E}{P^*_K}\right]_t = \sum_{s=0}^{T}\left[\frac{P_E}{P_K}\right]_{t+s+1}\frac{(1-\delta)^s}{(1+r)^{s+1}},$$

where we have assumed that the firm discounts relative prices using the real interest rate, r. This expected relative price inherits the forward-looking structure of the investment decision problem.

After that decision was made, the energy-efficiency relation is fixed and the firm can only adjust the utilization intensity of that vintage, according to how much is the resulting energy cost, which is defined as

$$(31)\quad C_t \equiv P_{E,t}\sum_{\tau=0}^{T}F_{t-\tau}u_{t,t-\tau}K_{t,t-\tau} = P_{E,t}\sum_{\tau=0}^{T}a\left[\frac{P^*_E}{P^*_K}\right]_{t-\tau}^{-\sigma}u_{t,t-\tau}K_{t,t-\tau},$$

where C_t represents the energy cost, $P_{e,t}$ is the current price of energy and $u_{t,t-\tau}$ is the utilization rate of capital vintage $t-\tau$. The energy cost is defined as the price of energy, multiplied by the quantity of energy employed in the productive process. Naturally, this cost depends on the utilization rates

34 This equation is simply the first order condition of the maximization of a CES production function, combining capital and energy, subject to the budget constraint, which includes the expected cost cycle of energy relative to capital over the service life of the capital vintage.

of several vintages of capital ($u_{t,t-\tau}$) and the embodied energy-efficiency relations ($F_{t,t-\tau}$) of these vintages[35].

The marginal cost of employing an additional unit of surviving capital from the vintage t–τ is given by

$$(32)\quad \frac{\partial C_t}{\partial K_{t,t-\tau}} = P_{E,t}\, a \left[\frac{P_E^*}{P_K^*}\right]_{t-\tau}^{-\sigma} u_{t,t-\tau},$$

which holds across all vintages. If the firm is operating efficiently, it will try to equalize the marginal cost of employing surviving capital across all vintages t–τ, then, the following equation holds in equilibrium:

$$(33)\quad \frac{u_{t,t-\tau}}{u_{t,t}} = \left[\frac{P_E^*}{P_{EK,t-\tau}^*}\right]^{-\sigma},$$

where $P_{EK,t}^*$ is the (discounted) price of energy relative to capital. The intuition of equation (33) is the following: if $P_{EK,t}^*$ increases (for example, for a persistent shock of energy prices), then the utilization rate of energy-inefficient vintages will fall and the contrary will happen with (relatively) energy-efficient vintages. This utilization adjustment occurs when there is some substitution across capital vintages, i.e. $\sigma > 0$, otherwise no adjustment will take place. Hence, the adjustment after an energy price shock depends crucially on the elasticity of substitution and on the expected path of the relative price of energy and; furthermore, it will determinate the speed of the adjustment, jointly with the magnitude of the effect of the energy shock. If there is little substitution, the adjustment will be sluggish and the effects on productivity will be spread over many years.

Now, redefining the aggregate utilization rate of vintages as:

$$(34)\quad e_{t,t-\tau} = \frac{u_{t,t-\tau}}{u_{t,t}} = \left[\frac{P_{EK,t}^*}{P_{EK,t-\tau}^*}\right]^{-\sigma},$$

we can relate the micro-adjustment mechanism, induced by changes in the relative price of energy, to the aggregate capital services as follows:

[35] Note that in the second equality in equation (31), we use the exponential version of equation (29).

$$(35) \quad K_t^* \equiv \sum_{\tau=0}^{T} \left[\frac{P_{EK,t}^*}{P_{EK,t-\tau}^*} \right]^{-\sigma} \mathrm{K}_{t,t-\tau} \ ,$$

The intuition of equation (35) is the following: when the relative cost of energy is rising in year *t*, it encourages a fall in the use of that vintage, giving a lower weight to the capital service of that vintage and increasing the (relative) weight of older vintages, depending on the substitution across vintages. A useful measure that resumes these calculations is the aggregate utilization rate defined as

$$(36) \quad B_{K,t} \equiv \frac{K_t^*}{K_t} \ ,$$

which is simply the ratio of capital services, adjusted for utilization changes induced by energy price fluctuations, over the traditionally measured capital stock.

Microeconomic Policies and Productivity: An Exploration into Chile's Electricity Sector[1]

Alexander Galetovic, Cristian Hernandez
Cristian Muñoz, Luz María Neira

1. Chile's protracted productivity slowdown

In December 1993 Eduardo Frei won the presidency in a landslide. A Christian Democrat with probusiness sympathies, Frei was thought to be a competent, no nonsense administrator who would continue to steer and nurture the fastest economic expansion in Chilean history. In fact, he did little and achieved even less and while the economy grew fast during the first three years of his administration, Chile's golden period of 7% p.a. growth ended abruptly when the Asian Crisis hit in 1998. That external shock, a protracted hike in the minimum wage in 1998, 1999 and 2000 and a somewhat erratic management of interest rates by the Central Bank combined to cause the first recession in 15 years.

At the time many expected fast growth to resume as soon as the Asian crisis ended. But on the contrary, during the next ten years the growth rate more than halved, productivity growth slided and unemployment remained stuck above 8%. While several years passed before the fact was acknowledged, Chile's economy permanently slowed down.

Some argue that Chile's slowdown merely reflects convergence. As countries develop they close the gap with developed economies and the growth rate gradually falls, ceteris paribus. Nevertheless, this is unconvincing. One reason is that the slowdown has been rather abrupt-between 1998 and 2009, GDP per capita grew 2% P.A., far from the 5.8% growth rate achieved during the golden period. Moreover, Chile's growth since 2000 is well below the potential rate that experts estimated before and after the Asian Crisis. As historical data shows, Chile's GDP gap with the United States, while somewhat smaller than during the 1970s and 1980s, is still wider than in any year before the Great Depression[2]. Worse,

[1] We are very grateful to Vittorio Corbo for helpful comments, suggestions and, especially, patience.

[2] Studies also indicate that labor productivity is about 40% of the US level. About one-fifth of the gap is explained by Chile's lower capital output ratio, which is between 20 and 30% smaller; two fifths are due

total factor productivity has not grown since 1998 and, if anything, fell almost every year during the Bachelet administration, a rather strange way of converging.

A different explanation is that the impulse of market reforms peters out before a country becomes developed. First-generation reforms, so the argument goes, exploited easy opportunities like liberalizing markets, opening the economy to international trade, balancing the fiscal budget and reducing inflation, and in any case were sustained by Chile's rich base of natural resources. But that is no longer enough and now Chile needs innovative firms to engage in self discovery, diversify into knowledge –based activities and enlarge the scope of her exports. Alas, Chile's firms are weak they don't spend much in R&D, innovate little, patent even less and do not engage universities and public research institutes in cooperative ventures. And thus, at least in their discourse, successive administrations have set out to transform Chile in a nation of entrepreneurs and innovators nurtured and mentored deftly by a government-led national innovation strategy. As is usual with most public policies in Chile, the overhaul of the innovation system did not begin with systematic impact evaluations of existing programs, but simply with more spending. Moreover, advocates of a national innovation system consistently avoid particulars when asked about the details of their strategy and the mechanics that links their programs with productivity growth. On the contrary, they usually rush to point out that their role is to design the strategy and that implementation is a practical matter to be dealt with later. It is hard not to see the national innovation system as the latest version of the silver bullet to which policy makers almost inevitably fall back when they don't know what to do next.

Yet another view blames slow growth on a poorly educated workforce. Indeed, many agree that Chile's education system is mediocre, a belief confirmed by research on academic outcomes. Some work by Maloney and Rodríguez-Clare (2007) suggests, moreover, that most of the productivity gap between Chile and the United States can be attributed to low human capital (an accumulation problem) and not low technology (the A parameter). But so far nobody has compellingly linked low human capital with the fall in productivity and per capita output growth after 1998, much less quantified the effect.

to lower human capital (about a third less than in the United States) and the remaining two fifths are due to lower total factor productivity (between one fourth and one third less than in the United States).

Lastly, some argue that productivity growth stalled because few micro reforms have been introduced after Aylwin's administration and, on the contrary, during the last 15 years microeconomic policy mistakes and distortions, some small, others not so small, have protractedly piled up. Nevertheless, this view is not shared by many.

Of course, nobody knows how much faster productivity would have grown had vigorous microeconomic reforms been tried. But more fundamentally, many doubt that microeconomic reforms can achieve much at all. For example, when confronted with a specific sectoral distortion or policy mistake, macroeconomists usually argue that one sector is small and surely cannot explain the fall in aggregate growth. They also point out that many distortions existed before 1998, that Chile ranks fairly high in cross country competitiveness indices and that static distortions affect levels but not rates. Last, as with poor education, so far no study has mustered compelling quantitative evidence linking the slowdown with lack of microeconomic reforms. As a former Minister of Economic Affairs once claimed, micro reforms are difficult to push through and their payoff is small in any case.

In spite of widespread skepticism, this chapter builds evidence on efficiency, productivity and policies from the bottom up. We model one sector in detail, Chile's Central Interconnected System or cis, which produces about 1.3% of Chile's value added, with an intertemporal model with endogenous investment, price-responsive demand and explicit modeling of environmental externalities. We then quantify the impact of alternative policies on sectoral performance –cost, output, pollution, prices, profits and consumer surplus– and link this rather standard micro analysis of industry performance with sectoral productivity analysis. Then we link costs and price changes in the electricity sector with changes in value added in the rest of the economy using simple production theory. Assuming an exogenous trajectory of labor and capital inputs in the rest of the economy, we show that changes in value added accurately quantify the effect of sectoral changes on productivity in the rest of the economy. We find that some bad policies that affect the electricity sector, which are currently being discussed in Congress, can reduce tfp in electricity by about 15%. More importantly, because electricity is an input, the impact of bad policies on the rest of the economy can be large, about 0.3% of gdp, equivalent to about one-fourth of cis's total value added[3].

3 Alas, Congress passed this bad policy in August 2013.

The rest of the chapter is organized as follows. Section 2 links standard sectoral microeconomic analysis with GDP accounting and productivity. Section 3 describes Chile's CIS, our intertemporal model, and the relation between electricity and pollution. In section 4 we present our analysis of alternative policies. Section 5 presents our conclusions.

2. Microeconomic policies, GDP accounting and productivity

Our welfare analysis of policies uses standard consumer and producer surplus. Yet most of the discussion of policies and growth is couched in terms of productivity –how do different policies affect the output yield of a given set of inputs. What is the relation between the two types of analysis? In this section we study the differences between standard welfare analysis on one hand and standard GDP and productivity accounting on the other.

2.1. SUPPLY AND DEMAND MEET GDP ACCOUNTING

2.1.1. Supply and demand

Figure 1a shows a simple supply-and-demand diagram of a competitive electricity market. The inverse demand curve P^d adds up demands by firms. The supply curve S is perfectly elastic at the levelized cost of electricity –the sum of the per– MWh capital cost c_0^k and the variable fuel cost c_0^v. Competition implies that the equilibrium price p_0^e equals the levelized cost of energy, $c_0^k + c_0^v$; consumption equals MWh because

$$P^d(e_0) = (c_o^k + c_o^v).$$

Standard welfare analysis, in turn, says that consumer surplus equals the shaded triangle or, formally,

$$CS(e_0) = \int_o^{e_0} [P^d(\mathrm{e}) - (c_o^k + c_o^v)]\, de.$$

Similarly, the sum of the checkered and gridded area is the cost of electricity:

$$p_0^e e_0 = (c_0^k + c_0^v)\, e_0.$$

2.1.2. "Correct" GDP accounting

Assume for the moment that electricity is only an intermediate input to produce final output y. Furthermore, assume that final output is produced with capital K and energy with a constant-returns-to-scale, twice differentiable production function F such that

$$y = F(K, e),$$

which satisfies the Inada conditions. As is well known, Euler's theorem implies that $y = F^k K + F^e E$. Next assume that capital is exogenous to the energy sector (this is partial equilibrium analysis) so that $K = \bar{K}$ and that in equilibrium $e = e_0$. Then

$$y_0 = F(\bar{K}, e_0),$$

is the gross output of the final-good sector. Moreover, in equilibrium, the price of energy is equal to its value marginal product. Thus ify is the numeraire good, r_0 is the equilibrium return on capital and $F_0^e = p_0^e$, we can rewrite gross output as

$$y_0 = r_0\bar{K} + p_0^e e_0 .$$

Also,

$$va_0^y = y_0 - p_0^e e_0 = r_0\bar{K},$$

is the value added of the final-good sector.

Now $p_0^e e_0$ is the gross output of the electricity sector. If fuel is fully imported (as in Chile), the sector's value added is

$$va_0^e = (p_0^e - c_0^v)e_0 = c_0^k e_0 .$$

GDP is thus

(1) $\quad va_0^y + va_0^e = Y_0 = r_0\bar{K} + c_0^k e_0,$

(2) $\quad va^y + va^e = y_0 - c^v e_o .$

Equation (1) is the standard definition of GDP, the sum of the value-added of the electricity sector and the rest of the economy. Equation (2) restates GDP as the difference between the gross output of the rest of the economy and the cost of imported fuel to produce electricity.

2.1.3. GDP accounting and the demand for energy

How does GDP accounting relate to standard welfare analysis? The link is through the demand curve P^d: holding K constant, the demand for energy is equal to the value marginal product of energy, hence

$$P^d(\cdot) = F_0^e(\overline{K}, \cdot)\,,$$

Furthermore,

$$y_0 = F(\overline{K}, e_0) = \int_0^{e_0} F_0^e(\overline{K}, e)\, de = \int_0^{e_0} P^d(e)\, de.$$

It follows that the area below the demand for energy in Figure 1a equals the gross value of output in the final–goods sector. Also,

$$va_0^y = \int_0^{e_0} [P^d(e) - p_0^e]\, de\,,$$

i.e. consumer surplus–the shaded triangle in Figure 1a –equals the value added of the final– goods sector. Last, equation (2) implies that

$$Y_0 = \int_0^{e_o} [P^d(e) - c_0^v]\, de\,,$$

i.e. GDP equals the sum of the shaded triangle and the checkered rectangle in Figure 1a, which in turn is equal to GDP. Thus we have shown the direct link between standard supply-and-demand analysis and "correct" GDP accounting.

2.1.4. Electricity as a final good

Electricity is also a final good[4]. Does our analysis change? Assume that households consume e_0^h of electricity. The main difference is that, as can be seen in Figure 1b, consumer surplus is not measured in GDP. In other

[4] In Chile's SIC about 30% of electricity consumption is residential. Most of the rest is used by businesses and firms.

words, the contribution to GDP of electricity is just c_0^k per MWh, the value added by the electricity sector equal to the checkered area in Figure 1b.

Figure 1a. Microeconomic analysis and GDP accounting: Electricity as an intermediate input.

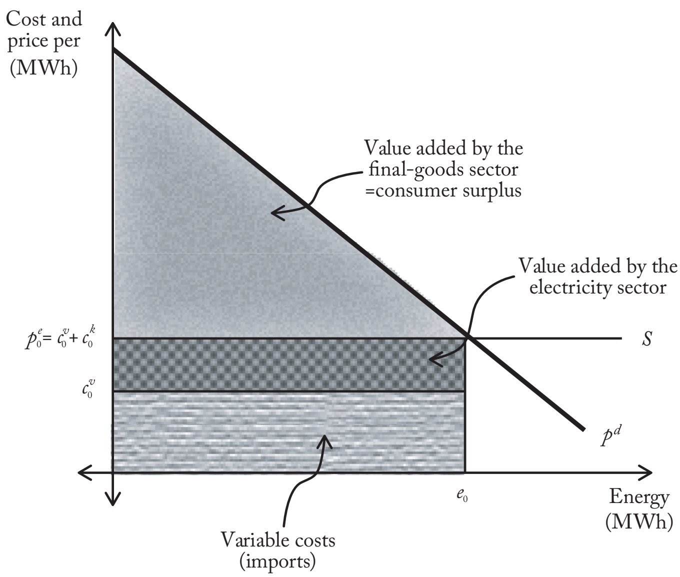
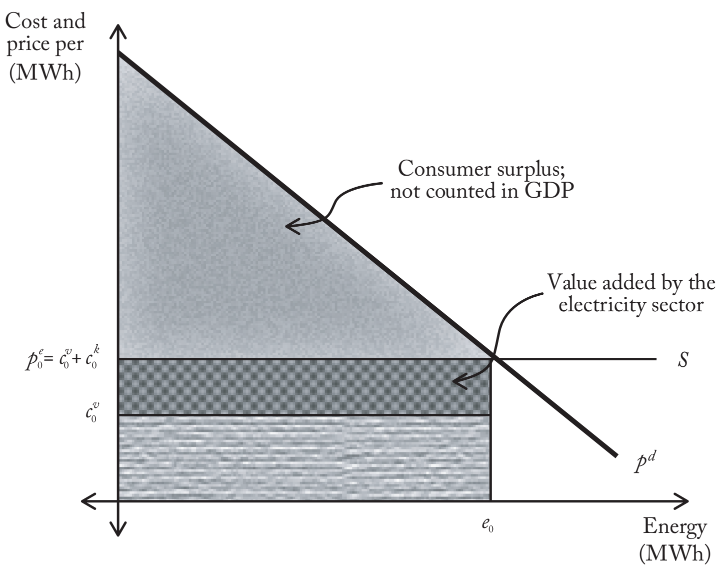


Figure 1b. Microeconomic analysis and GDP accounting: Electricity as a final good.



2.1.5. GDP accounting at constant prices

National accountants face a daunting task and measure real GDP at prices of a base year. To compare value added and GDP with our "correct" measures of gross output, let p_b^e , p_b^v , and p_b^k be the respective prices at the base year b. Then measured value added in the fina-goods and electricity sectors are

$$va_{0,b}^y = y_0 - p_b^e e_0,$$

$$va_{0,b}^e = (p_b^e - c_b^v) e_0 = c_b^k e_0 .$$

Measured GDP is thus

$$Y_{0,b} = va_{0,b}^y + va_{0,b}^e = y_0 - c_b^v e_o .$$

Now note that the difference between measured value added and "correct" value added in the final-goods sector is

$$va_{0,b}^y - va_0^y = (p_0^e - p_b^e) e_o .$$

Similarly, in the electricity sector

$$va_{0,b}^e - va_0^e = (c_0^v - c_b^v)\ e_0 .$$

In terms of Figure 1a, actual GDP calculations will get quantities right, but under or overestimate each sector's value added, depending on the difference between relative prices in the base year and the year GDP is calculated. The more frequently base years are adjusted and the more persistent relative price changes are, the less important this problem is.

2.2. Microeconomic policies and GDP

2.2.1. Electricity as an intermediate input I: changes in c^v

Policies in the electricity sector affect costs through c^v and c^k; they also affect the final-goods sector through p^e. It is helpful to consider first an increase in variable costs from c_0^v to c_1^v, as depicted in Figure 2a. The price of electricity rises from p_0^e to p_1^e, and consumption falls from e^0 to e^1. In the figure the fall in consumer surplus equals the sum of the shaded triangle and the large gridded rectangle; because the supply curve is flat, the fall in consumer surplus also equals the change in social surplus[5]. Of course, there is nothing new here. Higher costs reduce energy consumption and cause a net output and surplus loss somewhere in the economy equal to the shaded triangle. Furthermore, costs of producing final output rise, causing a further surplus loss equal to the gridded rectangle.

How does the standard welfare calculation compare with GDP accounting? Recall that when electricity is an intermediate good, consumer surplus equals value added by the final-goods sector. Formally, lost value added in the intermediate-goods sector is

(3) $$\Delta va_0^y = -\left[\int_{e_1}^{e_o} [p^d(e) - p_0^e]\, de + (c_1^v - c_0^v)\, e_1\right],$$

(4) $$\Delta va_0^y = [(y_1 - y_0) + (e_0 - e_1)\, p_0^e] - (c_1^v - c_0^v)\, e_1 .$$

Equations (3) and (4) decompose the fall in value added in three terms. The first two capture the effect of using less electricity; it is the same as the shaded triangle in Figure 2a. The third captures the effect of paying more for an input; it is the same as the gridded rectangle in Figure 2a. It follows that when GDP accounting includes changes in relative prices, there is an exact correspondence between changes in consumer surplus and changes of value added in the final-goods sector. The reason is straightforward: the reduction in the final-goods' sector value added is equal to the increase in costs plus the net value of lost output.

Now the fall in value added by the electricity sector is equal to the checkered rectangle in Figure 2a; formally, $\Delta va_0^e = -(e_0 - e_1)c_0^k$. Thus, after some algebra the change in GDP is

$$\Delta Y = \Delta va_0^y + va_0^e ,$$

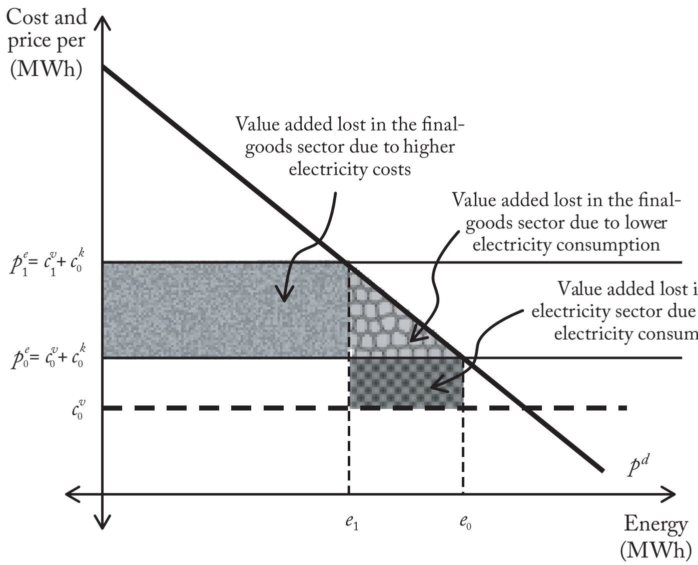
$$\Delta Y = (y_1 - y_0) + (e_0 - e_1)c_0^v - (c_1^v - c_0^v)\, e_1 .$$

The first term, $y_1 - y_0$, is the change in gross output in the final-goods sector. The second term, $(e_o - e_1)\, c_0^v$, shows the savings in variable costs due to reduced

[5] With an upward-sloping supply curve, the change in social surplus equals the sum of changes in consumer and producer surplus.

electricity consumption. The last term, $(c_1^v - c_0^v)\, e_1$, captures the effect of the relative price change on costs and value added by the final-goods sector.

Figure 2a. The long-run effect of an increase in variable costs.



The change in GDP wrought by a change in c^v is *larger* than the fall in social surplus because standard welfare analysis ignores the fall of value added in the electricity sector, $(e_0 - e_1)\, c_0^k$. Why? The reason may be obvious, yet it is subtle. Standard welfare analysis correctly acknowledges that only final output creates economic value and that costs reduce net economic surplus. Thus, the fall in $(e_0 - e_1)\, c_0^k$ is a *benefit*, which is offset by the loss of output. GDP accounting, by contrast, includes capital costs in value added, hence GDP falls when capital costs in the electricity sector fall, *ceteris paribus*.

A second limitation is that national accountants compute year-to-year real GDP at constant prices. Because the measured change in value added by the final-goods sector is

$$\Delta va_b^y = (y_1 - y_0) + (e_0 - e_1)\, p_b^e \ ,$$

value added ignores the loss in surplus caused by the increase in variable costs, $(c_1^v - c_0^v)\, e_1$. This is important, for many if not most microeconomic policies work their effect through changes in relative prices.

The measured change in value added by the electricity sector is, in turn, $\Delta va^e_b = -(e_0 - e_1)\, c^k_b$. After some algebra, it can be seen that the measured change in GDP is

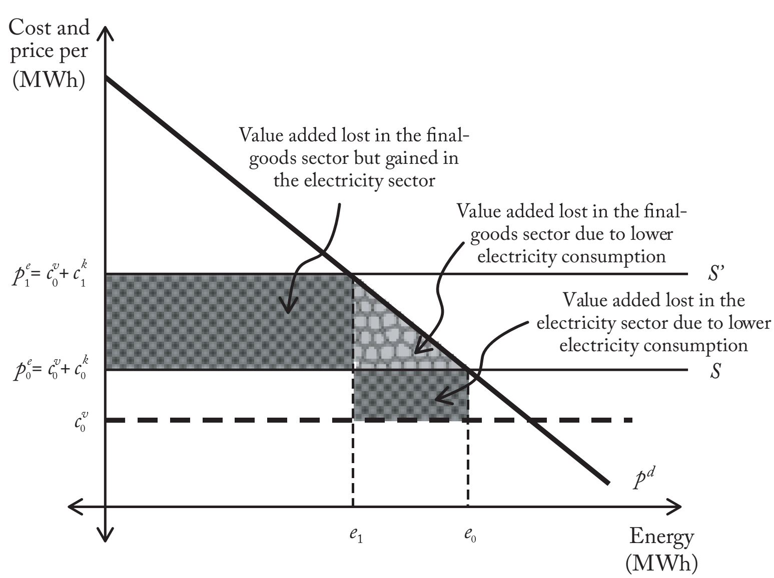
$$\Delta Y_b = \Delta va^y_b + \Delta va^e_b = (y_1 - y_0) + (e_0 - e_1)\, c^v_b.$$

When compared with changes in social surplus, changes in GDP at constant prices miss the effect of higher input costs and prices, but include the lost value added by the electricity sector, which does not affect social surplus. On the other hand, when compared with "correct" GDP, measured GDP misses the increase in variable costs.

2.2.2. Electricity as an intermediate input II: changes in c^k

Figure 2b depicts the effect of an increase in capital costs from c^k_0 to c^k_1. As with a change in variable costs, the price of electricity rises from p^e_0 to p^e_1, and consumption falls from e^0 to e^1. Indeed, welfare analysis is exactly as before, because it makes no difference what causes higher costs in the electricity sector.

Figure 2b. The long-run effect of an increase in capital costs.



As before, lost value added in the intermediate–goods sector is

$$\Delta va_0^y = -\left[\int_{e_1}^{e_0} [p^d(e) - p_0^e]\, de + (c_1^k - c_0^k)\, e_1\right],$$

$$\Delta va_0^y = [(y_1 - y_0) + (e_0 - e_1)p_0^e] - (c_1^k - c_0^k)e_1.$$

But now the change in value added in the electricity sector is

$$\Delta va_0^e = (c_1^k - c_0^k)e_1 - (e_0 - e_1)c_0^k,$$

the difference between the large and small checkered rectangles in Figure 2b. Hence, if the demand for electricity is sufficiently inelastic, value added by the electricity may well increase, even though the origin of higher costs may be inefficient policies! It follows that the change in GDP is

(5) $$\Delta Y = \Delta va_0^y + \Delta va_0^e = (y_1 - y_0) + (e_0 - e_1)\, c_0^v,$$

Now even "correct" GDP accounting fails to capture that higher capital costs per MWh decrease social surplus.

At constant prices the measured change in value added by the final-goods sector is, as before, $\Delta va_b^y = (y_1 - y_0) + (e_0 - e_1)\, p_b^e$. In turn, the measured change in value added by the electricity sector is, just as before, $\Delta va_b^e = -(e_0 - e_1)\, c_b^v$. It follows that the measured change in GDP is

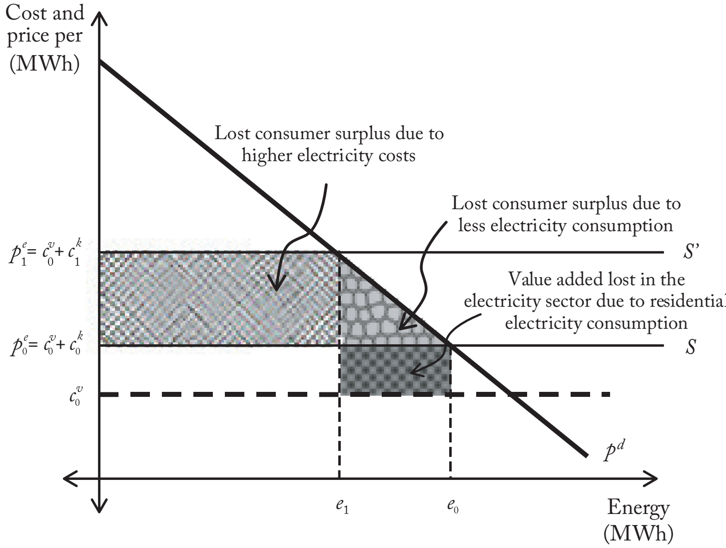
$$\Delta Y_b = \Delta va_b^y + \Delta va_b^e = (y_1 - y_0) + (e_0 - e_1)\, c_b^v,$$

save for c_b^v, it is the same as equation (5).

2.2.3. Electricity as a final good

As Figure 2c shows, when electricity is a final good and its price increases, consumer and social surplus fall and lost welfare equals the sum of the shaded triangle and the striped rectangle. But now consumer surplus is not part of GDP, and the effect on consumers is therefore ignored by GDP accounting. Moreover, GDP accounting will capture only the effect of the cost increase on value added in the electricity sector.

Figure 2c. Electricity as a final good.



If the increase in price occurs due to increases in variable costs, the change in value added equals, as before, the checkered rectangle. But if the increase in price is due to higher capital costs, GDP may even increase, as the striped rectangle will be part of the value added by the electricity sector. Thus, GDP may even increase, because now it will not be offset by lost value added in the final-goods sector. Of course, this does not happen when GDP is measured at constant prices. Hence GDP accounting is fairly misleading when it comes to assess the economic effect of policies in sectors that produce goods sold to consumers.

2.3. Policies and productivity

We can now relate productivity and policies. Productivity change is the expansion or contraction of production possibilities holding factor inputs constant. The main question is how much policies affect productivity in the electricity sector and in the rest of the economy[6].

As was stated earlier, policies affect the cost of producing electricity and its price. In equilibrium, changes in the price of electricity alter both the final consumption of electricity and consumption by businesses.

[6] According to the Central Bank's 2009 input-output matrix, electricity generation accounted for about 1.7% of total value added.

Nevertheless, productivity analysis is interested only in changes wrought on the rest of the economy, not on final consumption.

In the rest of the economy, electricity consumption affects the productivity of capital and labor. Ceteris paribus, the productivity of given capital and labor inputs falls when electricity input is lower, because output falls; this is captured by real GDP calculations as a matter of course. In addition, higher input prices reduce value added in the rest of the economy –they are akin to an internal terms of trade shock wrought by one sector in the economy. GDP calculations at constant prices do not capture this effect. Because of this, productivity in the rest of the economy will be overestimated. Over long periods, however, the base year changes and presumably GDP accounting captures long-term movements in relative prices.

Now when a policy changes electricity consumption as an intermediate output, a natural estimate of the effect is the change in value added by our final-goods sector given by equation (4), which we repeat here with a slight modification:

$$(6) \qquad \Delta va_0^y = [\Delta y + (e_0 - e_1)\, p_0^e] - (c_1^v - c_0^v)e_1 \,,$$

with $\Delta y = y_1 - y_0$. Because our partial equilibrium analysis of the electricity sector in section 4 gives us estimates of each term in equation (6), we can compute the change in value added in the rest of the economy for each policy. Furthermore, with an exogenous estimate of GDP, one can also compare Δva_0^y relative to GDP, which equals

$$(7) \qquad \frac{\Delta va_0^y}{Y_0} \,.$$

With a negative sign, expression (7) quantifies the effect of policy on aggregate productivity in the rest of the economy. When capital (and labor) in the rest of the economy are fixed, this expression shows the fall in total value added produced by capital, labor and energy. At the same time, expression (7) quantifies the rate of real cost increase caused by electricity in the rest of the economy. As Harberger (1998) shows, a given change in TFP equals the rate of real cost change with opposite sign.

At the sectoral level, policies affect how efficiently generators deploy capital and the optimal mix of fuel and capital. Both directly affect aggregate productivity[7]. Because input prices are exogenous to the electricity sector and the same across policies, one can estimate the effect of policies on total factor productivity directly from differential changes in costs per MWh; this is what we do below in section 4[8]. Of course, one might estimate the changes in the productivity of capital, because we have estimates of the capital stock. But the exercise would make little sense, because policies affect the efficient capital intensity through the capital-fuel mix. At the sectoral level, an intermediate input matters as much as capital or labor when it comes to computing total factor productivity[9].

Lastly, because we perform partial equilibrium analysis, we assume that the trajectory of capital and labor inputs in the rest of the economy is exogenous to the electricity sector. This simplification is inevitable in order to study the electricity sector in detail. But, of course, in reality the cost and price of electricity affects investment, employment and growth –cheaper electricity increases the marginal return on capital, especially in energy– intensive sectors and should lead to faster accumulation and growth, at least for a while. We do not have much to say about this.

3. Preliminaries: modeling Chile's electricity market

In this section we briefly describe Chile's Central Interconnected System (CIS), the model we use to study the impact of microeconomic policies and the basics of the relation between electricity and the environment.

3.1. Chile's CIS

While there are four disjointed electricity systems in Chile, in what follows we consider only the CIS, which is by far the largest. Indeed, CIS extends from Chile's Second Region to its Tenth, covering around 92.2% of Chile's population in 2010, and comprising around 76% of its total installed capacity.

In December 2010 CIS total capacity was 12,147 MW and about two thirds of the energy generated on average comes from hydro plants. Nevertheless, hydro plants availability is volatile. In a very wet year, such

7 Almost no labor is used to produce electricity-according to the Central Bank's 2009 input-output matrix, wages and salaries amount to just 7% of total value added by electricity generation.

8 Again, this follows directly from Harberger (1998): the rate of real cost change equals the change in TFP with opposite sign.

9 See Domar (1961) and Hulten (1975).

as 1972-73, over 81% of generation could be supplied by hydroelectric plants[10]. But in a very dry year, such as 1998-99, only a little more than 11,000 GWh, or roughly 27% of the quantity generated could be supplied by hydroelectric plants. In other words, over half of the hydroelectric energy normally available or close to one third of annual generation is lost.

Hydro generation is complemented with natural gas-fired turbines (22.8% of installed capacity), coal (12.2%), diesel turbines (18.7%) and others, including renewables (2.2%). The high share of natural gas reflects investments made between 1998 and 2004, when combined-cycle turbines fueled with imports from Argentina were massively installed and the share of hydro in total capacity fell from 80% in 2003 to 52.3% in 2009. After the Argentine government restricted natural gas exports, hydro generation and coal became profitable again and combined cycles turbines were made to run with diesel, which is more expensive.

Generators exchange energy and power in the so-called spot market. In order to minimize the system's operation costs, the Economic Load Dispatch Center (CDEC for its Spanish acronym) centrally dispatches plants according to strict merit order[11]. The system's marginal cost (also known as spot price) is the running cost of the most expensive unit required to meet the instantaneous system's load, and changes every half hour. The spot price is used to value energy transfers from net sellers (those that generate more than their contractual obligations) to net buyers (those that generate less than their contractual obligations).

In addition, each generation unit is paid a monthly capacity payment based on its annual availability. The price of capacity (also called capacity spot price) equals the capital cost of the peaking technology, a diesel turbine. An annual capacity balance is calculated for the system's peak hour and generators with more capacity than their customers' load sell capacity to generators with deficit at the capacity spot price.

Because only generators exchange energy and power in the spot market and dispatch is mandatory, it is sometimes claimed that the

[10] The hydrological year begins in April and ends in March of the following year. The rainy season in central Chile runs from May through September. The thaw in the Andes Mountains (where water is stored as snow) starts in October and ends in March.

[11] This means that plants are ordered according to their variable cost per MWh and only the cheapest plants run to meet demand each half hour. CDEC also optimally manages the water in reservoirs, in particular the large Laja lake. See Galetovic and Muñoz (2009).

term "spot market" is an oxymoron –in a market, so the argument runs, wholesale customers directly bid and exchange energy at the spot price[12]. This description of the Chilean market overlooks three facts. One is that it is built on the premise that generators sell electricity to large customers through long-term contracts. Hence, contract prices smooth out the hourly, daily and seasonal variation of the marginal cost of energy, which is substantial. It is also the case that any generators' opportunity cost of energy and capacity is always given by the spot price, a direct consequence of mandatory marginal cost dispatch. Hence, even unregulated contracts with large clients, which represent about 40% of energy sold, must reflect expected marginal costs in equilibrium. Consequently, the rule used to set regulated energy and capacity prices just follows the logic of a competitive contract market. Last, entry into generation is free, hence expected spot prices must be high enough to pay for operation and investment costs in equilibrium. In other words, free entry and the resulting composition of generation plant determines average spot prices.

That said, the 1982 law creating the electricity market introduced neither customer access to the wholesale market nor retail competition for small customers. Instead, it defined "large" costumers-those who consume more than 2 MW –and "small" customers– the rest. Large customers, it was thought, can bargain supply conditions and tariffs with generators, and were left alone. Each small customer, by contrast, pays regulated capacity and energy prices and is supplied by a distributor who has a legal monopoly, buys energy and capacity under regulated wholesale contracts and pays transmission charges on behalf of customers. Therefore, distributors develop and maintain the medium and low-voltage grid and deliver electricity to regulated costumers inside their concession area.

12 For example, Joskow (2000a, 2000b), argues:

> *What is generally referred to as a spot market in Chile is not really a market in the sense that the spot markets for energy in California, Norway, or England and Wales are markets. Indeed, it is little different from the centrally dispatched power pools like PJM that existed in the United States for decades before restructuring. Generators are dispatched based on estimates of their marginal production costs, and the marginal cost of the last supply unit called to meet demand determines the market clearing price. Network congestion and constraints are centrally managed by the system operator (the CDEC in Chile) in conjunction with the least–cost dispatch of generators. While this mechanism for dispatch and spot–price calculation gives generators incentives to keep their costs low and their availability high, it represents a simulated spot market for energy rather than a real spot market.*

3.2. A brief introduction into the Emma model

As stated earlier, Chile's electricity regulation combines centralized dispatch with free entry into generation and contracting. Because of this, the short run of Chile's cis is almost fully determined by the system's load on the one hand and, on the other, by the available capacity and water. Consequently, policies work almost exclusively through investment decisions. This section briefly describes the Emma model (Spanish acronym for "electricity, markets and the environment") which we use to study the intertemporal impact of alternative policies[13].

Description and basic assumptions. Emma is an intertemporal integrated assessment model that minimizes the private expected cost of supplying electricity –the sum of capacity, operation and outage costs. Just as it is done in the cis, in our model plants are dispatched by merit order and water from the Laja reservoir is used optimally[14]. We assume that the generation profile of hydro plants follows the historic profile. We also assume that both wind and solar plants produce their average output during all hours. This simplification does not invalidate our results, because, in Chile's cis, the output of wind plants does not correlate with the marginal cost of energy[15] –average revenue per mwh is approximately equal to the average marginal cost. Moreover, the time profile a solar plant's output has little correlation with prices[16]. Nevertheless, it is known that intermittent generation from wind and solar causes incremental investments in transmission to maintain system stability. We do not model this cost here.

Existing capacity in 2010 is taken as given and, from then on, the model optimally installs new plants-hydro, coal, natural gas, diesel, nuclear and renewables. It also optimally chooses plant location in three different zones, that differ in population size and transmission costs. Available hydro projects are carefully modeled with a supply curve which we built with public information about water rights (see the next section). We assume

[13] This subsection is rather technical and can be skipped without loss of continuity. It is based on Galetovic,Hernandez, Muñoz and Neira (2012).

[14] Laja is the only reservoir in Chile that has interannual storage capacity. There are also smaller reservoirs in the cis that we model as run–of–river plants, whose availability varies in every demand block.

[15] The correlation coefficient of output and prices of wind plants in the cis ranged, in 2011, from –0.1 to –0.02.

[16] Assuming a standard generation profile of photovoltaic cells and the hourly marginal costs of the cis in 2011 we estimate that the correlation coefficient of output and prices of solar plants is approximately 0.15, and the average revenue is approximately 6% higher than the average marginal cost.

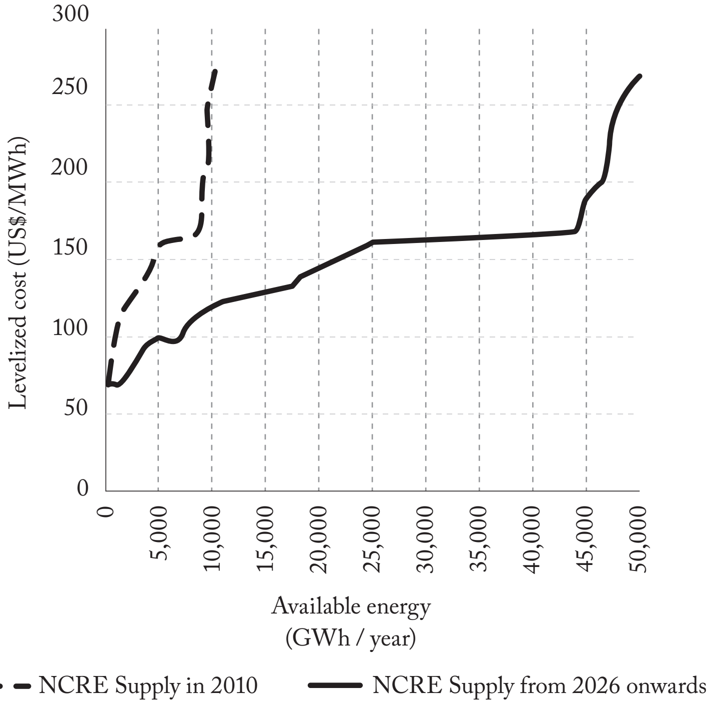
Table I. Availability and costs of non-conventional renewable energies in Chile's cis.

	Small hydro 1(6)	Small hydro 2	Small hydro 3	Wind 1 (7)	Wind 2	Wind 3	Bio–mass 1	Biomass 2	Biomass 3	Bio–gas (8)	Geo Thermal 1 (9, 10, 11)	Geo–Thermal 2	Geo–Thermal 3	PV Solar (12)	Solar–thermal (12)
Capacity factor	60%	60%	60%	30%	25%	20%	90%	90%	90%	90%	72%	72%	72%	30%	30%
Exploration's success prob.	–	–	–	–	–	–	–	–	–	–	30%	15%	5%	–	–
Available capacity (MW) (1)	267	544	333	150	300	1,050	325	650	2,274	350	150	300	1,050	1,051	500
Available Energy (GWh/year) (2)	1,404	2,858	1,748	394	657	1,840	2,562	5,123	17,931	2,759	941	1,883	6,590	2,762	1,314
Investment US$/kW (plant)	2,467	2,467	2,467	2,409	2,409	2,409	3,500	3,500	3,500	2,828	3,964	4,556	6,923	6,325	5,260
O&M in US$/kW–year (plant) (3)	20	20	20	32	32	32	68	68	68	68	173	173	173	12	60
Average distance to transmission system (km) (4)	40	60	80	3	3	3	3	3	3	3	65	65	65	3	3
Investment US$/kW (transmission) (5)	798	2,284	6,580	211	211	211	562	562	562	562	715	715	715	357	357
Investment in US$/MWh	50	50	50	108	130	162	52	52	52	42	79	91	138	283	236
O&M in US$/MWh	4	4	4	12	15	18	9	9	9	14	29	29	29	5	23
Variable fuel costs in US$/MWh	–	–	–	–	–	–	31	70	103	64	–	–	–	–	–
Other variable costs in US$/MWh	–	–	–	8	8	8	–	–	–	–	–	–	–	–	–
Transmission in US$/MWh	16	46	132	10	11	14	8	8	8	8	13	13	13	15	15
Total costs US$/MWh	70	100	186	137	163	202	100	139	172	128	121	133	180	303	273

Notes: (1) In each case, except for hydropower, the availability was taken from UTFS (2008). We assume that between 2010 and 2026 the available capacity of all technologies increases linearly from 20% to 100%; (2)(available energy) = (available capacity × capacity factor)×8.76; (3) Fixed operation and maintenance costs come from EIA (2010); (4) Average distances come from our own estimations. (5) In each case, the cost of connecting a NCRE plant to the system, in USD/kW, was estimated assuming it corresponds to a transformer at the plant and a transmission line in 110kV between the plant and the nearest substation. For small hydro plants, the transmission costs were estimated by minimizing the cost of each project. We report average values; (6) the available capacity and energy of small hydro plants was estimated through the study of the granted water rights, which aren't yet in use. To calculate the LCOE of each project the following parameters of each plant were considered: water flow rate, hydraulic head, location, distance to transmission system and the average capacity factor of the already existing plants located near the water right. Small hydro 1 considers projects that range from 49 – 86 US$/MWh. Small hydro 2 considers projects between 86 – 140 US$/MWh. Small hydro 3 considers projects between 140 – 197US$/MWh; (7) the cost of a wind turbine comes from Pavez (2008) and was adjusted by CPI's variation. The capacity factors supposed for wind turbines exceed the ones deduced by numerous studies ordered by the CNE. See Galetovic and Muñoz (2008); (8) CNE and GTZ Consultants (2009). The investment cost is the average value of the GTZ study, assuming plants smaller than 6 MW; (9) the investment costs of geothermal power plants is obtained from the following formula: let I is the total investment cost conditional to success in the exploration, let π be the probability of success and λ the fraction of the investment that takes place after a successful exploration. Then, the total expected cost of a kW of geothermal is $\lambda I + (1-\lambda) I / \pi$. We assume $\lambda = 0.95$ and $I = 3{,}550$ US$/kW; (10) to date, there are 10,715 MW of geothermal capacity installed around the world, and it is expected that they will generate 67,246 GWh (average capacity factor of 71.6%). See Holm et al. (2010); (11) we are currently working on a more precise estimate of Chile's geothermal potential and costs; (12) the investment cost of a kW of solar energy comes from EIA (2010); (13) the rest of the parameters come from estimations obtained in interviews with experts.

that renewables, described in Table 1, become gradually available over the years. The initial fraction of the renewable supply curve in Figure 3 is 20% in 2010 and this fraction increases linearly until the total potential is fully available by 2025.

Figure 3. The nonconventional renewable energy supply curve.



Precipitation uncertainty is modeled assuming four hydrologies –dry, intermediate, normal and wet–, each one with independent probabilities that mimic the historical distribution of precipitation in the CIS. Fossil fuel price uncertainty is modeled with four equally-likely price vectors[17].

Formally, if *r* is the discount rate, π is the probability of a hydrology-fuel price vector combination, *k(t)* is the annuity payment of the total cost of the installed capacity in year t, *c(t)* is the operation cost during year t and *o(t)* is the outage cost during year t, Emma minimizes

17 We assume that coal and natural gas prices are positively correlated with the price of oil.

$$(8) \qquad \sum_{t=1}^{60} \frac{1}{(1+r)^t} \sum_{j=1}^{16} \pi_j \, [k(t) + c_j(t) + o_j(t)],$$

subject to producing the energy demanded each year –given the prices that consumer's pay– and complying with renewable quotas and environmental standards. Notice that Emma is an intertemporal model, not a dynamic programming model –there are no reservoir level states and the optimization finds the vector that minimizes (8) over the whole planning horizon.

The simulations assume that the demand for electricity grows about 5% p.a. until 2020, and then at lower rates as the rate of GDP growth eventually converges to developed country levels.

Demand responds to price. One novel feature of Emma is that both energy prices and consumption are endogenous because the demand for power responds to the price of energy. This way, every year, installed plants are dispatched to fill the load duration curve of three types of customers –residential/commercial, regulated LV-HV (for low voltage and high voltage) and non regulated HV–, which determines the system's marginal costs and expected spot prices. Residential clients pay a regulated energy tariff, called BT1. The BT1 tariff is obtained from the sum of the expected marginal costs, the capacity cost and the distribution cost, adjusted by average losses. Regulated LV-HV and non-regulated HV clients pay separate tariffs for energy and capacity during peak hours. The energy price for LV and HV clients is equal to the expected marginal cost, also adjusted by average losses and the capacity cost is distributed prorate as an energy charge during the peak load block. Given those prices, the demanded quantities during each block match the produced quantities every year –the model iterates until it finds the market's equilibrium. Because the price each client pays during a demand block is constant, the quantity of energy demanded during each block is deduced directly from the power demanded at each instant during the respective block.

From planning to markets. Cost minimization is equivalent to competitive behavior. This is a plausible assumption in the CIS because, as we have seen, the CDEC centrally dispatches plants according to strict merit order to meet load at every moment. Dispatch is mandatory and independent of contractual obligations, which ensures competitive behavior in operation given plant installed at each moment in time.

Then, in the long run, free entry of generation ensures cost minimization. Consequently, marginal projects earn zero profits, because electricity prices are calculated directly from the shadow prices of the constraints of serving the quantity of energy demanded each year[18]. At the same time, hydro and renewables obtain Ricardian rents because their supply curves are upward sloping.

It should be noted that in Chile's CIS, a significant fraction of the water rights, which are necessary to build hydro plants, are owned by Chile's main generator, Endesa. Moreover, Endesa has a strategic alliance with Colbun, another generator who owns water rights, to jointly develop the large HydroAysen project in southern Chile[19]. Emma has a module that models the joint strategic behavior of Endesa and Colbun, assuming that they expand their installed capacity to maximize their joint profits.

3.3. Electricity and the environment

Power plants that run on fossil fuels emit CO_2, other greenhouse gases (GHGs) and air pollutants: particulate matter (PM_{10} and $PM_{2.5}$[20]), sulfur oxides (SO_x) and nitrogen oxides (NO_x). CO_2 emissions and greenhouse gases contribute to global climate change. The damage they cause does not depend on where the emission occurs. On the other hand, air pollutants affect only the area surrounding the source, damaging health, materials, visibility and crops. Any efficiency analysis of electricity generation must quantify these damages. In this section, which follows Galetovic, Hernandez, Muñoz and Neira (2012), we briefly explain how environmental externalities are modeled by Emma.

3.3.1. The damage caused by air pollutants

We quantify the total damage caused by the emission of an air pollutant with the marginal damage caused by its emissions. The marginal damage of the emission of an air pollutant is the value assigned to the externality wrought by emitting one additional ton of the pollutant.

18 The strong duality theorem ensures that, if output is values with these shadow prices, marginal projects earn zero profits. We thank Heinz Müller for making us aware of this.

19 We estimate that Endesa's water rights account for 22% of the total hydro potential in GWh/year and that Endesa and Colbun's water rights account for 47%. The latter number includes the water rights owned by Endesa, Colbun, and HidroAysen.

20 Particulates smaller than 2.5 μm.

Formally, if $md_i(s)$ is the marginal damage of air pollutant i when the amount emitted is s, then the total damage (D_i) caused by emissions t_i is

$$(9) \qquad D_i(t_i) = \int_0^{t_i} md_i\,(s)ds,$$

We assume that the marginal damage is constant within a locality, no matter the amount emitted by each power plant. Therefore, the total damage of emissions of a power plant is linear within the amount emitted. Hence equation (9) can be simplified to

$$(10) \qquad D_i(t_i) = md_i \text{ x } t_i\,,$$

It is important to distinguish between marginal damage and marginal per capita damage. Per capita damage is the harm caused to a particular individual or thing (e.g. a building) by a given concentration level of a given pollutant. On the other hand, the marginal damage wrought by an additional ton of the pollutant is a linear function of the number of individuals and marginal per capita damage, vis

$$(11) \qquad md_i = (\text{\# of individuals}) \times (\text{damage per person})_i\,,$$

A straightforward implication of equation (11) is that marginal damages grow with the size of the population around the source, ceteris paribus.

Table 2 exhibits the estimates of the marginal damages caused by $PM_{2.5}$, NO_x and SO_x in Chile and the United States. For Chile, we use the estimates of Cifuentes et al. (2010) for the marginal damages of $PM_{2.5}$, SO_x and NO_x[21] emitted by each power plant in Chile, which consider only mortality, morbidity and the reduction of agricultural yields. Muller and Mendelsohn (2007) estimate that these effects account for 94% of the total damage in the United States[22].

21 We quantify only the effects of PM2.5, SOx and NOx emissions, the pollutants that cause major concern (USEPA, 1995). There aren't any estimates of the marginal damage of other pollutants in Chile– carbon monoxide (CO), volatile organic compounds (VOC) and trace metals like mercury (Hg), nickel (Ni), vanadium (V), arsenic (As) and cadmium (Cd).

22 Muller and Mendelsohn (2007) also include the damage to timber, materials, visibility and recreation.

TABLE 2. MARGINAL DAMAGES CAUSED BY CO2 AND POLLUTANTS(IN US$/TON).

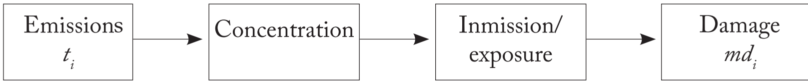
	(1) CO_2	(2) $PM_{2.5}$	(3) SO_2	(4) NO_X
Nordhaus	5.6 to 55.8	–	–	–
Big city (1)	–	29,679	434	4,268
Small city (1)	–	8,330	138	1,228
Town (1)	–	325	5	42
M&M (2) (EE.UU.)		3,220	1,310	260
M&M (3) urban	–	3,300	1,500	300
M&M (3)r ural		1,100	900	300

Source: CO_2: Nordhaus (2010). $PM_{2.5}$, SO_2 y NO_X: from Cifuentes et al. (2010). Notes: (1) Cifuentes et al. (2010) performs a stochastic assessment of the marginal damages and for each power plant reports the 5th percentile, the median, and the 95th percentile of the marginal damage for each pollutant. The group "Big city" corresponds to the 90th percentile of the vector that contains the median marginal damages of each power plant. Analogously, the group "Small city" corresponds tothe 60th percentile of the median marginal damage, and the group "Town" corresponds to the 30th percentile of the median marginal damage. (2) Muller and Mendelsohn (2009). (3) Muller and Mendelsohn (2007).

We assume four different locations such that marginal damages differ because of population size (see table notes). We further assume that the value of the marginal damages in 2010 are the ones estimated by Cifuentes et al. (2010), but over time they converge to the ones estimated by Muller and Mendelsohn (2007) for the United States as Chile's GDP per capita gradually converges to USA's GDP per capita. While per capita damages are larger in the United States, the marginal damages of emissions are larger in Chile due to larger population densities around the sources of emissions.

Note that in equations (9) and (11) total damage is a function of emissions t_i. Nevertheless, in practice the damage is caused by the exposure of individuals and things (like buildings or crops) to pollution. As shown in Figure 4a, emissions interact with the local environment to determine the concentration of the pollutant in the air and only then humans and things are exposed and damaged.

Figure 4. The mapping between emissions and damage (a) Local pollutants.



We assume a direct relation between emissions (t_i) of pollutant i and the marginal damage it causes (md_i). In practice, emissions of local pollutants interact with the local environment and affect concentrations. Damage depends on emissions or exposure to the pollutants.

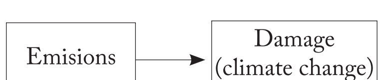
The mapping between emissions and concentration is highly dependent on local conditions and even on the characteristics of each source. For example, Muller and Mendelsohn (2009) show that ground-level emissions in urban areas increase concentrations nearby more than high-stack emissions, because tall smokestacks disperse pollutants away from the source. On the other hand, they also show that in rural areas concentration levels do not depend on whether the source is at ground level or arrives through a high stack. This is one source of imprecision in the assessment of environmental costs.

Similarly, the mapping between exposure and emission on the one hand and damage on the other is subject to considerable uncertainty. Protracted exposition to pollution increases the prevalence of several chronic and acute diseases (morbidity), and lowers life expectancy (mortality). However, both morbidity and life expectancy are influenced by many other factors and it is not easy to quantify the incremental contribution of pollution.

3.3.2. The damage caused by CO_2 emissions

The adverse effects of climate change are floods, droughts, changes in storm patterns, temperature, higher sea levels, among others, causing costs in those affected human activities. The marginal damage of CO_2 is the present value of all incremental economic costs (present and future), caused by the incremental climate change of emitting an additional ton of CO_2 into the environment. As Figure 4b shows, the damage caused by greenhouse gases does not depend on local conditions around the source, but only on the carbon content of the fuel burned.

Figure 4. The mapping between emissions and damage (b) Global pollutants.



The damage caused by greenhouse emissions is global, and is a direct function of the carbon content of the fossil fuel burned.

Nordhaus (2010) estimated the price per ton of CO_2 for five post-Copenhagen scenarios using the RICE-2010 model. In our evaluations we assume that the marginal damages of CO_2 over time are the prices of CO_2 reported in Nordhaus (2010) optimal scenario. This scenario maximizes economic welfare, assuming that all countries mitigate emissions optimally from 2010 on, equating the marginal cost of reducing CO_2 to the marginal damage of CO_2 in all sectors of the economy. Therefore, in this case CO_2 prices can be interpreted as marginal damages. Table 2 exhibits the marginal damage of CO_2 emissions, estimated in Nordhaus (2010). The price of CO_2 increases overtime and ranges from $5.6 in 2010 to $55.8 in 2063 per ton of CO_2[23, 24].

Finally, to compute the total damage of CO_2 we assume that the marginal damage is constant with power plant emissions but increases exogenously over time.

4. Policies, efficiency and productivity in Chile's CIS

4.1. ENDOWMENTS AND THE SCOPE OF AN EFFICIENT ENERGY POLICY

Good microeconomic policy fosters the efficient use of resources, but outcomes also depend on factor endowments. How is Chile's CIS endowed to produce electricity? In the long run there are four sources of energy. One is Chile's vast reserves of hydroelectricity. Second, generators can also import fossil fuels: coal, LNG and diesel. Third, while it seems unlikely, the CIS might go nuclear. Last, imports of natural gas may resume at some unknown date in the future, since there are vast reserves of natural gas in Argentina and pipelines that cross the Andes are already sunk. How should one compare them?

4.1.1. Some basic electricity economics

Electricity can be produced with several different technologies and because electricity demand varies over a day, week, month and year, cost

23 In the long term, the price of CO_2 in Nordhaus (2010) is capped by the price of the technology that can replace all carbon fuels. Nordhaus (2010) argues that the price of this technology is $1,260 per ton of carbon, which is equivalent to $343.3 per ton of CO_2. To convert from dollars per ton of carbon to dollars per ton of CO_2 divide by 3.67.

24 A very brief survey of the literature that estimates the social cost of greenhouse gas emissions is in Galetovic and Muñoz (2013).

minimization implies that different technologies will optimally coexist in equilibrium[25]. Base loads –i.e. those consumptions that do not vary over the course of a day, week, month or year, like those needed to keep refrigerators working– are efficiently served with high-capital, low-fuel cost technologies. By contrast, loads that are only present at peak hours should be served with low-capital, high-fuel cost technologies, like diesel turbines.

At the same time, it is also the case that the bulk of capacity additions should come from only one base load technology that with the lowest "levelized" cost. The levelized cost is the average cost per MWh or unit of energy. It combines capital and fuel costs by prorating the cost of a unit of capacity over all MWh produced. Of course, the more intensely capacity is used (i.e. the higher the so-called "capacity factor"), the lower the levelized cost of energy. Formally, let f be the annual cost of the capacity needed to produce one MW of power continuously with a given technology, let c the fuel cost of producing one MWh of energy and let $\lambda \in [0, 1]$ be the availability factor and recall that a year has 8,760 hours[26]. Then, the levelized cost per MWh is

$$\frac{f}{8760\lambda} + c. \tag{12}$$

As can be seen from equation (12), cost variations between technologies stem from variations in f, c and λ. For example, hydro plants are cheap to run ($c \approx 0$), but expensive to build (f is large) and their availability factor varies a lot depending on precipitation patterns. Fossil fuel plants, by contrast, are more expensive to run ($c > 0$), but cheaper to build and their availability factor is high. Last, nuclear plants are cheap to run (c is smaller than for fossil fuels) and their availability factor is very high. Nevertheless, they are very expensive to build, so that f is large. Which one is more cost effective depends on all three parameters and is ultimately a practical matter.

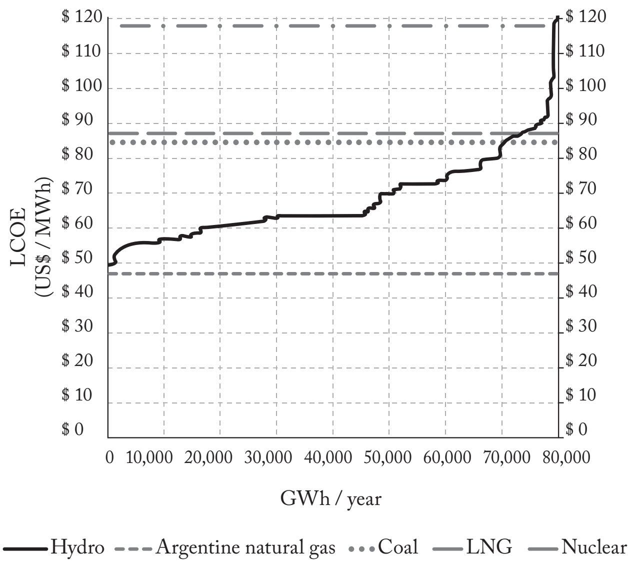
25 The seminal reference is Boiteaux (1960).

26 Power is the ability to perform mechanical work and is measured in watts (W). Energy is the use or generation of power during a given time period and is measured in watts per hour or watt-hours (Wh). For example, a 100 W light bulb consumes 50 Wh of energy if it is on for half an hour. One kilowatt (kW) = 1,000 watts (W), one megawatt (MW) = 1,000 kW and one gigawatt (GW) = 1,000 MW.

4.1.2. The levelized cost of energy in Chile's cis

Figure 5 shows the levelized cost of energy of each technology[27]. Argentine natural gas is clearly the cheapest alternative, at approximately US$46/ MWh. Not surprisingly, between 1997 (when natural gas first arrived) and 2004 (when the Argentine government reneged on its 1991 trade agreement and curtailed natural gas exports), capacity expanded exclusively with gas-fired combined-cycle plants.

Figure 5. The levelized cost of electricity in Chile's SIC.



Notes: (1) The hydro supply curve. The supply curve of hydro power was estimated from detailed public records of water rights still not in use. These records are used to assess yearly patent fees that the owners of unused rights have to pay. Each record reports the size of the water right in cubic meters per second and its location. Geo referencing of each right allowed us to estimate its height and generation potential. Projects were then connected to the main grid at minimum cost. Availability factors vary across regions according to empirical yearly precipitation variability. The robustness of the supply curve was tested with Monte Carlo simulations. (2) Assumptions and parameter values. We estimated the annuity of each technology assuming a 10% real rate of return. Except for hydro, availability factors are assumed to be 85%. Coal plants consume 7.2% of their output; Argentine gas –and LNG– fired combined cycles consume 1% of their output. The levelized cost of fossil-fuel power plants includes the cost of abatement equipment needed to comply with current environmental standards. The cost of environmental externalities is not included. (3) Cost data sources Investment and maintenance costs for coal, LNG, and Argentine natural gas were obtained from EIA (2010). Average operation costs for coal and LNG were obtained from historical data. Investment, maintenance and operation costs for nuclear plants were obtained from De Carvalho et al. (2009). (4) Investment/fuel cost/variable cost Hydro: US$261.7/kW-year + transmission. Coal: US$306/kW-year, US$97/ton and US$38.2/MWh. LNG: US$123/kW-year, US$9.925/MMbtu and US$70.1/MWh. Argentine natural gas: US$123/kW-year, US$4/MMbtu and US$29,3/MWh. Nuclear: US$772/kW-year and US$14.5/MWh.

[27] The levelized cost of energy includes capital, operation, and maintenance costs.

But unless imports resume, the main source of cheap energy is hydroelectricity. Indeed, based on a detailed count of available water resources, we conclude that hydroelectricity can add about 75,000 GWh per year of energy at lower cost than coal (around US$85.5/mwh) and LNG (around US$87.4/mwh)[28]. This is substantial: recall that currently yearly consumption of electricity in the cis is about 45,000 GWh. Thus, Figure 5 indicates that Chile's cis should expand with hydro for a long time.

Figure 5 largely maps the scope of an efficient energy policy. It is apparent that when natural gas exports from Argentina were first curtailed and then suspended, the cis was hit by a large supply shock, which increased the long-run cost of electricity-roughly the difference between the hydro supply curve and the system's levelized cost with Argentine natural gas. Given that Argentine gas exports will not resume in the foreseeable future, the main implication is that policy should facilitate the development of Chile's hydro potential. Nevertheless, while not apparent from Figure 5, investments in hydro have been rather slow in practice. Whether the cis develops along the hydro supply curve or expands mainly with fossil fuels will probably be influenced by policies. In what follows, we quantify the effect of alternative policies with our intertemporal model Emma.

4.2. Baseline

Assumptions. All simulations estimate the system's expected operation between 2010 and 2049 with actual installed capacity in 2010 and under construction until 2016. Between 2016 and 2049 we study the effects of alternative policies by imposing different constraints on investment plans.

In the baseline case, the system freely invests in hydro according to the supply curve in Figure 5. In addition, Endesa and Colbun choose their sequence of hydro investments to maximize joint profits and the rest of the system minimizes expected investment and operation costs given the behavior of Endesa and Colbun. Fossil fuel plants install emissions abatement equipment to comply with current environmental standards, including the recent regulation of SOx and NOx emissions. Furthermore, generators must either meet a quota of non-conventional renewables, which increases from 5% of total energy in 2010 to 10% in 2024 as mandated

[28] The levelized cost of diesel-fired plants is not shown in Figure 5 because it is well above nuclear, at approximately US$220/mwh.

by the current law. Thus, the baseline case combines actual investments, regulation and market structure with unrestricted development of Chile's hydro potential[29].

We assume that both Endesa and Colbun and the planner make their intertemporal decisions discounting flows at a 10% annual real rate. Thus, when deciding whether to make an investment, intertemporal costs and benefits are discounted at this rate.

At the same time, in order to report outcomes in Table 3, we discounted yearly flows at the rate of growth of the demand for electricity and then averaged out over 40 years. This might be a little unconventional but convenient because it scales quantities to levels at the initial year[30]. For example, the first line and column of Table 3 says that 40,385 GWh are sold every year on average in the baseline case and that the yearly average capital cost is US$1,844 million. In addition, not discounting by time preference allows us to assess the average yearly performance of each policy without weighing the present more than future. Thus, for example, when reporting results, we weigh US$1 of capital costs incurred in 2030 the same as US$1 of capital costs incurred in 2012. In this way we have a better sense of the year-by-year performance induced by alternative policies, which is convenient when assessing the effects of policies on productivity.

The composition of generation. Panel (a) in Figure 6 shows the composition of generation between 2010 and 2049. The figure shows the share of hydro at the bottom, followed by coal, LNG, NCRE and diesel. Three periods can be distinguished.

In the first, between 2010 and 2015 the share of hydro falls from 69% to 56% and coal's share grows accordingly; this reflects the fact that about half of the capacity that will become operational until 2016 will burn coal. Second, in 2016 hydro's share jumps back to 69% and remains there until about 2032[31]. This reflects that from 2016 on, the system expands with hydro, just as Figure 5 suggests. Note also that coal's share steadily falls, partly because NCREs expand to comply with the law, but also because LNG capacity expands to serve the peak, whose size grows year by year.

29 At the time of the last revision (December 2012) the entry schedule of new plant was already dated. Hence, the "predicted" evolution of the system between 2010 and 2014 does not coincide with reality.

30 In the appendix we report results with standard discounting.

31 Indeed, between 2010 and 2015 the model "builds" 2,500 MW of nominal hydro capacity. Massive entry of hydro capacity as soon as the model allows it suggests that investments in hydro are behind schedule.

Table 3. Comparative evaluation of the system's performance under each policy (annual averages, in millions of US$).

	(1) Baseline	(2) With Argentine natural gas	(3) Freezing water	(4) Neither water nor coal	(5) Uncontrolled emissions	(6) NCRE's quota = 20%	(7) Optimal environmental policy	(8) Water rights divestment	(9) Good policies added	(10) Bad policies added
Total sales (GWh) (1)	40,385	45,263	39,973	39,605	41,590	38,473	39,714	40,823	40,354	37,783
Capital cost	1,844	1,315	1,450	1,234	1,886	2,127	1,868	1,881	1,846	1,648
Operation cost	754	980	1,110	1,544	727	593	678	751	716	1,126
Environmental cost	11	10	22	10	468	7	12	11	12	184
Total	2,609	2,304	2,582	2,789	3,081	2,727	2,558	2,643	2,574	2,958
Δ generators' profits	0	–527	238	71	–116	484	97	–24	–22	561
Δ consumer surplus	0	1,182	–236	–322	156	–790	–254	30	–96	–959
Δ environmental cost	0	–1	11	–1	457	–4	1	0	0	173
Tax collections	0	0	0	0	0	0	144	0	148	0
Δ social surplus (4)	0	656	–9	–250	–416	–302	–13	7	30	–571
Δ value added	0	813	–156	–222	114	–532	–173	25	–65	–654
Δ residential surplus	0	369	–80	–100	42	–258	–81	5	–31	–305
TFP electricity (private)	100	127	100	92	102	91	100	100	101	88
TFP electricity (social)	100	127	100	92	87	91	100	100	101	83
Price/MWh	89	61	95	97	84	109	91	88	87	114
Cost/MWh	64	51	64	70	63	71	64	64	63	73
Pollution damage/MWh	0.3	0.2	0.6	0.3	11	0.2	0.3	0.3	0.3	4.9
Hydroprofits	818	291	1,001	828	685	686	973	784	946	721
Fossil fuel profits	20	3	71	76	40	–24	–30	24	–34	52
NCRE profits	146	163	150	151	143	806	139	153	50	772

Notes: (1) Total sales are equal to generation less average transmission losses. (2) Capital costs include the annuity paid to initial capacity. (3) Environmental costs are the sum of the social cost of pollution and CO2. (4) Change in social surplus = Δ Consumer surplus + Δ Generators' profits – Δ Environmental costs.

Figure 6. The composition of generation under alternative environmental policies.

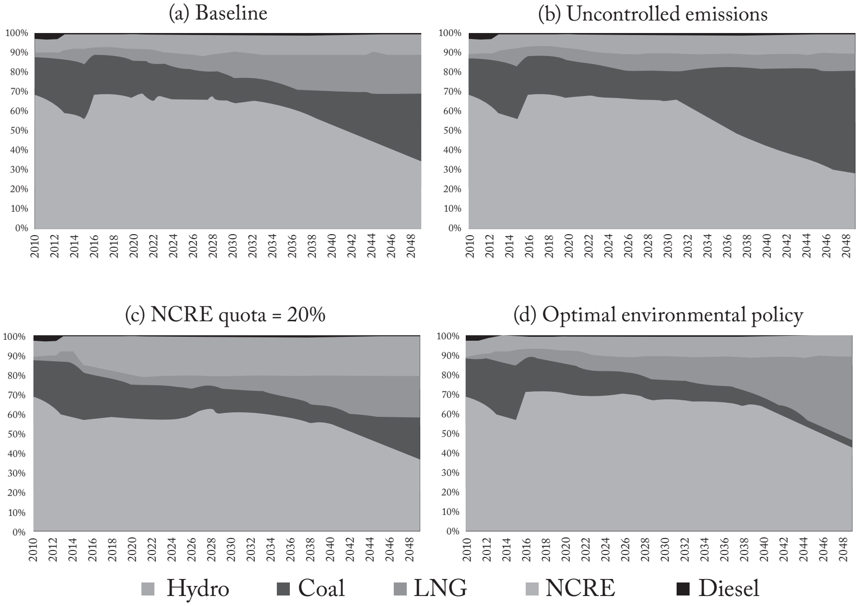
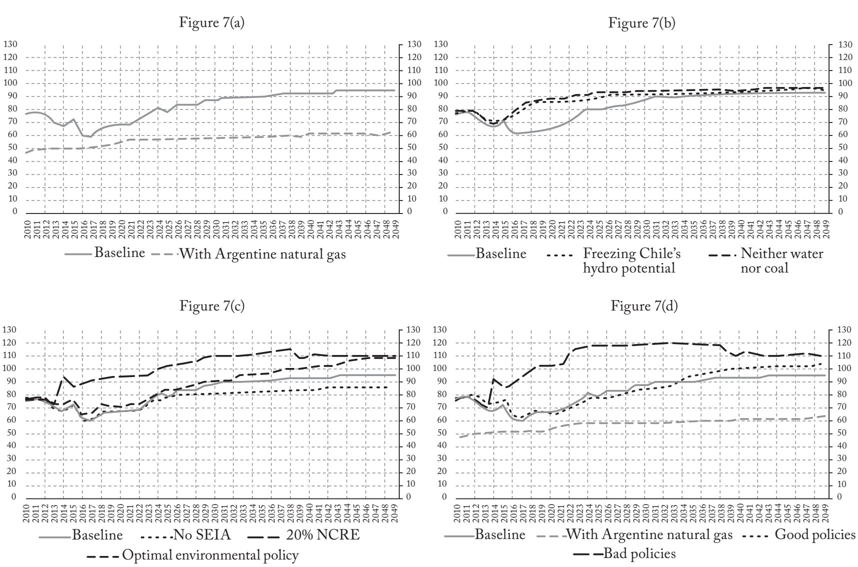


Figure 7. Expected levelized price of energy under alternative policies.



Third, after 2033, when all efficient hydro projects are already operational, the system expands with fossil fuels, again a direct consequence of Figure 5. Consequently, while hydro generation remains roughly constant in levels, its share steadily falls. On the other hand, the share of coal rises from about 10% in 2033 to one-third in 2049 as coal substitutes for hydro as base load technology. Last, LNG is still the technology of choice to serve the peak, so its share remains constant at about 20%.

Prices. Panel (a) in Figure 7 shows the expected levelized price of energy[32]. As capacity grows between 2010 and 2016 and massive investments in hydro enter in 2016, it falls to US$59/MWh in 2016. From then on the levelized price of energy steadily increases as the system climbs up the hydro supply curve. By 2030 the levelized price is about US$90/MWh and, by the time hydro investments run out, it reaches US$94/MWh and remains there as the system expands with coal as base load technology and with LNG to serve the peak.

Economic outcomes. Column 1 of Table 3 summarizes the economic outcomes of the baseline case. It can be seen that 40,385 GWh are generated on average, which cost US$2.6 billion. About 70% of the total costs of generation are capital costs (US$1.8 billion) and 30% are operation costs (US$754 million); environmental costs are small.

As the lower panel in Table 3 shows, hydro generators make substantial profits-US$818 million per year. This follows from Figure 5: as the equilibrium price of electricity increases over time along the supply curve, inframarginal capacity earns Ricardian rents. By contrast, fossil-fuel generators earn close to zero profits, which is a consequence of competitive entry.

To put these magnitudes in perspective, note that the IMF estimated Chile's GDP in 2011 at around US$250 billion. At the same time, the Central Bank (2012) estimates that roughly 90% of generation's value added are capital costs and gross operating surplus. In our base case capital costs and profits add up to 2.8 billion (see column 1 in Table 3), i.e. the contribution to total value added is roughly 3.0 billion per year or about 1.2% of GDP[33].

32 Expected levelized costs include the marginal cost of energy, the marginal cost of capacity, and a postage charge due to the non-conventional renewables quota.

33 The Central Bank (2012) estimates that in 2009 electricity generation contributed 1.7% of total value added. Since about 75% of Chile's electricity is generated in the SIC, it follows from this estimate, that the SIC contributes about 1.3% of total value added.

4.3. Estimating the cost of not having Argentine natural gas

Natural gas found and lost. Until the early 1990s capacity in Chile's cis expanded mainly with hydro generation, complemented with a few coal plants and diesel turbines, mainly backups against severe droughts. But in 1991 Chile and Argentina signed a protocol to freely trade natural gas which mandated open access to gas pipelines[34]. By the mid 1990s two pipelines were under construction and in 1997 the first combined cycle plants began to generate in Chile's cis. Electricity prices fell precipitously and capacity began to expand almost exclusively with natural gas. But gas cuts began in May 2004 and soon the Argentine government suspended further export permits, thus violating the 1991 agreement that made gas exports possible. Worse, protracted and increasing gas cuts ensued, as shortages in Argentina, caused by the price controls introduced in the aftermath of the 2001 devaluation, worsened.

In this section we estimate the cost of losing Argentine natural gas, comparing the baseline trajectory of the system with what would have happened had natural gas been freely available in the same conditions that prevailed until 2004.

Prices and quantities. Figure 5 shows that no hydro investments are competitive with Argentine natural gas. Indeed, the share of hydro falls fast from 60% in 2010 to 40% in 2020 and 15% in 2045. Panel (a) in Figure 7, on the other hand, shows the trajectory of the levelized price of energy. It is just US$50/mwh during this decade and stabilizes at slightly less than US$60/mwh after 2024, once the 10% non-conventional renewable requirement is met. As can be seen from Column 2 in Table 3, average energy prices are about one-third lower than in the base case (US$61/mwh against US$89/mwh).

Column 2 in Table 3 reports the economic outcomes with Argentine natural gas. Electricity consumption is about 13% higher than in the baseline (45,263 GWh against 40,385 GWh). Yet the annual total cost of generation is 12% lower on average (US$2.3 billion against US$2.6 billion). Because natural gas generation is less intensive in capital, capital costs are almost 29% lower (US$1.3 billion against US$1.8 billion), and the share of capital costs is smaller, 57% against slightly more than 70%. Finally, while natural gas is a fossil fuel, environmental costs barely change.

34 "Acuerdo de complementacion economica N 16", signed on August 2, 1991.

Our exercise suggests that the recovery of Argentine natural gas would have large welfare and distributive effects. As column 2 on Table 3 indicates, consumer surplus is on average some US$1.2 billion higher, equivalent to 45.3% of baseline system cost or slightly less than 0.5% of GDP[35]. By contrast, generator profits fall, because natural gas reduces the Ricardian rents of hydro generators (but of course, not of NCRE generators). All in all, social surplus is US$656 million higher, equivalent to 25.1% of baseline system cost or about 0.25% of current Chilean GDP.

Efficiency and productivity. As column 2 in Table 3 shows, the return of Argentine natural gas would increase value added in the rest of the economy in US$813 million every year on average. In other words, GDP would be permanently higher by 0.3%. Depending on your point of view, this may seem large or small. It is large if the yardstick is the size of Chile's CIS –about one-fourth of CIS's value added[36]. Moreover, Chile's CIS is "large", macroeconomically speaking– its contribution to total value added (about 1.3% in 2009) would rank in the 82nd percentile among 111 economic sectors of the Chilean economy. On the other hand, 0.3% of GDP might not seem very large in the sense that it is not enough to account for Chile's productivity slowdown, a usual argument one hears from macroeconomists. We will return to this discussion in section 5.

In any case, note that Argentine natural gas would increase total factor productivity in Chile's CIS by 27% compared with the baseline case. This, of course, is despite the fact that the value added by generators would fall substantially, from about US$3 billion to about US$1.8 billion. But this is precisely the point of higher productivity: Argentine natural gas produces the same amount of electricity with fewer resources.

4.4. Red tape and policy uncertainty

Is red tape important? Perhaps most would agree that red tape slows entry and productivity growth, but careful cost estimates for specific sectors are hard to come by. In Chile's electricity sector, casual observation suggests

[35] In what follows we will refer most comparisons to baseline total system costs, US$2,609 million. In this case, 1,182/2,609 = 45.3%.

[36] The Central Bank's 2009 input-output matrix distinguishes 111 sectors. The median sector (non-ferrous mining) contributes 0.36% of total value added. The 90th percentile sector (real estate development) contributes 2.7% of total value added. The largest sector (copper mining) contributes 13.2% of total value added.

that it has become increasingly difficult over time to get regulatory clearance to build new plants, especially large hydro projects and coal plants. It is also the case that through judicial action and sometimes direct lobby, those who oppose projects on principle or to extract rents, have been able to delay them and sometimes obtained their cancellation. Finally, getting eminent domain to build new transmission lines is difficult and some argue that this has slowed down investments in capacity.

Regardless of the explanation, there are clear indications that investments are delayed beyond of what is efficient. As said, the base case indicates that about 2.500 MW of hydro capacity should enter the energy sector as soon as possible. By contrast, until 2014 only 700 MW of hydro capacity and 800 in coal will enter[37]. Worse, at the time of writing (October 2012) no further projects are under construction, so that new capacity will not be available before 2017 at the earliest.

We can evaluate the consequences and costs of slowing down investments by comparing the baseline with restrictive regimes. While this exercise assumes the constraints, it is realistic: if the future of coal became uncertain when Suez's Barrancones project was canceled after a presidential request despite having received environmental clearing[38], it now looks even more unlikely, because a recent ruling of Chile's Supreme Court cancelled the 700 MW Castilla coal plant, questioning the environmental evaluation methodology used by the agency in charge.

To estimate the consequences of slowing down investments we have simulated two restrictive investment regimes:

Freezing Chile's hydro potential. The first simulation calculates the system's expected expansion and operation from 2010 on, with plants under construction until 2014. After 2014, we assume that, for hydro entry, only two hydro plants are built: Alto Maipo (a 500 MW run–of–river plant near Santiago) and Endesa and Colbun's 2,750 MW project HidroAysen. We assume that no other hydroproject is ever undertaken.

Neither hydro nor coal. The second simulation assumes that no further hydro or coal projects are developed besides the ones under construction until 2014. The system is then forced to expand with LNG.

37 See Galetovic and Hernandez (2012).

38 Apparently the President intervened to please environmental groups who vociferously oppose coal plants.

Prices. Panel (b) in Figure 7 shows the evolution of the expected levelized price of energy. There is little difference between either restrictive regime –the price of energy quickly approaches US$90/MWh. At the same time, until 2030 the price of energy is between US$10 and US$25/MWh higher than the baseline. After 2030 the difference narrows and eventually disappears, but only because prices rise in the baseline case when new hydro projects run out. Two conclusions follow. First, large but isolated hydro projects have little impact on prices. Second, as far as the price of energy is concerned, there is not much difference between expanding with coal or LNG, a fact that is already suggested by Figure 5.

Economic outcomes. Columns 3 and 4 in Table 3 show the economic impact of restrictive regimes. Compared with the baseline, neither average yearly generation nor costs change much, because after hydro projects run out around 2030 system expansion is almost the same. Furthermore, note that the cost of local externalities remains of the same order of magnitude, which confirms that current environmental regulation is effective to control local pollution.

On the other hand, the distributive effects of restrictive regimes are rather large. If only HidroAysen and Alto Maipo are built, consumers lose US$236 million a year on average, but yearly generator profits rise by US$238 million. On the other hand, because both Alto Maipo and HidroAysen have relatively low costs, the cost of generation does not change by much compared with the baseline (in both cases on average electricity costs US$64/MWh) but Ricardian rents increase. Thus, limited hydro development allows the owners of hydro plants to earn rents without lowering the price of energy.

Column 4 shows that when neither hydro nor coal develop, consumers lose even more (US$322 million) but generator profits increase only a little (US$71 million). The reason is that generation costs per MWh rise almost 10% with no further hydro investments, from US$64/MWh on average in the baseline to US$70/MWh with neither hydro nor coal. All in all, social surplus falls by US$250 million. This is large; for example, it amounts to about 40% of the benefit of recovering Argentine natural gas.

Note that incumbent hydro generators like restrictive regimes. Compared with the baseline hydro generators as a group earn only US$10 million more (US$828 million in the neither-hydro-nor-coal case against US$818 million in the baseline). But this obscures the fact that in the restrictive case hydro capacity is frozen at its initial level. Hence rents per installed MW of capacity are substantially higher.

Efficiency and productivity. Columns 3 and 4 in Table 3 show that productivity in generation does not change much when some hydro development is allowed and the system expands with coal, but falls 8% when the system is forced to expand with LNG. Value added in the rest of the economy falls, depending on the case, by US$156 million or US$222 million, between one-fifth and one-fourth of the increase in value added that would accrue with the return of Argentine natural gas.

4.5. Environmental policies

4.5.1. Introduction

As in the rest of the world, the environmental impact of fossil fuels generation is hotly debated in Chile. Currently all projects must pass an environmental evaluation, carried out by the Environmental Impact Evaluation System (SEIA for its Spanish acronym). SEIA forces plants to install abatement equipment for pollutants, particularly particulate matter, and ensure compliance with environmental standards. Second, a recent regulation imposed rather stringent emission standards on SOx and NOx. Last, the quota of renewable energy forces companies to supply at least 5% of their annual sales of electricity with non conventional renewable energies (NCRE) in 2010, increasing to 10% in 2024[39]. If a company doesn't meet the quota, it has to pay a fine of about US$42/MWh for each unmet MWh.

It seems fair to say that many consider that the current environmental control system (SEIA) is ineffective, while others think that it is very expensive. Still others believe that NCREs are necessary to decrease CO_2 emissions. Not coincidentally, a bill is currently in Congress which would increase the NCRE quota to 20% by 2020. To evaluate the impact of the environmental policies we simulated the following:

Uncontrolled emissions (without SEIA). This simulates how the system would have expanded had neither SEIA existed nor standards on NOx and SOx emissions imposed.

[39] NCRE include biomass, biogas, geothermal, tidal, solar, wind and small hydroelectric power plants (smaller than 20 MW).

A 20% NCRE quota by 2020. The quota increases from 5% in 2010 to 20% in 2020[40]. Generators cannot pay a fine for noncompliance.

Optimal environmental policy. In this case generators pay the marginal damage of SOx, NOx, PM and CO_2 emissions. Existing and new plants optimally install abatement equipment to minimize their cost of generating electricity and the environmental damage they cause. The global marginal damage caused CO_2 emissions is valued following Nordhaus (2010).

4.5.2. Assessing the effect of current environmental policies

Environmental policies and the environment. Table 4 shows the environmental impact of each policy. Note that with the exception of column 5 ("uncontrolled emissions"), total emissions of local pollutants vary only marginally across policies[41]. Indeed, by simulating what would happen with no regulation at all, it becomes apparent that current environmental regulation is quite effective. For example, compared with the base case, uncontrolled emissions of SOx would be almost 17 times larger and NOx emissions are 18 times larger. Particulate material emissions, in turn, would be some 3,300 times larger. In other words, current regulation succeeds in making them almost negligible –the denominator is small. Thus, current regulation has nearly eliminated particulate material and strongly reduced SOx and NOx emissions.

Economic impact. As can be seen in column 5 in Table 3, with uncontrolled emissions consumers would gain US$156 million, because the price of energy would be slightly lower (see the dotted line in Figure 7c). But generator profits would fall by US$116 million and compensate in part by what consumers gain. More important, as column 5 shows, uncontrolled emissions would increase the social cost of generation by US$457 million on average each year and reduce social surplus by US$416 million. These effects are large, of the same order of magnitude as those caused by Argentine natural gas. Thus, the social benefit of forcing the installation of abatement equipment is substantial.

40 The quota increases to 15% in 2015 and increases every year in 1% until it reaches 20% in 2020.

41 Column 10 ("bad policies added") also shows simulations with uncontrolled emissions.

TABLE 4. COMPARATIVE EVALUATION OF THE ENVIRONMENTAL IMPACT OF EACH POLICY (ANNUAL AVERAGES).

	(1) Baseline	(2) With Argentine natural gas	(3) Freezing water	(4) Neither water nor coal	(5) Uncontrolled emissions	(6) NCRE's quota = 20%	(7) Optimal environmental policy	(8) Water rights divestment	(9) Good policies added	(10) Bad policies added
Emissions (thousand tons)										
SOx	21	3	36	13	343	14	22	20	22	124
NOx	17	13	30	15	311	11	24	17	24	169
PM 2.5	0	0	1	0	109	0	0	0	0	40
Emissions (baseline = 100)										
SOx	100	14	174	65	1,665	67	108	99	105	604
NOx	100	77	180	91	1,841	64	143	99	143	1,001
PM 2.5	100	10	161	73	33,264	72	139	99	135	12,025
Damage (US$ millions)										
SOx	5	1	9	3	84	3	5	5	5	29
NOx	5	9	12	6	107	3	6	5	6	61
PM 2.5	1	0	2	1	277	1	1	1	1	93
CO2 emissions										
Emissions (thousand tons)	28,452	35,083	46,470	36,154	39,632	20,220	18,152	28,166	18,977	29,997
Emissions (baseline = 100)	100	123	163	127	139	71	64	99	67	105
Damage (US$ millions)	206	259	338	269	284	148	135	203	139	223

An alternative way to appreciate the effectiveness and efficiency of current policies is to compare them against the optimal policy, which forces generators and consumers to internalize all environmental externalities. Note that, as column 7 shows, an optimal policy would barely change social surplus and prices relative to the baseline (see Figure 7c)[42]. Indeed, with an optimal policy emissions are slightly higher, which suggests that current environmental standards in are quite strict.

Efficiency and productivity. It is often claimed that there is a trade-off between economic efficiency and the environment. Nevertheless, our results put this in doubt because the economic burden of current environmental standards is rather small. As can be seen in Table 3, doing away with current environmental regulations would reduce the average price of electricity from US$89/MWh in the baseline case to US$84/MWh and value added by the rest of the economy would increase by US$114 million. This is not negligible, but is much smaller than the reduction in the cost of emissions. Also, the average cost of producing electricity would fall, but only marginally, from US$64/MWh in the baseline case to US$63/MWh, and TFP in electricity generation would increase only by 2%.

Indeed, uncontrolled emissions have a small positive effect on measured TFP in electricity generation and value added in the rest of the economy only because standard efficiency and productivity measures ignore environmental impacts. But, as column 5 indicates, the environmental cost per MWh of uncontrolled emissions is about US$11/MWh. As can be seen by comparing the damage wrought by each generated MWh, current environmental policies reduce this cost to almost nothing. Should one consider these costs in productivity calculations, TFP in electricity generation turns out to fall by 13% with uncontrolled emissions (see column 5 in Table 3, line TFP electricity (social)).

4.5.3. Renewable's policies

Environmental effects. Sound environmental policies are part of sound microeconomic policy, but some environmental policies which are currently popular are ineffective and very expensive.

42 The alert reader may wonder how an optimal policy may make social surplus fall relative to the baseline. The answer is that our system is not fully optimized to begin with, because it inherits investments–we minimize costs conditional on them.

Column 7 in tables 2 and 3 show the impact of the so called 20/20 policy currently being discussed in the Chilean Congress –20% of electricity generated by NCRE by 2020. Compared with the baseline, the incremental abatement of local pollution is negligible, because emissions are small in the first place. Yet the policy is very expensive and massively redistributes wealth to the owners of renewables.

The price of energy. As Figure 7c shows, a 20/20 policy increases the price of energy almost immediately, to about US$90/MWh. This may seem surprising; after all, the policy forces the 20% renewables quota only after 2020. But Figures 6(a) and 6(c), which show the composition of generation in the baseline and with a 20/20 policy, explain why. Essentially, because NCREs have low or negligible operation costs, they substitute baseload hydro generation and this slows investments in hydro as soon as the policy is announced. As can be seen in Table 3, over time the price of energy rises from US$89/MWh in the baseline to US$109/MWh or 22%.

Economic impact. As can be seen in column 6, the steep rise of the price of energy reduces consumption by 5% on average (from 40,385 GWh in the baseline to 38,473 GWh), and consumer surplus falls by US$790 million. Generators' profits rise by US$484 million and, consequently, social surplus falls on average by US$302 million. The magnitude of this effect is large –a little less than half of the gain that would accrue with Argentine natural gas.

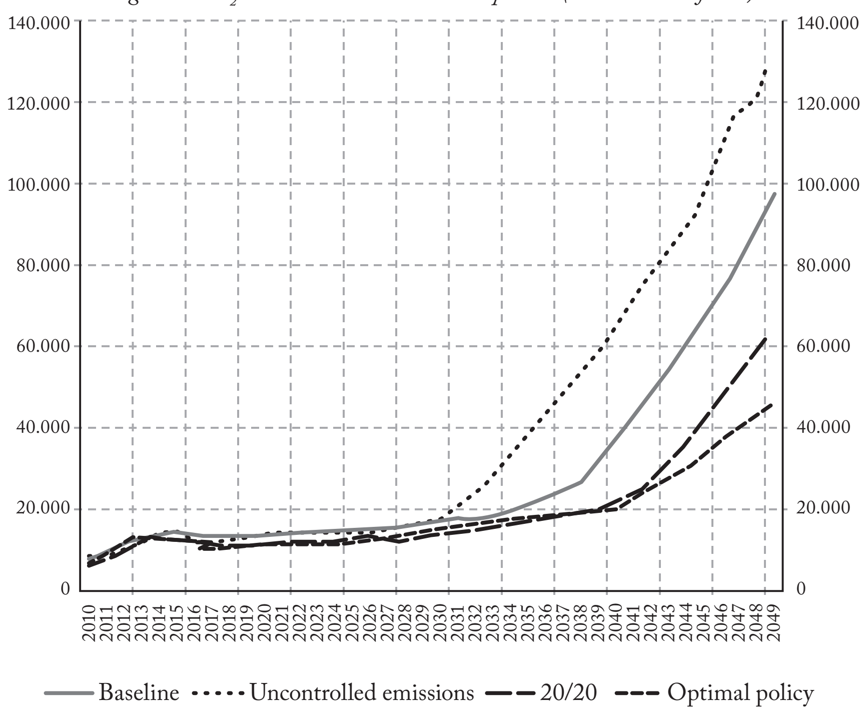
It is interesting to decompose the gain of generators. Both hydro and fossil fuel generators lose somewhat with a 20/20 policy, because they are displaced by NCREs. But the owners of NCREs gain US$806 million in Ricardian rents, about the same as hydro generators in the baseline case, but with far fewer MW of capacity. Large Ricardian rents are the mirror image of the large costs wrought by a 20/20 policy. Indeed, renewable quotas are quite expensive because their supply curve is upward sloping and their impact is highly nonlinear. As we have shown elsewhere (see Galetovic, Hernandez, Muñoz and Neira, 2012), a 5% quota is not binding, a 10% quota causes a small deadweight loss, but increasing the quota from 10% to 20% multiplies the deadweight loss by a large factor.

Efficiency and productivity. As column 6 in Table 3 shows, a 20/20 law would reduce value added in the rest of the economy in US$532 million per year on average, or about 0.2% of GDP –about two– thirds of the effect of recovering Argentine natural gas. Total factor productivity in generation would fall by 9% on average compared with the baseline case. By contrast, value added by generation increases, from about US$3 billion to about US$3.6 billion. But this only says that more capital is used to produce less electricity.

4.5.4. The composition of generation and CO_2 emissions

As far as the discourse goes, reducing CO_2 emissions should be one of the main goals of environmental policies. Figure 8 shows the trajectory of CO_2 emissions with each policy. Until about 2030 one can hardly see any difference. But from then on, CO_2 emissions with either the optimal policy or a 20/20 law are much larger when compared with uncontrolled emissions and, to a smaller extent, with the baseline case. Interestingly, in the long run taxing CO_2 emissions is not only the more efficient policy but also the most effective.

Figure 8. CO_2 emissions under alternative policies (in thousands of tons).



It is commonly thought that policies affect emissions through changes in the price of energy. If energy is more expensive, consumers use less and emissions fall, or so the argument goes. In reality, however, most of the differences across policies stem from differences in fuel composition. As can be seen in Figure 6, with uncontrolled emissions and, to a lesser extent, in the baseline case, the share of coal is larger than with either the 20/20 law or with a carbon tax; consequently, CO_2 emissions are larger.

In view of these results one might argue that both a 20/20 law and a carbon tax have similar effects. But this overlooks that, as we have seen, a 20/20 law is considerably more expensive. Again, the reason becomes apparent comparing Figures 6c and 6d. An optimal policy takes full advantage of hydro generation, a cheap zero-carbon technology and, when hydro runs out, switches to LNG, a technology that is marginally more expensive than coal but which emits about half per MWh. Thus, the carbon tax slows the growth of CO_2 emissions by tilting the scale towards LNG, which pays a lower tax per MWh. As a result, coal is squeezed out and its share falls fast.

By contrast, the 20/20 law achieves reductions in CO_2 emissions by increasing the share of NCRES, a clean but expensive technology. Moreover, NCRES retard the development of hydro, a clean but cheap technology.

4.6. Competition policies and water rights divestment

Ever since public utilities were privatized in the late 1980s it has been claimed that Endesa retards the development of hydro capacity to maintain high energy prices. Antitrust concerns were heightened by the alliance between Endesa and Colbun to build HydroAysen, because they own about 50% of the remaining available hydro potential. More generally, some claim that antitrust policy is key to ensuring efficiency and productivity growth. In this section we estimate the potential gain of mandating the divestment of water rights.

Column 8 in Table 3 exhibits the system's performance with divested water rights. Compared with the baseline, gains are rather negligible. The price of energy barely falls, costs per MWh do not change and consumption increases very little. The conclusion is that for the time being market power and water rights divestment should not be a concern.

4.7. The value of good microeconomic policies

Let us now summarize by comparing good with bad policies. We estimate the impact of combining good policies and compare it with the impact of combining bad policies:

Good policies. Divested water rights, optimal environmental policies and no NCRE quota.

Bad policies. 20/20 law, uncontrolled emissions and neither hydro nor coal development.

As usual, our benchmark is the baseline case.

Good policies do little; bad policies hurt a lot. Columns 9 and 10 in Table 3 present the results. Perhaps the main conclusion is that in Chile's electricity sector good policies can do little to improve resource allocation, but bad policies can hurt a lot. On the one hand, column 9 is very similar to column 1 and, as Figure 7d shows, prices follow a very similar path. On the other hand, bad policies would reduce social surplus by a magnitude similar to the loss of Argentine natural gas. For this reason, in what follows we comment on the effect of bad policies.

Prices and economic outcomes. Figure 7d shows that prices would be considerable higher with bad policies. Essentially, in this case cheap hydro capacity is not used and, at the same time, users must pay for the NCREs quota. On average, the price of energy is 28% higher than in the baseline –US$114/MWh against US$89/MWh. Consequently, yearly consumption falls by 6.5% on average (37,783 GWh against 40.385 GWh) and consumers lose US$959 million per year. Social surplus falls by less, because profits of NCREs generators rise; but the fall is still large, US$571 million.

The environment. Our bad policies case combines uncontrolled emissions with a 20% NCRE requirement. Because now the system expands with LNG, a fossil fuel, one might think that NCREs are a far more effective environmental tool, but this is not so. For one, as can be seen in Table 4, emissions are considerably higher than in the baseline case. For another, pollution is less than in the uncontrolled case (column 9) because now the system expands with LNG instead of coal. In any case, the bad policy case confirms that current environmental policies are very effective.

Efficiency and productivity. As column 10 in Table 3 shows, bad policies would reduce value added in the rest of the economy by US$654 million per year on average, or about 0.3% of GDP. Private total factor productivity in generation would fall by 12% on average compared with the baseline case, and 17% if higher environmental costs are treated as any other cost.

General lessons. Our conclusion is that in the case of Chile's CIS bad policies hurt. At the same time, provided that the system is allowed to expand with water, policy has little more to do. This is of course not a general statement and might seem close a tautology-after all, the baseline assumes that hydro resources are used efficiently. But it says something quite fundamental: when prices reflect relative scarcities, policy deals appropriately with externalities and resources at hand are used efficiently, and then there is little room for policy to improve resource allocation. Policy is needed either to correct externalities or to set rules that facilitate bilateral exchanges. This fundamental lesson is too often forgotten.

5. Conclusions

We began this chapter discussing the possible causes of Chile's productivity and growth slowdown. Many doubt that vigorous microeconomic reforms are effective to permanently accelerate productivity and GDP growth. This chapter quantified the effect of a supply shock, the value of good microeconomic policies and the cost of bad policies in Chile's CIS, which produces about 1.3% of total value added. To conclude we summarize our results and discuss a few implications that go beyond Chile's CIS.

We have shown that an intertemporal model with endogenous investment and price-responsive demand is appropriate to evaluate how different policies affect sectoral TFP. Essentially, with exogenous input prices the evolution of sectoral TFP can be directly deduced from the evolution of unit costs. Moreover, with simple production theory one can link policies in one sector with value added and productivity in the rest of the economy –the link is through the demand curve of the rest of the economy for the goods and services that the sector produces and that are used as inputs in the rest of the economy.

Of course, our quantification beyond the sectoral level is subject to limitations because we assumed that the trajectory of employment and the capital stock in the rest of the economy is exogenous. More generally, we have quantified effects on levels but not on rates of growth. But this is hardly a defect of sectoral analysis. Rather, the problem is that the growth literature, beyond telling us that steady economic growth only occurs if the marginal products of all reproducible factors of production are bounded away from zero, has been unable to tell us in an empirically meaningful way how this is brought about in practice. Beyond using a coefficient estimated from some cross-country growth regression, there is little that one can do to estimate the rate-of-growth effects of a policy. By contrast, production theory tells us how to quantify level effects: one only needs to know the elasticity of demand, an economically meaningful parameter. Until growth economists produce such a synthesis, estimating credible rate-of-growth effects will not be possible.

Our main finding is that some policies in Chile's CIS can have effects of the order of 20% on its own TFP and change value added in the rest of the economy in magnitudes as large as 0.3% of GDP. Macroeconomically speaking, are these effects "small" or "large"? 0.3% of GDP might not seem very large in the aggregate, in the sense that, sure enough, it is by far not enough to account for Chile's protracted productivity slowdown. Neither can reductions of TFP within Chile's CIS explain much of the slowdown, because it accounts for only 1.3% of GDP. But significant micro policies tend to have effects of this order of magnitude. For example, Chumacero et al. (2004) estimated the free trade agreements that Chile signed with the United States and the European Union in the early 2000s raised the level GDP by 1%[43]. Corbo and Schmidt-Hebbel (2003), in turn, estimated that pension fund privatization, one of the major reforms ever implemented in Chile, increased the level of GDP between 1.92% and 9.75%[44].

Moreover, if the yardstick is Chile's CIS, these effects are large-about one-fourth of CIS's value added. So whatever your macroeconomic yardstick for "large" is, we have shown that the claim that micro policies can't have sizable effects at the sectoral level is rather indefensible. Thus, perhaps one might excuse the Minister of Finance or the president of the Central Bank for not caring about micro policies. But we should not excuse a sectoral minister unless she musters compelling evidence that micro policies are right. Similarly, we should not excuse the Minister of Economic Affairs,

[43] Former President Ricardo Lagos thinks that free trade agreements are one of the main achievements of his administration.

[44] This is an estimate for 2001.

who is nominally in charge of micro policy, unless he musters compelling evidence that micro policies are right in most sectors. If, on the other hand, there are reasons to think that government is introducing bad policies into many sectors (as today in Chile's electricity sector); or that a given minister inherits significant distortions in many sectors; or that new policies in many sectors have become necessary to keep up; then the Minister of Economic Affairs is not doing its job unless he cares deeply about efficient micro policies.

Indeed, perhaps neither should we excuse the Minister of Finance for not caring. To see why, note that Chile's CIS is "large" macroeconomically, at least in relative terms. As the Central Bank's 2009 input-output matrix shows, the median of 111 sectors (non-ferrous mining) contributes 0.36% of total value added; the 90th percentile sector (real estate development) contributes 2.7% of total value added; and the largest sector (copper mining) contributes 13,2% of total value added. Chile's CIS contribution to total value added (about 1.3% in 2009) would rank in the 82nd percentile among 111 sectors. Arguing that sectoral micro policies are not relevant because sectors are not large relative to GDP comes close to saying that productivity in most sectors doesn't matter macroeconomically! In practice the point is different: by definition, micro policy is a pointillist exercise with potentially large effects provided that policies improve simultaneously and continuously in many sectors. And this is perhaps the main reason why most ministers of Finance and of Economics Affairs are loath to attempt them: it requires, at the same time, attention to detail and ability to think and implement many consistent policies simultaneously. And then there are the uncountable small and large fights with organized pressure and interest groups. In recent Chilean history only Sergio de Castro, Hernan Buchi and perhaps Alejandro Foxley have been proved to be up to the task and in the case of the first two, in very unusual political circumstances.

Of course, micro policies could be irrelevant after all: if current policies in most sectors would allow or facilitate bilateral exchanges and deal appropriately with market power and externalities, then prices would reflect relative scarcities, resources at hand would be used efficiently and there would be little scope for further policy to improve resource allocation. Indeed, we have seen that in Chile's electricity sector environmental regulations deal appropriately with externalities, concentration of water rights is not a significant problem and policy has little room for improvement *provided that hydro generation can be freely developed*. But we have also seen that the scope for introducing bad policies that hurt efficiency and productivity is large. For example, a renewables 20/20 policy would be akin to a large negative supply shock and currently hydro and perhaps coal development have grinded to a halt. More generally, it is hard not to fear that significant distortions have been protractedly introduced in many sectors, especially during the last decade. Nevertheless, this is the topic for another paper.

REFERENCES

BANCO CENTRAL DE CHILE, "Cuentas nacionales de Chile 2008-2011", Santiago: Banco Central de Chile, 2012.

BARROSO, L., H. RUDNICK, R. MORENO and B. BEZERRA, "Ensuring Resource Adequacy with Auctions of Options and Forward Contracts", Power Engineering Society General Meeting, 2007, 1-6, 2007.

BOITEAUX, M., "Peak-Load Pricing", Journal of Business 33, 157-179, 1960.

CHUMACERO, R., R. FUENTES and K. SCHMIDT–HEBBEL, "Chile's Free Trade Agreements: How big is the Deal?" Working Paper Nº264, Central Bank of Chile, 2004.

CIFUENTES, L., C. DE LA MAZA, F. DONOSO, S. GARCÍA V. FLORES and L. MADRID, "Analisis tecnico-economico de la aplicacion de una norma de emision para termoelectricas".

GTZ Consultants, "Potencial de biogas", mimeo, 2009.

CORBO, V. and K. SCHMIDT-HEBBEL, "Macroeconomic Effects of Pension Reform in Chile", in FIAP: Pension Reforms: Results and Challenges. Santiago: CIEDESS, 2003.

DOMAR, E., "On the Measurement of Technological Change", The Economic Journal 71, 709-729, 1961.

EIA, "Assumptions to the Annual Energy Outlook 2010", Washington: EIA, 2010.

DE CARVALHO, J. and I. SAUER, "Does Brazil Need New Nuclear Power Plants?" Energy Policy 37, 1580-1584, 2009.

GALETOVIC, A. and C. MUÑOZ, "Energías renovables no convencionales: ¿cuanto nos van a costar?" Estudios Publicos 112, 31-81, 2008.

GALETOVIC, A. and C. MUÑOZ, "Estimating deficit probabilities with price–responsive demand in contract-based electricity markets", Energy Policy 37, 560–569, 2009.

GALETOVIC, A. and C. MUÑOZ, "Regulated electricity retailing in Chile", Energy Policy 39, 6453-6465, 2011.

GALETOVIC, A. and C. MUÑOZ, "Coal, wind and the cost of environmental externalitities", to appear in Energy Policy 2013.

GALETOVIC, A., C. MUÑOZ, C. HERNANDEZ and L.M. NEIRA, "Are Renewable Quotas Effective to Reduce CO2 Emissions?" Working Paper No. 458, Stanford Center for International Development, 2012.

GALETOVIC, A. and C. HERNANDEZ, "El costo diferencial de las alternativas de generacion en el SIC", mimeo, 2012.

HARBERGER, A., "A Vision of the Growth Process", American Economic Review 112, 1-32, 1998.

Holm, A., L. Blodgett, D. Jennejohn and K. Gawell, "Geothermal Energy: International Market Update", Washington: Geothermal Energy Association, 2010.

Hulten, C., "Growth Accounting with Intermediate Inputs", Review of Economic Studies 45, 511-518, 1978.

Joskow, P., "Comments". Economia 1, 199-215, 2000a.

Joskow, P., "Why Do We Need Electricity Retailers? Or Can You Get it Cheaper Wholesale?" mimeo, mit, 2000b.

Maloney, W. and A. Rodríguez–Clare, "Innovation Shortfalls", Review of Development Economics 11, 665-684, 2007.

Muller, N. Z. and R. Mendelsohn, "Measuring the Damages of Air Pollution in the United States", Journal of Environmental Economics and Management 54, 1-14, 2007.

Muller, N. Z. and R. Mendelsohn, "Efficient Pollution Regulation: Getting the Prices Right", American Economic Review 99, 1714-1739, 2009.

Nordhaus, W. D., "Economic Aspects of Global Warming in a Post-Copenhagen Environment",, Proceedings of the National Academy of Sciences of the United States of America 107, 11721-11726, 2010.

Pavez, M., "Wind Energy Generation Feasibility on the Northern Interconnected System (sing)", Master's Thesis, Pontificia Universidad Catolica de Chile, 2008.

usepa, "Emissions Factors & AP 42, Compilation of Air Pollutant Emission Factors", 1995.

utfs, "Estudio de contribucion de ernc al sic al 2025", mimeo, 2008.

Productivity, Misallocation and the Labor Market[1]

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1. Introduction

A wealth of empirical research based on longitudinal establishment data for a number of countries has consistently found large and persistent productivity differences among plants or firms in the same industries in any given time period[2]. A closely related literature has demonstrated overwhelmingly that the process of input and output reallocation that takes advantage of these productivity differences significantly contributes to aggregate productivity growth. Chile is no exception: almost half of Chilean manufacturing growth is accounted for by this process of economic restructuring (Bergoeing et al., 2010).

Together with the economy's capacity to reallocate inputs and outputs, the evolution of productivity dispersion is thus a relevant factor in understanding the dynamics of growth. There are many reasons for the existence of heterogeneity in plant-level decisions and outcomes. Differences in entrepreneurial ability, the organizational structure or the vintage of capital, may all explain cross-sectional variation in productivity. Similarly, differential access to human capital, infrastructure and credit may generate variation in the way firms invest in technology and use their resources. Uncertainty may also underlie the observed dispersion. For instance, plant specific shocks to demand, investment opportunities, input costs and technology are the main sources of uncertainty discussed by the class of models developed in Jovanovic (1982) and Hopenhayn (1992). The development and adoption of new products or production techniques is also an uncertain process. Finally, regulation may protect some firms by discouraging entry, reallocation or

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2 See Bartelsman and Doms (2000) and Foster et al. (2001) for surveys.

innovation through special tax exemptions, subsidies or credit priorities (Parente and Prescott, 1994; Acemoglu et al., 2001).

Not all these reasons for plant-level heterogeneity are associated to the misallocation of inputs or outputs. For instance, reallocation may be costly due to technological barriers. However, some of these mechanisms generate highly persistent differences in productivity across plants, whereas others bring about only transitory variation. For example, credit constraints and special subsidies and taxes typically generate permanent differences in plant-level productivity, and may explain why largely different plants produce in the same narrowly-defined industries in any given time period. Similarly, shocks and adjustment costs have transitory effects on plant productivity dispersion.

In this paper we focus on the dynamics of labor productivity dispersion and its relation to the observed process of aggregate growth in Chile. In particular, we use plant-level data for the manufacturing sector from 1979 until 2007 to estimate the distribution of labor productivity and its evolution over time. Based on the method of Hsieh and Klenow (2009), we estimate the extent of labor misallocation and analyze the evolution of observed dispersion over the sample period. More specifically, we find that the dispersion of labor productivity across firms increased sharply in 2004. By 2007 –the end of our sample period– the gap had not yet been fully closed. We also show that although plants producing in all sectors experienced this jump in dispersion, the largest and most persistent change is concentrated among sectors that hire skilled labor more intensively. This finding is consistent with the hypothesis that labor market regulations mostly affect the ability of firms to adjust skilled labor; that is, the ability to adjust the employment of workers who tend to have higher average tenure and more bargaining power within firms.

We then ask whether the reallocation process in Chilean manufacturing is productivity-enhancing and whether it has become more or less productivity-enhancing over time. To do so, we use the cross-sectional decomposition first introduced by Olley and Pakes (1996). We find that in every year the reallocation of employment has been productivity-enhancing; i.e., labor is being reallocated from less to more productive plants. However, in the latest period, the relative incidence of this process in explaining overall productivity growth has diminished.

An examination of events occurring in the Chilean economy leads us to relate the rise in productivity dispersion and the reduced relevance of the reallocation process to changes in the energy market, in particular, to cuts in the supply of natural gas imported from Argentina. We also argue that the increased volatility in the real exchange rate that resulted from the adoption of an inflation-targeting monetary policy may have affected the outcomes in the labor market as well. We also examine the role of spikes in the interest rate as a result of the Asian crisis that hit the Chilean economy at the end of the 1990s. A simple econometric model shows that the rise in the observed macroeconomic volatility does correlate with the observed rise in the dispersion of labor productivity, in particular among those sectors that produce traded goods and/or use gas or oil more intensively as a source of energy.

In other words, we hypothesize that the volatility of shocks that firms face explains the observed rise in productivity dispersion. However, it is also possible that the speed at which firms adjust to these shocks has slowed down over time. Following Caballero et al. (2010) we estimate the speed of adjustment in our manufacturing data set to find that if anything, firms tend to adjust more quickly in recent years. We do find, however, that plants producing in skilled-labor intensive sectors close the gaps in employment more slowly than the mean. Again, this finding may be related to labor market regulations that mostly affect the ability of firms to adjust skilled labor.

Finally, we estimate the aggregate effects of labor misallocation. In a simple, yet revealing exercise, we find that if half of the employees in the first quintile of plants' labor productivity distribution were reallocated to the top quintile plants, manufacturing productivity would increase by about 17%.

The remainder of this paper is organized as follows. Section II describes Chile's labor market and the regulations that may affect the responsiveness of plants to shocks. Section III presents the data set and the methodological approach we use to estimate the extent of misallocation. Section IV presents our basic estimates of labor productivity dispersion, while Section V correlates this dispersion to developments in the Chilean economy. Section VI estimates the losses associated to the observed level of labor productivity dispersion. Finally Section VII provides concluding remarks.

2. The Chilean labor market and its regulatory framework

In this section we briefly describe the stylized facts on Chile's labor market. We also describe its regulatory framework.

2.1. Chile's labor market

Table 1 presents the main facts on the Chilean labor market. Table 2 compares Chile's employment and unemployment rates to those of the OECD country members. Table 1 shows how rapidly Chile's GDP and income per capita grew between 1986 and 2010. The annual average rate of GDP growth equaled 4% over the period. That is, over the past two and a half decades, Chile's income per capita increased by an approximate factor of 2.5. Over the period between the mid 1980s and the mid 1990s –the so called "Chilean miracle"– this annual growth rate averaged over 6% per year. It noticeably slowed down, however, after the deterioration in terms of trade in the late 1990s, a result of the Asian crisis. The unemployment rate increased and remained stubbornly high for a number of years. At the onset of the 2008 international crisis, the unemployment rate had not yet returned to the levels observed in 1998.

Tables 1 and 2 also show that Chile is characterized by low labor force participation and employment rates, especially among women and youth. These employment rates contrast with those observed in OECD countries: while 79% of men and 59% of women in the OECD are employed, only 68% and 36% of their Chilean counterparts are. A similar pattern emerges for young workers.

A number of factors might explain these relatively low participation and employment rates: lack of job opportunities, family arrangements and the cultural role associated to women, low access to childcare provision, a rigid part time labor regulation and a relatively high minimum wage, among others[3]. The recent rise in female labor market participation is most likely the result of the expansion in the provision of childcare for working women (Hernando, 2009).

Figure 1 plots the percentages of employed workers by the type of job they hold[4]. Although more than half of employed workers are salaried workers in the private sector –64% of men and 50% of women–, a relevant percentage of employed workers are either self-employed, unpaid family workers or domestic service workers. As a matter of fact, one in four male workers and one in three female workers are employed in one of these sub categories.

3 See, for instance, the report of the *ConsejoAsesor Presidencial para el Trabajo y Equidad* (2008).

4 Data for 2008 based on INE's Employment Survey.

Table 1. Chile's Growth and labor market outcomes, 1986-2010

Year	All Population (15 or more)				Women		Men	
	GDP Growth	Unemployment Rate	Labor Force	Employment Rate	Unemployment Rate	Employment Rate	Unemployment Rate	Employment Rate
1986		12.0%	50%	44%	15.0%	24%	11.0%	65%
1987	5.7%	10.9%	51%	45%	14.4%	25%	9.5%	66%
1988	7.6%	9.7%	52%	47%	13.5%	26%	8.1%	69%
1989	11.0%	7.9%	53%	48%	10.6%	27%	6.8%	71%
1990	3.2%	7.8%	53%	49%	9.7%	28%	7.0%	70%
1991	7.8%	8.2%	53%	48%	10.3%	28%	7.3%	70%
1992	12.6%	6.6%	53%	50%	8.9%	29%	5.6%	71%
1993	6.6%	6.5%	55%	52%	9.0%	31%	5.4%	73%
1994	7.2%	7.9%	55%	51%	10.3%	31%	6.7%	72%
1995	9.1%	7.3%	55%	51%	9.5%	31%	6.3%	72%
1996	8.5%	6.4%	54%	51%	7.9%	31%	5.6%	71%
1997	6.6%	6.1%	54%	51%	7.7%	32%	5.4%	71%
1998	3.3%	6.4%	54%	51%	7.6%	32%	5.8%	70%
1999	0.3%	10.1%	55%	49%	10.8%	32%	9.8%	67%
2000	4.2%	9.7%	54%	49%	10.4%	32%	9.4%	67%
2001	3.6%	9.9%	54%	49%	10.1%	31%	9.7%	66%
2002	2.2%	9.8%	54%	48%	10.1%	32%	9.6%	66%
2003	3.9%	9.5%	54%	49%	10.3%	33%	9.1%	66%
2004	6.0%	10.0%	55%	49%	11.2%	34%	9.4%	66%
2005	5.6%	9.2%	56%	50%	10.6%	35%	8.5%	66%
2006	4.6%	7.8%	55%	51%	9.5%	35%	6.9%	67%
2007	4.6%	7.1%	55%	51%	8.6%	36%	6.3%	67%
2008	3.7%	7.8%	56%	52%	9.5%	37%	6.8%	67%
2009	-1.5%	9.7%	56%	50%	10.7%	37%	9.1%	65%
2010	5.2%	8.2%	59%	54%	9.6%	41%	7.1%	67%

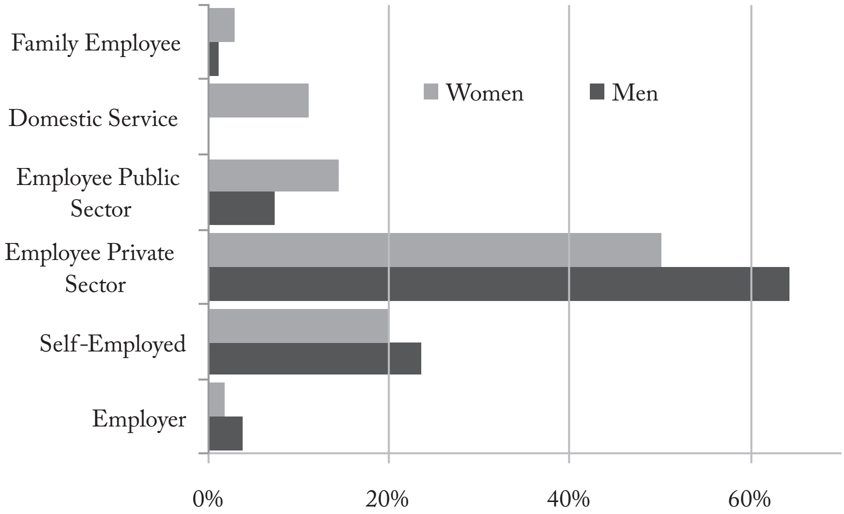
Sources: INE and Central Bank. The Employment Survey and methodology were changed in 2010.

Table 2. Employment and Unemployment in Chile and the OECD, 2007

	Employment Rate			Unemployment Rate		
	Men	Women	Both 20-24 years	Men	Women	Both 20-24 years
Chile	68.0	35.6	44.9	6.5	8.4	15.8
European Union 19	74.5	59.2	55.7	6.5	8.0	13.8
European Union 17	75.8	60.3	58.1	6.3	7.8	13.0
G7	80.1	64.8	64.0	5.4	5.5	9.7
United States	81.8	63.0	65.6	4.5	4.5	7.8
OECD	79.0	59.3	59.8	5.4	5.9	10.5

Source: OECD.

Figure 1. Workers by Job Type

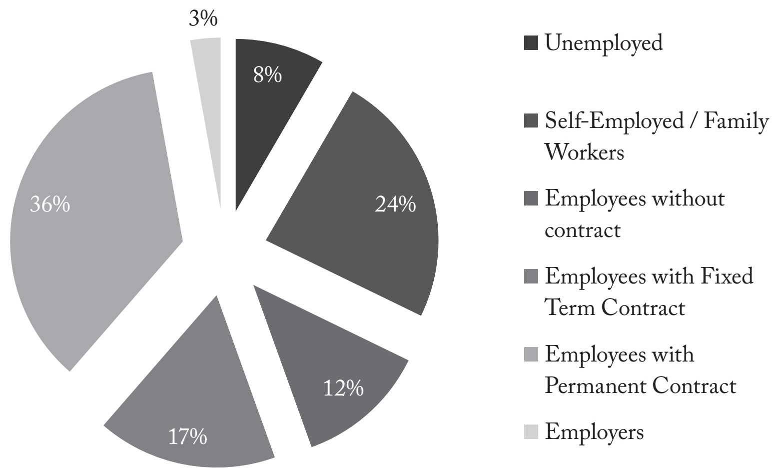


Individuals who participate in the labor force are classified in Figure 2 according to their employment status. The figure also classifies workers by the formality of their employment; i.e., whether there is a contract that regulates the relationship and if so, by the type of contract that has been signed[5]. During years 2004-2008, the average unemployment rate equaled 8%. Similarly, self-employed and unpaid family workers accounted for 24% of the labor force, whereas employers represented 3% of the total. Among employees (65% of labor force), almost 20% of workers did not have a contract. Finally, among formal salaried workers, 32% were hired under fixed-term or temporary contracts.

This distribution of workers across different types of jobs implies that almost half of the labor force does not come under the Labor Code. In addition, informal workers, the self-employed and temporary workers tend to receive lower coverage from mandatory contributory programs such as pensions, unemployment insurance and health insurance.

5 Averages for 2004–2008. The fractions of unemployed, self–employed, family workers, employers and employees are estimated from INE's Employment Survey. To estimate workers by formal contract type, we used pensions and unemployment insurance contributions data gathered by the *Superintendencia de Pensiones*.

Figure 2. Workers by Employment Status and Contract Type



The fraction of the labor force with indefinite contracts has increased over the past decade (Figure 3). However the share of fixed term contracts has risen even faster: it accounted for 13% of the labor force in 2004 and for 18% in 2008. During the 2009 crisis, however, the share of temporary contracts fell to 15.5%. In other words, a large fraction of the adjustment to the recession was accomplished by a reduction in the hiring rate of workers under fixed term contracts. These temporary contracts allow for more flexibility than indefinite contracts, a matter we discuss below. The share of workers without a contract also fell in 2009.

Figure 3. Share of Unemployed and Employed Workers by Contract Type

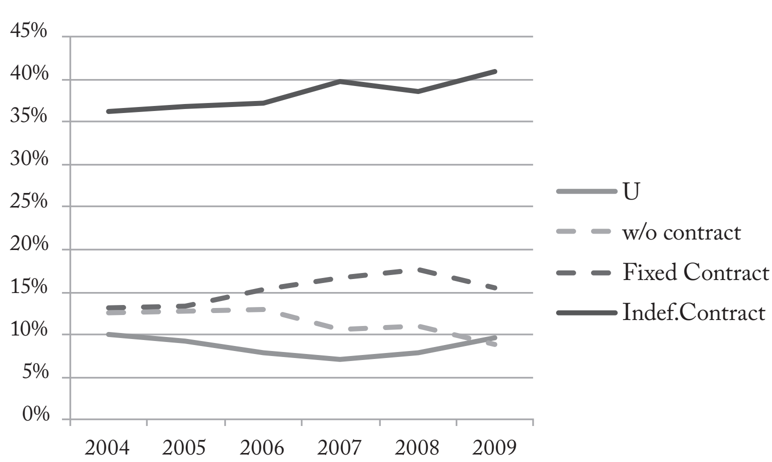
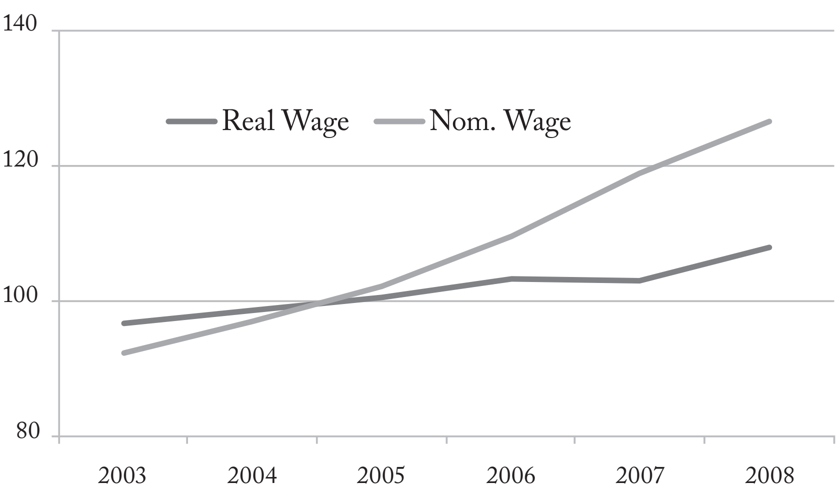


Figure 4 shows the evolution of nominal and real wages. During the period under analysis, nominal wages increased at an annual rate of at least at 5 percent, while real wages grew at a 2 percent average rate. In 2008, after the inflation shock of 2007 and at the onset of the international crisis, nominal wages increased faster, at a rate over 8 percent. In real terms, however, wages were constant due to the rising inflation rate.

2.2. The regulatory framework

The ability of the economy to reallocate labor depends on many factors. In this subsection we describe the main institutional aspects of the labor market that may affect the restructuring capacity of firms. The regulations described in what follows may inhibit turnover or reduce the ability of wages to adjust. Also, they may have a differential effect on the hiring and firing rates of different groups of workers. For instance, job security provisions, like severance pay, that depend on the worker's tenure will have a relatively greater effect upon the rotation of workers with shorter average tenure, like the youth, women and unskilled workers. We will turn to this potential differential impact in Sections IV and V.

Figure 4. The Evolution of Wages



Severance pay: Workers hired under permanent contracts who are laid off for no fault of their own are entitled to severance pay of at least one month of pay per year of work up to eleven years. There is a surcharge of 20% if the dismissal cause of economic need cannot be demonstrated in court. The maximum number of years of work covered was increased in the early 1990s from five months. Since workers hired under temporary contracts and those who quit voluntarily are not entitled, the effective coverage of severance pay is relatively low –about 6% of formal workers can expect to receive severance pay. This by no means implies that severance pay is irrelevant, as it affects the hiring decisions of firms, the type and length of contracts and wages paid. As a matter of fact, Montenegro and Pages (2004) estimate that severance pay regulation in Chile reduces the employment opportunities for young, female and low skilled workers.

Firing regulations: In addition to severance pay, workers under indefinite contracts are entitled to one month advance notice prior to termination. Employers must justify the cause for termination. Temporary contracts can be terminated at no cost at expiration, but must be paid in full if terminated before its expiration date. Fixed-duration contracts cannot last longer than a year and allow for one single renewal. The second renewal entitles the worker to an indefinite contract. The worker is also automatically entitled to a permanent contract if he is employed under a fixed term contract for 12 months or more in any 15 month period.

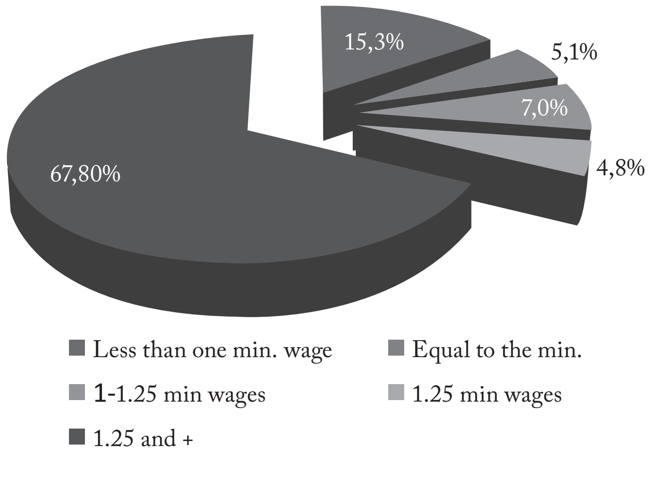
Regulations on hours worked: Full time employees cannot work more than 45 hours per week –distributed over not less than and not more than 6 days per week–, and no more than 10 hours per day. Additional hours must be negotiated in advance with a maximum of two extra working hours per day. These are paid with a 50% surcharge. Exceptions to these norms are allowed, but they must be approved by the Labor Inspectorate (*Direccion del Trabajo)*. The currently conceded exceptions are mainly concentrated in the mining industry.

Size related regulations: A number of regulations discriminate across firms depending on the size of the firm. The main ones relate to the hiring of foreign workers and to the provision of child care. The first one requires that at least 85% of hired workers are Chilean nationals if the firm employs 25 or more individuals. The second one mandates firms to provide child care services whenever there are 20 or more female workers hired in the firm. The age of the worker, the age of their children and the hours per month worked are not relevant dimensions of this mandate. Anecdotal evidence suggests that a significant fraction of small firms have exactly 19 female employees.

Minimum wage: The minimum wage is set on a yearly basis. There is no explicit regulation on the level at which it should be set. Typically, it is set on the basis of a bargaining process among the government and employers' and workers' organizations, since annual minimum wage adjustments require the approval of Congress. As of today the minimum wage equals 182 thousand Chilean pesos per month, a level that represents about 60% of the median wage. A lower level is set for workers under the age of 18. According to the Minimum Wage Commission (2010), 15.3% of workers contributing to the Unemployment Insurance system earn less than the minimum wage; 5.1% earn exactly the minimum wage, and 11.8% earn between one and 1.25 minimum wages (Figure 5)[6].

Profit sharing: Firms that earn profits are mandated to distribute 30% of profits minus the 10% of the value of its capital to workers. There is no explicit regulation on how capital should be valued to determine the amount of profits that has to be distributed among workers. Alternatively, firms can choose to pay a surcharge of 25% of wages to all workers with an annual maximum of 4.75 minimum wages. According to the *Direccion del Trabajo*, the overwhelming majority of firms choose to pay the surcharge, as less than 7% of firms distribute profits. Most likely, this regulation explains why 4.8% of workers contributing to the Unemployment Insurance system earn exactly 1.25 minimum wages (Figure 5).

Figure 5. Minimum Wage Incidence



[6] Part time contracts may earn less than the minimum wage. Informal workers may as well, but they do not contribute to the UI system and hence are not included in the statistics of the figure.

Payroll taxes: Pensions and unemployment insurance are financed by a tax on wages. Although these deductions are deposited in an individual account owned by the worker, employees may not fully consider them as a deferred compensation (Edwards and Cox-Edwards, 2002). In addition a fraction of wages is dedicated to health insurance finance and pension funds management fees. In total, over 20% of wages must be deducted to finance social security.

3. Data and methodology

In this paper we use data from the *Encuesta Nacional Industrial Anual* (ENIA), an annual survey of manufacturing conducted by the Chilean statistics agency, the *Instituto Nacional de Estadísticas* (INE). The ENIA covers all manufacturing plants that employ at least ten individuals. It thus includes all newly created and continuing plants with ten or more employees, and it excludes plants that ceased activities or reduced their hiring below the survey's threshold. Employment in the ENIA represents about 50% of total employment in manufacturing[7].

The data available extend from 1979 to 2007 and contain detailed information on plant characteristics such as manufacturing sub-sector at the 4-digit ISIC level, sales, employment, investment, intermediate inputs and location[8].

All nominal variables were deflated at the 3-digit ISIC level, using deflators constructed from the wholesale price indices compiled by INE[9]. Our analysis considers all 29 3-digit ISIC rev.2 sectors. However, we have excluded copper production –sector 3721– from the analysis, which is classified under the mining sector by national accounts. We also exclude oil refineries -sector 3530.

7 We observe plants and not firms in our data set and thus we are unable to distinguish single-plant firms from multi-plant firms. According to information provided by Central Bank statisticians, about 3.5% of plants belong to a multi-plant firm in our data set.

8 INE changed the plant identification method in the 1996 survey. Fortunately, we had access to three data bases that allowed us to match over time almost all of the surveyed plants. The 1979–1996 and the 1995–2007 data sets do not have a common identifier, but a third survey covering years 1995 to 2007 had both identifiers for year 2000. As a double check on the common identifier, we compared relevant variables such as wages, number of days in operation, ISIC code, electricity consumed, VAT paid, number of employees, gross output and machinery and equipment investment, for year 1995 and 1996. In 97% of cases these variables were identical. For plants that were in 1995 and 1996 but not in the year 2000, we matched plants by these same variables. Using this method, 97% of plants reported identical values of these variables in both surveys. We excluded plants we could not find a match for four or more of these variables.

9 Most of our results below do not require the use of deflators as we estimate differences with respect the average plant in any given sector defined at the 3 digit ISIC rev.2 level.

Table 3 provides basic statistics characterizing the plants in our data set over the sample period. The first column presents the number of respondent plants in each year. The next two columns show the average value added and gross output produced by the plants in ENIA over time, expressed in 1992 millions of Chilean pesos. The average wage bill paid is also measured in millions of 1992 Chilean pesos. Employment includes all workers in the plant, with no distinction by skill level or type of job. On average, value added and output per plant has grown at an annual 5.5% rate between 1979 and 2007, whereas employment and total wages per plant have grown at a 2.2% and 2.3% per year, respectively. These rates vary considerably over the sample period, from a 20% growth rate in value added in 2005 relative to 2004 to a 4.2% drop in year 2003 relative to year 2002. In what follows, we show that productivity also presents wide variation across and within sectors, a fact consistent with idiosyncratic technology and efficiency differences.

Based on ENIA's data, in this paper we analyze the evolution of the potential misallocation of labor in Chilean manufacturing during the 1979–2007 period. Olley and Pakes (1996), Levinsohn and Petrin (2003), Caballero et al. (2004), Micco and Pages (2004) and others have, in different contexts, estimated the potential gains from inputs and outputs reallocation across plants. Hsieh and Klenow (2009), for instance, estimate the extent of misallocation in China and India relative to the United States based on a model of heterogeneous firms and monopolistic competition. According to their model, under full efficiency firms should display equal marginal productivity in equilibrium. If not, aggregate output would be higher if inputs were reallocated from firms with low marginal productivity to firms with high marginal productivity. Under certain assumptions, the observed dispersion in marginal productivity can thus be used to estimate a measure of the distortions faced by firms.

In this paper we do not impose the structure of Hsieh and Klenow (2009) on our data. However, we do follow their study in relating the dispersion of productivity across plants to labor misallocation. In our benchmark estimates, we proxy marginal labor productivity by the ratio of value added to the wage bill. We do not directly estimate total factor productivity to avoid imposing the strict conditions needed to measure TFP. We use the wage bill rather than employment to approximate the level of human capital within plants. As a robustness check, we also estimate the distribution of average productivity using value added over employment at the plant level[10].

[10] The results of this robustness exercise can be found in the Appendix.

Table 3. ENIA 1979-2007, Basic Statistics.

Year	Number of plants	Value added per plant \$92 millions	Output per plant \$92 millions	Total employees per plant	Total wages per employee \$92 millions	Average Deflator (1992=100)
1979	5,139	461	983	54	1.5	8
1980	4,764	470	988	55	1.7	11
1981	4,242	536	1,118	56	2.1	13
1982	3,830	525	1,049	52	2.2	14
1983	3,715	525	1,116	54	1.9	18
1984	4,119	527	1,143	56	1.7	22
1985	4,123	531	1,189	60	1.5	31
1986	3,890	541	1,315	67	1.4	38
1987	4,270	558	1,370	70	1.3	45
1988	4,208	645	1,540	76	1.3	54
1989	4,255	735	1,705	82	1.5	63
1990	4,291	739	1,692	81	1.6	75
1991	4,426	776	1,787	82	1.7	90
1992	4,653	845	1,917	83	1.9	100
1993	4,745	910	2,017	84	2.0	112
1994	4,761	934	2,072	84	2.2	122
1995	5,055	946	2,086	81	2.3	133
1996	5,295	988	2,176	76	2.5	138
1997	5,097	1,084	2,353	77	2.7	138
1998	4,877	1,175	2,454	75	2.7	143
1999	4,484	1,276	2,605	74	2.8	147
2000	4,353	1,380	2,772	76	2.7	153
2001	3,963	1,378	3,087	76	3.0	162
2002	4,230	1,353	3,088	75	2.9	169
2003	4,257	1,297	3,010	76	2.9	179
2004	4,494	1,301	3,025	74	2.9	183
2005	4,205	1,566	3,739	87	2.9	187
2006	4,004	1,645	3,953	88	3.0	194
2007	3,785	1,947	4,456	98	2.8	206

Source: Author's calculations based on ENIA.

To correct for common shocks and differences in productivity across sectors, we estimate the distribution of plant-level natural logarithm of productivity relative to the average natural logarithm of the productivity of the plants producing in the same 3-digit ISIC sector in the same period of time. That is, we estimate the fraction of plants that produce X% less than the typical plant in its industry in a given year. We then estimate the distribution of these gaps for each year of our sample weighing by the number of employees hired in each plant. That is, the distributions below represent the density of workers' relative productivity in manufacturing in any given year; i.e., the fraction of workers that display a certain level of relative productivity.

We use a number of statistics as a measure of productivity dispersion in our data set. That is, in addition to following the evolution of the standard deviation, we also provide information on the difference between various percentiles of this distribution.

4. The evolution of dispersion

Tables 4a and 4b displays several points in the distribution of relative productivity for the full sample period. The table describes the distribution of

$$\ln\left(VA_{jst} / w_{jst}\, e_{jst}\right) - \ln\left(\textstyle\sum_{j\in s} \frac{1}{n_{st}} \left(VA_{jst} / w_{jst}\, e_{jst}\right)\right),$$

where VA_{jst} represents value added, w_{jst} represents wages and e_{jst} employment, all for plant *j* producing in sector *s* in year *t*. Recall that plants' productivity is weighted by the number of workers, so the distribution actually depicts employees and their productivity within plants. The statistics in the Table confirm the existence of wide differences in productivity among plant employees even within narrowly defined industries. Employees in the first percentile are 65% less productive than the average, whereas employees in the 99th percentile are 529% more productive[11]. Large gaps are still observed at less extreme points of the distribution. For instance, percentile 20th is 31% less productive than the mean, whereas percentile 80th is 76% more productive.

[11] Note that productivity is expressed in natural logarithm, so the gap is calculated as 67%=exp(–1.06)–1.

Table 4a. The distribution of productivity gaps.

	Deviation from the mean	
	Natural logarithm	%
Percentile 1	-1.06	-65%
Percentile 5	-0.78	-54%
Percentile 10	-0.59	-45%
Percentile 20	-0.37	-31%
Percentile 30	-0.22	-19%
Percentile 70	0.36	44%
Percentile 80	0.57	76%
Percentile 90	0.90	147%
Percentile 95	1.23	243%
Percentile 99	1.84	529%

Table 4b. Average deviation of productivity gaps.

	Deviation from the sectoral Mean	
Average	Ln Deviation	Implied %
1th Quintile	-1.02	-64%
2th Quintile	-0.44	-36%
3th Quintile	-0.07	-7%
4th Quintile	0.35	42%
5th Quintile	1.25	251%

As a benchmark, Table 5 reproduces the results of Hsieh and Klenow (2009) for China, India and the United States. The table provides revenue TFP dispersion statistics for years 1998, 2001 and 2005[12]. For comparison, we estimated the dispersion of this measure of productivity using our data set for Chile.

[12] Revenue TFP is calculated on the basis of value added using a sector–specific (instead of plant–specific) deflator. See Foster et al. (2008).

Table 5.Dispersion of Revenue tfp in Chile, China, India and the United. States

Chile	1990	1995	2000	2005
SD	0.59	0.58	0.65	0.61
p75-25	0.73	0.70	0.79	0.74
p90-10	1.50	1.44	1.60	1.52
China	1998	2001	2005	
SD	0.74	0.68	0.63	
p75-25	0.97	0.88	0.82	
p90-10	1.87	1.71	1.59	
India	1987	1991	1994	
SD	0.69	0.67	0.67	
p75-25	0.79	0.81	0.81	
p90-10	1.73	1.64	1.60	
USA	1977	1987	1997	
SD	0.45	0.41	0.49	
p75-25	0.46	0.41	0.53	
p90-10	1.04	1.01	1.19	

Dispersion measures estimated by Hsieh and Klenow (2009) for China and India are much larger than for the United States. According to our estimates, dispersion in Chile lies in between the dispersion in these Asian countries and the dispersion in the United States. Although these differences may reflect data sampling, they are also consistent with the relative extent of distortions in these economies.

Figure 6a plots the evolution of alternative measures of labor productivity dispersion in our sample of plants without weights (the standard deviation[13], and the difference between percentile 99 and percentile 1, between percentile 90 and percentile 10, and so on)[14].These alternative series are highly correlated; e.g., the simple correlation of the standard deviation and the gap between the 95th and the 5th percentiles is 0.96. Figure 6b shows that the unweighted standard deviation follows a very similar time pattern than its weighted counterpart.

13 To estimate the standard deviation we excluded the extreme 0.4% of observations from each tail of the distribution.

14 Weighting the mean to define relative productivities leads to very similar results. The estimates are available from the authors upon request.

Figure 6a. Evolution of Labor Productivity Dispersion.

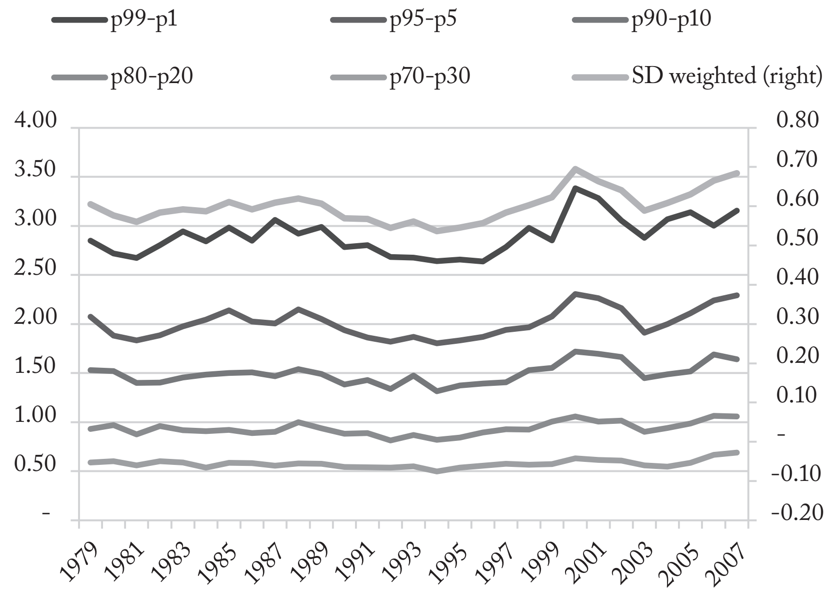
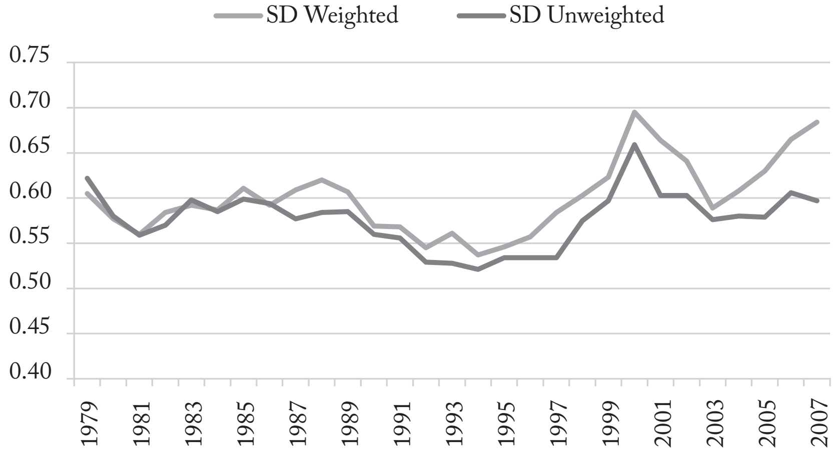


Figure 6b. Weighted and Unweighted Productivity Dispersion.

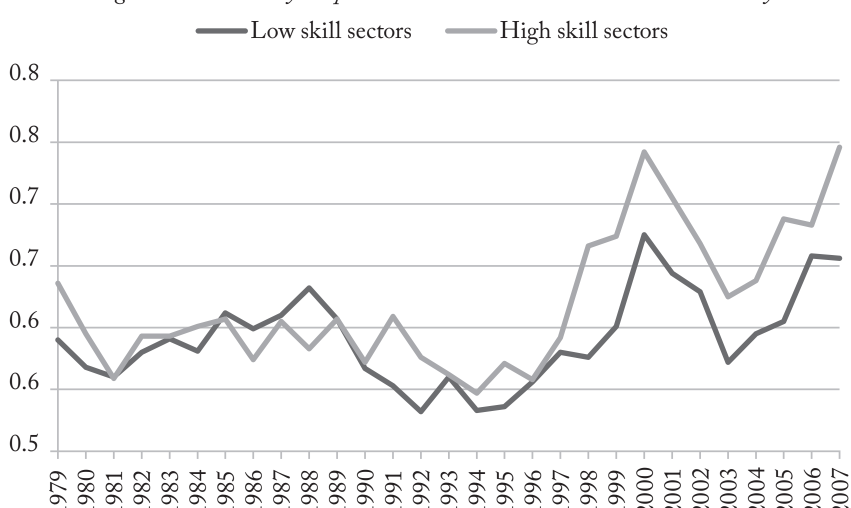


As the figures show, dispersion in the early 1980s was highly volatile. The international crisis of 1981-1982 hit Chile hard: the economy fell into a deep recession as GDP dropped by 13.6% in 1982 and a further 2.8% in 1983. Unemployment, already at high levels, swelled to 34% of the labor force (including as unemployed those working under emergency employment programs), and the government deficit increased to almost 9% of GDP when the Central Bank had to rescue the financial sector from bankruptcy. At the end of the 1980s, dispersion started to steadily fall, reaching its lowest levels in the mid 1990s. This period has been dubbed by many as the "Chilean miracle" with GDP growth rates reaching annual averages near 7% (Table 1). Dispersion abruptly increased as the Asian crisis hit Chile and the international markets, coupled with a large increase in the monetary policy interest rate set by the Central Bank. Dispersion, however, declined rapidly: by 2003 it had already returned to its pre crisis level.

In 2004 all our dispersion measures experienced again a relevant rise. By 2007, the weighted standard deviation had risen by 16% and the 90th-10th percentiles gap had increased by 13%. In Section V below we relate this rise of the observed dispersion to a number of developments in the Chilean economy.

Figure 7 follows the evolution of the weighted standard deviation of the natural logarithm of labor productivity after classifying sectors according to the intensity of use of skilled *versus* unskilled labor. According to our exercise, a sector is defined as skilled labor intensive if the ratio of skilled labor over total employment is larger than the median in our data base. The figure shows that dispersion among both sets of sectors was volatile but slightly declining until 1996-1997. The pattern starting in 1998 is remarkably close to that of the aggregate dispersion depicted in Figure 6b. However, the rise is much sharper among sectors that use skilled labor more intensively, generating a gap that does not close by the end of our sample period.

Figure 7. Productivity Dispersion and Skilled vs. Unskilled Labor Intensity.



This result is consistent with the literature that examines the effects of labor market regulation on the employment rates of different subpopulations of workers. According to this literature, labor market regulations, particularly job security provisions that increase with tenure, reduce the cost of dismissal of workers with short tenures relative to those with more seniority. More generally, policies or institutions may generate heterogeneity in the costs or benefits of adjusting through different subpopulations of workers. Thus firms that need to adjust employment find it easier to do so by rotating workers that are relatively less protected. This is likely the case of skilled workers, who tend to be better protected by provisions in the Labor Code and possibly by unions.

4.1. Productivity-enhancing reallocation

After estimating the dynamics of productivity dispersion, we provide estimates intending to evaluate the extent of misallocation and the aggregate impact of gaps in the marginal product of labor across plants. In order to do this, we take two approaches. In this section we ask whether the observed reallocation process is productivity-enhancing and whether it has become more or less productivity-enhancing over time, using the cross-sectional decomposition first introduced by Olley and Pakes (1996). In Section VI below we estimate the aggregate losses associated to differences in labor productivity across plants.

For a 3-digit manufacturing sector in year t, we decompose average weighted labor productivity as

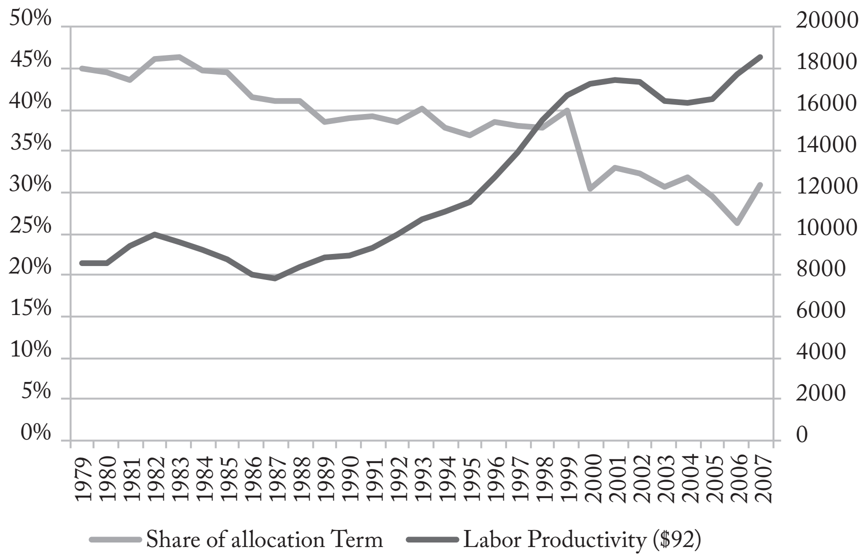
$$LP_t = \sum_j s_{jt}\,(LP_{jt}) = \overline{LP}_t + \sum_j (s_{jt} - \bar{s}_t)\,(\overline{LP}_{jt} - LP_t),$$

where LP_{jt} stands for average labor productivity of plant *j* in year *t* (value added over employment) and s_{jt} is its share in total sector employment. Variables with upper bars describe the simple mean of the variable within the sector and year. This decomposition shows that aggregate labor productivity can rise either because plants are becoming more productive over time (the simple mean term) or because inputs and outputs are being disproportionately reallocated towards their most productive use (the cross term).

Table 6 presents this decomposition for the Chilean manufacturing sector in period 1979-2007. Similarly, Figure 8 shows both, the average labor productivity and the share explained by the allocation term. The weighted average productivity remains stagnant until 1986 and then rises quickly. As a matter of fact, labor productivity increases at an annual rate of 6.2% between 1987 and 1999, the golden period of GDP growth. After the Asian crisis productivity slowed down, and even declined in years 2002–2004, recovering after 2005.

The cross term is positive during the full period under analysis, implying that the ongoing process of reallocation has been productivity-enhancing in every single year; i.e., labor is being reallocated from low productivity to high productivity plants[15]. Nevertheless, it is important to note that after 1999, the share of labor productivity explained by the allocation term starts to fall from an initial level of 40% to around 30%. These results are in line with the increasing dispersion observed in productivity post–Asian crisis.

Figure 8. Labor Productivity and the Reallocation Term.



[15] Appendix 2 decomposes mean productivity at the sector level. Not all estimated reallocation terms are positive. However, these results must be analyzed with caution, in particular in those sectors where a very small number of plants are in production. Also, the exercise in the Appendix does not take into account reallocation that may occur across sectors.

Table 6. Labor Productivity Decomposition.

Year	Weighted average (1992 Ch$)	Simple Average	Cross term
1979	8549	0.550	0.450
1980	8567	0.554	0.446
1981	9422	0.563	0.437
1982	9985	0.539	0.461
1983	9547	0.537	0.463
1984	9261	0.554	0.446
1985	8750	0.554	0.446
1986	7990	0.584	0.416
1987	7803	0.590	0.410
1988	8424	0.590	0.410
1989	8817	0.615	0.385
1990	8982	0.609	0.391
1991	9321	0.608	0.392
1992	9998	0.616	0.384
1993	10730	0.599	0.401
1994	11047	0.621	0.379
1995	11565	0.631	0.369
1996	12739	0.614	0.386
1997	13930	0.618	0.382
1998	15504	0.621	0.379
1999	16744	0.600	0.400
2000	17213	0.696	0.304
2001	17445	0.669	0.331
2002	17312	0.678	0.322
2003	16393	0.693	0.307
2004	16313	0.682	0.318
2005	16481	0.704	0.296
2006	17749	0.738	0.262
2007	18547	0.690	0.310

5. *Understanding the Rise in Dispersion*

The late 1990s and the 2004 rise in dispersion seem related to a number of developments occurring in Chile during those years. One has to do with the surge in real interest rates as a response to the Asian currency crisis. The other has to do with changes in monetary policy and the volatility of the real exchange rate, along with developments in the energy market. Table 7 reports the evolution of the 90-365 days real interest rate, the oil price, the nominal exchange rate and the CPI, along with their standard deviation.

Table 7. Interest Rate, Exchange Rate and Oil Price Evolution.

Year	Real Interest Rate [%]	Oil Price Brent $/bbl	Nominal Exchange rate $/ US$	Consumer Price Index	Real Interest Rate StdDev/ Mean	Oil Price Brent StdDev/ Mean	Nominal Exchan-ge rate StdDev/ Mean
1984			98.5	13.5			0.143
1985			160.9	17.6			0.121
1986		2754.7	192.9	21.1		0.212	0.033
1987		3951.3	219.4	25.3		0.060	0.049
1988		3666.9	245.0	29.0		0.093	0.010
1989		4869.7	267.0	33.9		0.102	0.066
1990	132.8	7232.3	304.9	42.7	2.152	0.363	0.044
1991	84.8	6987.4	349.2	52.0	0.483	0.089	0.033
1992	81.3	7006.5	362.6	60.0	0.383	0.072	0.036
1993	92.3	6858.3	404.2	67.7	0.181	0.077	0.028
1994	92.7	6623.4	420.2	75.4	0.273	0.072	0.020
1995	85.3	6770.4	396.8	81.6	0.363	0.059	0.037
1996	93.4	8534.1	412.3	87.6	0.199	0.109	0.012
1997	87.7	8030.5	419.3	93.0	0.238	0.089	0.017
1998	119.3	5873.2	460.3	97.8	2.612	0.101	0.018
1999	81.9	9160.2	508.8	101.0	0.924	0.331	0.047
2000	74.8	15368.8	539.5	104.9	0.249	0.142	0.049
2001	63.3	15419.8	634.9	108.7	0.759	0.108	0.079
2002	43.9	17264.6	688.9	111.4	1.658	0.144	0.042
2003	43.0	20033.5	691.4	114.5	1.157	0.117	0.065
2004	31.7	23346.7	609.5	115.7	1.175	0.162	0.039
2005	39.5	30367.0	559.8	119.2	1.292	0.097	0.045
2006	51.8	34554.8	530.3	123.3	1.244	0.092	0.015
2007	46.4	37767.9	522.5	128.7	0.903	0.142	0.028

Source: Real interest rate (90 days-1 year), CPI and Exchange rate: Central Bank. Oil price: Platt´s, OLADE.
Note: Nominal exchange rate and oil price in logarithms divided by the year average CPI.

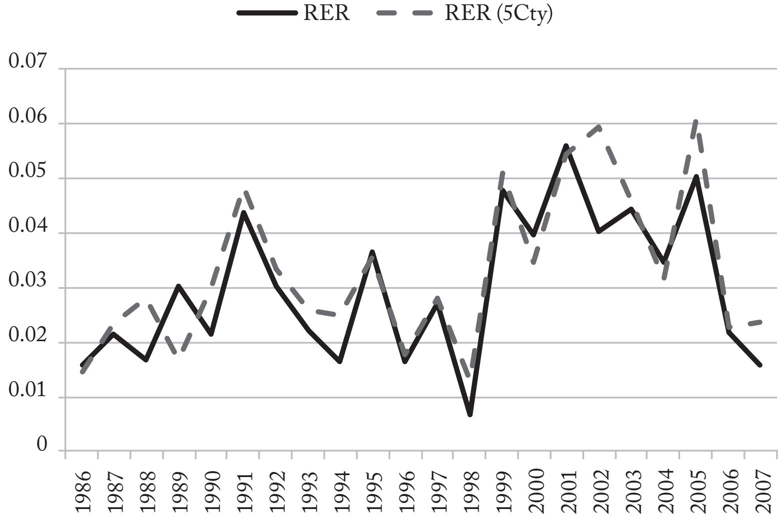
5.1. Interest rate hikes

Firms in Chile mainly rely on banks for finance, especially small firms with no access to the equity market or the domestic corporate bond market (Caballero, 2000). So large interest rate fluctuations, such as the one observed in 1998, leave firms with little access to funding sources. This in turn limits the economy's ability to efficiently reallocate resources and to smooth shocks when needed.

5.2. Real exchange volatility

Another possible factors behind the increased volatility observed in the labor market is the new monetary policy adopted by the Central Bank since 1998. Inflation targeting targets nominal inflation at a two–year horizon at the expense of not targeting nominal or real exchange rates. Figure 9 shows the observed real exchange volatility measured within years. Two indices are constructed: rer is the rate relative to all of Chile's commercial partners whereas rer(5Cty) only uses the five most relevant ones. During the period 1986 and 1997, the average real exchange rate volatility, measured by the monthly standard deviation, is 2.5%. This measured mean volatility jumped sharply to 3.8% during the period 1999-2007. Real exchange rate volatility affects both, demand and total costs. This higher volatility requires more labor adjustment and therefore, under the presence of adjustment costs, labor productivity dispersion increases.

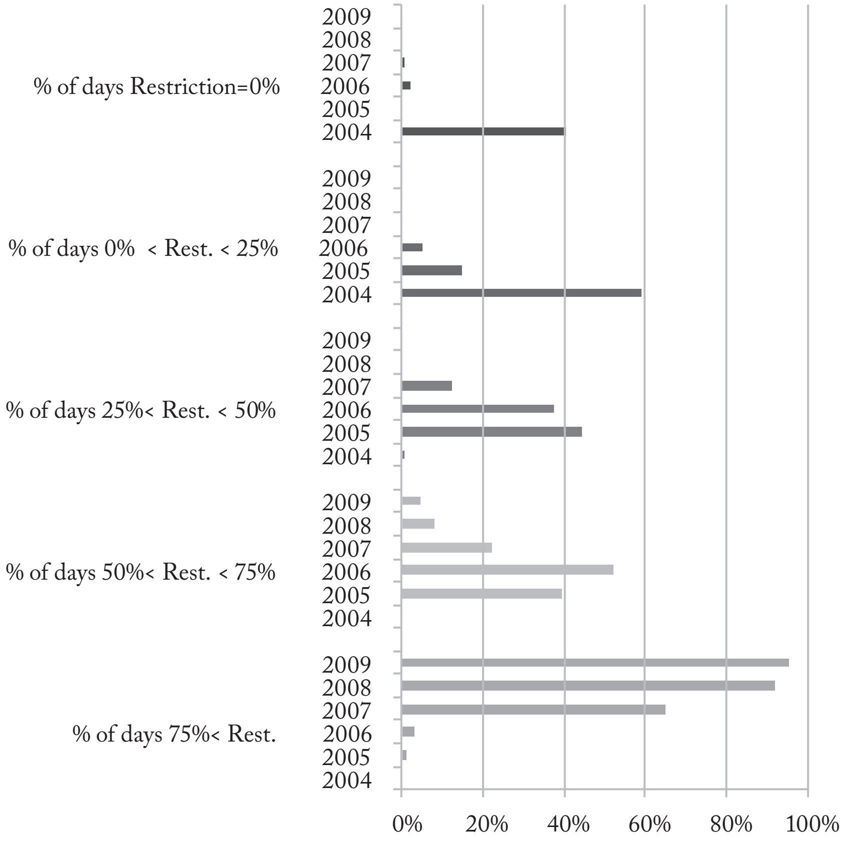
Figure 9. Real Exchange Rate Volatility.



5.3. Energy prices

Since the 1990s, Chile invested in natural gas power plants and in cross-border pipelines in order to import energy from Argentina. The economy also invested in the conversion of industries and homes to natural gas. In April 2004, however, the Argentinean authorities cut natural gas exports to Chile in response to a local energy shortage. Production had to switch to diesel and old coal powered plants had to be brought back to service. Since then, gas supply has been erratic. Figure 10 reports the fraction of days that gas imports have been restricted classified according to the fraction of contracted supply that was not delivered. The Figure shows how supply cuts have become more frequent over time.

Figure 10.Restrictions on Imports of Argentinean Natural Gas



These developments led many firms to switch to oil. During this period, oil prices were also characterized by a higher level of volatility. Oil price volatility within a year –measured by the standard deviation– increased from an average of 9.9% during years 1996 and 1997 to an average of 14.4% during the period 1998–2007 (Table 7). Plants have different energy requirements; thus this increasing uncertainty in energy prices mainly affects the most energy intensive plants.

5.4. Accounting for the rise in dispersion

In this subsection we provide a very simple test of our hypothesis by estimating the relationship between the described macroeconomic shocks and changes in the observed dispersion of productivity. More specifically, this simple model relates the standard deviation of the natural log of our productivity measure at the sector/year level to a number of variables describing whether the sector is relatively open to international trade, is export-oriented, capital-intensive, energy-intensive and oil-intensive. These sectorial characteristics are then interacted with variables proxying shocks; i.e, the volatility of the exchange rate, the interest rate and oil prices, as well as the fraction of days in a given year experiencing gas cuts and the level of the interest rate. We define a sector as open if, according to the input-output matrix of 1996, the sum of exports and imports over total supply (domestic output plus imports) is higher than the median. Similarly, a sector is export-intensive if the average ratio –across plants and years in the ENIA– of exports over gross output is higher than the median. Capital-intensity is defined by the ratio of value added minus the wage bill over gross output. Oil-intensity is defined by the value of oil expenses over gross output whereas gas intensity is measured by energy expenses different than electricity and oil over gross output[16]. Finally, the variable gas cuts measures the percent of gas that was not delivered using the contracted level as the benchmark, averaged across days.

The results of this simple exercise are shown in Table 8. According to our estimates, a rise in the dispersion of the exchange rate does not affect significantly the dispersion of labor productivity unless the sector is classified as open. Our point estimate indicates an effect equal to 11.7% of one

[16] Note that this definition assumes that only these three sources of energy are used. If, for instance, coal is also used in production, our intensity definition will incorrectly associate these expenses to gas consumption.

standard deviation of labor productivity when the exchange rate dispersion increases by one standard deviation (keeping the mean constant). Similarly, a rise of one standard deviation in the dispersion of interest rates leads to a rise of 5.88% of one standard deviation of labor productivity in capital-intensive sectors (again, keeping constant the average interest rate). The effect of rises in the interest rate itself (now keeping its volatility constant) on overall labor productivity dispersion is positive, although the estimated effect is attenuated among capital-intensive sectors. The effect of rises in the dispersion of oil prices is also positive among oil-intensive sectors (10.4% of one standard deviation), whereas a one standard deviation rise in the gas cuts measure is correlated with a rise of 14.9% of one standard deviation in the dispersion of labor productivity among gas-intensive sectors. The third and fourth columns of the Table repeat this exercise limiting the sample to sectors classified as skilled labor intensive. The results are very similar to those to using the aggregate data set.

Summing up, the results of this very simple econometric exercise are consistent with the hypothesis that labor productivity dispersion rose as a result of the increased variance of shocks in both the exchange rate and the price and availability of energy. Plants that suffered most are those producing in traded sectors and those that use oil or gas relatively intensively.

However, an alternative hypothesis for which this exercise cannot account is that the increased dispersion responds to a slowdown in the speed at which plants adjust when they face disequilibria. We examine this alternative hypothesis by estimating the evolution of the speed of adjustment as in Caballero et al. (2010). According to this view, firms face adjustment costs that can be the result of technological and/or institutional constraints. That is, firms may not fully adjust immediately to a shock, so the observed level of employment may not be equal to its frictionless level. The speed of adjustment is thus a measure of how long it takes to close the gap between current employment and its frictionless level.

Following Caballero et al. (2010) we estimate the observed changes in employment of plants producing in sector s at time t as a function of the gap between actual and frictionless employment and a sector-year dummy. The gap is in turn estimated as a function of changes in the labor productivity. Table 9 reports our estimation results. As a benchmark, column (1) estimates the average speed of adjustment in our data set. We find that on average 70.9% of the employment gap is closed in each period.

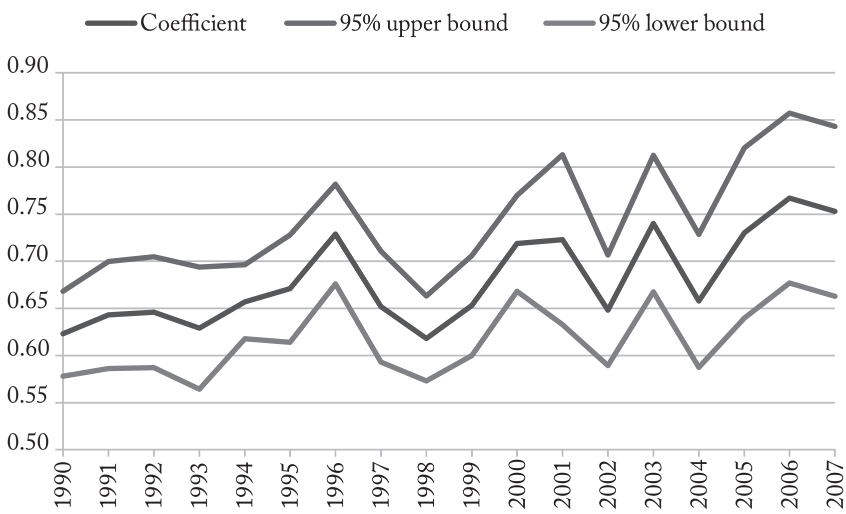
Table 8. The Dispersion of Labor Productivity and the Volatility of Shocks.

	All Sectors	All Sectors	Low Skill Sectors	Low Skill Sectors
Open Sector SD Exchange Rate	1.616 (0.736)**	1.617 (0.708)**	1.685 (0.773)**	1.684 (0.773)**
Export-Intensive Sector SD Exchange Rate	-0,019 (0,617)	-0,015 (0,602)	0,533 (0,734)	0,533 (0,718)
Capital-Intensive Sector SD Real Interest Rate	0,049 (0.020)**	0,049 (0.020)**	0,050 (0,044)	0,050 (0,044)
Capital-Intensive Sector Real Interest Rate	-0,008 (0.004)*	-0,008 (0.004)*	-0,001 (0,009)	-0,001 (0,009)
Oil-Intensive Sector SD Oil Price	0,225 (0.128)*	0,225 (0.126)*	0,104 (0,149)	0,104 (0,149)
Gas-Intensive Sector Gas Cuts (%)	0,142 (0.054)***	0,141 (0.054)***	0,102 (0,074)	0,102 (0,075)
SD Exchange Rate	-0,401 (0,796)		-1,035 (0,631)	
SD Real Interest Rate	-0.034 (0.015)**		-0.033 (0.114)**	
SD Oil Price	-0,195 (0.114)*		-0,040 (0,101)	
Exchange Rate	0,080 (0,138)		0,043 (0,111)	
Real Interest Rate	0.021 (0.007)***		0.018 (0.007)***	
Oil Price	0,010 (0,038)		0,025 (0,041)	
Gas cuts	-0,061 (0,073)		-0,095 (0,081)	
Time trend	0.012 (0.005)**		0.012 (0.005)***	
Observations	484	484	252	252
R-squared	0.52	0.55	0.61	0.64
Year Fixed Effects	No	Yes	No	Yes

Note: Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Regressions include a full set of sector dummies.

Column (2) allows for nonlinearities by controlling for the cubic of the gap. The positive estimated coefficient implies that plants facing larger gaps adjust more quickly. The column also allows for a time varying average speed of adjustment. Figure 11 presents the estimated coefficients of the gap interacted with year dummies, along with the respective 95% upper and lower bounds. The Figure shows relevant variation in the average speed of adjustment. More important, it suggests that the speed at which manufacturing firms adjust in Chile if anything has increased over time. This result is consistent with our main hypothesis: that the observed rise in labor productivity dispersion is mostly related with an increased variance of the shocks firms face.

Figure 11. Average Adjustment Speed over Time.



The final column of Table 9 estimates again the model, now allowing for a difference in the adjustment speed of plants producing in sectors that are relatively skilled labor intensive. We find a negative coefficient; that is, plants in these sectors find it harder to adjust and take more time to close gaps between actual and frictionless employment. In turn, this finding is consistent with the idea that labor market regulations are not neutral. They have different effects upon the hiring and firing rates of different worker populations, and at the same time they also have different effects upon the ability of firms to respond to shocks.

Table 9. Speed of Adjustment Estimation Results.

	(1)	(2)	(3)
Gap	0.709 (0.008)**		
Gap3		0,370 (0.056)**	0,364 (0.056)**
Gap*Skilled Labor Intensive			-0,078 (0.014)**
Gap_1990		0,623 (0.023)**	0,643 (0.020)**
Gap_1991		0,643 (0.029)**	0,661 (0.025)**
Gap_1992		0,646 (0.030)**	0,666 (0.028)**
Gap_1993		0,629 (0.033)**	0,647 (0.030)**
Gap_1994		0,657 (0.020)**	0,676 (0.019)**
Gap_1995		0,671 (0.029)**	0,690 (0.027)**
Gap_1996		0,729 (0.027)**	0,750 (0.026)**
Gap_1997		0,652 (0.030)**	0,674 (0.025)**
Gap_1998		0,618 (0.023)**	0,640 (0.021)**
Gap_1999		0,653 (0.027)**	0,675 (0.027)**
Gap_2000		0,719 (0.026)**	0,742 (0.022)**
Gap_2001		0,723 (0.046)**	0,746 (0.042)**
Gap_2002		0,648 (0.030)**	0,674 (0.027)**
Gap_2003		0,740 (0.037)**	0,764 (0.033)**
Gap_2004		0,658 (0.036)**	0,683 (0.031)**
Gap_2005		0,730 (0.046)**	0,754 (0.042)**
Gap_2006		0,767 (0.046)**	0,792 (0.043)**
Gap_2007		0,753 (0.046)**	0,780 (0.043)**
Observations	88086	60389	60389
R-squared	0.50	0.49	0.49

Note: Robust standard errors in parentheses. Regressions include year fixed effects. * significant at 5%; ** significant at 1%.

6. The aggregate implications of misallocation

As a second approach to quantifying the extent of misallocation, we estimate the potential gains in aggregate manufacturing value added that would be obtained if the lowest productivity workers were to move to higher productivity plants. More specifically, in our exercise we estimate the effect of reallocating half of the workers employed in plants in the first quintile of labor productivity, to plants in superior quintiles. We define labor productivity in the first quintile as the weighted average of labor productivity of plants in the quintile. That is,

$$LP_{1q} = ln\left(\sum_{i\in\Omega} \frac{L_i}{L_{1q}} A_i \left(\frac{K_i}{L_i}\right)^{\alpha}\right),\ \Omega_{1q} = \text{set of plants in the first quintile}$$

where L_{1q} denotes total employment in the quintile. LP_{iq}, the average labor productivity in the *ith* quintile, is defined in similar fashion. We assume that all plants produce under constant returns to scale and that the value added capital elasticity equals to α. Our estimates are a lower bound of the potential gains of reallocation as we have assumed that capital does not move across plants.

Four effects on aggregate productivity occur, two within the group of lowest productivity plants and two within the highest. The first is the loss of production by workers who were moved away from the first quintile. The second is the gain in productivity by workers left in the lowest productivity plants, as they now produce with a larger capital per worker ratio. Each of these workers now produces with twice the capital. The third is the gain in production of workers who have now moved to higher productivity plants. The final effect is a loss due to the fall in the capital per worker ratio that experience workers at these higher productivity plants. In these plants, the new capital/worker ratio is now two thirds of what it used to be before the reallocation of workers. Therefore the gain in total productivity is estimated as

$$\Delta LP = 0.1\ (-LP_{1q}) + 0.1\ (2^{\alpha} - 1)LP_{1q} + 0.1\left(\left(\tfrac{2}{3}\right)^{\alpha} LP_{jq}\right) - 0.2\left(1 - \left(\tfrac{2}{3}\right)^{\alpha}\right)LP_{jq}$$

$$= 0.1\ (2^{\alpha} - 2)LP_{1q} + \left(0.3\ \left(\tfrac{2}{3}\right)^{\alpha} - 0.2\right)LP_{jq}$$

Table 4b above reported the average labor productivity in each quintile. Based on these estimates, Table 10 presents the gains in productivity of reallocating half of the first quintile workers to plants in higher labor productivity quintiles for different values of α. Recalling that labor productivity is measured in natural logarithms, the figures in the Table present the estimated percent gain due to reallocation. Under our preferred estimates (with α=0.4), these gains range from 1% to 17% depending on the quintiles of the distribution to which workers are reallocated[17]. As the share of capital in value added rises, however, the net gains fall, as the effect of a lower capital ratio at the higher productivity plants becomes more relevant.

Table 10. Productivity Gains from Reallocating Half of First Quintile Workers.

Workers moving to	Capital Share in Value Added		
	0.2	0.4	0.6
2th Quintile	0.02	0.01	0.01
3th Quintile	0.04	0.03	0.02
4th Quintile	0.08	0.05	0.03
5th Quintile	0.24	0.17	0.11

7. *Concluding remarks*

In this paper we have analyzed the evolution of labor productivity dispersion over time as a proxy for labor misallocation. We have found that while downturns are associated with an increase in dispersion, the golden period of Chilean growth was characterized by a reduction in observed dispersion. Moreover, our results show that the recent rise in dispersion may be attributed to a rise in the variance of shocks that firms face.

Although not conclusive, our results also suggest that labor market regulations are not neutral, as they affect the allocation of labor across plants. We provide suggestive evidence that these regulations and institutions decrease the adjustment speed of firms that undertake intensive hiring of relatively protected labor which in turn leads to larger and more persistent dispersion in firms using intensively this type of labor. These results imply that there might be space for labor market reforms that enhance productivity. One aspect that should be considered is the

17 See Bergoeing and Repetto (2006) for micro level estimates of the production function using the ENIA.

rigidity of hours, possibly by defining the length of the workday not at the weekly level, but at the monthly or even annual level. Another has to do with transforming the current severance pay system into a compensation scheme that finances job loss independently of the reason for separation, possibly financed through the individual accounts of Chile's UI system. Also, childcare should be financed by general revenues, replacing the current system of an implicit tax on female employment at medium sized and large firms. These and other proposals are the subject of ongoing debate in Chile. Future work could estimate the potential efficiency effects of these reforms.

References

Acemoglu, D., Johnson, S., Robinson, J.(2001). "The colonial origins of comparative development: An empirical investigation". American Economic Review 91(5), 1369-1401.

Bartelsman, E. and Doms, M. (2000). "Understanding Productivity: Lessons from Longitudinal Microdata". Journal of Economic Literature 38(2), 569-594.

Bergoeing, R. and Repetto A. (2006). "Micro Efficiency and Aggregate Growth in Chile". Cuadernos de Economía, Vol. 43 (Mayo), pp. 169-191.

Bergoeing, R., Hernando. A. and Repetto A.(2010). "Market Reforms and Efficiency Gains in Chile". Estudios de Economía, Vol. 37, No. 2, pp. 217-242.

Caballero, R. J. (2000), "Macroeconomic Volatility in Latin America: A View and Three Case Studies", NBER Working Paper 7782.

Caballero, R., Engel M.R.A, Cowan, K. and Micco, A. (2010). "Effective Labor Regulation and Microeconomic Flexibility". Mimeo.

Comision Asesora Laboral y de Salario Mínimo (2010). Informe Final.

Consejo Asesor Presidencial Trabajo y Equidad (2008). Informe Final.

Edwards, S. and Cox-Edwards, A. (2002). "Social Security Privatization Reform and Labor Markets: The Case of Chile". Economic Development and Cultural Change, 50(3), 465-489.

Foster, L., Haltiwanger, J. and Krizan, C. (2001). "Aggregate Productivity Growth: Lessons from Microeconomic Evidence", in Edward Dean Michael Harper and Charles Hulten, eds., *New Developments in Productivity Analysis*. Chicago: University of Chicago Press.

Foster, L., J. Haltiwanger, and C. Syverson (2008). "Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?" American Economic Review, 98, 394-425.

Hernando. A. (2009). "Female Labor Participation and *Childcare* in Chile: A Natural Experiment". Mimeo Universidad Adolfo Ibañez.

Hopenhayn, H. (1992). "Entry, Exit, and Firm Dynamics in Long Run Equilibrium", Econometrica, 60(5), 1127-50.

Jovanovic,B. (1982). "Selection and the Evolution of Industry", Econometrica, 50(3), 649–670.

Hsieh, C.-T. and Klenow, P. (2009). "Misallocation and Manufacturing tfp in China and India". The Quarterly Journal of Economics, 124 (4), 1403-1448.

Levinson J. and A.Petrin (2003). "Estimating Production Functions Using Inputs to Control for Unobservables". *Review of Economic Studies*, 70(2), No. 243, 317-342.

Micco, A. and C. Pages, 2006. "The Economic Effects of Employment Protection: Evidence from International Industry-Level Data", IZA Discussion Papers 2433, Institute for the Study of Labor (IZA).

Montenegro, C. E. and Pages, C.(2004). "Who Benefits from Labor Market Regulations?: Chile 1960–1998". In *Law and Employment: Lessons from Latin America and the Caribbean,* ed. James Heckman and Carmen Pages. Chicago: University of Chicago and National Bureau of Economic Research.

Olley, G.S. and Pakes, A. (1996). "The Dynamics of Productivity in the Telecommunications Equipment Industry". Econometrica 64(6): 1263-1297.

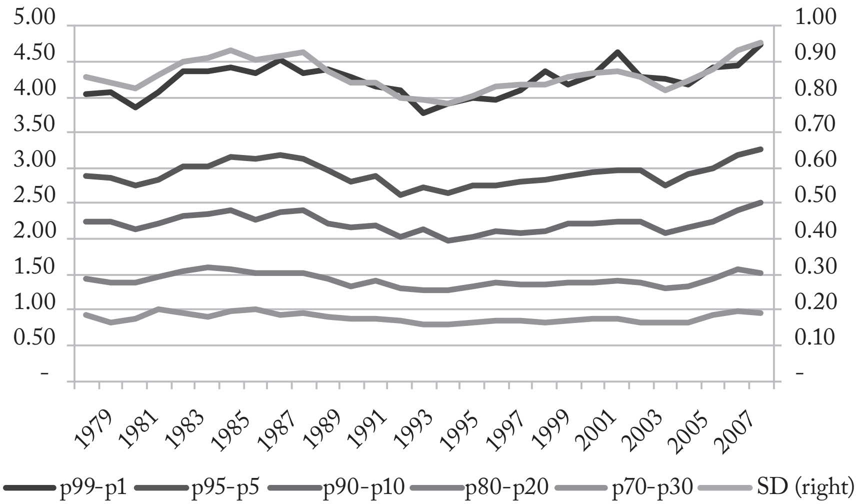
APPENDIX A: ROBUSTNESS EXERCISES

In this Appendix we analyze the robustness of our main estimates in order to assume a different definition of labor productivity, and to limit the analysis to continuous firms.

The definition of labor productivity:

In the main text we approximated labor productivity by the ratio of value added to the wage bill. We used the wage bill as a proxy for human capital within the firm. In this Appendix we estimate the evolution of dispersion using value added over total employment. Figure A.1. shows that our main conclusions are robust to these measurement decisions.

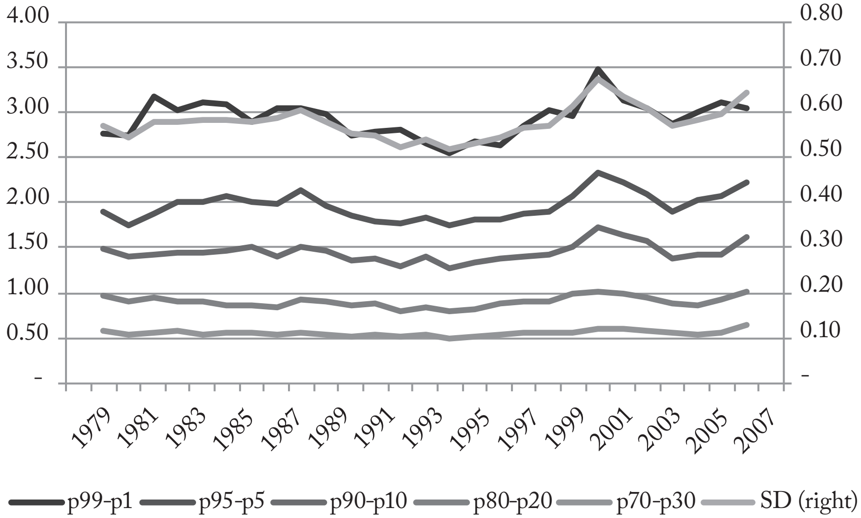
Figure A1. Evolution of Productivity Dispersion
(Labor Productivity = ln(Value Added /Employment)).



Continuous firms:

The data shows an important turnover of plants. In order to account for this fact, in this Appendix we compute the labor productivity dynamics using only plants that are present in the sample in years t–1,t and t+1. Figure A.2 reports these results. Labor dispersion is again mainly unaffected by this sample redefinition.

Table A.2. Evolution of Productivity Dispersion Continuous Firms



Appendix 2. Cross Term of Olley and Pakes (1996) decomposition by sector (as a % of sector level mean labor productivity)

Sector	311	312	313	314	321	322	323	324	331	332	341	342	351	352	353	354	355	356	361	362	369	371	372	381	382	383	384	385
Obs	35284	1927	3294	76	9076	7786	1343	3492	9258	3479	2339	5892	1912	4934	129	429	1623	6101	422	659	4009	1239	638	11407	5348	1867	2923	635
1979	47.5%	39.6%	31.0%	35.2%	16.7%	29.9%	29.9%	49.1%	32.3%	40.0%	53.9%	45.6%	49.0%	16.4%	-10.5%	35.7%	31.4%	23.8%	44.1%	37.9%	50.4%	50.2%	26.5%	29.9%	17.1%	28.2%	51.8%	5.2%
1980	48.5%	40.0%	39.7%	31.5%	21.8%	25.4%	26.5%	43.3%	25.6%	41.6%	54.0%	47.5%	11.3%	24.0%	-24.8%	6.3%	31.8%	13.2%	16.5%	42.3%	54.4%	20.8%	16.1%	25.8%	22.0%	24.0%	46.3%	-1.8%
1981	43.9%	34.6%	34.0%	28.4%	18.7%	19.1%	27.4%	47.5%	20.6%	30.9%	48.9%	46.1%	12.2%	23.4%	4.9%	25.6%	34.6%	12.9%	42.6%	34.3%	56.7%	4.6%	45.4%	22.2%	16.6%	23.4%	48.8%	6.5%
1982	44.2%	30.5%	33.9%	35.0%	19.9%	22.2%	25.7%	48.3%	39.1%	28.4%	54.0%	48.1%	6.8%	25.9%	7.2%	26.4%	39.3%	17.3%	27.7%	42.8%	53.1%	10.9%	31.8%	28.5%	27.6%	24.8%	39.1%	4.8%
1983	44.3%	30.3%	32.3%	0.0%	21.6%	25.5%	21.3%	35.0%	38.0%	28.3%	52.4%	46.6%	19.5%	20.7%	-16.4%	30.3%	51.3%	19.3%	28.2%	44.0%	52.6%	37.9%	51.3%	26.8%	2.9%	24.4%	34.9%	11.0%
1984	44.9%	13.2%	33.5%	33.8%	27.3%	30.8%	20.1%	37.4%	37.4%	26.3%	57.1%	47.6%	7.3%	23.9%	11.7%	17.2%	40.1%	11.3%	23.9%	38.3%	50.6%	30.7%	48.7%	24.7%	11.4%	30.9%	38.8%	6.9%
1985	45.0%	19.8%	35.4%	30.5%	26.6%	33.0%	19.7%	37.4%	34.7%	24.8%	55.2%	45.5%	12.6%	23.8%	0.1%	-26.2%	40.3%	13.3%	16.0%	38.6%	51.2%	24.4%	52.4%	22.8%	19.1%	33.7%	45.5%	14.8%
1986	42.9%	19.1%	27.1%	34.0%	30.2%	25.4%	16.6%	37.1%	27.1%	33.3%	56.3%	42.4%	15.5%	19.6%	1.0%	-23.4%	42.0%	10.7%	0.9%	30.4%	53.8%	31.4%	34.6%	22.5%	20.7%	23.4%	32.1%	1.5%
1987	44.6%	23.6%	31.0%	36.6%	22.9%	22.6%	21.9%	41.7%	26.9%	36.2%	59.2%	44.9%	10.3%	19.3%	1.0%	-55.5%	49.9%	9.7%	21.5%	17.4%	54.9%	39.4%	42.8%	22.6%	26.9%	19.7%	25.8%	15.2%
1988	45.1%	22.2%	31.2%	39.6%	19.6%	32.0%	19.1%	37.7%	35.7%	29.5%	60.2%	42.8%	0.1%	19.2%	-0.1%	-8.9%	40.5%	11.6%	-11.1%	18.6%	47.1%	46.6%	20.3%	21.9%	14.7%	27.0%	31.2%	14.6%
1989	43.7%	22.6%	23.0%	42.1%	21.7%	22.7%	3.6%	38.8%	28.6%	37.8%	54.4%	38.3%	-1.9%	20.3%	-0.3%	-0.6%	36.1%	12.6%	17.2%	36.0%	44.2%	47.3%	34.5%	22.9%	7.7%	28.3%	28.9%	13.9%
1990	41.6%	23.4%	25.7%	0.0%	15.9%	20.8%	10.9%	35.2%	26.9%	27.9%	51.7%	45.2%	11.4%	28.9%	0.2%	-64.4%	46.0%	13.8%	31.2%	30.3%	54.1%	40.1%	20.4%	28.4%	10.9%	20.0%	24.9%	10.5%
1991	37.7%	28.6%	24.3%	0.0%	15.7%	24.7%	4.1%	32.9%	24.1%	29.2%	50.6%	42.8%	4.6%	30.0%	-0.2%	-33.5%	43.8%	13.6%	12.2%	34.6%	45.8%	16.6%	48.6%	22.9%	12.7%	29.4%	29.9%	21.7%
1992	39.9%	30.8%	21.5%	0.0%	14.8%	21.1%	15.2%	34.2%	23.5%	34.4%	44.2%	44.0%	0.1%	28.2%	0.1%	-20.9%	33.2%	7.6%	23.7%	30.4%	51.2%	45.7%	38.9%	26.1%	23.0%	25.5%	24.9%	19.2%
1993	41.9%	27.6%	22.2%	48.1%	10.1%	34.3%	18.5%	34.4%	18.4%	28.6%	36.1%	43.0%	6.9%	22.2%	0.0%	-48.5%	41.7%	17.9%	18.9%	21.0%	51.1%	37.2%	34.8%	21.1%	20.3%	29.9%	26.3%	25.9%
1994	37.8%	18.7%	29.0%	0.0%	9.6%	29.7%	23.0%	35.5%	21.7%	29.4%	47.7%	47.2%	-8.3%	21.0%	0.1%	-21.4%	40.0%	18.7%	15.7%	26.0%	42.4%	36.8%	29.9%	20.0%	21.0%	25.1%	24.9%	17.8%
1995	37.6%	11.0%	28.0%	0.0%	13.0%	31.3%	18.5%	40.0%	22.8%	26.8%	47.8%	45.9%	-15.0%	23.4%	-0.2%	-34.9%	39.3%	16.9%	31.9%	39.5%	42.7%	7.6%	39.1%	19.5%	26.5%	25.8%	25.2%	11.6%
1996	40.4%	26.6%	26.5%	0.0%	8.9%	32.3%	12.7%	35.5%	24.6%	28.3%	47.8%	42.4%	-8.0%	18.3%	0.3%	-77.1%	35.2%	14.4%	30.4%	26.9%	36.3%	34.1%	43.4%	22.4%	23.2%	22.8%	39.6%	12.1%
1997	42.6%	21.8%	32.8%	0.0%	10.8%	33.6%	12.2%	37.7%	21.2%	32.6%	47.2%	48.1%	-19.5%	17.1%	0.0%	-43.4%	47.1%	9.0%	30.1%	42.6%	38.4%	21.7%	40.9%	22.3%	26.3%	26.3%	39.6%	12.0%
1998	43.4%	19.2%	-22.2%	15.8%	13.5%	29.4%	21.0%	38.4%	14.6%	34.5%	46.8%	45.0%	-16.7%	17.5%	50.5%	-7.8%	54.9%	14.7%	17.6%	45.7%	30.7%	44.2%	40.6%	24.0%	25.1%	29.0%	33.3%	7.1%
1999	38.0%	18.3%	-22.6%	0.0%	8.9%	33.6%	14.6%	38.6%	22.7%	37.8%	49.9%	43.8%	22.0%	19.3%	30.4%	-82.8%	44.1%	14.9%	18.6%	60.1%	24.5%	19.0%	42.2%	27.4%	21.8%	13.4%	32.5%	13.1%
2000	38.6%	-17.9%	-41.6%	18.7%	5.0%	22.3%	22.1%	33.1%	26.4%	37.6%	51.9%	41.6%	7.9%	7.1%	39.8%	-46.6%	47.3%	8.3%	30.6%	54.0%	-6.4%	-29.4%	-28.9%	28.9%	31.3%	23.1%	20.8%	20.1%
2001	39.0%	23.5%	-30.2%	0.0%	3.6%	22.5%	11.3%	24.8%	24.9%	26.2%	40.5%	33.7%	16.2%	6.0%	25.0%	-28.9%	41.5%	22.2%	38.8%	49.2%	24.9%	34.2%	21.8%	38.1%	20.7%	30.0%	34.8%	-1.3%
2002	34.8%	9.6%	-35.8%	0.0%	4.1%	23.0%	12.9%	23.3%	24.1%	27.1%	44.2%	42.2%	5.1%	6.0%	26.5%	-58.9%	48.2%	28.4%	35.6%	58.7%	29.1%	34.1%	33.6%	16.9%	32.0%	24.3%	39.7%	10.6%
2003	32.3%	10.3%	-7.8%	0.0%	0.3%	16.2%	4.7%	23.7%	9.3%	4.6%	47.8%	16.4%	7.2%	0.0%	33.4%	-82.4%	41.9%	17.4%	44.2%	59.6%	23.1%	34.4%	29.1%	21.1%	19.4%	16.3%	27.9%	15.0%
2004	29.4%	11.3%	6.1%	43.3%	1.4%	15.0%	12.1%	45.4%	23.3%	15.2%	50.4%	19.3%	21.4%	13.1%	45.9%	-33.3%	37.1%	20.7%	46.7%	61.0%	20.5%	53.7%	34.1%	12.2%	21.3%	13.4%	48.1%	11.0%
2005	28.1%	1.4%	10.5%	43.5%	-4.3%	23.8%	-3.0%	31.7%	11.8%	12.0%	46.8%	14.4%	56.1%	15.3%		-42.1%	20.2%	19.7%	34.1%	49.1%	8.0%	-35.3%	30.8%	6.6%	24.3%	19.9%	40.6%	5.0%
2006	32.1%	37.8%	-25.7%		-6.4%	24.0%	15.4%	32.6%	22.5%	5.4%	47.9%	16.1%	30.5%	20.0%	-2.6%	-45.7%	24.7%	17.2%	40.2%	51.3%	5.1%	-9.6%	37.9%	18.1%	21.2%	15.7%	30.0%	-9.1%
2007	26.7%	16.8%	-7.3%		-28.9%	21.8%	12.3%	35.6%	17.1%	7.9%	51.1%	13.4%	30.9%	13.7%		-42.9%	20.7%	18.8%	38.9%	37.2%	12.8%	42.6%	19.4%	26.7%	25.2%	15.8%	5.8%	2.5%

Finance, Productivity and Growth: Does it work for Chile?

Fernando Diaz, Fernando Lefort, Marco Morales[1]

1. Introduction

The purpose of this chapter is to analyze the effect that financial and securities markets developments have had in increasing productivity and economic growth in Chile.

As total factor productivity has been the main engine during periods of rapid growth in Chile, our working hypothesis is that structural policies aimed at developing financial markets will tend to increase productivity and thus economic growth.

In a recent paper, Fuentes and Morales (2011) show that productivity has been largely responsible for the accelerated growth periods in Chile. Conversely, in the period of relatively moderate growth, 1998-2005, productivity growth rates average only half the rates attained during the early 90s.

Similarly, low rates of growth observed until the early 80s are associated with a very low contribution of productivity compared with the accumulation of capital and labor.

Table 1: Sources of Growth.

	GDP Growth	Capital Share	Labor Share	Productivity Share
1963–2005	3.87%	1.47%	1.53%	0.86%
1963–1973	3.07%	1.46%	1.36%	0.25%
1974–1989	2.90%	0.92%	2.49%	–0.51%
1990–2005	5.39%	2.04%	0.70%	2.66%
1990–2007	7.35%	2.12%	1.69%	3.54%
1998–2005	3.43%	1.95%	–0.28%	1.77%

Source: Fuentes and Morales (2011)

1 *This research has been partially funded by the Bicentennial Program of Science and Technology through a Social Science Ring, SOC–04.

Interestingly, Beyer and Vergara (2002) argue that the strong productivity growth observed during the "golden years" of growth in Chile (1985-1997), is explained by the reforms implemented in the country during the 80s and early 90s. According to these authors, in order to repeat the growth rates exhibited during those years (7.6% on average) Chile needs a new wave of reforms, mainly microeconomic and institutional, in order to use available resources more efficiently.

In that sense, the depth, liquidity and sophistication of the financial system, in addition to contributing to a greater accumulation of physical capital (encouraging a higher level of savings) and human capital (allowing access to funding for education), could have a significant effect on improving efficiency in resource allocation, creation of new forms of production and technological innovation, thus fostering economic growth.

Specifically, more developed financial markets reduce the costs of acquiring information and assessing credit risks, improving the allocation of savings. In addition, well-functioning financial markets encourage technological innovation by funding those entrepreneurs with the greatest chance of success in developing new products and production processes.

More developed financial markets may also contribute to the improvement of corporate governance. To the extent that shareholders and creditors are monitoring and inducing managers to maximize the economic value of firms, the efficiency of resource allocation causes savers to be more willing to finance new production projects. In this context, institutional investors, such as PFAs, insurance companies, mutual funds, etc. can play an important role in terms of monitoring and improving corporate governance of companies in which they invest, particularly in markets where minority shareholders cannot afford monitoring (Lefort, 2007).

Risk diversification is a key element in markets with risk-averse investors (savers). For example, the ability to maintain diversified portfolios of projects reduces risk and promotes investment in new activities with significant potential for productivity gains. In this way, financial systems that allow for better risk diversification can accelerate economic growth through increased productive investment and creation of new industries.

On the other hand, more liquid stock markets facilitate savers the selling of shares at little cost under negative personal shocks, allowing high-yield projects to be financed by the new shareholders. Thus, the liquidity provided by a developed stock market allows for an accelerated growth rate by facilitating the financing of high productivity projects, which otherwise would offer no "exit" alternative to initial investors, and would face a shortage of funding sources for implementation and development.

Financial development may take several forms. However, according to the international empirical evidence, financial services offered by banks and other nonbank intermediaries are complements rather than substitutes in the contribution to productivity growth of the economy.

For example, the results obtained by Levine and Zervos (1998) –later confirmed by Beck and Levine (2002, 2004)– suggest that although financial services provided by banks and stock markets are different, both contribute independently to economic growth. In particular, these authors find that the individual effect of each market is statistically and economically significant. For example, for a sample of 47 countries between 1976 and 1993 an increase in the initial Turnover of 0.3 (with an average value 0.3) implies an increase in the rate of productivity growth of 0.6 percentage points per year, corresponding to a 11% higher productivity in the entire period. Likewise, an increase of initial Bank Credit to GDP of 0.5 (with a mean of 0.8) implies an increase in the rate of productivity growth of 0.55 percentage points per year or 10% higher productivity, for the whole period. Levine and Zervos (1998) conclude that stock market liquidity, rather than depth, contributes to output growth.

The complementarity between bank financing and stock market financing in an optimal financing strategy for business growth is well known as the "pecking order theory". After reaching a certain level of bank debt companies need new capital to continue growing and maintaining an optimal capital structure. Access to fresh capital from new shareholders allows existing shareholders to diversify risks.

On the other hand, often new companies may not have sufficient collateral to access bank financing, while they could obtain resources through mutual funds or venture capital operating in the stock markets.

Finally, La Porta et al. (1999) argue that the existence of an appropriate legal and regulatory framework that ensures the rights of shareholders and creditors is essential to provide financial services that promote economic growth. For this to happen, it is required that the laws and rules be respected and obeyed by market players. Without this minimum institutional framework, financial development does not have the dynamism needed to be an engine of economic growth.

Concordant with this, Corbo *et al.* (2005) suggest that the quality of institutions (government effectiveness, audit quality, rule of law, corruption control, etc.) account for half of the difference between the growth in Chile and Latin America during the period 1960–2000.

For the Chilean case, looking at the major market indicators in Table 2, we can see that the size of the banking and stock market in Chile compares very favorably with that of other Latin American countries, while it behaves in a similar manner to that of some European countries. However, our markets still have room for growth to the levels of more developed markets.

On the other hand, the liquidity of the stock market and the size of the corporate bond market present figures that show a high potential for development.

As we can see in Table 2a below, Chile has a lot of room, particularly on improving liquidity at the stock markets. In terms of Private Credit and Private Bonds to GDP, even though the country presents figures similar to some developed markets, there is a long distance to some top countries like USA or Spain.

The figures above confirm the complementarity between the banking and securities markets, since financially more developed countries have a large size of the banking sector and high liquidity in equity markets. Moreover, all indicators for USA are high, showing that the parallel development of various financial services in the same country is possible.

TABLE 2: SIZE AND MARKET LIQUIDITY.

	PRIVATE CREDIT/GDP	MARKET CAP/GDP	TURNOVER	PRIVATE BONDS/GDP
Latin America	32%	43%	14	8%
Argentina	12%	62%	6	10%
Brazil	33%	36%	32	10%
Chile	75%	86%	10	19%
Mexico	18%	18%	21	3%
Colombia	23%	15%	3	0%
USA	174%	118%	121	113%
Europe	100%	53%	123	38%
Italy	83%	37%	121	44%
France	88%	67%	85	42%
Germany	117%	37%	129	43%
Spain	111%	71%	157	24%
Asia	98%	72%	91	37%
Japan	105%	60%	87	44%
Korea	120%	48%	235	50%
Malaysia	132%	141%	34	53%
Philippines	35%	40%	9	0%

Source: Betancourt et al. (2006) and own calculations of averages for countries in the sample.

Table 2a: Country/Economic Rank.

	Private Credit/gdp	Market Cap/gdp	Turnover	Private Bonds/gdp
Chile	20	19	38	23
usa	3	15	2	4
Canada	13	6	24	20
Italy	15	42	1	10
France	12	23	15	5
Germany	19	32	12	18
United Kingdom	6	22	n.a.	26
Spain	4	16	8	6
Japan	21	28	14	16
Total	54	53	52	40

Source: The Financial Development Report 2011, World Economic Forum.

2. *Measuring the impact of financial development on Chilean* TFP

2.1. Growth accounting

Traditionally, growth accounting starts with an aggregate neoclassical production function that exhibits positive and decreasing marginal productivity to all factors, constant returns to scale and satisfies Inada's conditions. Let Y represent total output, K physical capital, L raw labor, h human capital, and Z a TFP index. In this setting, Z could be interpreted as another factor of production, which is not remunerated. The traditional decomposition can be written as

(1) $\Delta 1\text{n}Y_t = \alpha \Delta 1\text{n}K_t + (1 - \alpha)\ \Delta 1\text{n}h_t L_t + \Delta 1\text{n}Z_t,$

where α under perfect competition and profit maximization is the share of capital cost in total revenues. Here we measure TFP growth as a "Residual".

Note that if labor is not corrected by human capital, the residual will be the change in Z plus the contribution of human capital. In addition, given that usually capital is not corrected for quality, the residual should also include a measure of capital quality.

2.2. A state-space model for TFP

As proposed by Fuentes and Morales (2011), the state-space model is a useful tool to represent a dynamic system involving unobservable variables as in the GDP-TFP system.

Let the linear Gaussian state–space representation be defined as follows.

Signal Equation:

$$(2)\ \Delta 1\text{n} y_t = \alpha\Delta 1\text{n}\, k_t + \Delta 1\text{n} Z_t + \varepsilon_t,$$

where y is observable per worker GDP, k is the observable capital/labor ratio (both adjusted by human capital) and Z is the unobservable TFP. If we consider that the TFP growth is also determined by exogenous variables, then we have:

State Equation:

$$(3)\ A(\text{L})\Delta 1\text{n} Z_t = \gamma + X_t\beta + \eta_t,$$

and white noise disturbances, uncorrelated with each other:

$$(4)\ \begin{pmatrix}\varepsilon_t\\ \eta_t\end{pmatrix} \approx \text{NID}\left[\begin{pmatrix}0\\0\end{pmatrix}, \begin{pmatrix}\sigma^2_\varepsilon & 0\\ & \sigma^2_\eta\end{pmatrix}\right],$$

With A(L) being a p–order polynomial on the lag operator L, and X a matrix of observable exogenous variables determining the TFP growth rate specified later.

The Kalman Filter is an updating algorithm for the linear projection of the state-vector (latent variables) based on observable variables that allow writing down –under the normality assumption– the likelihood function of the model based on the prediction error decomposition. Once the likelihood function is obtained, the coefficients are estimated by numerical optimization methods. In addition, a smoothed state-vector estimate for the full sample can be obtained if the values of the latent variables are of interest and permit a structural interpretation.

The filter requires meaningful startup conditions (parameter values) to achieve convergence. This is not a minor issue given the potentially high nonlinearity in the likelihood function for the state-space representation of the GDP-TFP model. A possible set of initial conditions can be extracted from a regression of the Solow residual (computed using growth accounting) on exogenous or predetermined variables.

2.3. Estimation results

In order to see the results of this methodology, we apply it to Chilean annual data (1960-2005) used by Chumacero and Fuentes (2006), and

Fuentes and Morales (2011). These authors analyze, from an empirical perspective, which variables are correlated with TFP and per capita GDP for Chile. The variables included in their study are terms of trade, government expenditures over GDP, the relative price of investment to consumption, and the inflation rate divided by one plus the inflation rate. In addition, we include three variables measuring financial development in Chile. The new variables are Banking Credit to GDP, Market Cap to GDP, and Turnover.

Table 3 below presents the estimated coefficients for the state–space representation proposed above. The explanatory variables included are selected according to a general to specific approach, based on individual significance, considering up to two lags of each explanatory variable in the state equation. To select the lag order for the model, the Akaike Information Criterion (AIC) is minimized. The likelihood function is maximized by using the Broyden-Fletcher-Goldfarb-Shanno (BFGS) Quasi-Newton algorithm, under the assumption of Gaussian errors. Starting values for the parameters come from the regression of the Solow residual on the independent variables considered for the state-space model. In addition, we compare growth accounting and Kalman filter estimates for the model, as well as for TFP growth.

Table 3: State-Space Estimation.

	Coeff.	Stand. Dev.	T-test	p-value
Capital per worker	0.3974	0.0850	4.6778	0.0000
Constant	–0.0344	0.0484	–0.7113	0.4769
Terms of trade growth (t)	0.0905	0.0374	2.4174	0.0156
Terms of trade growth (t-1)	0.1305	0.0363	3.5914	0.0003
Government expenditure (t-1)	0.1283	0.0716	1.7909	0.0733
Inflation growth (t)	–0.0359	0.0122	–2.9317	0.0034
Inflation growth (t-1)	–0.0223	0.0161	–1.3818	0.1670
Price investment to consumption (t-1)	–0.3900	0.1225	–3.1830	0.0015
Price investment to consumption (t-2)	0.4787	0.1224	3.9099	0.0001
Banking credit (t)	–0.0331	0.0236	–1.4021	0.1609
Market cap (t)	0.0061	0.0219	0.2795	0.7799
Turnover (t)	–0.0745	0.0635	–1.1738	0.2405
TFP growth (t-1)	–0.1415	0.2329	–0.6075	0.5435

Source: Authors' own calculations.

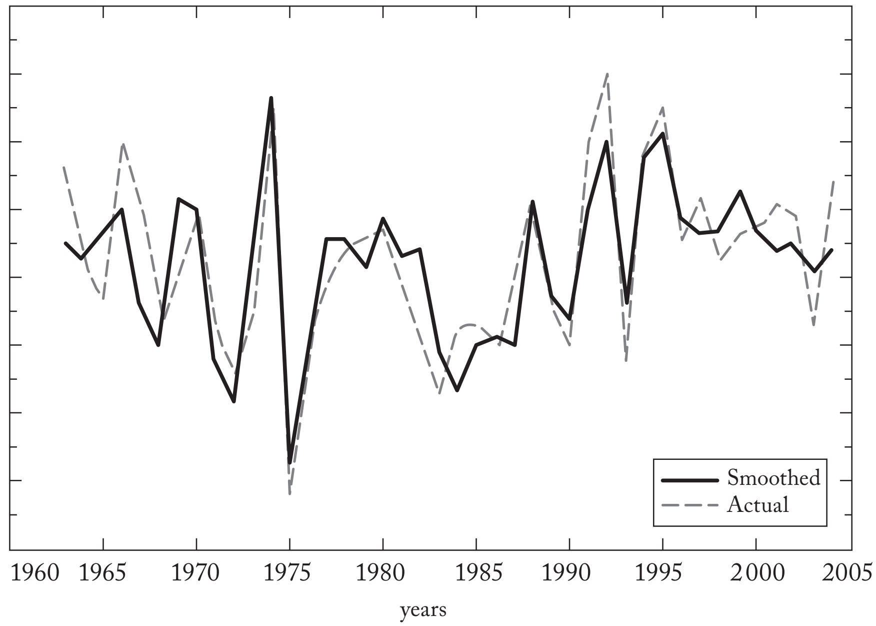
From equation (2), we obtain an estimate for the capital-output elasticity of 0.3974 which is almost the same as the 0.4 used to compute the Solow Residual.

The coefficients of the explanatory variables used in Fuentes and Morales (2011) are generally consistent with those obtained here, with some of them –however– not statistically significant or with the opposite sign here.

The main new result, however, has to do with the financial development variables included in the present model. The coefficients for all of them are not statistically different from zero, and when close to being significant the parameter has the opposite sign as expected (negative in the case of Banking Credit and Turnover).

Figure 1 depicts the growth rate of actual GDP per worker and the Kalman smoothed GDP per worker growth (obtained by using all the sample data to smooth the Kalman Filter estimate of the unobserved TFP growth). The smoothed series closely follows the actual series, but presents some difficulties in matching some of the realizations of the growth rate during the last part of the sample.

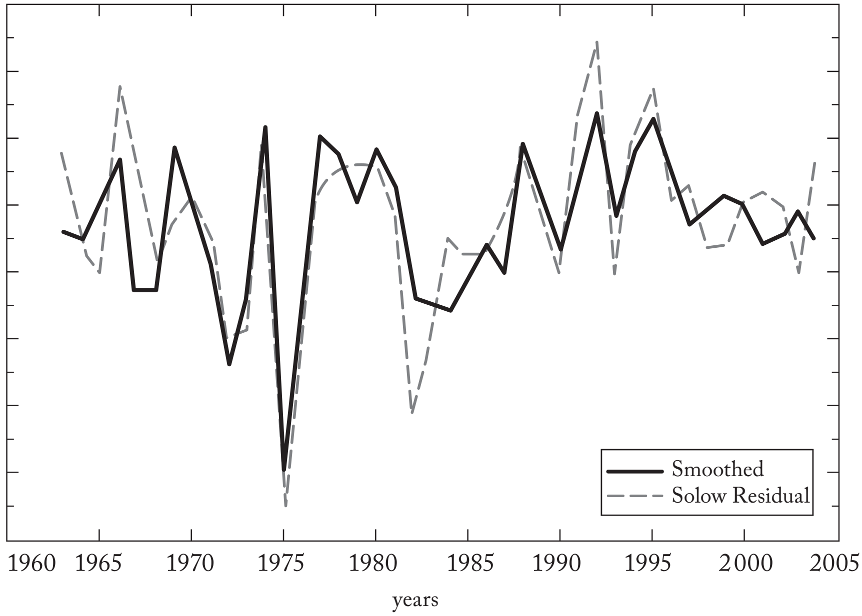
Figure 1: GDP per capita growth: 1963-2004.



Source: Authors' own calculations.

Figure 2 compares the TFP growth rate from the state-space model with the one computed using growth accounting. Even though both series move closely together, the estimated series presents a lower variance compared to the Solow Residual series, particularly from the 80s to the end of the sample.

Figure 2: TFP growth: 1963-2004.



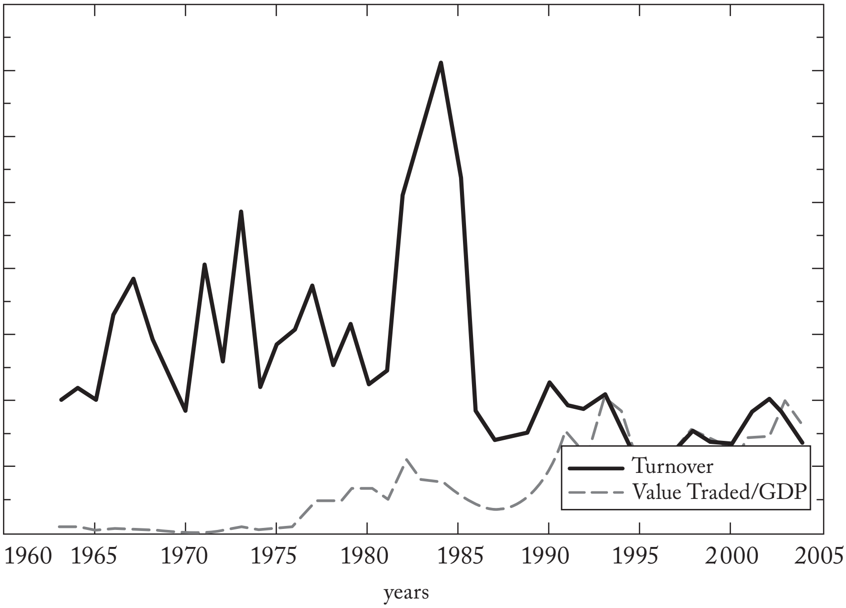
Source: Authors' own calculations.

Figure 3 presents series measuring Banking Depth (Banking Credit and Domestic Credit to Private Sector), while Figure 4 exhibits series measuring Stock Market liquidity (Turnover and Value Traded to GDP).

Figures 3 and 4 show that in the Chilean case there has been a very significant increase in banking depth over the last 40 years. However, stock market liquidity has remained stagnant.

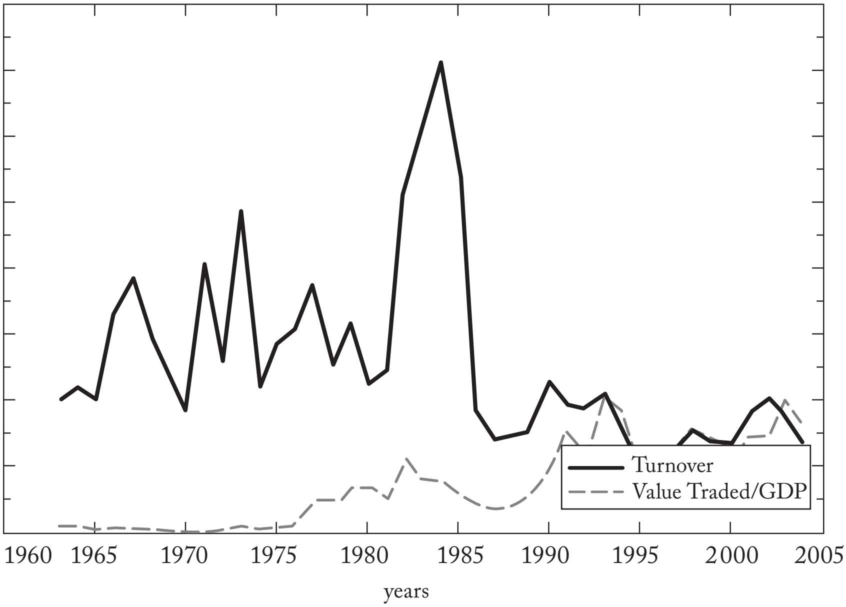
Why were financial variables included here not statistically relevant to explain productivity and growth in the sample period analyzed? The answer is likely related to the omission of some important variables correlated with the ones included to capture the effect of financial development.

Figure 3: Banking depth: 1963–2004.



Source: Authors' own calculations.

Figure 4: Stock market liquidity: 1963–2004.



Source: Authors' own calculations.

The next sections show that lack of access to financial services, as well as low liquidity of stock markets, could make it difficult for financial markets to improve productivity by serving the functions described in the economic literature and briefly summarized in the previous section.

3. The functioning of the Chilean financial sector

3.1. Access to financial services

We hypothesize that the lack of statistical significance of financial variables in explaining TFP in Chile is due to the limited access to financial services for a significant number of Chilean companies. Roman (2003) shows that by the year 2000 the access to banking credit classified by size of the companies in the Chilean formal sector was as shown in Table 4.

Table 4: Access to banking credit.

	Number	Sales Share	Credit Share	Banking Access
Micro	533,479	3.69%	9.23%	39.43%
Small	93,842	10.17%	13.95%	61.85%
Medium	13,159	9.46%	10.74%	72.13%
Large	6,065	76.68%	59.35%	78.31%

Source: Authors' own calculations.

The figures in Table 4 show a limited access to banking credit by an important number of micro companies. In addition, if we consider that the larger the company, the better the access, then the 39.43% is overestimating the real access to banking services for a representative micro company in Chile. The lack of access to banking services for micro companies is even worse if we include informal companies, which are estimated to be at least as numerous as the formal companies in this segment. Moreover, 59.35% of banking credit is offered to less than 1% of the companies in the country.

There are several reasons offered as explanation for the low credit share by smaller companies in the country (see Larrain 2006, and Roman 2003). Among them we have the Maximum Rate on loans, limits on extrajudicial fees, the Stamp tax on credits, lack of collateral, lack of payment records for new borrowers, and lack of standardized financial information from companies, among others.

In addition, banks charge larger spreads to small borrowers due to the higher credit risk and the higher associated evaluation and operational costs.

The Maximum Rate on loans and the limits on extrajudicial fees charged on overdue loans, require banks to improve their risk analysis for small and new companies in order to offer them access to banking credit. In the same vein, the lack of payment history, standardized financial statements and collateral make small companies too risky for banks.

On the other hand, the Stamp tax charged on each new loan makes it difficult for small companies to take advantage of market opportunities (in terms of better rates or supply of funds) moving from one bank to another, as well as representing a larger financial burden for companies using short-term financing as is the usual case for small companies in Chile.

From the above explanation, the main issue for banks in giving better access to small companies has to do with specialized risk analysis.

In terms of specialized risk analysis, the few banks that concentrate most of the micro companies market have created special units working close to small companies in a totally different way compared to the traditional banking service provision.

Finally, the use of simplified standardized financial statement reports (such as a FECU PYME), as well as pools of collateral for small companies (as FOGAPE) would help banks to offer better access to loans for small companies in the country.

3.2. Monitoring and governance of firm's activities in Chile

Securities markets play a fundamental role channeling investment funds from investors to companies with a minimum use of intermediaries. The main barrier to the proper functioning of a securities market is the existence of information asymmetries that increase financing costs to all issuers.

Information asymmetries in capital markets tend to be reduced through the interaction of various institutions and laws that provide investors with more reliable information about the quality of different issuers and intermediaries. In relatively developed markets this process is done at different levels. On the one hand, investment bankers acting as intermediaries provide useful information about issuers backed by their own reputation. On the other hand, brokers associations organized in the form of self–regulatory organizations (stock markets) require additional information disclosure and other conditions to companies interested in having their stocks traded in those markets. Of course, there is also a fundamental role fulfilled by regulators and supervisory entities establishing strict rules for markets and issuers in terms of information disclosure, procedures for issuance and rules for trading.

Investor protection is probably the main objective of an appropriate regulatory framework. There is plenty of empirical evidence showing that better investor protection is key to promoting the development of capital markets and the economic growth of a country. Good investor protection is achieved through a combination of effective governmental regulation and supervision, and adequate self-regulatory practices by private agents.

The self-regulatory nature of stock markets is usually justified based on considerations of two types. First, in a competitive environment, stock exchanges have incentives to disciplining its members in order to improve its reputation, attract more customers operations and increase traded volumes. On the other hand, because of the complexities inherent to the regulation and supervision of capital markets, government regulators and supervisory entities have tended to entrust part of their regulatory functions to market participants.

In spite several of recent reforms, there is still a perception that investor protection in Chile is far from perfect. Imperfect investor protection may have two related consequences. On the one hand, as previously discussed, because of increased information asymmetries, unprotected investors may be more reluctant to provide medium and small companies full access to financial sources. On the other hand, imperfect investor protection induces large investors to retain control stakes in companies, decreasing stock market liquidity. Both effects can be seen in Chilean financial markets.

It can be argued, that the poor investor protection observed in Chilean capital markets is due to the lack of adequate self-regulatory practices provided by private market participants, especially the stock exchanges. From a legal point of view, Chilean stock exchanges must operate in accordance with Title VII of the Securities Act and under the supervision of the Superintendencia de Valores y Seguros (svs). In addition, Chilean stock exchanges can set their own regulations to both members and issuers. There are three main areas in which a stock exchange may exercise a monitoring role. First, a stock exchange may contribute to the functioning of the primary market by setting requirements for the listing of companies. This important function is not performed by the Chilean stock exchanges since the current legislation requires exchanges to accept any joint stock company that is registered on the National Register of Securities (RNV). An extreme example of this occurred in 1989 when the Electronic Exchange of Chile unilaterally decided to list in its market all companies registered in the RNV, even though they had not requested it. The lack of a role for the Chilean stock exchanges in this important monitoring function is in clear opposition to the worldwide trend of exchanges contributing to improving corporate governance of listed companies through private mechanisms. In Chile, information asymmetries in primary markets are diminished by legal requirements, the Risk Rating Commission in the case of pension funds investments, and in the case of large companies, the mechanisms of ADR markets. Hence, a shortcoming of the Chilean stock market is the absence of private monitoring mechanisms in the case of medium and smaller companies.

In spite of the relatively high market capitalization, the Chilean stock market presents very low traded volumes. Among other things, low traded volumes are explained by the concentration of ownership in Chilean companies. Indeed, unlike the U.S. and the U.K., corporate ownership in Chile is characterized by a high degree of ownership concentration. Furthermore, as in most emerging economies the identifying feature of corporate structure in Chile is the generalized presence of business groups. Table 5 shows that Chilean business groups control over 90% of the assets of the largest companies operating in Chile. This proportion has remained very stable since 1990.

TABLE 5: IMPORTANCE OF CHILEAN CONGLOMERATES.

CONGLOMERATES	1990		1994		1998		2002	
	Assets	Relative Size	Assets	Relative Size	Assets	Relative Size	Assets	Relative Size
	US$ MM	%	US$ MM	%	US$ MM	%	US$ MM	%
Largest	4,617	22.0	9,454	14.0	16,220	23.0	11,306	20.5
5 Largest	9,264	44.0	34,018	51.0	37,704	54.0	26,304	47.6
10 Largest	16,784	79.0	46,316	69.0	49,357	70.0	37,008	67.0
20 Largest	18,784	88.0	54,259	81.0	57,750	82.0	46,655	84.5
All	19,422	91.0	57,973	87.0	63,957	91.0	49,729	90.0
Non–affiliated	1,841	9.0	8,879	13.0	6,059	9.0	5,511	10.0
Total	21,263	100.0	66,852	100.0	70,017	100.0	55,241	100.0

Source: Lefort (2010).

In addition, Lefort (2010) shows that Chilean business groups use mostly simple pyramid structures to separate control from cash flow rights. In fact, Chilean business groups directly or indirectly own 59% of the consolidated equity of the listed firms controlled by the group, usually retaining over two thirds of shares in each layer of the pyramid and thus retaining total control of each company.

Because of the high degree of ownership concentration in Chilean companies, control is exercised in practice through board members elected directly or indirectly by the controlling groups. A survey of board practices at large listed Chilean companies indicates that more than 50 percent of all board members are directly related by family relations to the controlling shareholders or are executives in the company or in other companies owned by the same controlling shareholder.

Moreover, evidence provided by Lefort and Walker (2000) suggests that even board members elected with minority shareholder votes rarely sit in companies controlled by other groups. Exceptions are board members elected by pension funds in large corporations. Iglesias (2000) shows that, in those companies where the pension funds own shares, 10 percent of board members are elected with their votes. Despite this, the evidence provided in Lefort (2010) shows that controlling shareholders of Chilean business groups are increasingly favoring independent directors to sit on the boards of their companies, indicating a trend towards the professionalization of Chilean boards.

External mechanisms of control and corporate governance are rarely important in Chile. For instance, in the vast majority of companies high ownership concentration eliminates the possibility of hostile takeovers. However, since 1998 a large number of acquisitions have taken place in Chile. Lefort and Walker (2001) analyze 12 major acquisitions involving transfer of control between 1996 and 1999. They found that the average excess price for these 12 acquisitions was 70 percent, while the average control block purchased amounted to 40 percent of shares. On average, the cumulative abnormal return was approximately 5 percent, indicating that the average acquisition was perceived as value enhancing by the market.

Lefort and Walker (2007) show that in most Chilean companies the traditional agency conflict between owners and managers is better characterized by the horizontal agency problem between controlling and minority shareholders. Hence, they perform regression analysis of measures of firm market valuation and performance on agency conflict indicators at the firm level including a series of control variables. In summary, they find that firms whose controlling shareholders have higher coincidence between cash flow and control rights tend to consistently have higher market values. This result is interpreted as an indication that potential conflicts of interest between controlling and minority shareholders are penalized by the Chilean capital market. Adequately controlling for endogeneity and omitted variable biases, an increase in the degree of coincidence between cash and control rights of one standard deviation (0.21) increases share prices by 10 percent.

On the other hand, Lefort and Walker (2007) find no significant evidence of a group effect on companies' market valuation. This result might be interpreted as supporting the idea that the economic benefits of the efficiency gained by the actions of the business group are being captured by the controlling shareholders.

Corporate governance of Chilean companies ranks relatively high in international comparative studies, especially in areas such as transparency, delivery of information and protection mechanisms to minority shareholders. Some of the reasons for this performance may be related to early reforms of capital markets and the banking system, including the reform to the pension system and more recently the OPA reform. In addition, large Chilean companies, pioneering the ADR program, have been forced to comply with North American governance standards.

However, corporate governance practices in Chile can be improved at least in three aspects. First, it is necessary to modify the current regulatory balance promoting self-regulation by Chilean companies and financial market participants. In order to achieve this, we need a more comprehensive legal framework allowing for its general application under specific indications of the SVS and the criterion of the companies themselves and the market. This requires a strengthening of the governance structure of the SVS and improved capabilities of Chilean courts. Second, as recently seen in the context of the retailer La Polar, it is feasible and desirable to improve the amount, quality and opportunity of the transmission of relevant company information to the market. Third, despite the efforts initiated with the OPAs law, ownership and control concentration in Chile have not diminished over the past 20 years. International evidence shows that there is not an easy recipe to increase the depth of capital markets and decrease stock ownership concentration. In this regard, Chilean evidence indicates that it is not enough to increase protection to minority shareholders in order to decrease ownership concentration. In addition, it is important to highlight the importance of strong owners managing their own companies to avoid the agency problems faced by dispersed ownership companies operating in more developed markets.

Finally, there is much room for improvement in the functioning of Chilean boards as main mechanisms of corporate governance. In particular, it is important to create incentives for major stockholders of Chilean companies to use their voting power to professionalize their boards and expand the functions they carry out in practice.

4. Stock market efficiency and informational content of stock prices

According to Tobin (1982) in a *functional efficient market*, market prices help investors to allocate their capital efficiently –i.e., to those activities in which the return on their invested capital is maximized. According to this line of thought, the functional efficiency of capital markets is central to the development and growth of any economy. As Durnev, Li, Mork and Yeung (2004) point out, economic growth requires that economic assets, including capital, be allocated to their most valuable uses.

As more (and better) information is produced, market participants will benefit from more informative relative prices leading to better asset allocation and to a higher rate of wealth creation. Furthermore, the possibility of participating in larger and more liquid markets makes the research activities of informed traders more attractive.

Given the association between financial systems and economic growth, many developing countries have been making efforts lately to generate conditions that foster the informativeness, liquidity and depth of their capital markets. In particular, several countries in Latin America have adopted significant economic reforms during the last two decades. However, and as McKinsey (2007) has pointed out, financial systems in the region remain rather small.

Due to early economic reforms developed during the late 70s and the 80s, Chile is today one of the most opened, integrated and healthy economies of the region. The country also pioneered financial system reforms in the region at the beginning of last decade. In 2000 the Corporate

Governance Reform took place. One year later the first reform of the capital market, known as MKI, was launched. The reform was aimed at modernizing capital markets, fostering financial integration and liquidity, and promoting long-term savings.

In March 2007, a second reform of the capital markets was approved by the Chilean congress. The reform contained measures aimed at improving the competitiveness and development of the local financial markets, fostering the industry of venture capital in order to provide small firms access to external funding, and improving the standards of market regulations.

Since the ultimate goal of any market reform is to obtain a sounder financial system to sustain higher levels of economic growth, it is important to assess the effectiveness of these reforms. How is it possible to measure the success of a capital market reform? One possibility is to look at the correlation between specific characteristics of a financial market (size, depth, liquidity) and the economic growth rate of the corresponding country. A problem with this type of approach is the endogeneity relation that can be generated by a reverse causality issue between the degree of development of a country financial market and the economic growth rate of its economy. As a result, empirical studies of this type will tend to overstate the importance of the degree of financial development on economic growth. Therefore, we choose to make an effort to assess the possible improvement in the informational content of stock prices due to the implementation of the capital reforms.

4.1. THE MYY PRICE SYNCHRONICITY MEASURES

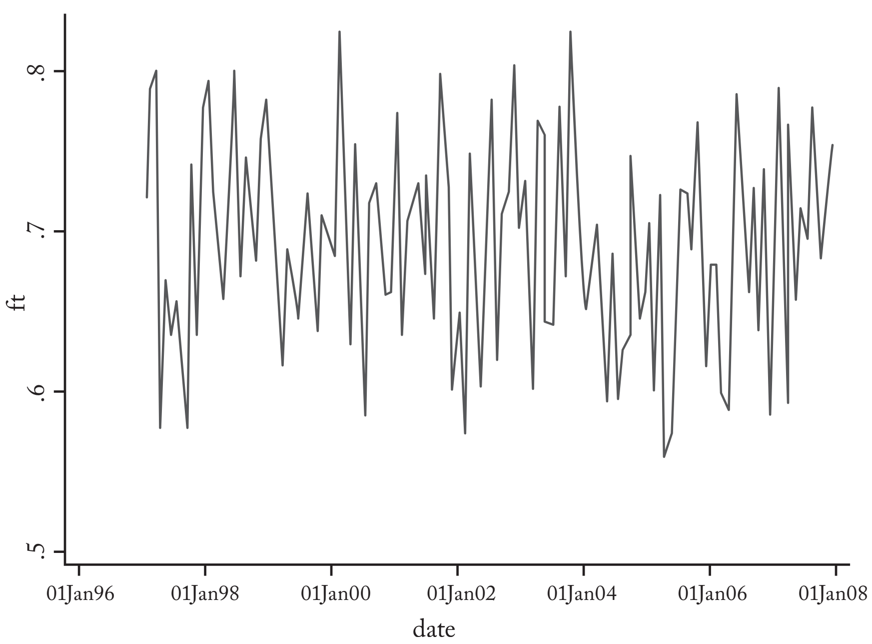
Mork, Yeung and Yu (2000) develop two stock price synchronicity measures. The first one is the fraction of stocks that move in the same direction in a given period τ:

$$(5)\; f_\tau = \frac{1}{T}\sum_{t=1}^{t=T} \frac{\max\left[n_t^{up}, n_t^{down}\right]}{n_t^{up} + n_t^{down}},$$

where n_t^{up} and n_t^{down} is the number of stocks whose prices rise and fall in period t, respectively, and T is the number of periods in τ used to compute f. It should be clear that this measure of synchronicity lies between 0.5 and 1. We compute f for the sample period beginning on January 1st, 1997 and ending on December 31st, 2007, based on daily closing stock prices. In our case, t is weeks, τ is months and f corresponds to the average fraction of stock prices moving in the same direction during an average week, for each month, in every year of our sample period. Stocks that were traded only once in a given week or whose prices do not move during that week are dropped out from the sample.

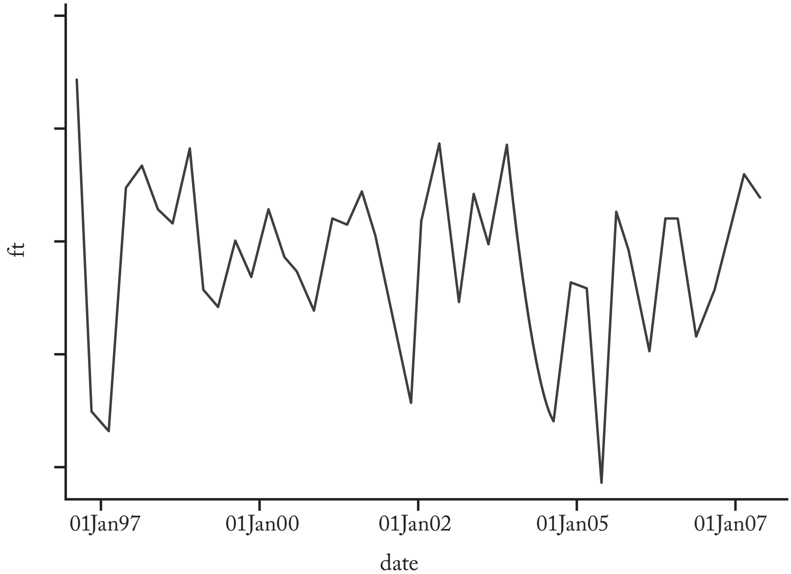
Figure 5 depicts the monthly evolution of f for our sample period. Descriptive statistics are presented on Table 6, Panel A. The mean value of f is 0.69, with a median of 0.68 and a standard deviation of 0.13. These values are virtually the same for both sample periods, before MKI and after MKI. Since any possible trend in the evolution of f might be hidden inside its monthly variability, in Figure 6 we present the quarterly average f for our sample period. As can be seen from the graph there does not seem to be a trend in f.

Figure 5: Monthly evolution of the f statistic.



Source: Authors' own calculations.

Figure 6: Quarterly evolution of the f statistic.



Source: Authors' own calculations.

Table 6: Estimated Density of f and wr^2

	Panel A: Descriptive Statistics for *F*							
Period	N	Mean	Std. Dev.	Skewness	Kurtosis	Median	25% Centile	75% Centile
Whole Sample	611	0.69	0.13	0.51	2.55	0.68	0.59	0.78
Before MKI	221	0.69	0.13	0.42	2.42	0.68	0.59	0.79
After MKI	335	0.68	0.13	0.60	2.72	0.67	0.58	0.77
T test for equality of means	Statistic	P value (two tailed)						
	0.85	0.39						
	Panel B: Descriptive Statistics for WR^2							
Period	N	Mean	Std. Dev.	Skewness	Kurtosis	Median	25% Centile	75% Centile
Whole Sample	42	0.17	0.07	1.22	4.86	0.15	0.12	0.21
Before MKI	14	0.17	0.07	1.46	5.20	0.16	0.12	0.21
After MKI	24	0.16	0.07	1.13	4.48	0.15	0.12	0.20
T test for equality of means	Statistic	P value (two tailed)						
	0.37	0.71						

Source: Authors' own calculations.

The second measure of stock price synchronicity that Mork et al. develop is based on the decomposition of the variation in individual equity returns. The authors calculate the R^2s of market model type of regressions. In our case, since we are dealing only with Chilean firms, and analogously to Mork et al., we run the following quarterly regressions:

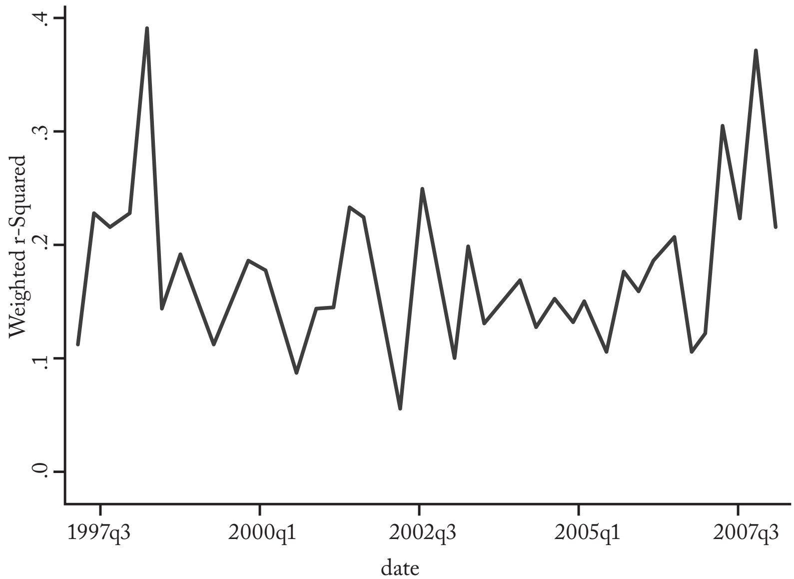
$$(6)\ r_{i,t} = \alpha_i + \beta_{1i} r_{m,t} + \beta_{2i} \left[r_{US,t} + e_t \right] + \varepsilon_t,$$

where $r_{i,t}$ is the return of stock i at time t, $r_{m,t}$ is the market return at time t, $r_{US,t}$ is the US market return, converted to Chilean currency using the exchange rate adjustment e_t, and $\varepsilon_{i,t}$ is a random disturbance. We compute daily returns for each of the stocks in our sample and estimate equation (6) for each quarter. The R^2 obtained for stock i measures the proportion of the variation of the return of that stock explained by the market. A high R^2 indicates that a high proportion of the variation of a particular stock return is explained by the market and, therefore, there is relatively little idiosyncratic information contained on its price. Following Mork et al., we then compute a quarterly weighted average R^2 for all the firms in our sample:

$$(7)\ WR^2 = \frac{\sum_i R^2_{i,t}\, SST_{i,t}}{\sum_i SST_{i,t}},$$

where $SST_{i,t}$ is the is the sum of squared total variations for firm i in period t. Stocks that were traded only once in a given week or whose prices do not move during that week are dropped from the sample. WR^2 can be interpreted as a measure of the average informational content of stock prices in the capital market. Mork et al. suggest that the higher the WR^2, the less informative are the prices in the economy, and consequently, the less the functional efficiency of the market. In Figure 7 we present the evolution of the annual average of this measure during our sample period. There seems to be no apparent trend in stock variation explained by the market despite the introduction of MKI in 2001. Descriptive statistics for WR^2 are presented on Table 5, Panel B. As can be seen from the results presented on the table, there is no significant difference in this statistic between the pre reform and post reform periods in our sample.

Figure 7: Evolution of WR².



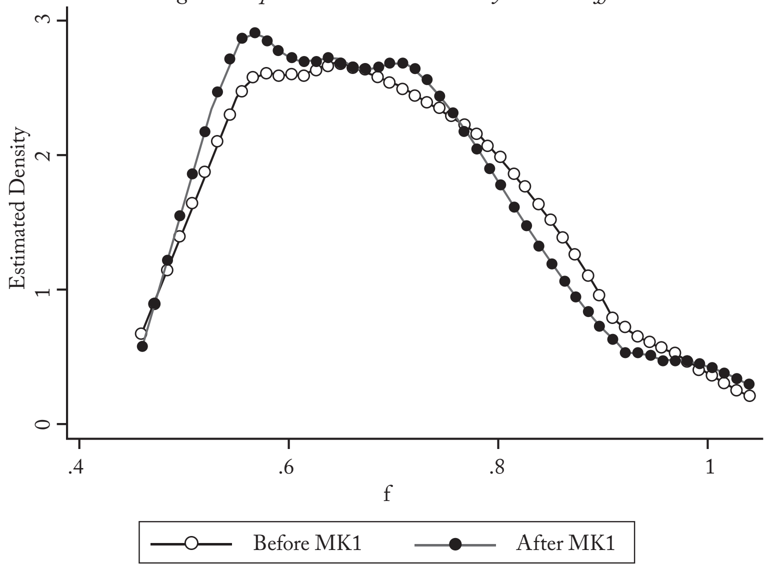
Source: Authors' own calculations.

4.2 The effect of the capital market reform on the informativeness of stock prices

What is the effect of the 2001 Reform to the Capital Market on the synchronicity of Chilean stock prices? If the reform is able to improve the efficiency of the capital allocation, we should expect a reduction in prices synchronicity after it came into effect. To explore the effect of MKI on stock prices, we first analyze the distribution functions of *f* and WR² before and after the implementation of the reform in 2001. In the analysis that follows, we drop the year 2001 when the reform was introduced.

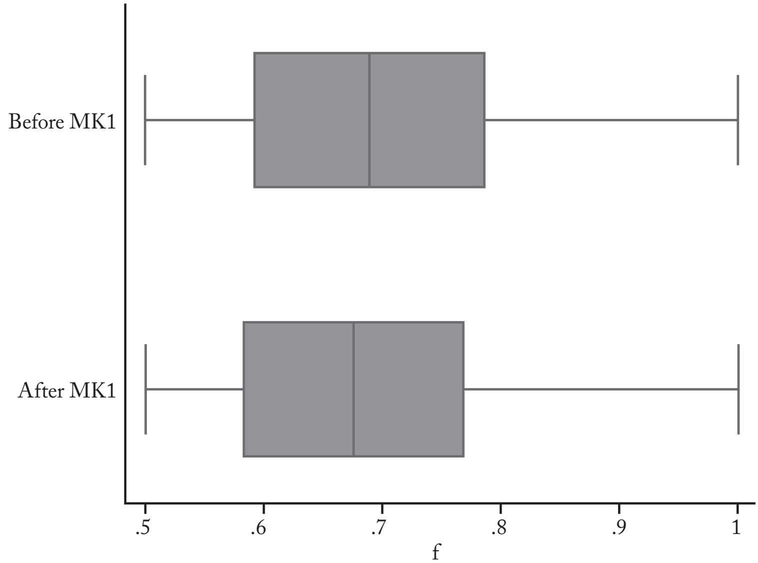
In Figure 8, we present the Epanechnikov kernel density estimate of *f* for the periods before (1997-2000) and after (2002-2007) MKI, using weekly estimates of this measure. As can be seen, the estimated densities of *f* seem to be similar before and after the year 2001, which is consistent with the descriptive statistics presented on Panel A of Table 6. Furthermore, the Box plots of *f* for both sample periods, presented in Figure 9, are almost identical. To formally test this results, on Table 7, Panel A, we report the Kolmogorov-Smirnov test for the equality of distributions of *f* before and after MKI. We drop the year 2001 when the reform came into place. The results of the test suggest that is not possible to reject the null hypothesis that the distribution of *f* does not change after MK1, casting doubts on its effectiveness to improve the functional efficiency of the stock market.

Figure 8: Epanechnikov kernel density estimate of f.



Source: Authors' own calculations.

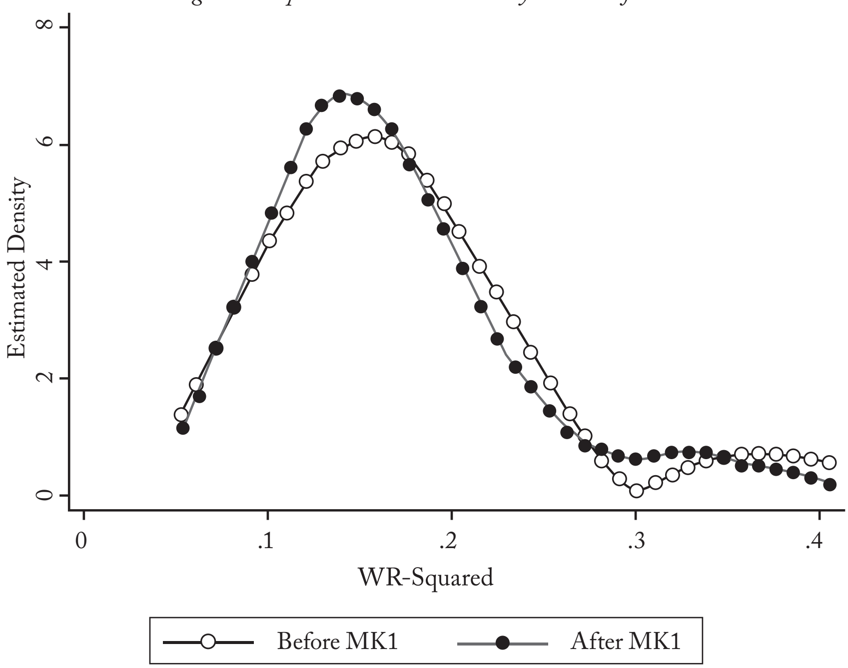
Figure 9: Box plots of f. Source: Authors' own calculations



Source: Authors' own calculations.

In Figure 10, we show the Epanechnikov kernel density estimate of WR² for the sample periods before and after MK1. In Figure 11 we report the Box plots of this statistic for both sample periods. The two density functions appear to be quite similar again. Furthermore, all the descriptive statistics for the densities of WR² do not substantially differ between the two sample periods. On Table 7, Panel B, we present Kolmogorov–Smirnov test for the equality of distributions of WR² before and after MK1. Consistently with the evolution of WR² in Figure 7 and its estimated densities presented in Figure 10, we cannot reject the null hypothesis that that both periods have equal distributions of WR².

Figure 10: Epanechnikov kernel density estimate of WR².



Source: Authors' own calculations.

This evidence seems to suggest that despite the capital market reform in Chile there has been no improvement in the informational content of stock prices during our sample period.

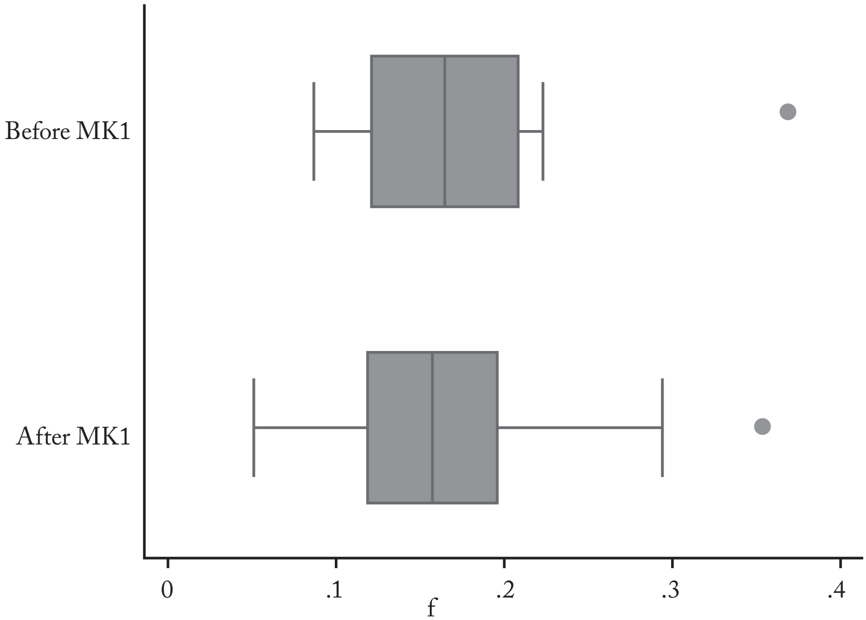
The fact that WR² has not changed significantly during the 1997–2007 period cannot be taken directly as evidence that the effects of the capital market reform have been mute. The WR² statistic might be affected by both the idiosyncratic risk of individual firms and by the systematic risk of the economy. Bartram, Brown and Stulz (2009) decompose total risk into systematic risk and idiosyncratic risk through market model estimation. For an international cross section of firms they show that the effects that some country characteristics have on R^2 might be driven by the relations between these characteristics and the components of total risk. For instance, they find that idiosyncratic risk is inversely related to government stability and the respect for the rule of law and that systematic risk seems to be affected by creditor rights and the quality of disclosure. Díaz and Lefort (2011) analyze the evolution of systematic and idiosyncratic risk in the Chilean stock market for the 1997-2007 period and find that systematic risk has significantly decreased over the post MKI period. However, they find that, consistent with the results of Bartran et al., idiosyncratic risk has decreased as well, situation that might explain the stability of WR^2 through time.

Table 7: Kolgomorov-Smirnov Distribution Tests.

Panel A: Distribution Tests for *F*			
Period	Null Hypothesis	Statistic	p-value
Before MKI	The 1997-2000 period contains smaller values of f than the 2000-2007 period	0.033	0.744
After MKI	The 1997-2000 period contains larger values of f than the 2000-2007 period	-0.057	0.422
Combined K–S	The 1997-2000 period and the 2002-2007 period have equal distributions of f	0.057	0.781
Panel B: Distribution Tests for WR^2			
Period	Null Hypothesis	Statistic	p-value
Before MKI	The 1997-2000 period contains smaller values of WR^2 than the 2000-2007 period	0.0536	0.951
After MKI	The 1997-2000 period contains larger values of WR^2 than the 2000-2007 period	-0.125	0.759
Combined K–S	The 1997-2000 period and the 2002-2007 period have equal distributions of WR^2	0.125	0.999

Source: Authors' own calculations.

Figure 11: Box plots of WR².



Source: Authors' own calculations.

Despite these results, with a more traditional notion of market efficiency, Díaz and Lefort (2011) find a significant effect of MK1 on the efficiency of the Chilean stock market. They analyze whether stock price correlation can be explained by fundamentals correlation, and whether the strength of this association is stable over time. Using weekly returns, they compute yearly return correlations for each pair of firms in the sample period 1997-2007 and assign them a unique identifier. To avoid losing too many observations due to relative low liquidity of the Chilean stock market, they consider the pre MK1 and post MK1 periods separately. For the post MK1 period, they are able to identify 38 firms for which we have enough trading information to compute pairwise return correlations for each year in the 2002-2007 period. This sample of firms comprises 70% of the total market capitalization of the General Price Index of the Chilean market as of December 2007. For the pre MK1 period, 41 firms are identified for which trading information is enough to compute pairwise return correlations for each year in the sample period. These firms represent near 70% of the total capitalization of the General Price Index as for December 2000. The authors hand collect financial information from the public records of the Chilean Securities and Insurance Supervisor (svs, the government entity responsible for maintaining transparency in publicly traded markets, www.svs.cl). Based on quarterly financial statements, they compute quarterly return on assets (roa), defined as earnings divided by total assets. Then they obtain yearly firms roa correlations for each pair of firms in the sample which are then matched to their corresponding stock price return correlations. They collect both individual financial statements and consolidated financial statements.

The final samples are panel data sets comprised by firms-pair-year observations for the Pre mk1 and Post mk1 periods. For each pair of firms they have yearly return correlation (*ret_corr*) and yearly roa correlations (*ROA_correl*). Their objective is to measure the strength of the relation between price correlations and fundamentals correlations, where fundamentals are proxied by roa. Given the panel structure of their data set, they are able to control for unobservable, time invariant characteristics that might be affecting the return correlation between two specific stocks. Firms are also classified according to the International Standard Industrial Classification (ciiu), since it is likely that two firms in the same industry have stronger co–movements in their prices, so an industry dummy variable (*Dum_Ind*), that takes the value of one if both firms belong to the same industry according to the ciiu classification at the two digit level, is included in their empirical specification. The regression in their analysis takes the following form:

$$(8)\ ret\_corr_{i,t} = \beta_1 + \beta_2 ROA\_corr_{i,t} + \beta_3 Dum\_Ind_i + d_t + \alpha_i + \nu_{i,t},$$

Using different panel data estimation techniques, Diaz and Lefort find that for the Pre mk1 period, β_2 is insignificantly different from zero. For the post mk1 period, β_2 results positive and significant, regardless of the estimation technique. For the post mk1 period, their evidence suggests that the high stock price synchronicity observed in the Chilean stock market can be at least partially explained by common movements in stock fundamentals.

5. Some conclusions and policy implications

The empirical results provided in this paper fail to find a statistically significant relationship between financial development and tfp. We used as a proxy for the degree of financial development the ratio between domestic banking credit to gdp, the ratio of stock market capitalization to gdp and a measure of stock market turnover.

A possible interpretation for these results is that, contrary to international cross-section empirical evidence, the development of the Chilean financial markets has not contributed to increase total factor productivity in Chile. However, a second more plausible interpretation is that the aggregate variables employed in our time series analysis fail to capture the key dimensions of financial development.

Capital markets have, among other functions, the important task of reducing information asymmetries between investors and securities issuers and contributing to improving the governance of firms. During the last 10 years, Chilean capital markets have experienced at least two important legal reforms aimed at improving investor protection: the OPA Law in 2000 and the Corporate Governance Reform in 2008.

These reforms introduced, among other things, mandatory tender offer requirements, the obligation to constitute a directors committee, the obligation to have independent board members, more exigent information requirements and more restrictions to insider trading. In spite of these reforms, we have argued that there are still important shortcomings in the role that private agents have in monitoring firms' activities and improve investor protection. The evidence provided in this paper regarding the null increase in informational content of stock prices after the MK3 reform is consistent with this idea.

Overall, the main conclusion of this paper is that we have several areas for improving the functioning of the Chilean capital markets, and that there is no reason to assume that further development of our financial markets will not improve TFP. First, we consider that is important to reduce ownership concentration in companies. The 2000 OPA Law increased required quorums to approve major corporate decision from 50% to two thirds of votes. Lefort and Walker (2008) and Morales (2009) showed that after the reform ownership concentration in Chile increased. We think that, given the more restrictive legal framework faced by companies and the increased supervisory capacity of the SVS, required quorums could be reduced to induce the reduction of ownership concentration and increase in both float and traded volumes.

Regarding the informational content of stock prices, we think that there is room for increased involvement by private agents such as analysts, market makers and dealers. A possible reason for the diminished involvement of such agents is precisely the relatively low traded volumes in Chilean markets and a legal framework that does not promote adequate self regulatory practices.

In terms of banking credit, the main issue for banks in giving better access to small companies has to do with specialized risk analysis. In addition, more flexible regulatory and tax codes would help banks to incorporate an important number of companies not currently using banking debt to grow. Finally, the use of simplified standardized financial statement reports (such as a FECU PYME), as well as pools of collateral for small companies (as FOGAPE) would help banks offer better access to bank loans for small companies in the country.

REFERENCES

BECK, T., R. LEVINE, and N. LOAYZA (2000). "Finance and the Sources of Growth", Journal of Financial Economics 58(1-2): 261–300.

BECK, T., and R. LEVINE (2002). "Industry Growth and Capital Allocation: Does Having a Market– or Bank–Based System Matter?" Journal of Financial Economics 64: 147-180.

BECK, T., and R. LEVINE (2004). "Stock Markets, Banks, and Growth: Panel Evidence". Journal of Banking & Finance 28(3): 423-442.

BETANCOUR C., J. DE GREGORIO, and A. JARA (2006). "Improving the Banking System: The Chilean Experience". Documentos de Política Economica No 16, Banco Central de Chile.

BEYER, H., and R. VERGARA (2002). "Productivity and Economic Growth: The Case of Chile", in Economic Growth: Sources, Trends, and Cycles, Norman Loayza and Raimundo Soto, eds. Central Bank of Chile.

BLACK, BERNARD and REINIER KRAAKMAN (1996). "A Self–Enforcing Model of Corporate Law", Harvard Law Review, 109: 1911-1982.

CALDERON, C. y R. FUENTES (2005). "¿Cuanto Explican las Reformas y la Calidad de las Instituciones el Crecimiento Chileno? Una Comparacion Internacional", Documento de Trabajo No 314, Banco Central de Chile.

CHUMACERO, R., R. FUENTES, and K. SCHMIDT-HEBBEL (2004). "Chile's Free Trade Agreements: How Big is the Deal?" Documento de Trabajo No 264, Banco Central de Chile.

CORBO, V., L. HERNANDEZ, and F. PARRO (2005), "Institutions, Economic Policies and Growth: Lessons from the Chilean Experience", Documento de Trabajo No 317, Banco Central de Chile.

DIAZ, F. and F. LEFORT (2011). "The Effects of MKI on the Efficiency of the Chilean Capital Stock Market", Working paper, UDP.

DEMIRGUC–KUNT, A., and R. LEVINE (2008). "Finance, Financial Sector Policies, and Long-Run Growth", Policy Research Working Paper 4469, The World Bank.

DURNEV, A., MORCK, R., YEUNG, B., (2004). "Value-Enhancing Capital Budgeting and Firm-specific Return Variation", The Journal of Finance 59, No 1, 65-105.

DURNEV, A., MORCK, R., YEUNG, B., (2004). "Capital Markets and Capital Allocation: Implications for Economies in Transition", Economics of Transition 12, 593-634.

FUENTES, R., M. LARRAÍN, and K. SCHMIDT-HEBBEL (2006). "Sources of Growth and Behavior of TFP in Chile", Cuadernos de Economía 41:5-48.

Fuentes, R. and M. Morales (2011). "On the Measurement of Total Factor Productivity: A Latent Variable Approach", Macroeconomic Dynamics, 15: 145-159.

Frost, C., E.A. Gordon and A.F. Hayes (2002). "Stock Exchange Disclosure and Market Liquidity: An Analysis of 50 International Exchanges", Revised draft.

Glassman, James (2003). "The End of sro", testimony before Committee on Financial Services, U.S. House of Representatives.

Karmel, Roberta S. (2001). "Turning Seats into Shares: Implications of Demutualization for the Regulation of Stock and Futures Exchanges", Draft.

Kim, Hwa-Jin (2002). "Searching for a Model for Effective Self-Regulation in Korea". Introduction to Self-Regulation in the Korean Securities Market, 7-15. Seoul: Korean Securities Law Association.

King, R., Levine, R. (1993). "Finance and growth: Schumpeter might be right", Quarterly Journal of Economics 108, 717-738.

La Porta, Rafael, Florencio Lopez-de-Silanes, Andrei Shleifer and Robert Vishny (1997). "Legal determinants of External Finance", The Journal of Finance, 52(3): 1131-1150.

La Porta, R., F. Lopez de Silanes, A. Shleifer and R. Vishny (1999), "Corporate Ownership Around the World", Journal of Finance, 54.

La Porta, R., F., Lopez-de-Silanes, A., A. Shleifer and, R. Vishny (1998). "Law and Finance", Journal of Political Economy 106(6): 1113-1155.

La Porta, R., F., Lopez-de-Silanes, A., A. Shleifer and, R. Vishny (1999), "Corporate Ownership Around the World", Journal of Finance, 54(2): 471-517.

Larrain, C. (2006). "El Acceso al Credito y a los Servicios Financieros: informe de Chile", Secretaria General Iberoamericana, Madrid, España.

Lefort, Fernando (2010), "Business Groups in Chile", in The Oxford Handbook of Business Groups, Ed. A. Colpan et al, Oxford University Press.

Lefort F., and Walker E. (2000c). "Ownership and Capital Structure of Chilean Conglomerates: Facts and Hypothesis in Chile". abante, Vol 3(1), Abril.

Lefort F., and Walker E. (2007a). "Do Markets Penalize Agency Conflicts Between Controlling and Minority Shareholders?: Evidence from Chile". The Developing Economies, 45(3): 283–314.

Lefort F., and Walker E. (2007b). "The Effect of Corporate Governance Practices on Company Market Valuation and Dividend Policy in Chile", in Investor Protection in Latin America, Chong and Lopez-de-Silanes (eds.), Stanford U. Press.

Levine, R. (2000), "Son Mejores Los Sistemas Financieros Basados en el Sistema Bancario o Los Basados en el Mercado Bursatil", Economia Chilena, 3(1): 25-56.

Levine, R., and S. Zervos (1998). "Stock Markets, Banks, and Economic Growth", American Economic Review 88(3): 537–58.

Loayza, N., P. Fajnzylber, and C. Calderon (2004). "Economic Growth in Latin America and The Caribbean: Stylized Facts, Explanations, and Forecasts", Documento de Trabajo No 265, Banco Central de Chile.

McKinsey Quarterly Report (2007). "Fulfilling the Potential of Latin America's Financial System".

Morales, M. (2009), "Determinants of Ownership Concentration and Tender Offer Law in the Chilean Stock Market", Documento de Trabajo No 1, Superintendencia de Valores y Seguros.

Morales, M., M. J. Melendez and V. Ramirez (2013), "Determinants of Ownership Concentration and Tender Offer Law in the Chilean Stock Market", Cepal Review, 110: 175-188, August.

Morck, R., Yeung, B., Yu, W., (2000). "The Information of Content of Stock Markets: Why do Emerging Markets have Synchronous Stock Price Movements?" Journal of Financial Economics 58, 215-260.

Pardo, A., and P. Meller (2002). "El Rol de las Exportaciones en el Crecimiento Economico Regional", Documento de Trabajo No 143, CEA-Universidad de Chile.

Roll, R., (1988). "R^2". Journal of Finance 43, 541–566.

Roman, E. (2003). "Acceso al Credito Bancario de las Microempresas Chilenas: Lecciones de la Decada de los Noventa". Serie Financiamiento del Desarrollo, CEPAL.

Tobin, J., (1982). "On the Efficiency of the Financial System". Lloyd's Banking Review 153, 1-15.

Education and Productivity: Some New Evidence and Implications for Chile[1]

Harald Beyer, Francisco Gallego

1. Introduction

Most of the surge of Chile's economic growth in the golden period from the mid 1980s to the late 1990s is related to increases in TFP growth (Gallego and Loayza, 2002; De Gregorio, 2005; Fuentes et al., 2006). Since then there is a decrease in economic growth that seems to be closely related to a decrease in TFP growth, consistent with previous evidence (Bitran y Gonzalez, 2010). So the question is, what may be driving this decrease in TFP growth in the last decade? There are several hypotheses but in a sense the decrease in growth rates over the 2000s was not unexpected in an scenario with (i) no significant structural reforms over the 2000s and (ii) the presence of conditional convergence in income levels, as at least two papers forecasted in the late 1990s (Barro, 1999 and Gallego and Loayza, 2002).

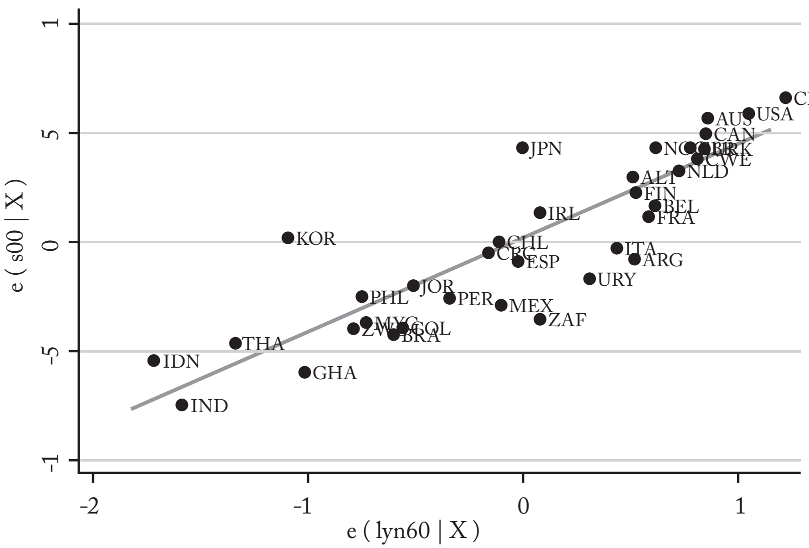
In this paper we focus on one particular dimension that may have affected the growth rates: human capital. From a conceptual point of view, human capital levels can be deconstructed in terms of quantity and quality. Figures 1 and 2 present the cross-country correlation between proxies for both dimensions and per-capita income across countries. Data suggest that while Chile presents a *quantity* of human capital (proxied by average years of schooling) consistent with its per-capita income, the *quality* of human capital (proxied by scores in internationally comparable tests) is below what is expected given its economic development[2]. Thus, in this paper we first estimate the potential impact of this relatively low level

1 We would like to thank Vittorio Corbo for inviting us to write this paper, and his comments on an initial version of this article. We also thank the participants in the conference on "Raising the Sustainable Rate of Growth in Chile: Where are the Opportunities?" (October 2010) for comments, and Felipe Gonzalez and Andres Osorio for superb research assistance. The usual disclaimer applies. Gallego would like to thank the CONICYT/Programa de Investigacion Asociativa (Project SOC 1102) for financial support.

2 Several papers have identified this low level of quality of human capital (e.g., Barro, 1999; Beyer, 2001).

of human capital quality on economic growth, distinguishing between capital accumulation and TFP growth[3].

Figure 1: Human Capital Quantity and Income.



coef = .42168513, se = .04159679, t = 10.14

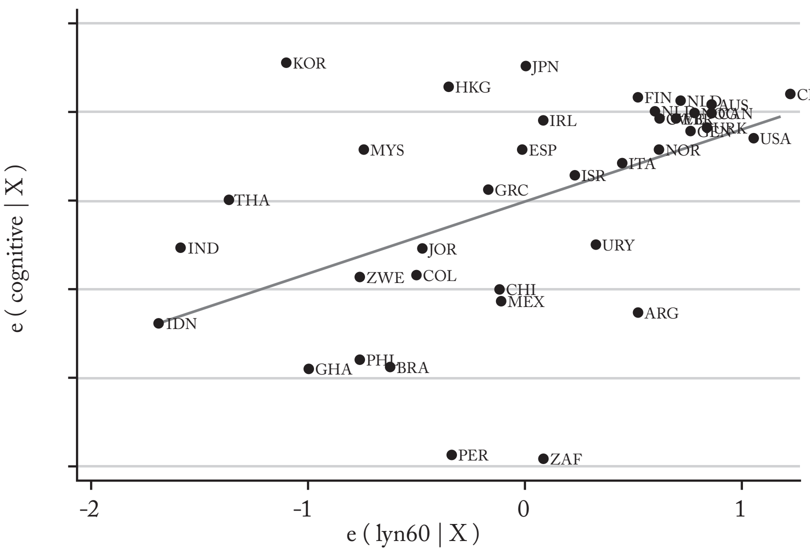
We base our approach in the empirical literature that suggests the existence of positive causal effects of human capital quality on economic growth (Barro, 2001; Hanushek and Kimko, 2000; Hanushek and Woessmann, 2008, 2009). These papers are relatively silent in terms of evidence on the mechanisms (i.e., factor accumulation versus productivity growth) that explain the effect of human capital quality on growth, with the exception of the paper by Jamison et al. (2007), which presents evidence suggesting that the effects are related to TFP growth.

In order to study in more detail the mechanisms, we use as a motivating theory the papers that suggest that "advanced" levels of human capital may be more relevant as countries approach the technology frontier (Acemoglu et al. 2006; Vandenbussche et al., 2006; Aghion et al., 2009).

[3] Both Barro (1999) and Gallego and Loayza (2002) actually identify the quality of human capital as one of the dimensions in which Chile had the most opportunities to gain in terms of increasing growth rates.

We argue that human capital *quality* is probably more related to advanced human capital than the *quantity* of human capital. As there is no previous evidence on this, we explore this hypothesis and find that, as expected, the quality of human capital becomes more important as a determinant to growth as countries get closer to the technology frontier. Our results also imply that the effects seem to be entirely related to TFP growth. The policy implications of this result are very important for a country like Chile, which is now getting closer to the technology frontier.

Figure 2: Human Capital Quality and Income.



coef = .38204423, se = .11973057, t = 3.19

Next, we present an analytical diagnostics to study how to affect several margins that may increase the quality of human capital. The production of human capital is a complex subject because there are, among others, non trivial effects of out-of-school variables (eg. socio-economic status) on the human capital production function, dynamic complementarities, i.e., returns of investments depend upon previous and future investments (Cunha and Heckman, 2007; Cunha et al., 2010), non-trivial agency problems, and –given the relevance of the public sector in the provision and financing– government failures and political economy factors playing a significant role in potential reforms.

In this part of the paper we rely on our judgment and reading of the literature to suggest four lines of potential reform which may produce significant increases in human capital quality: (i) institutional reforms to redefine the number of policy instruments aimed at increasing human capital quality, (ii) making better connections between the pre-primary education sector and the primary and secondary sector, (iii) interventions to improve the working of input markets that are key for educational production (i.e., the teachers and principal markets), and (iv) reforms to improve the link between the educational sector and the labor market. Given that these are mainly conjectures based on our reading of the theoretical and empirical literature we think these suggestions, when possible, should be implemented initially in pilot programs evaluated using randomized control trials (RCTs).

2. Human Capital and Economic Growth

2.1. The previous literature

There is a voluminous amount of cross-country and panel data empirical literature on the effects of the *quantity* of human capital on economic growth. Most papers find a positive correlation of the average number of years of schooling of a country's population and economic growth (Krueger and Lindahl 2001; Barro and Sala-i-Martin, 2004). However, it is unclear whether this effect is causal or not. For instance, Klenow and Bils (2000) present some evidence that the empirical patterns we observe are more consistent with reverse causality going from economic growth to human capital accumulation. Pritchett (2001) goes further to argue that the causal effect of years of schooling is essentially zero.

A key limitation of all studies in this area is that the identification of the effects is unclear and therefore one cannot rule out that the positive correlation masks reverse causality or omitted variables[4]. A recent study by Aghion et al.

[4] One partial solution to this problem is the use of internal instruments (ie. lagged realizations of schooling) in the context of panel data models as in the estimates by Vandenbussche et al. (2006), Barro and Sala-i-Martin (2004), and Gallego and Loayza (2002). The problem with this approach is that if there is inertia in the factors that affect schooling –as suggested in several papers that relate schooling outcomes to history, eg. Becker and Woessmann (2009) and Gallego (2010)– then lagged realizations of schooling cannot be valid instruments and, therefore, these estimates are not causal. However, from an empirical point of view, the estimates that use GMM methods (as in Gallego and Loayza, 2002) pass the Sargan over-identification tests and, therefore, one have some confidence on the interval validity of the estimates.

(2009) tries to overcome this criticism by using plausibly exogenous political instruments for the quantity of higher education across the U.S. states. This paper presents evidence of positive causal effects of higher education variables on income levels and growth at the state level operating mostly through productivity effects. The effects are not only statistically significant but also economically relevant. Unfortunately, the authors are unable to find credible instruments for primary and secondary schooling and therefore do not present evidence on causal effects of these variables on growth.

Regarding the effects of the quality of human capital quality on economic growth, the literature is more recent since datasets with measures of the *quality* of education (using tests applied to students of several countries) are only recently available. In this dimension the datasets used in Barro (2001), Hanushek and Kimko (2000) and more recently Hanushek and Woesmman (2008, 2009) are key for the study in this area. The inclusion of this variable in the analysis is relevant because it captures a dimension which seems important for the growth process: the efficiency or productivity of workers. Let us think of an extreme case in which students attend school many years but receive no instruction or human capital at all, in this case the numbers of years students attend will have a zero effect on growth. As Pritchett (2001) argues bad quality schools may explain his finding of an absence of a positive effect of schooling on growth.

The papers by Barro (2001), Hanushek and Kimko (2000) and Hanushek and Woessmann (2008, 2010) present positive cross-country correlations of measures of the quality of human capital and economic growth, considering different samples and methodologies. This correlation is actually much bigger than the one between the quantity of schooling and economic growth (especially after the quality of human capital is included in the regressions). Indeed, as in the case of the quantity of human capital, it is not clear whether the correlation reflects a causal effect or not. Hanushek and Kimko (2000) and Hanushek and Woessmann (2008) argue that reverse causality problems are not that relevant in this margin. They present evidence that there is a positive and statistically and economically relevant correlation between proxies of quality of human capital of the country of origin of immigrants and their wages in the US. They then argue that obvious concerns of reverse causality cannot explain the positive correlation they find. Still, it may be possible that some omitted variable explains the positive correlation. To deal with this problem, Hanushek and Woessmann (2009) present (i) some IV results using instruments related to institutional features of the education system and (ii) estimates using immigrants data in which they directly compare immigrants educated in the country of origin versus those educated in the U.S. All these results and checks seem to suggest that the quality of human capital has a positive causal effect on economic growth.

In terms of mechanisms that explain the correlation, the literature is mostly silent with the exception of the paper by Jamison, Jamison, and Hanushek (2007) which presents evidence suggesting that most of the effects come from the quality of human capital on TFP growth. In addition, a recent study by Gennaoili, La Porta, Lopez-De Silanes, and Shleifer (2013) also suggests that the impact of human capital on development operates mostly through productivity effects. They explore economic development in more than 1500 subnational regions finding that regional education levels account for a large share of the variation in regional income. The direct influence is through the workers' education, entrepreneurs' human capital, and externalities associated with the quality of human capital instead of the quantity. It is interesting that the second factor mostly affects development through the productivity of firms.

2.2. New estimates: quality/quantity of human capital and distance to the frontier

In this sub-section we present new evidence on the effects of human capital on economic growth. Our main contributions are two: (i) we use estimates of empirical models that extend the distance to the frontier hypothesis recently developed by Acemoglu et al. (2006) to the context of the study of the effects of quality and quantity of human capital on economic growth and (ii) we use a recently developed measure of human capital *quality* suggested by Schoellman (2012) to better study the impact of this variable on economic growth.

On the theoretical side, recent research suggests the existence of interaction between distance to the technology frontier and the importance of factors leading to growth. The main idea is that economic growth, and in particular, (endogenous) technology improvements of a country come from adaptation and innovation activities (Acemoglu et al., 2006). These two technology activities use different factors as countries move closer to the technology frontier.

Vandenbussche et al., (2006) apply this idea to the impact of different types of education (advanced versus basic schooling) on economic growth for countries located at different distances from the frontier. They assume adaptation is relatively (i) more intensive in basic education than innovation and (ii) more profitable when countries are far from the technology frontier. The result is that basic education has a bigger effect on growth for countries far from the frontier and advanced education has a bigger impact for countries closer to the technology frontier. Probably this result is also influenced by the fact that within the technology frontier adaptation involves efficiency gains through the reallocation of the same productive factors. Vandenbussche et al. (2006) present empirical evidence supporting that implication for OECD countries and, as previously mentioned, Aghion et al., (2009) present supporting evidence for this theory for U.S. states. They also present evidence that the effect of education on economic growth takes places mostly through technology improvements, as suggested by the motivating theory.

Our conjecture is that the differential effect of the quality/quantity of human capital on economic growth could be understood with the basic intuition of the models of distance to the frontier: it is likely that while the quantity of education is more related to the adaptation process, the quality of human capital is probably more related to the innovation process. If this conjecture is correct we should observe: (i) a bigger impact of the quantity of human capital on economic growth for countries located far from the technology frontier, (ii) a bigger impact of the quality of human capital on economic growth for countries located close to the technology frontier, and (iii) the impacts of human capital accumulation on economic growth being more related to productivity improvements than to resource accumulation.

The second contribution of this paper is related to the proxy of the quality of human capital we utilize in our empirical estimations. Most previous papers use internationally comparable test scores. This is a reasonable proxy for developed countries that have participated in several of the tests. However, as Hanushek and Woessmann (2008) argue, data for non-OECD countries are probably not as precise for developed countries. In addition, internationally comparable test scores measure a proxy for quality just for the school-age population and are potentially subject to a lot of reverse-causality problems.

Recently Schoellman (2012) suggests using Mincerian returns to immigrants in the U.S. as a proxy for human capital quality. This is a simple exercise that measures the marginal contribution of each additional year of schooling (i.e. the quantity of human capital) on wages and therefore is directly related to human capital quality. A particular contribution of the paper by Schoellman (2012) is the control for potential bias arising from the fact that there may be selection of migrants to the u.s[5]. Thus using this proxy we are able to both increase the number of countries with good information on human capital quality (and this allows us to include also poor countries that were not part of previous analyses) and solve the problem of reverse causality mentioned above. Thus, we use this proxy variable as our main proxy for human capital quality.

Then, our main estimating equation is:

$$g_i = (\alpha + \alpha_q q_i + \alpha_s s_i + \alpha_p p_i) y_{0i} + \beta_q q_i + \beta_s s_i + \beta_p p_i + \nu_i,$$

where g is the growth rate of per capita GDP (physical capital or TFP in some regressions) of country i, q is our proxy for the quality of human capital, s is our proxy for the quantity of human capital, p is a proxy for institutions, y_0 is initial per capita GDP (physical capital or distance to the TFP frontier in some regressions), and v is an idiosyncratic error to country i[6].

We use data on GDP, physical capital, and TFP from Bernanke and Gurkaynak (2002) and therefore include information ranging from 1960 to 1998 (and use values for 1960 as the initial relevant variables). As previously discussed, our proxy for the quality of human capital comes from Schoellman (2012) and corresponds to returns using the 2000 census and considering adult-age migrants working at least 30 hours in the u.s. Therefore, our proxy for human capital matches the age profile of adults working in the 1960-95 period. Our proxy for the quantity of human capital comes also from Bernanke and Gurkaynak (2002). Finally, our proxy for institutions corresponds to the variable called social infrastructure in Hall and Jones (1999). In terms of our proxy for distance to the frontier we consider the (log) difference between country i TFP in 1960 and the maximum of TFP in 1960 (that corresponds to Switzerland).

We run regressions for TFP, per capita physical capital, and per-capita GDP growth between 1960 and 1998 and present results in Tables 1, 2 and 3, respectively. Overall, results imply that that once we control for human capital quality, human capital quantity does not seem to have significant

5 In the relevant regressions Schoellman (2012) controls for country of origin fixed effects and therefore is able to controls for all omitted variables that are constant across cohorts and that may affect both the returns to years of education and wages directly.

6 In order to simplify the interpretation of the coefficients we run the regressions with q, p, y_0, and s measured as deviations from the mean of each variable. This implies that a, b_q, b_p, and b_s are the effects for a country having the average value of each variable.

statistical effects on the variables of interest, mirroring results in previous literature. In turn, human capital quality presents estimates that are mainly consistent with the distance to the frontier hypothesis: human capital quality affects much more TFP growth when countries are closer to the frontier (the opposite is true for human capital quantity, but the estimates are very imprecise). Interestingly, there is no evidence that human capital quality has any effect on the growth rate of physical capital per person[7].

Table 1: Dependent Variable: Capital Growth per Capita 1960-1998.

	(1)	(2)	(3)	(4)
log (Human Capital Quality)	0.001 (0.003)	0.000 (0.003)	-0.001 (0.003)	0.000 (0.004)
log (Human Capital Quality)	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)
log (Physical Capital per Worker in 1960)	-0.011*** (0.002)	-0.018* (0.009)	-0.018* (0.009)	-0.016* (0.010)
Institutions	0.036*** (0.005)	0.037*** (0.006)	0.038*** (0.006)	0.037*** (0.006)
log (Human Capital Quality) x log (Physical Capital per Worker in 1960)		-0.002 (0.003)	-0.002 (0.003)	-0.001 (0.003)
log (Human Capital Quality) x log (Pysical Capital per Worker in 1960)			0.001 (0.001)	0.002 (0.001)
Institutions x log (Physical Capital per Worker in 1960)				-0.004 (0.004)
Constant	0.057*** (0.010)	0.057*** (0.010)	0.054*** (0.011)	0.058*** (0.012)
Observations	60	60	60	60
R-squared	0.499	0.505	0.517	0.523

Notes: Standard errors in parentheses. Significance levels: * 10%, ** 5%, *** 1%.

[7] There are other results that are interesting but we do not comment them in the main text given the focus of this paper: (i) there is a significant convergence effect in both physical capital and TFP, (ii) institutions present a consistently positive correlation with the three growth measures, (iii) there are interaction effects between institutions and initial conditions for GDP growth (mirroring results in Acemoglu et al. 2006).

Tabla 2: Dependent Variable: Total Factor Productivity Growth 1960-1998.

	(1)	(2)	(3)	(4)
log (Human Capital Quality)	0.001 (0.001)	0.002 (0.001)	0.002 (0.001)	0.003* (0.002)
log (Human Capital Quality)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
log (TFP Distance to the Frontier in 1960)	0.007*** (0.003)	-0.010 (0.010)	-0.010 (0.010)	-0.004 (0.010)
Institutions	0.011*** (0.002)	0.010*** (0.002)	0.010*** (0.002)	0.010*** (0.002)
log (Human Capital Quality) x log (TFP Distance to the Frontier in 1960)		-0.006* (0.003)	-0.006* (0.003)	-0.006* (0.003)
log (Human Capital Quality) x log (TFP Distance to the Frontier in 1960)			0.000 (0.002)	0.001 (0.002)
Institutions x log (TFP Distance to the Frontier in 1960)				0.009* (0.005)
Constant	0.022*** (0.004)	0.023*** (0.004)	0.023*** (0.004)	0.027*** (0.005)
Observations	60	60	60	60
R-squared	0.332	0.370	0.371	0.413

Notes: Standard errors in parentheses. Significance levels: * 10%, ** 5%, *** 1%.

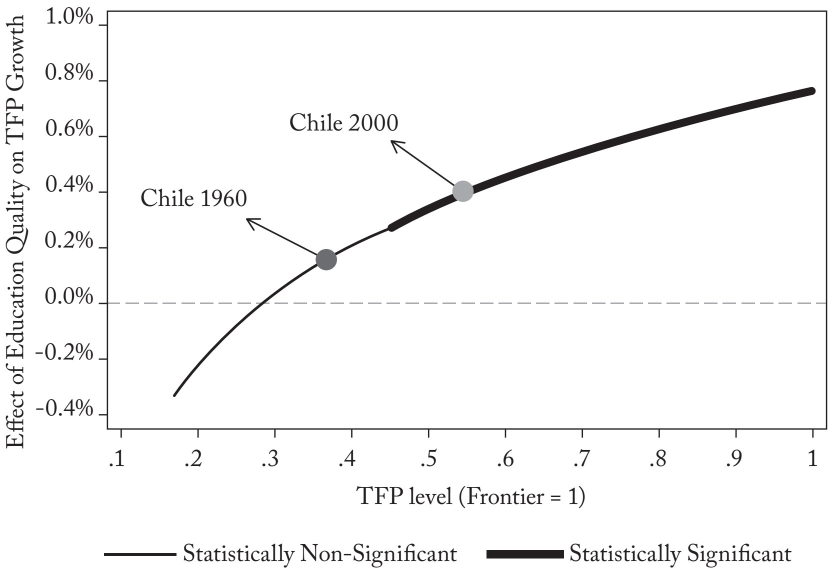
Table 3 : Dependent Variable: Income per Capita Growth 1960-1998.

	(1)	(2)	(3)	(4)
log (Human Capital Quality)	0.023 (0.084)	0.044 (0.089)	0.023 (0.090)	0.105 (0.093)
log (Human Capital Quantity)	-0.071* (0.041)	-0.070* (0.041)	-0.062 (0.041)	-0.081** (0.040)
log (Output per Worker in 1960)	-0.224** (0.091)	0.038 (0.372)	0.070 (0.369)	0.064 (0.354)
Institutions	0.776*** (0.152)	0.758*** (0.155)	0.760*** (0.153)	0.696*** (0.150)
log (Human Capital Quality) x log (Output per Worker in 1960)		0.094 (0.129)	0.101 (0.128)	0.183 (0.127)
log (Human Capital Quantity) x log (Output per Worker in 1960)			0.071 (0.050)	0.073 (0.048)
Institutions x log (Output per Worker in 1960)				-0.360** (0.154)
Constant	1.430*** (0.267)	1.462*** (0.272)	1.385*** (0.275)	1.677*** (0.292)
Observations	60	60	60	60
R-squared	0.391	0.397	0.419	0.474

Notes: Standard errors in parentheses. Significance levels: * 10%, ** 5%, *** 1%.

There are interesting results in terms of the effects' economic significance. An increase in school quality (moving from the 25th to the 75th percentile of the distribution of this variable) is associated with an increase in annual TFP growth of about 0.8% when a country is at the technology frontier, but just 0.2% (and not statistically significant) when the distance of TFP to the frontier is 40%. Figure 3 presents the marginal effect of human capital quality on TFP growth conditional on distance to the frontier. As evident in the figure, in 1960 Chile had a TFP close to 40% of the frontier and in 2000 had a TFP equivalent to 55% of the frontier and therefore the impact of human capital quality on TFP growth doubles from 0.2% to 0.4% and becomes statistically significant.

Figure 3: Marginal Effects of Human Capital Quality on TFP Growth.



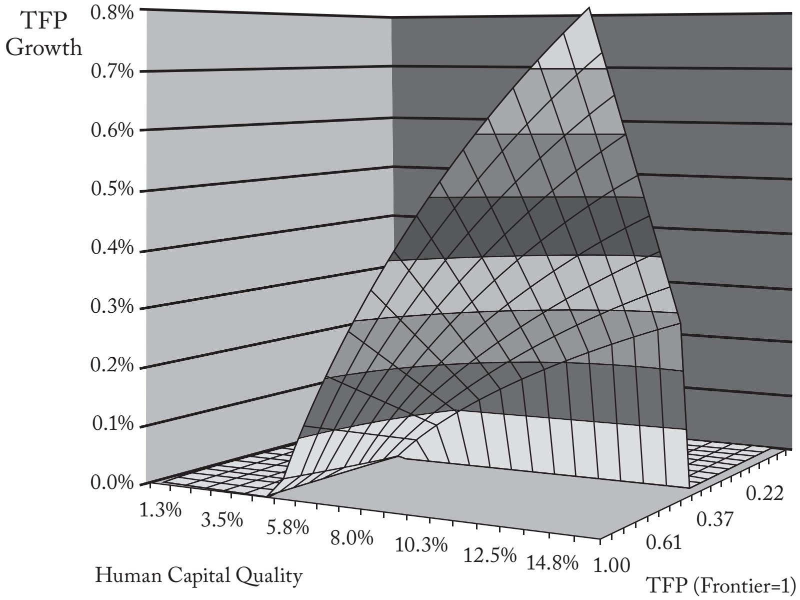
Additionally, our results imply that there are strong complementarities between human capital quality and TFP levels. Figure 4 presents the estimated effects. Therefore, increases in TFP levels increase returns of investments in human capital quality and vice versa. This suggests that the return can be very high when implementing (coordinated) packages of reforms that include both improvements in human capital quality and other reforms that increase productivity[8].

Finally, in terms of interpretation it is worth noting two relevant facts. First, while the effects are economically and statistically significant, the size of the effects does not imply that human capital is a *magic bullet* to get to the technology frontier and economic development. This relates to estimates in

[8] These results also imply that there may be under–development traps in which due to strong complementarities some countries may end up having *both* low levels of TFP and human capital quality.

Hanushek and Woessman (2008) in which significant movements in human capital quality indicate that closing the 50% of the gap in human capital quality of Chile to OECD levels in 20 years, increases the level of per capita GDP by just about 15% by 2050, *ceteris paribus*. This is certainly a profitable project but will not by itself close the development gap of a country like Chile. In contrast, our estimates give a more optimistic flavor as we present evidence that if a country like Chile does other things to close the technology gap, the returns to investing in human capital quality increase, but the highest effect on impact on TFP is just 0.8% (when human capital quality is very high and distance to the frontier is close to 0). As there is a strong convergence effect the medium and long run effects on TPF growth are much smaller[9].

Figure 4: Marginal Effects of the Interaction of Human Capital Quality and Distance to the Frontier on TFP Growth.



Second, as implicit in our previous calculations, reforms to increase human capital take time to produce positive effects as there need to be reforms to improve school quality today which will eventually produce effects on human capital quality of workers several decades after the reform

9 Obviously, there are other positive and normative reasons to improve human capital quality that go beyond maximizing economic growth.

is implemented. This obviously creates a number of political economy challenges to the implementation of reforms and also put a realism constraint on the discussion on human capital reforms.

In all, our results imply that human capital quality seems to be important to increase TFP and per capita GDP growth in Chile today as the country is getting closer to the frontier. Hence, the type of skills required to improve production capabilities further are much more intensive in quality as the country starts to move from adaptation to innovation activities.

3. Determinants of human capital quality

Given results in the previous section, the next question is how to improve human capital quality. In this section we discuss potential areas for reform in the case of Chile.

3.1. Some stylized facts[10]

We start by presenting a number of stylized facts derived from available national and international data which allows us to compare the current situation with that of other countries:

a) *Relatively low results in internationally comparable test scores that have been improving over time*

   Most available data suggest that the results of Chilean students in internationally comparable test scores are below those of most developed countries and that this low performance was also present in the 1970s (See Figure 5, Panel A). The most recent international data, however, suggest a process of convergence in test scores (see Figure 5, Panels B and C). In addition, the most recent national data also suggest statistically significant increases (for the first time) in test scores in several school levels, especially clustered among students coming from low SES households, and especially in language tests (Figure 5, Panels D).

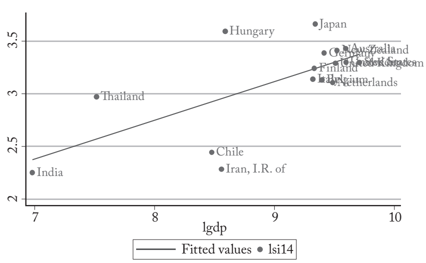
   In a sense, the best way to summarize recent developments in Chile's quality of education is looking at Figure 6 which indicates that between 2000 and 2009 the country not only increased its performance but also reduced the variation in achievements among students. Of course, it

10 We focus on stylized facts related to human capital "quality" and not on human capital "quantity".

could be argued that the country started from a very low performance and that it was only a matter of time before an increase in educational outcomes became noticeable. Nevertheless, the country's educational system is showing a dynamism that cannot be underestimated.

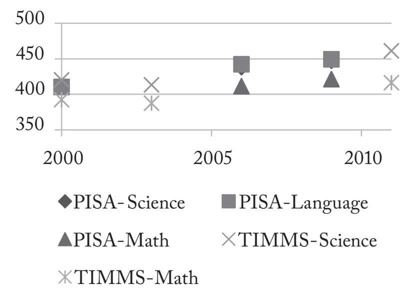
Figure 5: Human Capital Quality in Chile, several time periods.

Panel A: Science Tests and per–capita GDP, 1970 (log–log relationship; 14 years old students)



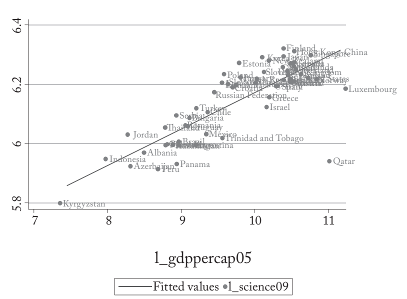
Source: Hanushek and Woessman (2008) and Penn World Tables.

Panel B: International Test Scores, 2000–2010



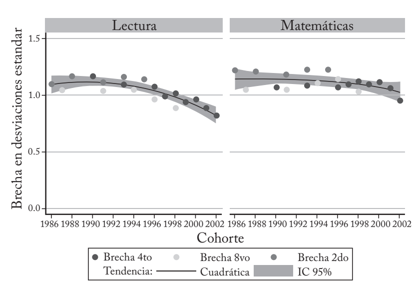
Source: Contreras and Gallego (2013)

Panel C: Science PISA Test Scores and per–capita GDP, 2009 (log–log relationship)



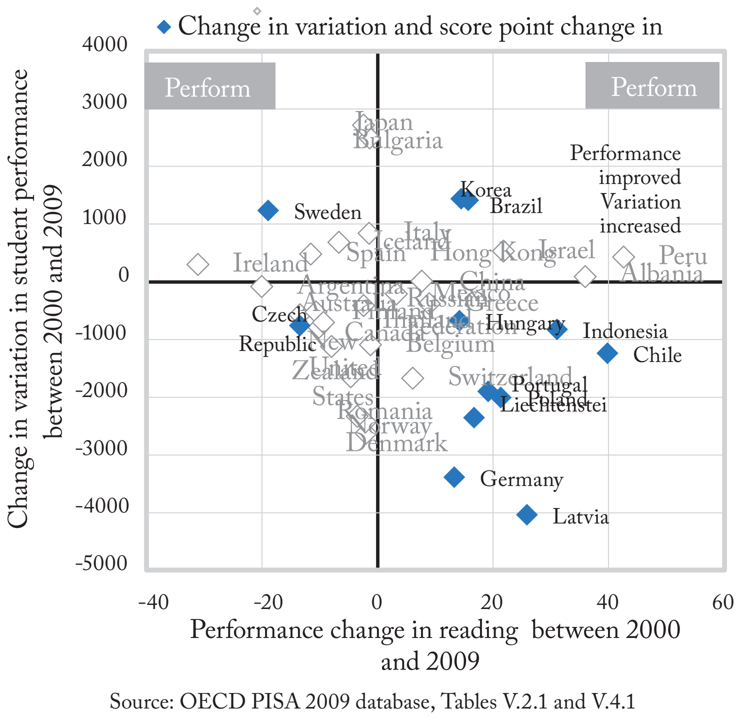
Source: OECD PISA dataset and Penn World Tables.

Figure D: Leaning gap, several years, Ratio of learning for 90/10 percentiles, by year of birth and grade



Source: MINEDUC (2013)

Figure 6: Change in Performance, 2000-2009, PISA test



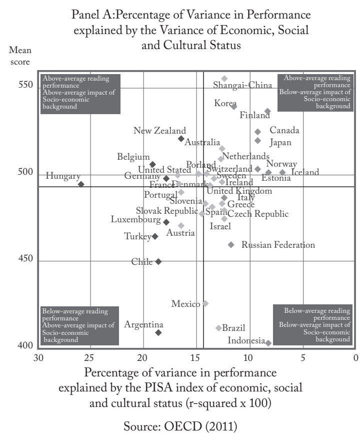
Source: OECD PISA 2009 database, Tables V.2.1 and V.4.1

b) *Importance of family background in educational achievement is significant (mainly through segregation)*

Results from international tests (like TIMSS and PISA) suggest that the percentage of variance in test scores explained by family background in Chile is high (Figure 7, Panel A). Interestingly, when one decomposes this among (i) the variance of family background in Chile and (ii) the effect of family background on test outcomes (measured using the PISA Economic, Social and Cultural Status Index (ESCS), see OECD, 2011), results imply that (ii) is relatively low in the case of Chile in comparison to the mean OECD average (Figure 7, Panel B), even when one considers average PISA outcomes (Figure 7, Panel C). At the same time (i) is significantly higher than of other countries (Figure 7, Panel D). Therefore, in the case of Chile it seems that the relevance of the ESCS is related to the fact that we are dealing with an economy with a high level of inequality.

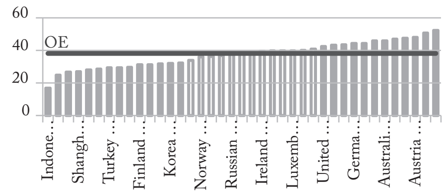
Figure 7: Socioeconomic Status and Education Outcomes

Panel A:Percentage of Variance in Performance explained by the Variance of Economic, Social and Cultural Status



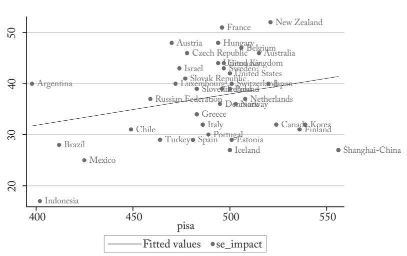
Source: OECD (2011)

Panel B:Effect of the Economic, Social and Cultural Status Index on PISA Test Scores



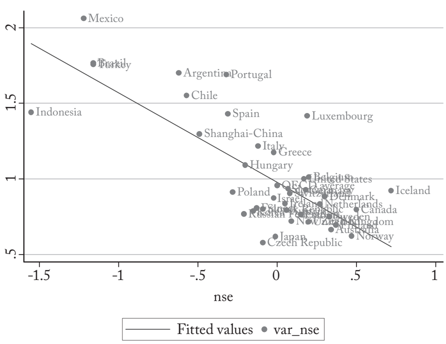
Source: OECD (2011)

Panel C: *Effect of the Economic, Social and Cultural Status Index on PISA Test Scores, controlling for PISA test scores*



Source: Authors´ elaboration using OECD (2011) data

Panel D: Variance of the Economic, Social and Cultural Status Index and PISA Test Scores



Source: Authors´ elaboration using OECD (2011) data

The previous result is amplified by the fact that ESCS segregation at the school level in Chile is high. In fact, OECD (2011) reports that Chile is the country with the highest value for the share of the ESCS variance explained by variation between schools (hence, it shows the lowest level of social inclusion). Research suggests that this high level of segregation is mostly explained by self-selection at the household level and a high level of residential segregation (Gallego and Hernando, 2009). This leads to a market equilibrium in which low SES students tend to attend low-performing schools. Interestingly, more recent research suggests that the self-selection problem is explained in a non-trivial part by the lack of information poor families have regarding school outcomes (Gallego et al., 2013 using a randomized control trial; Allende and Gallego, 2013 using a Regression Discontinuity Design).

c) *There is a high variance of results between schools educating children of the same socioeconomic background*
Effective educational systems promote clear and ambitious standards that are shared across the different educational actors. However, in the case of Chile, there is high variance of outcomes, particularly among low SES schools, among schools serving kids coming from the same SES background. Certainly, there is no single factor explaining these results but the fact that historically there has been almost no discussion about reasonable standards that every school requires to meet is something that needs to be remembered.

d) *There is a high variance of results within schools and among classes within schools*
A less noticed fact in the Chilean discussion is that there is a high degree of variance of student results *within* schools and even classrooms (Ramírez, 2007). If this were the only piece of information that an external observer had, he or she would not be impressed. After all, you would expect schools to have students of different abilities and social backgrounds. But as it was emphasized before, schools are not socially inclusive in Chile (indeed according to PISA they are not academically inclusive either), and therefore you would expect a lower variation within schools. Taken together, these facts suggest that the market equilibrium we observe in the production of school quality has not been able to produce a level of minimum quality for schools educating similar students. The equilibrium in education markets is obviously affected by both demand and supply characteristics but also by government regulations and interventions. In fact, the education markets in Chile are probably better characterized as quasi-markets in which government intervention plays a key role (Gallego and Sapelli, 2008).

3.2. Human capital production: a conceptual framework

The production of human capital is a complex process. Human capital is a multifaceted good: it is multi-dimensional, subject to dynamic complementarities, produced with the family, peers, and others co-producers, and there is public provision and public financing. Given this situation the optimal policy probably considers at least the following two elements:

- It includes several instruments aimed at different margins.
- It integrates coordinated investments/policies at several stages of the life-cycle of the agents

One formalization of the process of human capital production is related to the following human capital production function (Cunha and Heckman, 2007):

$$\theta_{t+1} = g_t\,(h, \theta_t, I_t),$$

where θ_{t+1} is the stock of human capital at period *t+1*, *g()* is a function that may change in different periods, *h* is family background (or, more generally, non-school characteristics that do not change over time, as genetic characteristics, conditions or shocks during pregnancy, to a great extent socioeconomic and cultural background of the household, etc.), and *I* refers to investment. We could further define $I=[I^f\ I^s]$ where I^f refers to family (or more generically outside-school) investment and I^s refers to investment in schools (or more generically in human capital-creating institutions).

If we substitute this repeatedly starting from θ_1 we find that:

$$\theta_{t+1} = g_t\,(h, \theta_1, I_1^f, \ldots, I_t^f\ I_1^s, \ldots, I_t^s)\ for\ t=1,\ldots,T.$$

The current literature suggests the existence of the following effects:

- Family background matters: $\dfrac{\partial\theta_{t+1}}{\partial h} > 0$, $\dfrac{\partial^2\theta_{t+1}}{\partial\theta_t\partial h} > 0$, $\dfrac{\partial^2\theta_{t+1}}{\partial I_t\partial h} > 0$. This implies that families with "better" family background tend to produce, ceteris paribus, better human capital both statically and dynamically.
- Co-production: $\dfrac{\partial^2\theta_{t+1}}{\partial I_t^f\partial I_t^s} > 0$. This implies that investments in the family

complement investments in the school and, therefore, families are co–producers of human capital

- Self–productivity: $\frac{\partial\theta_{t+1}}{\partial\theta_t} > 0$. This implies that previous human-capital increases current human capital.
- Dynamic complementarities: $\frac{\partial^2\theta_{t+1}}{\partial\theta_t \partial I_t} > 0$. This implies that the impact of investments on current human capital is increasing in the level of previous human capital, which in turn implies that if investments in initial periods were low (and, therefore, human capital is low), returns of future investments will be low. This is the idea of intertemporal complementarities.
- Critical stages. Self-productivity and dynamic complementarities imply the existence of critical stages and therefore, there are interventions which are critical for future returns of human capital, in particular early-life investments[11].

3.3. Human capital production: A conceptual diagnostics of the case of Chile

The previous conceptual framework is interesting but still misses one key point in terms of public policy: Where do I_t^f, I_t^s, and *g()* come from? They typically come from the outcomes of markets or quasi-markets with a bunch of (both market and government) failures and interventions aimed at different objectives. The formation of human capital through the educational system is a continuous process where every year is important and it is difficult to make exact distinctions at each stage. But there are some insights from the literature which are useful to take into account. So, for analytical purposes we would consider two stages of the production of human capital from early childhood development to secondary education[12]:

[11] It is worth emphasizing that all of these conclusions of the literature are *stochastic* (and not deterministic) findings and, therefore, the statements in the main text are not contradictory with some short–term interventions that are focused on poor students and improve significantly their educational outcomes. See a discussion on these programs in Banerjee and Duflo (2011) and Kremer et al. (2013) and evidence for Chile of one successful program in Cabezas et al. (2011).

[12] We will work only with a subset of all the relevant dimensions in each of the school systems (and the relevant educational stages) and we will omit the higher education system from this analysis..

a) Early childhood development

The pre-school system in Chile presents a multi-dimensional and unclear design: there are several (public and private) agents either providing directly or indirectly financing for child care centers. To some extent this is the result of the Labor Law that requires firms with 20 or more women employees to pay for care for children between the ages of 0 and 24 months (in practice between 6 and 24 months because there is paid maternity leave for six months). This service is provided by private paid institutions that work with companies in this age range and continue to offer the service for the next stages although the money then comes from the families. There is a very loose supervision of these child care centers by the most important state provider of childcare (JUNJI), which is a dependency of the Ministry of Education. Firms also do some supervision. There are also private child care centers which do not work with private companies and offer services with almost no supervision, except in matters unrelated to the child development. The exact number of children attending both types of child care centers is not very well known (some of them operate in both markets)[13].

The state provider has its own centers but also has agreements with municipalities, and not-for-profit NGOs to provide childcare. In addition there is a private large independent NGO (INTEGRA) that gets all its money from government and supervised by the First Lady (it also has agreements with external providers to support some of the child care centers). This system provides care and educational development for children from 0 to 6 years, although its focus is on children from 0 to 4 years since PK and Kinder are offered today mostly by Chilean schools, given the fact that the Chilean schools are financed through a voucher that includes PK and Kinder. JUNJI and INTEGRA are financed through a fixed amount of money each year in the National Budget. Table 4 presents the distribution of children from 0 to 6 years. It can be seen that the enrolment in PK and Kinder in both organizations is modest since, as it was said earlier, these stages are covered mostly by schools.

[13] Some very rough estimates could be obtained from household surveys.

Table 4. Enrolment in preschool education in junji and integra: 2012.

	Nursery	Day Care	PK	Kinder	Total
junji	58.622	103.252	13.123	2.202	177.199
Integra	15.744	43.243	8.772	1.107	68.866

Both institutions, especially the first, have shown some bias in recent years to concentrate its development in children from 0 to 2 years, motivated by the fact that mothers working in firms with less than 20 females workers or in the informal sector do not get child care coverage. Of course, given the discrimination in coverage, it is understandable. However, this generates some tensions between the care and educational functions. It is true that they don't need to be incompatible, but since most women in Chile work long shifts, the children stay for a long time at the child centers, which is expensive.

From a development point of view it seems that a couple of hours are enough. It is also unclear if the "institutionalization" of children requires starting so early from an educational point of view. As a result of these tensions coverage is lower than expected. In addition, there is no clear view about the standards that have to be asked from the different child care centers. Most of the supervision, if any, is weak and diffuse and based on administrative and bureaucratic controls, related to infrastructure compliance, availability of educational materials, and personnel/teacher coefficients in each child center. The supervision is in the hands of junji, which is also a provider. Conflicts of interest are evident. There is currently in Congress a bill that will change this situation and improve the institutional framework of the early childhood system but this is only a first step. Coverage has to increase, particularly for children between 24 and 48 months of age and quality has to be assured. To move in this direction the objectives of early childhood education require clarification, with clearer standards and their compliance must be professionally supervised.

b) School system

There is a (low-value[14]) quasi-voucher system operating for the pk–12 education system. The voucher can be used in private and municipal schools. The financing of free private schools through a voucher is a long

[14] This adjective requires a clarification. The relative annual expenditure per student in Chile is below the average expenditure per students among oecd countries when it is compared to the average income per capita, particularly in secondary education. See oecd (2012), Table B1.4.

tradition in Chile. There is evidence that in the 19th century such scheme was already in place. It was legally established in 1920. However state schools were for most of Chilean history financed differently, through an annual budget independent of the number of students attending each school. This dual system was changed in 1981. It was decided that all schools, state and private, were to be financed by a voucher per student of the same value. The voucher was independent of the socioeconomic background of the student. The same year, the state schools in the hands of the central government, were transferred to local governments. Since then, only two major changes occurred in the financing of the schools. At the end of 1993 a contribution from parents to schools, in addition to the voucher financed by the government, was allowed. This contribution has a cap and part of it is deducted from the voucher. Municipal schools were forbidden from seeking contribution from parents at the elementary level (although they operate with a very soft budget and get additional money from the local and central governments). This change was followed a couple of years later by a complimentary regulation that mandated schools charging a complementary fee to exempt at least 15 per cent of the enrollment from such fees if there were vulnerable students. Of course, the capacity of the government to enforce this regulation has been modest.

The second major change occurred in 2008 when the government introduced a complementary voucher for 40 per cent of the students, specifically the most vulnerable. The students receiving this complementary voucher are exempted from paying a fee whether or not they are attending a school that charges a fee. Since then, most of the increases in the money for schools have been channeled through this complementary voucher. Currently it represents approximately 58 per cent of the regular voucher between PK and 6th grade (the elementary school takes eight years in Chile until 8th grade) and 39 per cent in the next stages. This complementary voucher comes with additional regulations for the use of the additional money.

This financing framework is complemented by specific educational policies, some of which include additional public monies (although modest), aimed at: affecting both the extensive and intensive margins of the teacher markets, influencing the operation of schools, particularly the municipal schools, and the entry-exit of all schools, advising schools on how to improve their performance; and providing a system of information based on scores obtained in national low-stakes tests that are applied yearly in almost every school in different subjects and at least in two different grade levels. These multiple interventions produce a situation in which there is some lack of coherence in key components of the educational system (institutional weakness). Most of these interventions are based on a common underlying principle but are applied without coordination, and sometimes with contradictory objectives.

The differences among and within schools in performance that were mentioned before tend to appear very early in the development of the students. So, at the age of 10, when the first national tests are taken, there are important variations in performance that are explained to a great extent by differences in socioeconomic background, which persist until the students leave the schooling system. In spite of the information collected through these tests that date back to 1995 there has been, in practice, little concern for the schools and the children with low achievement level. Contrary to the norm in highly effective educational systems the picture in Chile shows an educational system without clear standards on what to expect about the performance of schools and students. This context will change in the next years since a new institutional framework is being installed in the country. A new institution, the Agency for Educational Quality, was created. It will be in charge of applying all the national tests but more important it will be a review office of the performance of schools. In order to do this task, it will propose standards that every school has to comply and will define a ranking for Chilean schools (of course there are controls for socioeconomic background of students attending each school) based on these standards. It will visit and review schools at the bottom of the ranking more often. If schools are not able to satisfy the standards within a reasonable period they will lose the authorization to offer schooling services to students in Chile[15]. This disposition is established by law and it is not a discretionary decision of the Agency. This institution is an educational review office that will visit schools and make recommendations to help them improve but each school is responsible for deciding changes. The reports issued by the Agency are public and therefore will be subject to open scrutiny.

[15] There are exceptions to this rule whenever there are no alternative schools for students. In this situation a provisional team takes charge of the school.

The methodology for ordering the schools and the standards they have to meet are not defined unilaterally by this new Agency. They have to be approved by the National Council of Education, a national board with 10 members, all with some educational expertise who represent the Chilean society in a broad sense. A different institution, the Superintendencia de Educacion Escolar, will assure transparency in the use of funds and that schools comply with different aspects of Chilean law. In this framework, the Ministry is in charge of guiding the whole educational sector specifically through the design of educational policies and support to schools to help them deal with the new standards. This new institutional scheme is in its early stages of development. It aims to generate checks and balances and specialization in terms of government intervention in education, but most importantly, after its installation is completed there will be, for the first time in Chilean educational history, clear and reasonable standards for all educational actors involved in the provision of education. If there is some truth is the affirmation of education specialists that high performing education systems have, among their characteristics, clear and ambitious standards that are shared and met across the system, this institutional change may play an important role in the near future.

One of the dimensions carrying a lot of attention recently in the public debate is the teachers market. Chilean teachers are typically selected from low ability groups (the extensive margin) and monetary incentives for Chilean teachers are not well aligned (intensive margin). In turn, the role of the school principal is totally undervalued.

This diagnostics suggests three general assertions bearing a number of policy implications that we develop in the following section:

i. It is quite clear that there is a de facto big difference in emphasis and instruments between pre–primary and primary–secondary education.
ii. There is a lack of coherence in some key components of the educational system (institutional weakness).
iii. It is unclear how much coordination occurs between the two initial levels: early childhood education and the school system, which is crucial from a dynamic perspective.

4. Policy suggestions

In this section we suggest a number of policy changes aimed at increasing the quality of human capital. There are two general principles that motivate our suggestions:

- Human capital policy should be consistent with other complementary reforms in other areas of policy, given the existence of complementarities among the quality of human capital and the productivity of the economy. Thus, suggestions in other chapters of this book aimed at improving the productivity of the economy are complements to the suggestions to improve the level and quality of human capital.
- In general, there is no bullet proof suggestion and we are dealing with a complex object of study: therefore our advice is to do experimentation with policy reforms. Most of our suggestions below should be carefully evaluated before being scaled up. Since the Chilean educational system is very decentralized such evaluation shouldn't be problematic. There are different instances where a random application of a specific treatment can be applied. Of course, there could be political complications in some cases, for example, if an increase in salaries is considered, particularly in the municipal sector but this type of experiments can be managed with these organizations since there is a large subsidized private sector. But we don't expect many problems nor do we find it too complicated to perform such experiments. There are several examples around the world (see Banerjee and Duflo, 2011, Kremer et al, 2013 and the literature quoted therein). In fact, a series of the policies we suggest may be evaluated in a rigorous way.

4.1. Institutional reforms

We start by suggesting our main institutional reform. As we argued before there are (probably) too many instruments trying to influence the behavior of the educational sector: some related to the supply side and some to the demand side. Some of them operate with contradictory logics and involve an enormous administrative burden upon schools (indeed, the new institutional framework explained above may asphyxiate a lot of schools if not appropriately installed). Then, we suggest ways to simplify the set of policy interventions and reallocate resources toward key margins and drop redundant instruments (e.g., there are too many sources of school financing with different rationales) and add new ones (e.g. insuring quality in the teachers market and improving the working of the pre-school market).

Specifically our suggestions along this line include:

- The definition of the value of the voucher consistent with some minimum quality and with SES background of students (in the beginning it could be a target to reach by a specific year). The key point here is that currently it is unclear where the value of the voucher comes from and this price creates a number of incentives and allocates resources in the market. In fact, in 1980 it was defined from the budget of that year divided by the number of students and augmented in an arbitrary amount. After the economic crisis of 1982-3 the voucher felt in real terms (25 per cent between 1981 and 1990). With the return to democracy in 1990 it began to rise but without a specific target. The complementary voucher introduced in 2008, although backed in some general studies, was also set at the end arbitrarily. Currently in Congress an additional complementary voucher is under discussion. It is to benefit the next 20 percent of students (keeping in mind that the first one in 2008 was for the 40 percent more vulnerable students). Although there is some empirical support for this new voucher it comes from the current equilibrium, already influenced by the different and contradictory incentives in place. Hence, it is a good moment to rethink the design of the school financing system in Chile.

  There are at least four factors to be considered in this design. First, the appropriate level of the voucher given a specific quality target. This will always require some narrow definition of quality, but the development of the standards proposed by the new Agency and approved by the National Council of Education will serve as a guide. The value has to be consistent with the proposed changes in the teachers' market (see below). The amount of the voucher will obviously differ for students from different socioeconomic and cultural backgrounds. But the design has to define the differential "prices" in the voucher accordingly and in a better way than has been formulated in the past.

  A second aspect deals with the fact that currently the difference in value associated with a lower socioeconomic background is paid as a complement and there is a different set of rules from the ordinary voucher. Given the new institutional framework this idea doesn't make much sense. Instead of having this additional voucher we proposed to have only one with a different price for students from different backgrounds. The schools will be subject to the supervision of the general system of institutions. This idea is not incompatible with the fact that part of the money can be channeled to schools through other mechanisms. But this requires a good justification. In some countries with vouchers there has been an effort to distinguish between fixed and variable costs. The allocation through vouchers is used for the second type of costs and a direct allocation, independent of the number of students in a school, is decided for the first type of costs. Of course, it is not easy to distinguish clearly between both costs and such a policy may lead to inefficiencies (indeed some countries require a minimum number of students enrolled before they decide to allocate them governmental funds). We are open to such a distinction but based on thorough studies that justify this idea.

A third aspect to discuss in the design of the voucher is how to integrate it appropriately with the fact that families in Chile are allowed to supplement the voucher. There is an ongoing discussion in Chile where some educational experts are arguing for terminating this provision. The main argument is that the family contributions give rise to social segregation. However, the evidence supporting this claim is weak, which is not incompatible with acknowledging, as we reported previously, that education in Chile is highly segregated. The segregation is very much influenced by the inequality of the country, the residential segregation and self-selection (see above). In addition, the decision to charge a complimentary fee is endogenous to the neighborhood where the school is located, the complementary voucher "works" as family contribution (schools are not allowed to charge those students), and there are mandatory scholarships. The bill currently discussed in Congress to create a new complimentary voucher for the next 20 percent of students (the first was for the 40 percent more vulnerable) was left compatible with family contribution. Its prohibition seems too high a price to pay since it amounts to only 44 percent of the complementary voucher for the 40 percent of students from the most vulnerable households and the typical contribution for the middle income families is a small percentage of their incomes. Of course all of this is debatable. We don't favor the elimination of families contributing on top of the voucher but there are several ways to improve the integration of the vouchers and family contributions in order to reduce the risk of segregation. As was said before, there is a "tax" established on family contributions that work as a deduction of the voucher. This tax, however, is very small. A better design of the deduction is required, along with a complementary definition of the maximum amount each family can contribute in relation to the amount of the voucher (basic plus the complementary) that the government defines for each student is required. A related element regarding this issue is the prohibition for municipal schools to ask for family contributions at the elementary level. Do these schools have to be liberated from this restriction or alternatively compensated for this prohibition? Since they operate on very soft budgets the answer is unclear. But is something that has to be answered in the context of designing a renewed voucher system.

The final element to be answered is whether there is room, within the design of the voucher system, to have additional resources channeled for specific institutions. In Chile, for example, some people said that state schools have to get more money. Two lines of arguments are put forward. The first is basically normative. State schools, it is argued, are the only ones able to offer an education that is pluralistic, tolerant and nonsectarian. Hence, there has to be some preference for them in the allocation of resources. The second is more practical. It is argued, on the one hand, that private subsidized schools are always able to select students in spite of what the law says, while state schools are impeded from acting in a similar way and, on the other hand, that state schools will sooner or later be affected by stricter legislation. They increase the cost for state schools to provide the educational service. Both claims, especially the second one, have some basis in fact. But they are weak and from the perspective of the effectiveness and performance of the educational system we think that accepting these claims opens a Pandora Box that it is difficult to anticipate. To support with additional resources specific schools, both municipal and private subsidized, that show a special care for specific virtues –for example social inclusion, diversity, tolerance, among others– is an avenue worth exploring but a preference for a subsector of schools is not something we recommend.

- A key player in the current institutional setting corresponds to the agency to insure quality. This institution just started to work in 2012 and has three main roles: (i) to administer national tests and propose quality standards, some of which will be based on these tests, with which schools have to comply, (ii) to visit schools, review compliance with the standards and inform the educational community through a report of the results of its visits, and (iii) inform the closing of the schools which after a reasonable period are not able to improve and incapable of meeting the standards defined, as required by law. In this institutional framework, the Ministry of Education has to ensure that schools are able to get effective support to deal with the weaknesses detected during the Agency's visit. These changes involve moving from very bureaucratic and administrative controls to very professional ones with high stakes for schools. It is crucial to insure that this change works well and that, if required, complementary policies are put into effect. We propose therefore a transitory task force to monitor this process with an independent opinion, able to propose corrective measures if necessary. One important uncertainty in this new institutional scheme is the availability of good advice for schools. It contemplates the possibility of schools choosing the advice from private providers and a specialized division within the Ministry of Education itself. This needs to be supervised appropriately.

- The development of public policies aimed at particular key input markets, since these are markets with important political economy problems. Below we develop a number of suggestions related to the teachers and principals markets.
- The quantity and quality of information in the system has to be improved. On the one hand, the evaluation of schools has to move ideally to a value added model. Currently, it is based on a standardized test that doesn't take into account children's characteristics. Of course, value added tests are not exempted from criticism (see Baker et al., 2010, for a good summary and Andrabi et al. 2011 for a recent application) and therefore there will be an intense debate if such a change is decided. We think there are good reasons to move in this direction and we recommend a value added model for evaluating schools (a defense of this model and its usefulness are presented in Chetty et al. 2011). Anyway, its implementation requires time since the country is lagging behind in the elaboration of a value added model. On the other hand, since in the short and medium run there will be no value added model available, there are some improvements which can be made within the current model. In particular, the current situation can be explored to its full potential. For example, most parents are not informed that their daughters and sons are recipients of a complimentary voucher. For this reason some are deterred from choosing schools that charge a contribution from the family, although its complimentary voucher would be enough to

> cover that fee. Hence, the choice set of these parents, who are the most vulnerable, is artificially reduced. It doesn't make much sense. Another restriction is that parents are not able to get the individual results of their children in the national tests. This is important in a country with an important variation in educational results between schools and with, it seems, a high grade inflation. Parents may believe that their children are doing well in their schools because they get outstanding grades but their performance in national tests could be very poor. If parents are able to check both results some uncomfortable questions for schools may follow which should be welcomed. Of course, in the absence of value added test some may believe that this information is of limited use but nevertheless helps parents to be more aware of performance of their children's schools. Therefore, this information is still of value to parents. These are only two examples, but there is much that can be done to improve information for parents and for the educational community in general.

Perhaps the main proof of the low standards of the Chilean educational system and at the same time the insufficient expectations about what students can achieve is the experience of the Chilean secondary technical schools. Almost 44 percent of the young people who graduate from secondary education in Chile are from technical schools. The decision to pursue this alternative is made four years before graduation. Mostly vulnerable students choose it expecting that they will be ready for a job after graduation. Unfortunately, in most of these experiences, there is a strong disconnection between the demands of employers and the skills developed in these courses (Bassi et. al., 2012). Currently, a major transformation of the curriculum for technical schools is under way. The process included consultation to employers to define the most important subjects, but still there is a need for relevant reforms in this area. We propose moving to a decentralization of the curriculum with a more important participation of the productive sectors of each region to define the areas to be taught in technical schools. At the same time we think there has to be at least an endorsement of those schools by employers' association in order to avoid teaching of irrelevant areas in each region. If schools do not find such an endorsement some doubt about the relevance will emerge. In these cases, it might be a better option to transform the school into a traditional one or eventually evaluate its continuity. An endorsement of productive sectors brings the Chilean technical schools closer to the tradition of the dual or vocational education that inspired them. Today, they are too far removed from these experiences and are therefore, with some notable exceptions where there is precisely a close connection with companies or productive sectors, very ineffective schools. Of course, this approach can be complemented with studies of the demand for labor which are not easily developed since data are not readily available. However, these studies may avoid eventual conflicts of interest in the participation of productive firms.

4.2. Policies aimed at early childhood development

Although there is controversy about very early "institutionalized" care, particularly in the first 18 months of life (see for example Baker et. al. 2008), the existing evidence suggests that preschool could be a powerful tool to increase both cognitive and non-cognitive skills. Hence, the low coverage in Chile needs to be addressed, especially given the existing income inequality. For example it is less than 50 percent of children under five years (and with a steep SES gradient). As mentioned before, there are multiple providers and quality seems very heterogeneous, probably as a consequence of weak institutions in charge of supervising preschool providers (one of which also has a role as provider). In terms of quality, current institutions do not have a clear focus. They are responsible for education in the 0-6 period but schools are gradually absorbing children from PK and Kinder. In this, schools are helped by the existence of the voucher (which is the tool to finance them), so that each child enrolled "comes with money under his or her arm"[16].

In turn, on the demand side of the market, there is little information on (i) returns to ECD and (ii) what is "good" in ECD.

Thus, our main policy suggestions are:

- Clarify roles, separate provision and supervision of quality, particularly the enforcement of standards and quality supervision. From the perspective of efficiency and effectiveness it doesn't make sense that the role of quality assurance is in the hands of the main state provider

[16] In recent years the emphasis has been on the enrollment of children who are 0-2 years old. This has a lot to do with the fact that firms with 20 women or more in its payroll are legally bounded to support child care in this age range for them. But a lot of women work in smaller firms or in the informal sector (and even the size of the firms may be endogenously affected by the policies leaving some mothers without coverage). So this emphasis tries to correct the implicit discrimination in the Chilean law. But it is clear that here the focus is on female labor participation and therefore, perhaps involuntarily, less attention has been put on the quality of the early childhood education.

of child care, as it is the case today. A specialized agency is better suited for this role. Given the recent changes in the school system's institutional framework, and the close connections between both subsystems it is reasonable that the role of quality assurance of the early childhood centers be transferred to the Agency of Education Quality. It should be noted that this Agency has been recently created to review quality for PK to secondary education. An externality of this step is that it will increase the coordination between early and primary education.

- Define focus: our suggestion is to evaluate the separation of institutions that provide child care and early development of skills for 0-2 from an experience that is more educational for 3 and up[17]. Institutions that provide child care for kids who are 3 years old and up may be absorbed slowly by primary education (a phenomenon already observed in the fee–paying private schools).
- Another aspect that requires clarification is the use of early education as a care system to increase labor participation of women. This is a valuable objective, particularly given that it stands among the lowest in Latin America and among OECD countries (only Turkey has a lowest rate). From the empirical literature, already quoted, it seems that at this level a brief (let's say four hours) educational experience is enough to produce the desired results in terms of cognitive and non-cognitive abilities. But not just any program helps. It has to be an enriched experience which, among other things, requires very well prepared personnel. This is expensive and, of course, the cost of financing a long day program is much more that a four hour program. The concern for women labor participation could override the risk is that to have manageable costs the quality of early childhood is below what is required to produce the desired changes in opportunities or that coverage remain low. A better alternative is to distinguish more clearly between both objectives and act in accordance with them (for example the personnel in the morning may be different from the afternoon in the preschool centers).
- The presence of multiple providers and regimes, and the way resources are allocated have led to an arrangement where expenditures for each

[17] We understand there is a lot of debate on this issue and we are simplifying the separation, but given some international experience it makes sense, at least from the point of view of organization of the sector.

child differs enormously. So there are children who receive over 100 percent more money than others for theoretically the same early education. The heterogeneity of the system has a lot to do with this unfair distribution of the resources. Given Chile's more than 30 years' experience with vouchers it seems reasonable to extend this financing scheme to early education (remember it is already in place for PK and K with some restrictions for the first of these levels). We have said earlier than a better design of the voucher system for schools was required. That impulse may be used for designing the voucher for early education. It will help the advance to a fairer treatment of each child and refine the allocation of resources to satisfy different objectives in the first year of children's lives. In addition, it will be an incentive to increase coverage which seems appropriate if all the other reforms we are proposing are in place.

- Some clarification is required about the organization of the state providers. As said before, one is a state organization (JUNJI) and the other is a private NGO (INTEGRA), but for most purposes it is also a state organization (the main difference is that their employees are hired under private law while employees in JUNJI have a public officer status). Both institutions have collaboration with municipalities and private NGOs that supply early childhood education under specific agreements. If a voucher system is introduced these collaborators will get the money directly through the voucher administrator (a division of the Ministry of Education) and the supervision will be in charge of the new institutions: Agency and Superintendencia. Both institutions will remain only as providers. To have two important centralized providers is strange. One possibility is to transfer both organizations' early childhood centers to the state providers of education. Currently these are the municipalities, but there is an ongoing debate as to whether they are the appropriate institutions to be in charge of education. An alternative organization being proposed is a local agency of education (an independent and professional body with a board)[18]. However, no matter how this debate is resolved, this alternative is a possibility. A

[18] The exact form these institutions could take, both geographically and from an organizational point of view, is unclear. We don't discuss this issue in the paper because we are skeptical about the real impact such a transformation could have on educational quality. We think, as suggested below, that independent of how the provider of state education is organized, the key aspect, given the changes in the institutional framework that is taking place in Chile, is to assure more autonomy to state schools.

different way is to keep a centralized provider, evaluating a merger of junji and integra, and organizing the new institution much more professionally with a board responsible for the day to day management and development of the institution, and is at the same time accountable to the Chilean authorities.
- Finally, it is surprising how little is known about the early childhood system. For example, there is no information about the costs of educating children in the different programs. There are no clear goals for these programs and there is a lack of basic performance measures. Hence, it is indispensable to increase the amount, pertinence and quality of information available. This policy is relevant in itself and also as a way of increasing accountability through parent supervision.

4.3. Primary and secondary school markets

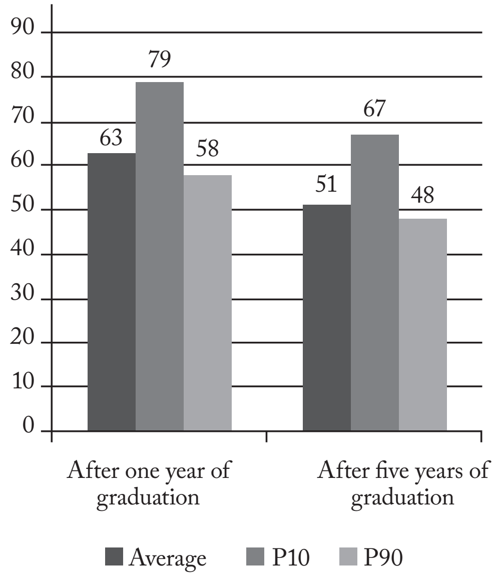
As it is evident from the conclusions of the theoretical framework, while ecd is important for increasing returns of future levels of education, it is also true that investments in preschool education will have a larger return if they are met with "good" schools. In these markets there are many margins in which to intervene, but here we want to mention two that are central and there maybe some room to implement serious reforms. These are teachers and principal markets. The education production function is intensive in human capital, and teachers and principal account for more of the expenditures. Directly or indirectly, governments act as a monopsony in the buying of these educational "inputs". Therefore, their actions and policies are fundamental for the clearing of both markets. Moreover, there are two subsectors receiving the voucher. On one hand, the state owned schools which are in charge of the local governments. Here, salaries are basically defined by a national statute for teachers employed by local governments. Principals are not able to influence their definition. Salaries increase automatically in the state sector with age. In some municipalities the local authorities define some bonuses linked to performance and mostly to children's attendance (the voucher is paid against attendance and not enrollment) that it is paid with extra resources. Principals face a lot of restrictions in the process of hiring and firing teachers, although a very restricted flexibility has been introduced in this process in the last two years. Anyway, the firing of teachers is very difficult. On the other hand, the private subsidized sector faces fewer restrictions. There is a minimum salary and some mandatory assignments that have to be paid to the teachers working in the private subsidized sector. But it is not mandatory to increase salaries with age. In addition, the teachers working in these schools do not have special protection and work under the conditions defined by the private law. Hence, firing is easier. Of course, the state sector works as a kind of benchmark for defining salaries but the private sector doesn't need to keep teachers who don't perform well. Indeed, teachers in the private subsidized sector are younger than in the state sector. This fact allows the private subsidized sector to pay their younger teachers more than in the municipal sector (these data come from the Encuesta Longitudinal Docente 2009). A similar analysis can be applied to the principals market. Hence these markets are far from being "pure" and face a lot of interventions and restrictions in their development. These facts have to be taken into account when considering any policy proposals. Some additional considerations are offered below.

i. Teachers market

Current available evidence suggests that school quality is highly correlated with teacher quality. Unfortunately, it is unclear how to best ensure a high quality teaching force (especially because teacher quality is not that related to *observable* characteristics of teachers), but in the case of Chile it is quite clear that ability plays an important role (as measured very imperfectly by SAT or PSU scores). Teachers in Chile come heavily from the percentiles 33 to 60 in the distribution of PSU scores (with test scores concentrated between 450 and 525 points). This is a consequence of market conditions and lack of social recognition for teachers (probably a by-product of both previous facts: the teaching profession is non selective and market conditions of the teacher market). Then, new teachers are not coming precisely from the high ability groups. It is difficult to change this situation without improvements in working conditions, including salary levels.

With regard to teacher salaries, wages are low and decrease in relation to other college graduates over time (see Figure 8). This happens because salaries in other professions grow fast in Chile with experience while salaries of teacher grow slowly. Moreover, the lower wage tier (which we proxy using the wages of the 10^{th} percentile of the distribution of wages) is in relative terms not that bad and therefore one may think that for a lower–ability individual finds it easier to choose the teaching profession in comparison with someone of higher ability. Therefore, the underlying incentives explain the important increase in teaching programs and enrolment.

Figure 8: Average Teacher Earnings as a Percentage of Other University Graduates' Earnings



We are aware that increases in salaries, especially if they are considered in isolation, are in general not an effective policy (Hanushek and Rivkin., 2006). Variance in salaries is the key but education is a highly unionized sector and the political economy of the reforms in education makes it difficult to achieve reasonable degrees of salary dispersions[19]. But the question remains of how is it possible to attract and retain high ability people without a reasonable compensation? It is important to take into consideration that returns to higher education in Chile are particularly high if compared with most OECD countries (see Education at a Glance 2012, table A8.1, age range 25-64). The same figure for Chile shows a

[19] One point in which Chile is unusual is that only a fraction of the enrollment (i.e. students in public schools) is subject to heavy regulations and a strong unionism. However, private educational providers observe a similar behavior in their salary schemes. Notwithstanding when pressured they react by differentiating salaries.

167 percent difference (based on CASEN 2011)[20]. Moreover, the variance in college graduate salaries is enormous and highly correlated with the selectivity of programs (as measured by college entrance exams). Hence, the opportunity cost for high ability people choosing the teaching profession is very high. Probably these are the relevant figures for attracting new teachers in the margin and in the future (today there are many who have not had higher education).

In this market, to a great extent government defines wages for teachers through negotiations with the only teachers union for the public sector (municipal sector). It is a complex process (e.g., currently there are 18 different allowances for defining teachers compensation) but at the end teachers' wages rely heavily on experience. Although the private subsidized sector requires meeting only some of the conditions agreed in those negotiations (minimum wage among others), it uses them as a benchmark. Moreover, they are constrained by the voucher, which imperfectly accommodates the negotiations recently described, and in some cases they count on additional resources from parents. However, they manage costs by controlling the age of the teachers, an option not open to public schools which face a rigid statute with heavy restrictions for dismissal.

We suggest that to overcome this problem one possibility is to let the government define salaries only for the most able teachers. In Chile there is a teacher evaluation program that classifies teachers in four categories (unsatisfactory, basic, competent and outstanding). The last ones are very few and they can get an extra reward only after getting good qualifications in an exam administered by the central government. The first category is also small.

This salary schedule may follow market conditions for college graduates that may be a relevant reference group for high-quality prospective teachers. A lower bound may be part of this definition but other allowances should be eliminated. School owners (*sostenedores*) will decide who are their outstanding teachers and probably through decentralized negotiations will define salaries for other groups of teachers. Our sense is that this scheme has a better chance to resist the political economy of the educational sector in Chile than alternative overall reforms would and, just as importantly, is aimed at *the* relevant extensive margin of the

[20] If you consider only university degrees, which probably is a better reference group for teachers since they require a university degree, the difference is 264 percent.

teachers market in Chile: increase the number of high quality prospective students entering the teaching profession.

Other policy options that are reflected in the current discussion of a new teachers' law and which should be reinforced are:

- The installation of new barriers of entry accompanied by higher salaries. We know that new requirements for teachers do not necessarily affect their quality (see for example Angrist and Guryan, 2008), particularly if they are implemented as isolated measures. However, there is evidence that a broad set of measures summarizing cognitive and non-cognitive skills can work as a moderately large and statistically significant predictor of teachers' capabilities as measured by students' outcomes (Rockoff et. al. 2011). Moreover, if there is some kind of provisional hiring for the two first years the possibility of screening the best teachers increases significantly. Chile has been experimenting with a screening test, but it is too modest in the abilities that it captures. A better design of the test along the ideas described here is worth pursuing.
- An extensive program of merit pay. Although controversial, merit pay seem to work in different cases (see evidence in Kremer et al., 2013). There are of course difficulties of linking it with children's learning. But it can influence behavior that directly or indirectly may help students' educational achievement. Chile has been experimenting with merit pay, but this is too far removed from daily teaching. Thus, this is an opportunity for new emphasis.
- Steps have to be taken to better inform principals about the teachers' performance, even if the information is not used to determine merit pay. The provision of objective measures of teachers' performance helps principals to make appropriate decisions. So, employer learning increases turnover for teachers with low performance and produces test score improvements (Rockoff et. al. 2012). In an educational system with low performance and lack of standards like the Chilean one it seems important to move in this direction. Chile has been experimenting with teacher evaluation for a long time and can move to more sophisticated levels of information. Particularly, if the country goes to a value added model as explained before, valuable information can be produced for principals. Currently they are getting more detailed information about the performance of their teachers in the national evaluation. Specifically, on the

different aspects that are evaluated in the portfolio they have to submit to this evaluation program. The portfolio includes a recorded class. But this evaluation is relevant only for teachers who work in the state sector and is the consequence of the existent restrictions to their hiring and firing.

ii. Public School Principals

Students tend to perform better in schools that have autonomy, especially if there is accountability (Woessmann, 2003). Chile is going to have a much more strict accountability system in the near future as schools will have to satisfy educational standards and if not, they will have to close. This tendency to be productive needs to be accompanied of higher levels of autonomy (especially at public schools). Currently, principals have almost no autonomy and to a great extent they face restrictions not seen in other countries for deciding about day-to-day matters. In addition, municipalities (the "owners" of public schools), in spite of some changes in the regulation, have too little influence in the appointment of principals.

This is a vicious circle that needs to be fixed: "We don't trust principals. Hence we put them restrictions that limit their autonomy and they are not subject to evaluation because we also don't trust local authorities in charge of education". Therefore, the educational system is characterized by an inertia that is not good for the production of human capital quality.

We think the new system of quality assurance being implemented in Chile is an opportunity to break this vicious circle. It should be much easier and less risky to move for increasing the autonomy of schools and principals in their day-to-day management of the schools and in selecting their teams. In fact, most good performing public schools should be rewarded with this autonomy. Such a policy will also increase incentives for low performance schools to improve their achievement levels.

These changes need to be accompanied by improvements in the process of selecting the principals. Since the system of quality assurance puts emphasis on school achievements the principals' performance will be relatively easy to evaluate. In addition, to comply with this idea, the teachers' statute must be reformed. This is a challenging task, but our view is that the teachers union is weak and has lost support among the public[21].

[21] Branch et al. (2012) provide evidence exactly along the lines of the suggestions in this sub–section. They find positive effects of school principals on student outcomes and argue that these effects seem to operate through the management of the teacher force.

5. Conclusions

This paper takes a relatively optimistic view of the role of education and the production of human capital as a factor to increase productivity and growth in Chile. It is optimistic because we present evidence that human capital quality is important for growth and will likely become more important as Chile approaches the technology frontier (as it is the case now). We are also optimistic because we identify some key areas of reform that we think are feasible and could yield significant improvements in human capital quality, even in the short– and medium-run. However, it is just moderately optimistic because our reading of the evidence is that human capital quality matters, but the *size* of the effects are not of an order of magnitude that will guarantee Chile becoming a developed country just by increasing this factor. Putting it differently, human capital quality is not a panacea for the Chilean growth prospects. Moreover, our evidence also suggests that the impact of human capital quality on growth depends upon other reforms that may increase the economy's productivity.

On how to increase human capital, we think there is room for reform, especially in four areas affecting different margins of the human capital quality production process: (i) institutional reforms to simplify regulations and align different policy instruments; (ii) the development of institutions and policies to increase the quantity and *quality* of the provision of early childhood development and to coordinate this system with the posterior processes of education; (iii) simple reforms affecting the teachers market and, in particular, the ability of the system to affect the extensive margin by increasing the number of high ability students entering the teaching profession, and (iv) reforms aimed at giving more autonomy to schools, and principals in public schools, and improving the selection process.

A final comment on the suggested reforms. As we discussed above we think an agenda of reform in the education system needs for most components to be evaluated from an ex-ante perspective. The education sector in Chile –and in other countries– is full of *grand* proposals or explanations without empirical evidence. Take the recent *discontinuous* increase of tests scores in Chile since the 2010 round of the SIMCE test, especially among the poorer students. Explanations given to this increase range from short-run policy changes implemented by different governments to explanations related to increases in pre-school enrollment, in the value of the voucher to poor students, in the number of hours taught in Chile since a major reform implemented since the late 1990s, and in the years of education of mothers. Do we know whether these explanations are plausible? Yes, for all of them one could find some supporting empirical correlations or even causal evidence for other countries. Do we know whether they mattered *for Chile*? No, unfortunately. All these policies lacked a serious evaluation to identify their causal effects of school quality. Why? Because most of them were implemented at once in most of the system without really knowing whether they were going to work or not. A humbler approach is to try to prove the reforms (when possible) in a pilot program for a subset of the educational system, learn whether they work as intended and whether they have the expected impacts and next, if they work, move to implement the reforms throughout the educational sector or in the areas where the worked as expected. This certainly applies to a number of the reforms we suggest in this paper.

References

Acemoglu, D. P. Aghion, and F. Zilibotti (2006) "Distance to Frontier, Selection, and Economic Growth" Journal of the European Economic Association, 4 (1): 37-74.

Aghion, P., L. Boustan, C. Hoxby, and J. Vandenbussche (2009). "The Causal Impact of Education on Economic Growth: Evidence from U.S". Brookings Papers on Economic Activity.

Aghion, Philippe, Peter Howitt y David Mayer-Foulkes (2005). "The Effect of Financial Development on Convergence: Theory and Evidence" Quarterly Journal of Economics 120 (1): 173-222.

Allende, C. and F. Gallego (2013) "Short Run Impacts of Information on School Choice and School Outcomes: Evidence from Discontinuities", Work in Progress, PUC-Chile.

Andrabi, Tahir, Jishnu Das, Asim Ijaz Khwaja, and Tristan Zajonc. 2011. "Do Value–Added Estimates Add Value? Accounting for Learning Dynamics". American Economic Journal: Applied Economics, 3(3): 29-54.

Angrist, J. and J. Guryan (2008) "Does teacher testing raise teacher quality? Evidence from state certification requirements", Economics of Education Review, Elsevier, vol. 27(5), pages 483-503, October.

Baker, M., J. Gruber, and K. Milligan (2008) "Universal Childcare, Maternal Labor Supply and Family Well–Being" Journal of Political Economy, Vol. 116 N. 4, pp. 709-745.

Baker, Eva L., Paul E. Barton, Linda Darling-Hammond, Edward Haertel, Helen F. Ladd, Robert L. Linn, Diane Ravitch, Richard Rothstein, Richard J. Shavelson, and Lorrie A. Shepard. (2010). "Problems with the Use of Student Test Scores to Evaluate Teachers", Economic Policy Institute Briefing Paper Nr. 278.

Banerjee, A. and Duflo, E. (2011). Poor Economics. Public Affairs.

Barro, R. (1999) "Determinants of Economic Growth: Implications of the Global Evidence for Chile" Cuadernos de Economía, Vol. 36, N° 107, pp. 443-478.

Barro, Robert J. 2001. "Human Capital and Growth". American Economic Review, 91(2): 12-17.

Barro, R. and X. Sala-i-Martin (2004). Economic Growth. The mit Press.

Bassi, M., M. Russo, S. Urzua and J. Vargas, (2012). Desconectados: Habilidades, Educacion y Empleo en America Latina. Banco Interamericano de Desarrollo.

Becker, Sascha O. and Ludger Woessmann, (2009). "Was Weber Wrong? A Human Capital Theory of Protestant Economic History", The Quarterly Journal of Economics, 124(2), pages 531–596, May.

Beyer, H. (2001) "Falencias institucionales en educacion: Reflexiones a proposito de los resultados del timss" Estudios Publicos 82.

Bernanke, B. and R. Gurkaynak (2002) "Is Growth Exogenous? Taking Mankiw, Romer, and Weil Seriously". in NBER Macroeconomics Annual 2001, Volume 16, mit Press.

Bitran, E. y C. Gonzalez (2010) "Productividad Total de Factores, Crecimiento e Innovacion", Documento de Referencia, cnic.

Branch, G., E. Hanushek, and S. Rivkin (2012) "Estimating the Effect of Leaders on Public Sector Productivity: The Case of School Principals" NBER Working Paper No. 17803.

Cabezas, V., J.I. Cuesta, and F. Gallego (2011) "Effects of Short-Term Tutoring on Cognitive and Non-Cognitive Skills: Evidence from a Randomized Evaluation in Chile", Manuscript, Catholic University of Chile.

Chetty, Raj. John Friedman, and Jonah Rockoff (2011) "The Long-Term Impacts of Teachers: Teacher Value-Added and Student Outcomes in Adulthood" NBER Working Paper No. 17699.

Contreras, D. and F. Gallego (2013) "La madre de todas las batallas: asegurar el acceso a una educacion decalidad integral" en 95 Propuestas para un Chile Mejor, Grupo Res Publica Chile.

Cunha, F. and J. Heckman (2007). "The Technology of Skill Formation", American Economic Review: Papers and Proceedings 97 (2): 31-47.

Cunha, F., J. Heckman and S. Schennach (2010) "Estimating the Technology of Cognitive and Noncognitive Skill Formation", Econometrica Volume 78, Issue 3, pages 883-931.

De Gregorio, J. (2005) "Crecimiento economico en Chile: Evidencia, fuentes y perspectivas" Estudios Publicos Nº 98.

Fuentes, R., M. Larraín, K. Schmidt-Hebbel (2006) "Sources of Growth and Behavior of tfp in Chile" Cuadernos de Economía, Vol. 43, N° 127, pp. 113–142.

Gallego, F. (2010) "Historical Origins of Schooling: The Role of Democracy and Political Decentralization", The Review of Economics and Statistics, vol. 92(2): 228–243.

Gallego, F. and A. Hernando (2009) "On the Determinants and Implications of School Choice: Evidence from Chile", Economía 9 (1)".

Gallego, F. Lagos, and Y. Stekel (2013) "Information and School Choice: Experimental Evidence from Low-Income Markets", Mimeo, puc–Chile.

Gallego, F. and N. Loayza (2002) "The Golden Period for Growth in Chile. Explanations and Forecasts", in Economic Growth: Sources, Trends, and Cycles edited by Norman Loayza and Raimundo Soto. Central Bank of Chile.

Gallego, F. and C. Sapelli (2008) "El Financiamiento de la Educacion en Chile: Un Analisis Economico" Revista de Pensamiento Educativo, 40 (1): 263-284.

Gennaoili, N., R. La Porta, F. Lopez-De-Silanes, and A. Shleifer (2013). "Human Capital and Regional Development" Quarterly Journal of Economics, 128 (1): 165-204.

Hall, Robert E., and Charles I. Jones. 1999. "Why Do Some Countries Produce So Much More Output per Worker than Other?" Quarterly Journal of Economics, 114(1): 83-116.

Hanushek, Eric A. & Rivkin, Steven G. (2006). "Teacher Quality", in Handbook of the Economics of Education, Elsevier.

Hanushek, Eric A., and Dennis D. Kimko. 2000. "Schooling, Labor–Force Quality, and the Growth of Nations". American Economic Review 90(5): 1184-1208.

Hanushek, E. and Ludger Woessmann, 2008. "The Role of Cognitive Skills in Economic Development", Journal of Economic Literature 46(3), pages 607-68, September.

Hanushek, E. and Ludger Woessmann, 2009. "Do Better Schools Lead to More Growth? Cognitive Skills, Economic Outcomes, and Causation", nber Working Papers 14633, National Bureau of Economic Research, Inc.

Jamison, Eliot A., Dean T. Jamison, and Eric A. Hanushek. 2007. "The Effects of Education Quality on Income Growth and Mortality Decline". Economics of Education Review, 26(6): 771–88.

Klenow, P. and Mark Bils (2000). "Does Schooling Cause Growth?", American Economic Review, vol. 90(5), pages 1160-1183, December.

Kremer, M., C. Brannen, and R. Glennerster (2013) "The Challenge of Education and Learning in the Developing World" Science 340, 297 (2013).

Krueger, Alan B., and Mikael Lindahl. (2001). "Education for Growth: Why and for Whom?" Journal of Economic Literature, 39(4): 1101-36.

mineduc (2013) "Equidad en los aprendizajes escolares en Chile en la ultima decada". Serie Evidencias, May.

oecd. (2011). Education at a Glance 2011. Paris

oecd. (2012). Education at a Glance 2012. Paris.

Pritchett, Lant. 2001. "Where Has All the Education Gone?" World Bank Economic Review, 15(3): 367-91.

Ramírez, M.J. (2007) "Diferencias dentro de las salas de clases. Distribucion del rendimiento en matematicas" Estudios Publicos Nº 106.

Rockoff, J., B. Jacob, T. Kane, and D. Staiger. (2011). "Can you Recognize an Effective Teacher when you Recruit one?" Education Finance and Policy. 6(1): 43-74.

Rockoff, J., D. Staiger, T. Kane, and E. Taylor. (2012). "Information and Employee Evaluation: Evidence from a Randomized Intervention in Public Schools". American Economic Review. 102(7): 3184-3213.

Schoellman, T. (2012) "Education Quality and Development Accounting" Review of Economic Studies, 79(1): 388-417.

Woessman, L. (2003) "Schooling Resources, Educational Institutions and Student Performance: the International Evidence", Oxford Bulletin of Economics and Statistics, vol. 65(2), pages 117-170, 05".

Vandenbussche, Jerome, Philippe Aghion, and Costas Meghir. 2006. "Growth, Distance to Frontier and Composition of Human Capital". Journal of Economic Growth, 11(2): 97-127.

What impedes Chile's catching up with the United States?

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1. Motivation

There are two main questions regarding total factor productivity (TFP) growth in Chile. First, how do development barriers contribute to lower TFP productivity in respect to the developed world? Second, what factors explain the "sudden stop" of TFP growth in the late nineties? This paper focuses on the first question. In particular, among the many factors that determine TFP, we focus on the role of technology adoption in explaining TFP improvements and the factors that impede technology convergence with leading economies such as the United States.

The literature has provided several explanations for TFP differences across countries. These explanations may be grouped in three main branches: technological change (*e.g.* Segerstrom, 1991; Grossman and Helpman, 1991; Aghion and Howitt, 1992), barriers and distortions (Parente and Prescott, 1994, 1999, 2002; Davis and Haltiwanger, 1992; Restuccia and Rogerson, 2013; Hsieh and Klenow, 2009) and institutions (Acemoglu, 2009 and the references therein). This paper concentrates on the relationship between technological change and TFP differences.

Adoption and innovation constitute the main vehicles producing technological change. Although all economies perform both types of activities, developed economies rely more on innovation while developing economies focus more on adoption activities. Due to our interest in the Chilean economy, we concentrate mainly on factors explaining technology adoption.

This paper quantifies the contribution of development barriers to the productivity gap between Chile and the United States. We concentrate on four factors that shape the absorptive capacity of a developing country and thus its possibility to grow through technology adoption. These factors are: the microeconomic flexibility of the markets that favor the entry and exit of firms and hence the rate of creative destruction; the overall institutional environment that enhances/impedes R&D activity; the number of hours students spend in school; and the quality of these education hours. The latter two variables are crucial in explaining the average stock of human capital.

Following Aghion and Howitt (1992), and Howitt (2000), we calibrate a model where technological adoption is a function of the distance to the technological frontier and the absorptive capacity of the economy. Key determinants for this capacity are the overall institutional environment that enhances/impedes R&D activity, the microeconomic flexibility of the markets that favor the entry and exit of firms and hence the rate of creative destruction, and the quantity and quality of human capital.

With the actual parameters for Chile and the United States, we calibrate the steady state technology gap for the Chilean economy. Starting from the predicted steady-state value, we conduct comparative statics to quantify the change in the technology gap when Chile improves the value of these parameters to the level of those in the United States. In other words, we measure how much the gap would close if Chile, for instance, increased human capital quality to match the one of the United States.

A second group of exercises is to estimate the effect on the level of productivity when improving two parameters at the same time, for instance the quality of human capital and the type of institutions. There are two forces acting on the technological improvement: a) the initial gap and b) the overall economic environment (determined by the level of all four parameters). If the economic environment is poor, the yield of making any reform (improve any given parameter) will be small. So when improving two parameters simultaneously, the economic environment will improve; but at the same time the technological gap will become smaller. The final effect depends on which effect prevails. This second type of exercises allows us to measure whether policies are complementary or not. In other words this exercise will compare the effect of improving two parameters at the same time with the sum of the individual effect of improving one parameter at the time.

Simulation exercises allow us to identify the main weaknesses of the Chilean economy and to quantify the concrete weight of each development barrier in explaining the TFP gap with the United States. Results show that Chile's most urgent tasks for improvement are to increase the quality of the education system and to improve the overall institutional environment that favors R&D activity and eases the adoption and use of new technologies. In fact, the actual education system quality explains more than 50% of the steady-state productivity gap with the United States and the lack of a competitive R&D environment an additional 30% of this gap.

This paper is organized as follows. After this introduction, the next section presents some stylized facts motivating our discussion. The third section outlines the conceptual framework sustaining the calibration exercises that quantify the role of each factor in explaining the adoption capacity of the economy. Section four presents and discusses the calibration of the relevant parameters to determine the technological gap between Chile and the United States in steady-state. This will set up the benchmark case; that is to say, it will set the steady-state gap between these two economies. Section five presents the calibration results for the Chilean economy in respect to the United States. In this section, we perform several comparative static exercises to disentangle the contribution of each factor in explaining the productivity gap between both economies. Finally, in section five we discuss some policy lessons for the Chilean economy.

2. Some stylized facts

There are two interesting facts in the Post-War period that need to be highlighted: the technological frontier's rapid growth and the way that some economies have taken advantage of this expansion while others have captured a small share of this benefit. These two features are shown in Figure 1, which shows the distribution for GDP per worker, averaged over the periods 1960-1965 (panel a) and 1995-2000 (panel b). Looking at the horizontal axis one sees that the GDP per worker distribution ends at 40,000 USD at PPP in 1960-1965, while in 1995-2000 the distribution ends at almost 60,000 USD at PPP.

This evidence supports the first conclusion regarding the fast expansion in the technological frontier. In addition, the distribution stretched out over this forty-year period. In the first period, the distribution shows a slight bimodality around 20,000 USD and 30,000 USD. In the second period, the distribution exhibits a marked bimodality, around 20,000 as in the previous period, but also around 52,000 USD for the second mode. There is a polarization in per capita income during the 1960s, but the poles moved further apart during the following forty-year period.

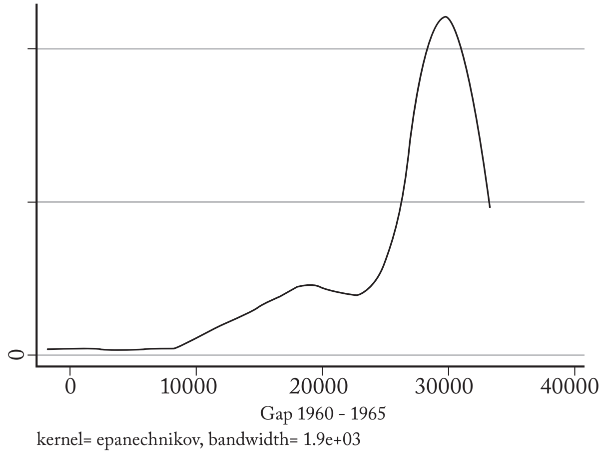
According to the economic development literature, total factor productivity is the main driver of cross-country differences in the level of *per capita* income. Unfortunately, TFP is a black box.

The understanding of innovation and adoption of new technologies has helped to lift the veil of our ignorance. Theory predicts that technological change, which is the outcome of these activities, is crucial for an economy to stay competitive. It is a consensus that, between both activities, adoption is the most relevant for less developed countries. Nevertheless, both activities, adoption and innovation, are relevant for developed economies to keep their leading positions.

The polarization observed in Figure 1 may be explained by the innovation and adoption efforts made by each economy. Research and development (R&D) investment is the required factor to change (innovation) or to catch up with (adoption) the technological frontier. Given this connection between R&D effort, adoption and, innovation, we present the following facts for Chilean R&D investment.

Figura 1. Productivity gaps in the world.

Panel (a)



Panel (b)

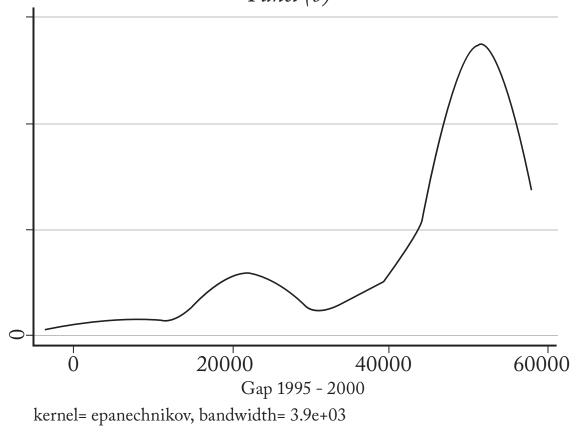
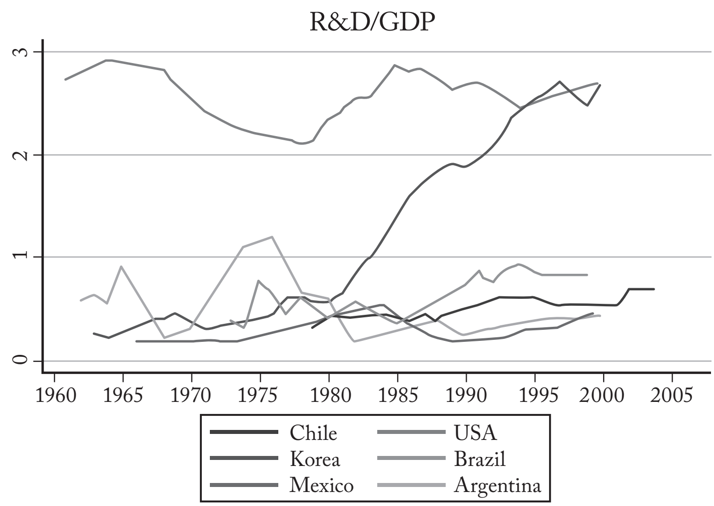


Figure 2 shows different patterns of R&D expenditures as a ratio of GDP across countries: a group of Latin American economies, a fast growing middle-income economy, Korea, and a developed economy, the United States. The latter economy spent, on average, 2.5% of GDP over the period 1960-2000 while the Latin American group spent, on average, 0.5% over the same period. It is interesting to note Korea did not differ from the Latin American group until 1980, but since then, the R&D to GDP ratio exhibits a pronounced upward trend, reaching the level of the United States by the 1990s. We should note that Korea was a fast growing economy during the 1960s and 1970s before increasing the R&D to GDP ratio. It seems that as an economy becomes more developed, it starts spending more on R&D, which allows it to keep growing and to maintain a leading position. In other words, this figure suggests that innovation efforts may come later in the process of development[1].

Figure 2. R&D expenditures over GDP for several economies: 1960–2000.



The determinants of R&D investment emphasized in the literature are the quality of institutions, the quantity and quality of human capital, and barriers to entry and exit. Human capital is a factor that enhances R&D investment, since the adoption of new technologies requires a certain stock of human capital to be performed. In the dynamic setting of a Schumpeterian world

[1] Another interpretation of this figure is that the production structure in Latin America is associated with natural resources, while Korea is more oriented to manufacturing due to natural resource scarcity Moreover, as Korea becomes more developed, its pattern of production may become even more R&D intensive.

where R&D firms invest to challenge incumbents, new market entrance barriers discourage R&D investment and act as deterrent for creative destruction. Barriers to entry decrease profits of R&D firms and thus, reduce the investment and innovation. Barriers to exit also operate as barriers to entry, keeping less productive firms in the market and discouraging the entry of more productive firms, since they will face high costs should they want to leave the market.

Given that economic development and R&D are related, it is worthy to address whether Chile's R&D efforts match its stage of development. In order to do so, we conduct a simple exercise, which does not represent a full model of R&D investment; it just illustrates some relationships and Chile's position regarding these factors. We use the Lederman and Saenz database to run locally weighted regression[2] (lowess) for panel data of 70 countries and annual data for the 1960-2005 period, using as dependent variable different measures of R&D investment. We estimate the predicted value for Chile and compare it with the actual value. The variables used are standard in the literature: R&D expenditure over GDP, personnel in R&D per 1000 people, and expenditures in licenses over GDP[3]. Table 1 presents the predicted and actual values and the corresponding ratio for each sub period. For all periods and all indicators Chile has lower R&D expenditure over GDP than the predicted value by its stage of development. For instance, in the period 2000-2005, Chile has 41 persons of 10000 inhabitants allocated to R&D compared to the 140 persons predicted by the model, *i.e.* Chile has only about one third of the people that it should have according to its *per capita* income. The gap for R&D expenditure over GDP is almost two-thirds of the predicted value of the regression, showing again a deficiency in the R&D effort.

Figure 3 displays the predicted values of the regression of R&D/GDP ratio on the quantity and quality of human capital, and barriers to entering and exiting the market. In all dimensions, except education quality, Chile appears below the corresponding predicted value by the regression. Given the average years of schooling, Chile should be investing more than three times what it is. On the other hand, conditional on the quality of human capital as measured by cognitive capacity (the average TIMSS science

[2] Locally weighted regression (lowess) is a non-parametric technique that searches for the closest relation between two variables via smoothing the scatter plot (see Cleveland, 1979). The idea is to smooth the fit of a low-degree polynomial regression for each point of the data.

[3] The latter variable has been questioned as being good proxy of inputs for technological change since it tend to be more relevant for the pharmaceutical industry rather than for the whole economy.

and mathematic test scores), Chile is investing accordingly based on the predicted value; this result suggests that low educational quality is the bottleneck for higher R&D investment. Regarding barriers to entry and exit, Chile is above the median, but below the predicted value. Table 2 summarizes the gaps between predicted and actual values for Chile conditional on each factor.

Table 1. Inputs for technological change.

	R&D/GDP (%)			Personnel in R&D 1000 inhabs.			Licenses/GDP (%)		
	Actual	Predicted	Ratio	Actual	Predicted	Ratio	Actual	Predicted	Ratio
71-75							0.08	0.18	0.45
76-80	0.37	0.62	0.60	0.24	0.96	0.25	0.10	0.18	0.55
81-85	0.42	0.59	0.71	0.28	0.95	0.30	0.14	0.00	
86-90	0.44	0.66	0.67	0.33	1.02	0.32	0.14	0.20	0.71
91-95	0.59	0.84	0.70	0.40	1.18	0.34	0.09	0.21	0.40
96-00	0.55	0.96	0.57	0.40	1.34	0.30	0.29	0.25	1.15
01-07	0.63	1.00	0.63	0.41	1.38	0.30	0.32	0.27	1.20

Figure 3. Determinants of R&D.

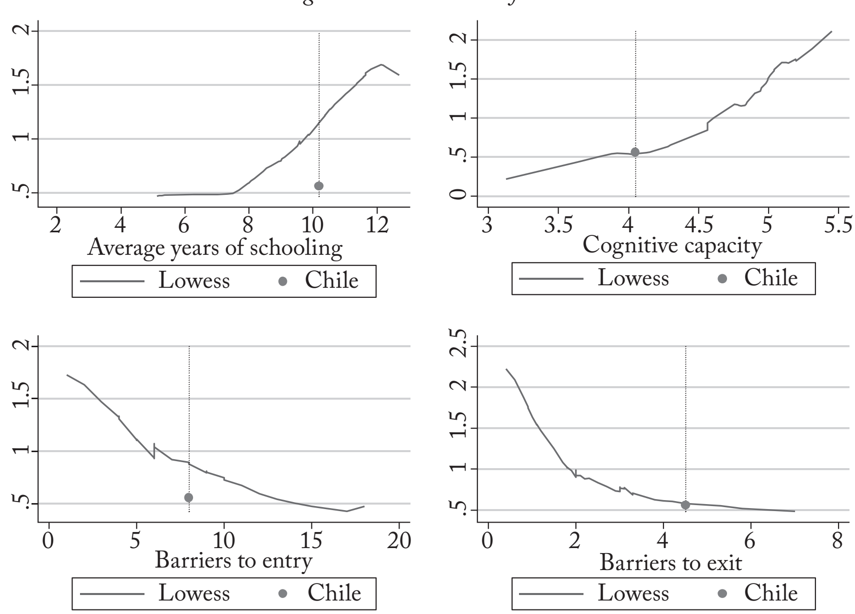


Table 2. Gaps in R&D efforts.

Indicator	R&D/GDP		
	Actual	Predicted	Ratio
Schooling	0.56	1.13	0.50
Cognitive	0.56	0.54	1.04
Barriers to entry	0.56	0.88	0.64
Barriers to exit	0.56	0.58	0.97

In summary, there has been an increasing dispersion in the level of *per capita* income across countries over time. One plausible explanation is that adoption and innovation activities take place at slower pace in some countries. These activities are associated with R&D investment. Exploring some correlations between this variable and development level, we find that Chile makes little effort in this regard compared to economies at a similar stage of development.

3. Conceptual Framework

Following the large body of literature that highlights the role of TFP differences in explaining per capita income gaps among countries (for instance, Klenow and Rodriguez-Clare, 1997; Hall and Jones, 1999; Casselli, 2005), we focus our analysis on TFP behavior, untangling the main components that explain TFP improvements in the long run. In the first part of this section, we write the typical accounting decomposition to show the effects of TFP on labor productivity differences. In the second part, we set up a canonical model of technology adoption comprising the main factors that explain TFP improvements through adoption.

3.1. Accounting for differences in average labor productivity

We start our analysis by assuming that both economies, Chile and the United States, produce a final good by a standard production function of the type:

$$(1)\ Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$$

where A_t corresponds to the average technology level of the economy, K_t to the stock of physical capital and L_t to the quantity of labor in the economy, which is fixed. Dividing equation (1) by L, we get average labor productivity, which corresponds to:

$$(2)\ y \equiv \frac{Y}{L} = A^{\frac{1}{1-\alpha}}\left(\frac{K}{Y}\right)^{\frac{\alpha}{1-\alpha}}$$

Consequently, the labor productivity gap between Chile and the United States can be expressed as:

$$(3)\ \frac{y_i}{y_{US}} = \left(\frac{A_i}{A_{US}}\right)^{\frac{1}{1-\alpha}}\left(\frac{K_i/Y_i}{K_{US}/Y_{US}}\right)^{\frac{\alpha}{1-\alpha}}$$

Therefore, to account for cross-country differences in labor productivity we need to estimate measures of TFP and the capital-output ratio gap. Equation (3) shows that the productivity gap is the main factor explaining average labor productivity differences in the long run, as the capital/output ratio of each country in respect to the US economy should be close to one in steady-state. Our goal is to identify and quantify the bottlenecks for accessing a higher TFP[4].

3.2. Modeling TFP differences

We build a model that encompasses three features of the growth process of *per capita* income in emerging economies. First, technology adoption is the main determinant of economic growth and *per capita* income in the long run (Howitt 2000; Howitt and Mayer; Foulkes, 2005). Second, policies and institutions affect the benefits of R&D investment and thus the speed and amount of productivity improvement (Parente and Prescott, 1994; Acemoglu *et al.,* 2006). Finally, the availability of human capital determines the ability of adopting advanced technologies (Nelson and Phelps, 1966; Benhabib and Spiegel, 2005).

All these characteristics are set up in an adoption model. Following Aghion and Howitt (1998), Howitt (2000), and Howitt and Mayer-Foulkes (2005), the dynamic path for TFP depends on two main factors: i) the gap between the country's actual level of technology and the technological

[4] We are not making any distinction between increasing TFP and improving the level of technology. We are aware that they are not the same, but they are closely related. From now on we will refer to both as synonyms.

frontier; and ii) the country's absorptive capacity to copy more advanced technology. At the aggregate level, technology will improve according to

$$(4)\ At = A_{t-1} + \eta\ (A_{max,t-1} - A_{t-1})$$

At each moment of time the potential adoption depends on the technology gap, where A_{maxt-1} is the technological frontier and A_{t-1} is the level of technology in a specific country at t-1. The absorptive capacity η is defined as

$$(5)\ \eta = \phi\lambda \left(\frac{hk_{t-1}}{hk^{*}_{t-1}}\right)^{\gamma}$$

This capacity comprises three elements. The first one includes barriers, policies, and all institutional arrangement that affect the copy of technologies; we will call it the adoption barrier parameter, λ. This parameter is in the spirit of the adoption barriers emphasized by Parente and Prescott (2002) and fluctuates in the range [0,1]; λ equal to one means there are not barriers to adopting technologies while λ equal to zero implies maximum barriers.

The second element is the probability of being successful in copying the technological frontier (φ). This is a key variable in the Schumpeterian growth literature; technological improvement occurs when a new firm successfully adopts a new technology and displaces the incumbent. In general equilibrium, this probability is endogenously determined (for instance, models in Aghion and Howitt, 1998; and Grossman and Helpman, 1991). It usually depends on all incentives to performing R&D. At the aggregate level, this probability becomes the rate of creative destruction, *i.e.* the fraction of sectors that are successful in adopting a new technology in each period. In equilibrium, all policies that affect the entry and exit of firms will affect this probability. In this setup, we take this probability as a given, but it can be derived endogenously in a more complete model.

The third component is the ratio of domestic human capital to the leading country's human capital stock, hk_t/hk^{*}_t. In this specification, we assume that the stock of human capital relative to the complexity of the technological frontier is what matters. We use the stock of human capital in the countries that are systematically improving the technological frontier as a proxy of the human capital needed to fully copy this frontier. We denote this stock by hk^{*}_t. Second, the measurement of human capital involves two components: quantity and quality. The quantity of human capital is closely related to the average years of schooling of the labor force and this is the measure used here. The second component is harder to measure. We use the return of one additional year of schooling for a Chilean immigrant in the United States, as estimated by Schoellman (2010). Thus our measure of human capital is $(1+\rho)^n$, where ρ is the return of one additional year of schooling and n is the average years of schooling of the labor force. All these elements are combined in equation (5).

Finally, parameter γ captures the intensity of the adoption activity using human capital to copy new technologies. When combining equations (4) and (5), it is easy to understand that the yield of improving a single parameter (φ, λ, hk) depends on the levels of the other parameters and the distance to the technological frontier. Therefore, a less developed economy that increase its human capital stock will have a large increase in the level of productivity as it has a large initial gap, but a smaller effect due to the low level of the other parameters. The contrary is true for a more developed economy, which is closer to the technological frontier, but has better parameters determining the absorptive capacity.

4. Calibration of the parameters of the model

The model in the previous section illustrates the determinants of the steady state gap of TFP between the leading economy and any other economy. In this section we present how we calibrate the parameters for Chile and the United States to conduct comparative statics using the model. In this way, we are able to quantify the contribution of different policies on the productivity gap between these two countries.

4.1. Parameter choice

We assign a value of 0.34 to the capital share of output a[5]. The World Bank constructs various indicators, called KEI indexes, which measure the capacity of an economy to diffuse and produce knowledge. One of the KEI indexes measures the innovation capacity of the country; this is our proxy for the institutional variable λ. As we measure income and productivity

[5] This number comes from Gollin (2002), who estimates this coefficient for a large group of countries.

gaps relative to the US, we consider the US economy as the one with the best practices. Consequently, we scale the index relative to the US, and assign a value of 1 to the US and 0.70 to Chile.

Human capital stock is composed by two elements, quantity and quality. The average amount of schooling in the US is 12.2 years, while Chile is 10.2. The quality is measured by the returns of an additional year of schooling as estimated by Schoellman (2010). The return for an additional year of education is 9.3% for a US worker and only 5.6% for a Chilean worker. The relative stock for Chile's human capital is estimated as 58.9%, using the following formula

$$\left(\frac{hk_{t-1}}{hk^*_{t-1}}\right) = \frac{(1+p_{CH})^{n_{CH}}}{(1+p_{US})^{n_{US}}} = \frac{(1.056)^{10.2}}{(1.093)^{12.2}} = 0.589$$

Creative destruction, in turn, is proxied by the firm entry rate reported by the World Bank for 2005. The US has an entry rate of 13.1%. Chile, in contrast, exhibits an entry rate of 11.2%. We assume that the growth rate of the technological frontier g is 2.2%, which is the average *per capita* US growth rate for the years 1960-2006.

4.2. Estimation of the parameter Γ

Finally, we need an estimate of parameter γ. This parameter defines the insensitiveness of human capital use by the adoption activity. There is no evidence in the literature about its value. We can estimate this parameter from equations (4) and (5) using cross-country data on total factor productivity provided by Calderon (2011), with t=2005 and t-1 = 2004. The institutional parameter λ summarizes the institutional framework that enhances or hampers the transfer and adoption of new technologies. The proxy used for this variable is the KEI indicator, constructed by the World Bank, which condenses a country's innovation capacity. The World Bank constructs various KEI indicators that measure the capacity of an economy to diffuse and produce knowledge. We estimate equation (4) using different KEI indexes as shown below.

The probability of technology improvement φ corresponds to the rate of creative destruction. The entry rates of firms reported by the World Bank for 2005 or the nearest available date are our proxy for the creative destruction rate. Finally the ratio of human capital in country c to the human capital needed to copy the frontier (hk_c/hk^*) corresponds to the ratio of human capital returns to the power of years of schooling for each country relative to the us.

We use a sample of 70 cross-country observations. We estimate the following equation using data for total factor productivity, computed Solow residuals for years 2004 and 2005:

$$(6)\ A_t = A_{t-1} + \phi\lambda \left(\frac{hk_{t-1}}{hk_{t-1}}\right)^{\gamma} (A_{max,t-1} - A_{t-1}) + \varepsilon_t$$

The tfp level of the us was used as the technological frontier. Table 3 exhibits the non-linear least square estimation of equation (6). We estimate the previous equation with four separate kei indices that serve as proxies for the institutional environment governing adoption activity. The value of the parameter γ, which estimates how intensively capital is used, fluctuates between 1.47 and 1.85[6].

Table 3. Estimation of productivity gaps: 1960-2000

	KI Innovation	KI Regulations	KI Infraestructure	kei Global
Γ	1.85**	1.47***	1.74***	1.63***
	(0.51)*	(0.51)*	(0.56)*	(0.50)*
N	70	70	70	70

Robust standard errors in parentheses * significant at 5%; ** significant at 1%

5. *Comparative statics using the model*

In this section we calibrate the model to estimate what are the main constraints for Chile to reach the technological frontier. First, we calibrate the model for the tfp parameter A. Afterwards, we use equation (3) to infer the steady-state gap between the *per capita* incomes of Chile and the us.

To disentangle the bottlenecks of the Chilean economy, we run some exercises. First, we estimate the steady-state productivity gap of Chile relative to the us using the current policy parameters. Then, we quantify the contribution of each factor in explaining this gap. The factors considered

6 In this type of model, Mies (2010) has shown that a γ greater than one may lead to polarization in the distribution of tfp around the world.

are: institutional environment for performing R&D (*l*), microeconomic flexibility (*f*), and human capital. In the case of human capital, we divide its contribution into education quantity and quality.

Given the actual Chilean policy parameters, the model generates a simulated productivity ratio of 0.757 in respect to the US total factor productivity in the steady state. Considering a *per capita* capital output ratio between Chile and the US of 0.86 (Calderon, 2011) and a capital output share of 0.34, this productivity ratio implies a per worker output ratio of 0.7 in the steady state. Actual per worker output ratio between Chile and the US is around 0.5. Thus, given the actual parameters of the Chilean economy, our simulations find that the income gap will be 30% in the steady state compared to the actual 50%[7]. In other words, the model predicts that the Chilean economy will close the gap by around 20% given its current policy parameters. Accessing higher per worker output levels than this would require drastic improvements.

It is not easy to determine the contribution of policy changes, since their effects on the productivity gap depends on all other parameter values and the distance to frontier. Therefore, we perform different policy exercises in an attempt to identify their potential contributions. Table 4 presents these results. The first row in each column, the "initial ratio" corresponds to the calibrated gap in the steady-state given the actual policy parameters in Chile. This is 0.757. Afterwards, we evaluate impacts on TFP by changing every parameter to the corresponding US value. The second column shows the results where simultaneously change two parameters to the US level. The third column shows the exercise of changing three policy parameters.

As seen in Table 4 improving educational quality will increase the steady-state ratio by 13 percentage points. Another way to say this is that the productivity gap in the steady state is 32%, and if Chile's education reaches the US levels, the new steady sate gap will be only 12%. That is to say, a large improvement in education quality would close the gap by almost 60%. If we increase the average years of schooling up to the level of the US (12.2 years), the gap will decrease by 7 percentage points. If we could implement both policies at the same time, as shown in the second part of Table 4, Chile's productivity will be 94% of the US, *i.e.* the gap will be only 6%. Improving education as whole will close the gap by 78%.

[7] Through growth accounting exercises, Calderon (2011) estimated a current TFP ratio of 0.49.

TABLE 4: PRODUCTIVITY GAPS: DIFFERENT POLICY PARAMETERS.

Parameters at the U.S. value A Chile)/(A U.S.)		Parameters at the U.S. value (A Chile)/(A U.S.)		Parameters at the U.S. value (A Chile)/(A U.S.)	
Initial ratio	0.7565	Initial ratio	0.7565	Initial ratio	0.7565
years schooling	0.7996	Years schooling, barriers	0.8693	years schooling, barriers, ed. quality	0.9886
ed. quality	0.8848	Years schooling, flexibility	0.8186	flexibility, barriers, ed. quality	0.9567
Flexibility	0.7766	Years schooling, ed. Quality	0.9391	years schooling, barriers, flexibility	0.8860
Barriers	0.8308	Ed. Quality, Flexibility	0.9009		
		Barriers, flexibility	0.8489		
		Barriers, ed. Quality	0.9431		

The second factor consists of an institutional environment that favors R&D, adoption and innovation (barriers). The poorer environment in respect to the US explains 27% of the gap. This institutional variable measures four different factors that are relevant in a knowledge economy (according to the KEI index used as proxy of institutional environment). These are economic incentives and institutional regime (including tariff and nontariff barriers, quality of regulations, rule of law); innovation systems (including royalty and license fees payments, patent applications granted, and scientific and technical journal articles); information and communication systems (computers and telephone lines per inhabitants and percentage of internet penetration); and general human resources (adult literacy rate, and secondary and tertiary enrollment). In these areas, Chile needs to particularly improve in ICT and innovations systems, while it performs better in economic incentives and institutional regime.

In the previous exercise, the effects of policy improvements were estimated by holding all other parameters fixed at the current (low) level. But, if multiple reforms are implemented at the same time, there will be an additional increase in productivity, resulting from all policy parameters being at a higher level. The second column of Table 4 shows the effect when moving two parameters at the same time and the third column when three parameters reach the value of those in the US. Note that if Chile improves education quality and quantity, and reduces barriers to adoption, the level of productivity in Chile will be almost 99% of the US. This effect is larger than adding individual effects because the policy interactions increase the marginal productivity of other policies.

Table 5 presents the implied steady-state income per worker gap, assuming that capital/income ratio between Chile and the US is at its current value of 0.86. We start with a labor productivity ratio of 0.7, which is the current steady-state ratio. Improving quantity and quality of human capital increase that ratio to 87%. Reducing adoption barriers increases the ratio to 91.5%.

TABLE 5: IMPLIED INCOME GAPS: DIFFERENT POLICY PARAMETERS. (ASSUMING ACTUAL CAPITAL INCOME RATIO=$(K/Y)_{CH}/(K/Y)_{us}$=0.86)

PARAMETERS AT THE U.S. VALUE (Y/L CHILE)/(Y/L US)		PARAMETERS AT THE U.S. VALUE (Y/L CHILE)/(Y/L US)		PARAMETERS AT THE U.S. VALUE (Y/L CHILE)/(Y/L US)	
INITIAL RATIO	0.6999	INITIAL RATIO	0.6999	INITIAL RATIO	0.6999
Years of schooling	0.7398	Years schooling, barriers	0.8043	Years schooling, barriers, ed. quality	0.9147
Education quality	0.8186	Years schooling, flexibility	0.7574	Years schooling, barriers, flexibility	0.8197
Flexibility	0.7185	Years schooling, ed. quality	0.8689	Flexibility, barriers, ed. quality	0.8852
Barriers	0.7687	Flexibility, Ed. quality	0.8335		
		Flexibility, barriers	0.7854		
		Barriers, Ed. quality	0.8726		

Although these results are quite staggering, we must remember that making great policy changes, such as increasing years of education or reducing adoption barriers are not simple or inexpensive.

6. Summary and policy implications

This paper is based on the idea that adoption of foreign technologies plays an important role in explaining long run growth rates and the persistence of *per capita* income differences observed around the world. Even for developed economies, adoption is a necessary investment to maintain economic leadership. One of the main implications of this is that is necessary to focus in policies that promote adoption rather than innovation in cases such as Chile. In other words, the challenge for the

Chilean economy is to close the gap with the leading economies rather than to invest in moving the overall technological frontier.

A simple theoretical model, as the one presented here, tells us that during transition, the growth rate of total factor productivity of an economy depends on the productivity gap with the leading economy and the absorptive capacity of technological progress in closing this gap. This absorptive capacity is determined by the probability of success in adopting the technological frontier, the institutions that promote adoption, and the level of human capital relative to the level of the target technology to copy. More sophisticated technologies require higher levels of human capital. There is also an important parameter capturing how intensively human capital is used when targeting the technological frontier. Using a cross-section of countries we estimate this important parameter, which is around 1.5.

With the objective to obtain policy insight, we calibrate the model to find the bottlenecks for adoption and closing Chile's productivity gap. The absorptive capacity depends on four gaps: institutional quality, economic flexibility measured by firm entry rate, and the quantity and quality of education gaps. We find that, for Chile quality of education followed by market entry and exit flexibility appear to be the most important deterrents for closing the gap with the leading economies.

Policies that improve the educational system (both quality and quantity) will reduce the technological gap of Chile by 26 percentage points, which is a large reduction considering that the actual parameters lead to a gap of 32%. Between the two, improving quality has a larger effect, meaning that will reduce the gap from 32% to 12%. By improving the institutions for adoption, the technological gap will fall from 0.32 to 0.29. Finally, easing the entry and exit restrictions will close the gap by 5 percentage points.

References

Acemoglu, Daron, Philippe Aghion, and Fabrizio Zilibotti (2006). "Distance to Frontier, Selection, and Economic Growth". Journal of the European Economic Association, MIT Press, vol. 4(1), pages 37-74, 03.

Acemoglu, Daron and Fabrizio Zilibotti (2001). "Productivity Differences". The Quarterly Journal of Economics, vol. 116, pages 563-606.

Acemoglu, Daron. (2009). "Introduction to Modern Economic Growth", Princeton University Press.

Aghion, Philippe and Peter Howitt (1998). "Endogenous Growth Theory". The MIT Press, Cambridge, Ma.

Aghion, Philippe and Peter Howitt (1992). "A Model of Growth through Creative Destruction". Econometrica, vol. 60, pages 323-51.

Benhabib, Jess and M. Spiegel, (2005). "Human Capital and Technology Diffusion". In Handbook of Economic Growth, edited by Philippe Aghion and Steven Durlauf, edition 1, volume 1, chapter 13, pages 935-966 Elsevier.

Calderon, Cesar (2011). "Measures of TFP". Mimeo, the World Bank.

Caselli, Francesco (2005). "Accounting for Cross-Country Income Differences". In Handbook of Economic Growth, edited by Philippe Aghion and Steven Durlauf, edition 1, volume 1, chapter 9, pages 679-741 Elsevier.

Cleveland, W.S. (1979). "Robust Locally Weighted Regression and Smoothing Scatterplots". Journal of the American Statistical Association vol. 74(368), pages 829–836.

Davis, Steven J. and John Haltiwanger (1992). "Gross Job Creation, Gross Job Destruction, and Employment Reallocation". Quarterly Journal of Economics, vol. 107(3), pp. 819-63.

Gollin, Douglas (2002). "Getting Income Shares Right". Journal of Political Economy, vol. 110(2), pages 458-474.

Grossman, Gene and Elhanan Helpman (1991). "Innovation and Growth in the Global Economy. The MIT Press. Cambridge, MA.

Hall, Robert E. and Charles I. Jones (1999). "Why Do Some Countries Produce so Much More Output per Worker than Others?" Quarterly Journal of Economics, vol. 114, pages 83-116.

Howitt, Peter (2000). "Endogenous Growth and Cross-Country Income Differences". American Economic Review, vol. 90, pages 829-46.

Howitt, Peter and David Mayer-Foulkes (2005). "R&D, Implementation and Stagnation: A Schumpeterian Theory of Convergence Clubs". Journal of Money Credit and Banking, vol. 37, pages 147--177.

Hsieh, Chang-Tai and Peter J. Klenow, 2009. "Misallocation and Manufacturing TFP in China and India". The Quarterly Journal of Economics, vol. 124(4), pages 1403-1448.

Klenow, Peter J. and Andres Rodríguez-Clare (1997). "The Neoclassical Revival in Growth Economics: Has it Gone too Far?" In NBER Macroeconomics Annual1997, edited by Ben Bernanke and Julio Rotemberg, pages 73-103. The MIT Press, Cambridge, MA.

Lederman, Daniel and Laura Saenz (2005). "Innovation and Development Around the World, 1960-2000". Policy Research Working Paper Series 3774, The World Bank.

Mies, Veronica (2010). "Technology Targets And Knowledge Dynamics: Consequences For Long-Run Prospects". PUC Economics Institute Working Paper, No. 385.

Nelson, Richard and Edmund S. Phelps (1966). "Investment in Humans, Technological Diffusion, and Economic Growth". American Economic Review vol. 56, pages 69-75.

Parente, Stephen and Edward C. Prescott (1994). "Technology Adoption and Growth". Journal of Political Economy, vol. 102, pages 298-321.

Parente, Stephen and Edward C. Prescott (1999). "Monopoly Rights: A Barrier to Riches". American Economic Review, vol. 89, pages 1216-33.

Parente, Stephen and Edward C. Prescott (2002). *Barriers to Riches*. The MIT Press. Cambridge, MA.

Restuccia, Diego and Richard Rogerson, 2013. "Misallocation and productivity". Review of Economic Dynamics, Elsevier for the Society for Economic Dynamics, vol. 16(1), pages 1-10.

Schoellman, T. (2010). "The Occupations and Human Capital of U.S. Immigrants". Journal of Human Capital, University of Chicago Press, vol. 4(1), pages 1-34.

Segerstrom, Paul (1991). "Innovation, Imitation and Economic Growth". Journal of Political Economy 99(4): 807-827.

The Political Economy of Distribution and Growth in Chile[1]

Klaus Schmidt-Hebbel

1. Introduction

Chile is at a critical juncture in its path toward development. While Chile's growth has been robust in comparison to Latin America's, Chile's potential growth rate is well below long-term growth in Asia. Absolute poverty has fallen substantially, but the distribution of income is highly concentrated. The country enjoys political stability under a mature democracy, yet both its political regime and its politicians command little support by survey respondents and are the target of large protest movements. While provision of education, health, and government protection has been extended to large parts of the population, the demands for more and better social protection and government services outgrow the larger supply. Access to consumer durables and more leisure has been extended to most Chileans but crime rates are growing steadily and more people feel insecure at their homes and on the streets. As income rises and awareness of environmental problems increases, stiffer trade-offs are faced between economic development and environmental sustainability.

Hence Chile faces many challenges to overcoming the "middle-income trap" of many upper middle-income economies. Since the late 1990s, successive governments representing different political coalitions have been aiming at higher growth and less inequality. While their policy objectives and tools have evolved over time, Chilean governments share a similar broad development strategy based on strengthening democracy, the market economy, and government provision of public goods and government

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services. Yet results have been mixed, partly because of rising difficulties in building strong and stable constituencies in support of required reforms. To join developed nations, Chile's biggest challenge is to strengthen the political economy of its development path toward higher income and less inequality.

I address in this paper several analytical, empirical, and practical questions related to the political economy of distribution and growth in Chile. How does Chile compare to the world in government size, income distribution, and per capita GDP? What is the relation between income distribution, government size and structure, and growth in a political-economy model of endogenous growth? How do changes in income distribution affect growth through changes in the size of government, in a model calibrated for Chile?

In addition, what are the dynamics of distribution and growth, if they are shaped by political leadership, the policy-making process, and the quality of institutions and policies? Under what conditions of such dynamics does a non-monotonic relation between income distribution and growth emerge, akin to the Kuznets curve? How do Chile's leadership, policy-making process, and reforms shape its relation and dynamics of equity and growth? What are the political economy requirements for successful adoption of key reforms to support growth and equity in Chile?

The following sections address the latter issues. In section 2 I review two key cross–country empirical relations between government size, income distribution, and economic growth, and Chile's position in relation to them. I then introduce a political-economy model of income distribution, government size, and growth, calibrated to Chile, and report simulations for alternative scenarios of income distribution, government spending, and taxation. Section 4 sketches a model for the role of political leadership, the policy-making process, and the quality of institutions and policies in shaping the dynamics of equity and growth. Then I apply qualitatively the framework and dynamic model presented in the previous section to Chile, assessing the features and quality of leadership, policy-making process, institutions, and policies, as well as their links to distribution and growth, and their dynamics. Section 6 identifies ten key reforms to support growth and equity in Chile and discusses the political economy requirements for successful adoption of these reforms. Section 7 concludes.

2. Government size, income distribution, and growth: How does Chile fare in cross-country comparison?

Government size, income distribution, and growth are linked through many causal relations, analyzed and measured in a huge literature in the fields of development economics, growth economics, and political economy. While the next two sections focus on some key relations, here I briefly review two key cross-country empirical relations and Chile's position in relation to them: Wagner's Law and the Kuznets Curve.

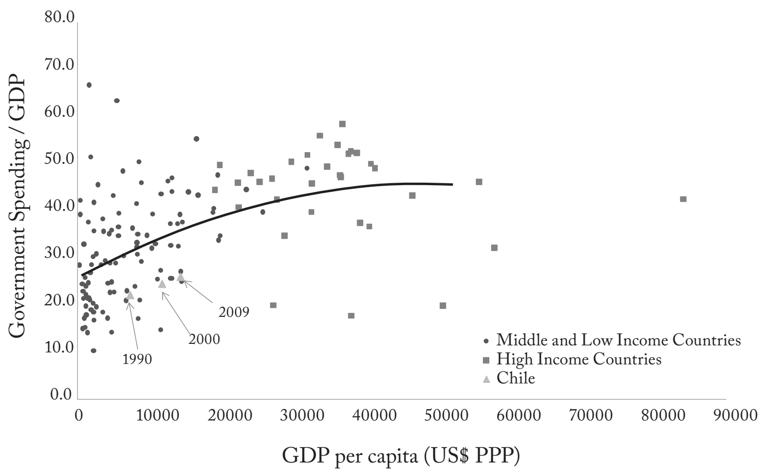
Wagner's Law reflects the positive empirical relation between the relative size of government (measured by the ratio of general government spending to GDP) and development (measured by per capita GDP). The cross-country data for circa 2008 depicted in Fig. 2.1 reflects this "law", which suggests that government services are valued at a high income elasticity. The continuous line embodies a quadratic relationship which is estimated econometrically. Chile displays a government spending ratio significantly below the international trend. It stands at 26.0% in 2009, when its per capita GDP stands at US$ 14,300, which is among the highest in the group of high middle-income countries. Moreover, the latter figure reflects Chile's largest government spending ratio in many decades, a result of very high government expenditure growth in 2006-2009. Yet one should take Chile's distance from the cross-country relation with significant caution, because a much larger share of social services and infrastructure –ranging from education and health to pensions and highways– are provided by the private sector in Chile than in most other countries in the world. Therefore Chile's government spending levels are correspondingly lower than in most countries.

Older cross-country data tend to confirm a non-monotonic relation between per capita GDP and income distribution, reflecting income concentration during the development transition from poor to middle-income countries, followed by income dispersion during the transition from middle to high levels of per capita income. This relationship, known as the Kuznets Curve, is reflected by cross-country data for the 1990s, as depicted in Figure 2.2. Chile is again an outlier from the cross-country quadratic regression line, displaying a much higher income concentration (a Gini coefficient of 0.56) than that observed in countries at similar levels of development[2].

[2] As reported below, more recent data for Chile's Gini coefficient reflect lower figures, such as 0.53 for 2009.

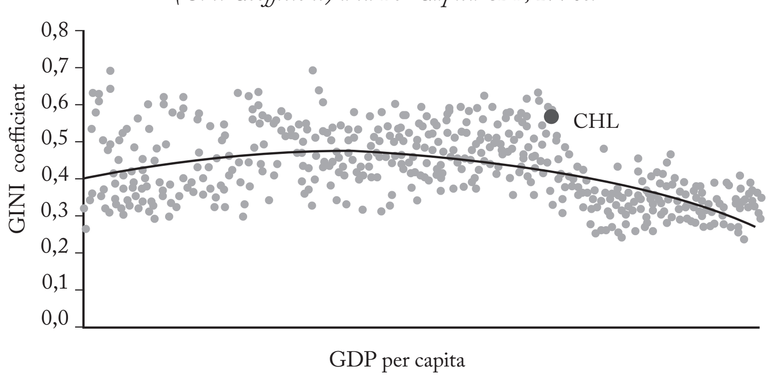
More recent cross-country data, for the period from the mid–1990s through 2008, suggest that the non-monotonic Kuznets Curve has been replaced by a monotonically declining relation between income concentration and per capita GDP. The estimated regression line depicted in Figure 2.3 also shows that Chile is and has been a historical outlier from the cross-country relation, exhibiting much higher Gini coefficients than most countries at similar levels of per capita GDP.

Figure 2.1. Wagner's Law: Cross-Country Relation between General Government Expenditure Ratio to GDP and Per Capita GDP, circa 2008.



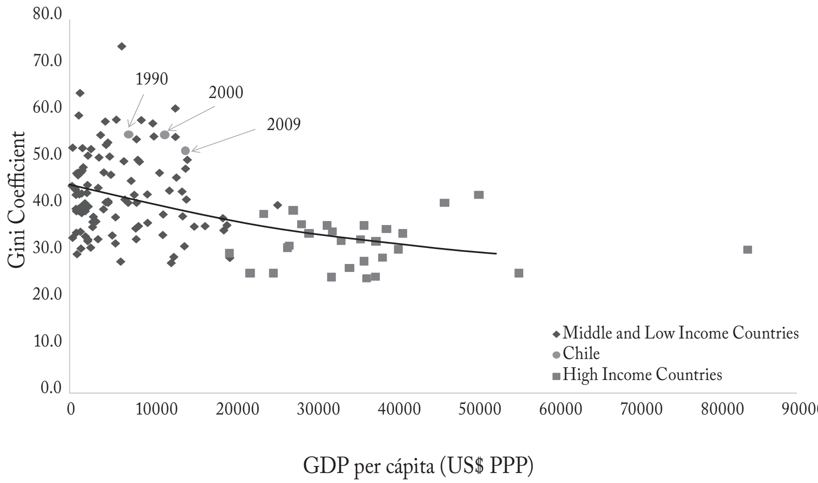
Source: World Bank, IMF.

Figure 2.2. Kuznets Curve Alive? Cross-Country Relation between Income Distribution (Gini Coefficient) and Per Capita GDP, 1990s.



Source: Author's calculation based on UN-WIDER World Income Inequality Database (2000). Data refers to the 1990s.

Figure 2.3. Kuznets Curve dead? Cross-Country Relation between Income Distribution (Gini Coefficient) and Per Capita GDP, 1995–2008.



Source: World Bank.

Hence Chile is different in two key relations that are observed empirically in cross-country evidence: the size of government is smaller (when government spending data is not adjusted for cross-country differences in public-private provision of services and infrastructure) and the degree of income concentration is larger in Chile than in most countries at similar per capita GDP levels.

3. Political economy of equity, government size, and growth in Chile[3]

In a perfect democracy –unhindered by principal-agent problems between government officials and voters– it is the voters who determine the overall size of government (the ratio of total taxation and government expenditure to GDP), as well as the composition of taxation and spending. Government size and the composition of taxation and spending affect marginal decisions to save, invest, and work because both taxes and government spending programs are not neutral and hence affect decisions by workers, capital owners, and consumers. While distorting taxation is generally growth

[3] This section is based on joint work with Jose Tello (Schmidt-Hebbel and Tello, forthcoming 2012).

and welfare-deteriorating (except taxes on bads), government spending augments growth and welfare if it falls upon public goods or upon private goods which raise aggregate production or private welfare.

The latter are standard results of public finance theory that are obtained for an equal society. Income and wealth inequality significantly complicate the latter results for several reasons. First, the representative-agent paradigm does not apply in an unequal society, because differences in factor endowments imply differences in marginal behavior. Second, tax and spending programs affect different agents in different ways, particularly when different income groups pay taxes or receive the benefits of government spending and transfer programs in ways that are not proportional to their income levels. Third, agents may differ in behavior or may face constraints (such as credit constraints) in ways that differ with their income levels. Fourth, any real-world distribution of income differs significantly from a normal distribution, reflecting distortions such as the fact that median income lies well below mean income. The (poorer) median voter differs in behavior and voting pattern from the (richer) mean voter. This changes the political and economic equilibrium in societies where the median voter casts his pivotal vote in deciding government size and composition.

In this section I briefly introduce a political-economy model of income distribution, government size, and growth, based on Schmidt-Hebbel and Tello (2012). The model is calibrated to Chile and used for carrying simulations for alternative scenarios of income distribution, government spending, and taxation.

The main features of the model, which represents a significant extension of Alesina and Rodrik (1996), are the following.

i) The government raises distorting income taxes levied on both capital and income, at a tax rate that is exogenous to the government. Tax revenue is used for private welfare-enhancing government consumption and output-raising (productivity-enhancing) government services, at shares decided by the government.
ii) The government determines and raises a non-distorting lump-sum tax level that is levied on the rich (all agents above the mean income earner) that is fully distributed as a distorting transfer to the poor, which grows more than proportionately with the distance of the individual poor's income from mean income. The lump-sum tax level paid by the rich grows with income dispersion: the smaller is the

ratio of median to mean income (i.e., the more unequal is income distribution), the large is the level of transfers. While not voted by the median voter but imposed by the government directly, this assumption reflects a second political-economy effect of income concentration, that is, stronger political pressure for larger transfers.

iii) Per-capita output is based on a simple endogenous growth technology, with constant returns to scale to reproducible capital and reproducible government services. Including raw labor as a factor of production of total output, there are increasing returns to scale.

iv) Competitive factor market conditions are reflected by standard first–order conditions.

v) Inter-temporal consumption optimization by the mean (representative) consumer and by the median consumer-voter are based on common standard CRRA preferences, with intra-temporal utility from private consumption goods enhanced by complementary but exogenous government consumption.

vi) The pre-transfer income distribution is exogenous and is not normal, with median income below mean income. The income distribution is mapped one-to-one by the distribution of capital. The distribution of capital is characterized by two parameters: the relative difference between median and mean capital and the relative difference between the 95th percentile capital and mean capital.

vii) The median voter votes for the rate of income taxation.

The model is solved in the following way. The economy's consumption and investment decisions are taken by the utility-maximizing representative mean-income earner at given factor prices and given tax rates, transfer rates, and government spending ratios. Tax rates are decided by the utility-maximizing median-income earner, given factor prices, transfer rates, and government spending ratios.

Using Chile's 2009 Casen income distribution data summarized in Table 3.1, the ratio of median to mean income is estimated at 0.53 and the ratio of the 95th percentile to mean income is obtained as 3.16. Parameter calibration for tax, transfer, and spending functions are determined in order to match the corresponding ratios observed for Chile.

TABLE 3.1. CHILE'S HOUSEHOLD INCOME DISTRIBUTION IN 2009.

Mean income	Ch$ 248,055		Median income	Ch$ 131,372
Standard deviation	Ch$ 473,530		95 percentile income	Ch$ 784,456
Variance	2.24e+11			
Skewness	8.861		Median / mean income	0.53
Kurtosis	115.5		95 perc. / mean income	3.16

Note: based on "monetary household data" (ingreso monetario del hogar), i.e., post–transfer household income data.

Source: Torche, A. (2010), based on 2009 Casen Survey data.

I start reporting simulation results for three different political-economy environments (Table 3.2). In the first case, there is no voting and therefore the tax ratio is set by a growth-maximizing government or representative agent at a level of 10%, consistent with the share of government productive services in the production function. In addition, there are no transfers. Hence the overall government size (its share in GDP) is 10%. Per capita endogenous growth is 5.45%.

TABLE 3.2. MODEL SOLUTIONS FOR GROWTH AND GOVERNMENT SIZE UNDER DIFFERENT POLITICAL ECONOMY CONDITIONS.

BENCHMARK SIMULATIONS	PER CAPITA GDP GROWTH (g)	TAX REVENUE/ GDP (tau)	TRANSFERS / GDP (tr)	GOVERNMENT SIZE (tau + tr)
1. No voting, tax set optimally, no transfers	5.45	10.0	0	10.0
2. No voting, tax set optimally, with transfers	4.91	10.0	3.90	13.90
3. Voting, with transfers	4.02	18.80	3.63	22.44

Adding government-set exogenous transfers to the latter implies a transfer ratio of 3.90% of GDP. The distorting effect of tax-financed transfers to the 50% poorer voters on capital accumulation implies a decline in per capita growth rate to 4.91%.

The third model solution is obtained for the political-economy and growth equilibrium, in which the median voter chooses an income tax ratio of 18.80%, which added to transfers of 3.63% of GDP, implies a government size of 22.44% of GDP, which is close to Chile's actual government share in GDP. Distorting income taxation reduces per capita growth further, to 4.02%, which is close to several estimates of Chile's potential or trend per capita growth rate (Schmidt-Hebbel 2006).

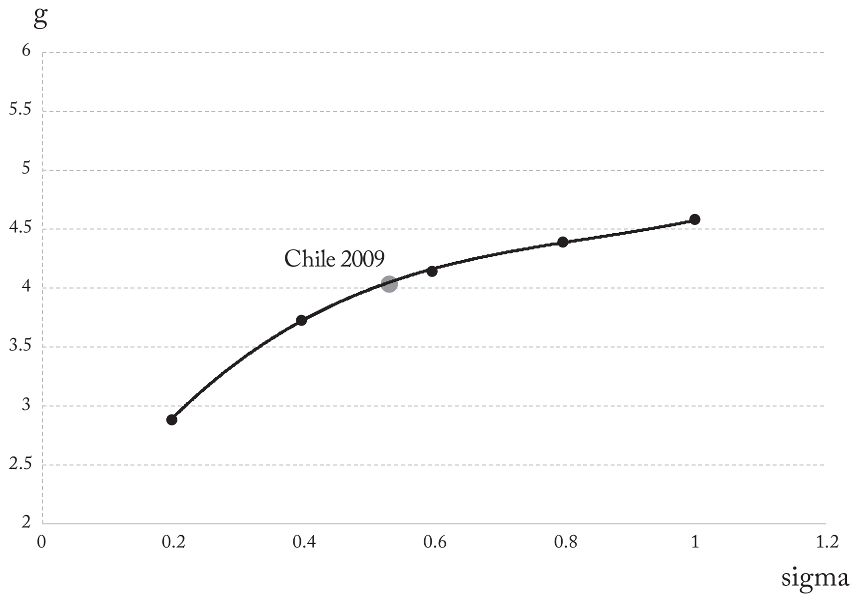
Now I turn to two sets of simulations, altering the exogenous distribution of income by changing the parameter that reflects the ratio of median to mean income.

I start by considering the general-equilibrium effects of exogenous changes in pre-transfer income distribution. The results, reported in Table 3.3 and Figure 3.2, show the effects of income distribution on growth and government size.

Table 3.3. Effects of Income Distribution on Per Capita Growth and Government Size.

Income distribution (Median / mean income = sigma)	Per capita GDP growth (g)	Tax revenue/ GDP (tau)	Transfers / GDP (tr)	Government size (tau + tr)
0.2	2.87	18.95	6.61	25.55
0.4	3.73	18.86	4.36	23.22
0.53 (Chile 2009)	4.02	18.80	3.63	22.44
0.6	4.14	18.79	3.36	22.14
0.8	4.39	18.77	2.76	21.53
1.0	4.56	18.77	2.35	21.14

Figure 3.2. Effects of Income Distribution on Per-Capita Growth.



The results are reported for a large range of income distributions, starting with a highly concentrated and skewed distribution (sigma = 0.2) and ending with a normal distribution (sigma = 1.0). For my parameter calibration, the median voter's choice of the income tax rate is not very sensitive to his income relative to that of the mean income earner. The reason is that he or she balances the costs of larger government expenditure (distorting effects of taxation on growth) with its benefits (higher spending on government productive services and government consumption). In contrast to the latter, transfers from the rich to the poor are highly sensitive to income distribution parameter Sigma. Their distorting effect is large and therefore per capita growth rates vary between 2.9% and 4.6%.

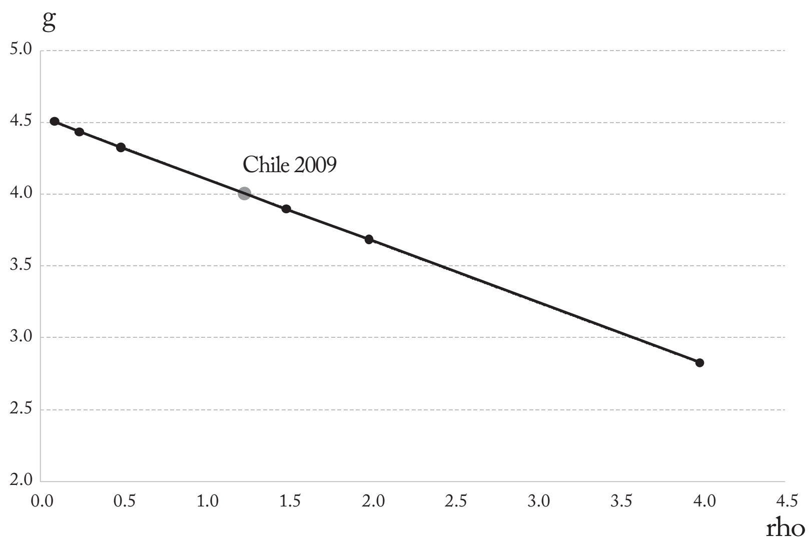
Finally I report the general-equilibrium effects of exogenous changes in the lump-sum tax level levied on the rich to finance the transfers to the poor, reported in Table 3.4 and Figure 3.3. As above, larger transfers weaken the incentives for capital accumulation and hence lower growth.

The model results point to several conclusions that illustrate the relation between income distribution, the structure of public finance, and economic growth in Chile. First, holding everything constant, a more concentrated income distribution can reduce growth by raising distortionary taxation. Second, composition of government spending and transfers matters for growth: more transfers and less spending on productive government services reduces growth. Third, the more distorting taxation is, the higher the reduction in growth.

Table 3.4. Effects of Transfers on Per Capita Growth and Government Size.

Transfer coefficient (rho)	Per capita gdp growth (g)	Tax revenue/ gdp (tau)	Transfers / gdp (tr)	Government size (tau + tr)
0.1	4.52	18.84	0.29	19.13
0.25	4.45	18.84	0.73	19.56
0.5	4.34	18.83	1.45	20.29
1.25 (Chile 2009)	4.02	18.80	3.36	22.44
1.5	3.91	18.78	4.38	23.16
2.0	3.70	18.74	5.83	24.57
4.0	2.84	18.40	11.68	30.08

Figure 3.3. Effects of Transfers on Per-Capita Growth.



However, the stylized model presented and calibrated here excludes many other causal relationships between equity, government size, and growth. First, there are potential positive links from income distribution to growth for several reasons not considered in the previous model. For example, a more equal distribution of income raises social capital and trust, and reduces distributional conflict and crime, leading to higher factor accumulation and productivity improvements. Second, the relationship between income distribution, the median voter's choice, and government is not as one-dimensional and direct as in the previous model. Voters decide on a multi-dimensional package of government decisions. Finally, implementation of voters' decisions is distorted by many principal-agent problems between voters and governments. The relevance of the latter in the case of Chile is discussed in subsequent sections.

4. Dynamics of income distribution and growth

Here I sketch a model for the role of political leadership, the policy-making process, and the quality of institutions and policies in shaping the dynamics of equity and growth. This framework, developed in Schmidt-Hebbel (2008), is presented in more detail in the Appendix of this paper. I discuss key features of the model next.

Political institutions, as key pillars of the organizational structure of a society, shape the form of government (democracy) and determine both economic institutions and economic policies (Diagram 4.1). Economic institutions, by shaping economic policies, have a major impact on development (growth and equity). The new institutional development economics underscores the importance of economic institutions for achieving higher growth, in contrast to previous views (i.e. the Washington Consensus, see Williamson, 1990) which focused more narrowly on economic policies and their reforms as triggers for growth. Rodrik (2005) warns against the temptation of policymakers to map first-order (universal) economic principles into unique policy packages, recommending the careful consideration of local opportunities and constraints in the design of policies and institutions.

Development and democracy interact positively (e.g., Przeworski et al., 2000). The dual challenge of development and democracy is to trigger sustainable reforms of political and economic institutions to break the vicious circle of underdevelopment and autocracy, in order to start a virtuous and sustainable path of high growth, improving equity, and broad–based political participation.

Diagram 4.2 represents the complex relations between the quality of institutions and policies (IP), and economic and political results. It shows the key role of leadership (L), the policy-making process (PMP) and the conditions for attaining cooperative outcomes as a result of the quality of institutions and policies, with feedback effects from the quality of leadership. The social norms and political culture of a society also shape the policy–making process. The leaders' own interests and incentives, conditioned by the efficiency of the state, also affect the quality of leadership.

Diagram 4.1. Relation between Institutional/Policy Hierarchy and Results

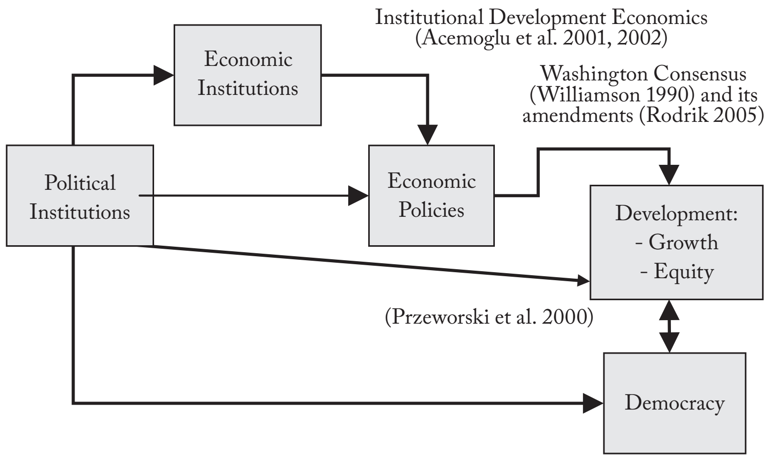
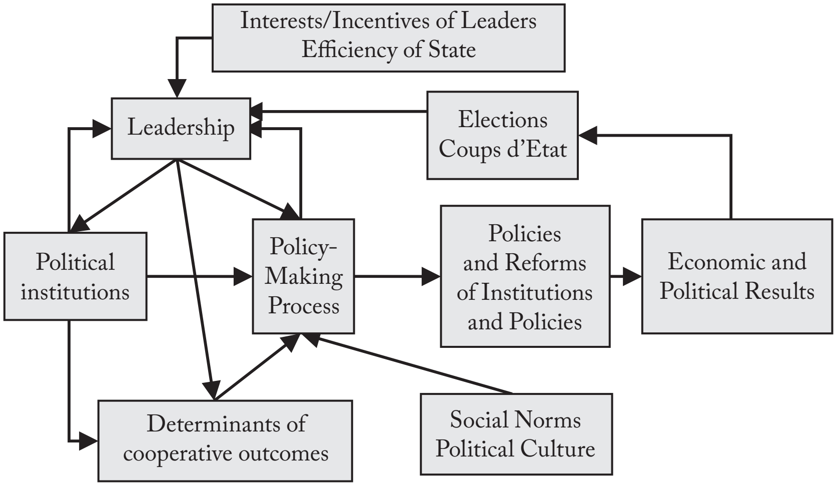


Diagram 4.2. Leadership, Policy-Making Process, Reforms, and Results



The PMP determines the content and quality of IPs and their reforms, and the latter impinge on economic and political outcomes. Good IP lead to good outcomes, with positive feedback for political stability. In contrast, badly designed, poorly implemented or unenforced IP lead to poor results. The latter lead to electoral rejection and democratic change in government when political institutions are strong and democracy is entrenched. However, when political institutions are weak, poor results may lead to political crises, armed domestic conflict, and violent overturn of government, in turn leading to further changes in L, PMP, and IP. Hence the challenge of development and democracy is to get societies on a virtuous path of improved L, PMP, and IP, leading to high growth, better equity, and a stronger democracy.

Next I formalize the dynamic relation between IP, L, and PMP in determining the growth of a society's average level of income (or output) and the change in a measure of society's distribution of income among its members.

Per-capita GDP growth ($\dot{y}$) is specified as a function of per capita GDP (y), a measure of income distribution (d), and a vector of relevant growth determinants (X):

(1) $$\dot{y} = f(\underbrace{y}, \underbrace{d}, \underbrace{X}, \ldots)$$

(+) or (-)
Sing depends on quality of IP^y, L^y and PMP^y
(+): Growth divergence
(-): Growth convergence

(+) or (-)
Sing depends on quality of IP^d, L^d and PMP^d

(+)

The change in income distribution ($\dot{d}$) is specified as a function of y, d, and a vector of relevant determinants of a better income distribution (Z):

(2) $$\dot{d} = g(\underbrace{y, d}, \underbrace{Z}, \ldots)$$

(+) or (-)
Sing depends on quality of IP^d, L^d and PMP^d

(+)

where *IP* is a vector of measures of the quality of institutions and policies, comprised by three sub-vectors: *IP* = $[IP^y, IP^d, IP^0]$, *L* is a vector of measures of the quality of leadership, comprised by three sub-vectors: $L = [L^y, L^d, L^0]$, and PMP is a vector of measures of the quality of the policy-making process, comprised by three sub-vectors: $PMP = [PMP^y , PMP^d , PMP^0]$.

The three sub-vectors in each vector represent sets of key determinants of the sign of the corresponding partial derivatives. The sub-vectors denoted by super-index *y* comprise variables within IP, L, and PMP that are keys in determining the sign of the influence of income levels on growth (equation 1). The sub-vectors denoted by super-index *d* comprise variables that are key to determining the sign of the influence of the level of distribution on growth (equation 1), as well as the signs of the influence of both *y* and *d* in the change of income distribution (equation 2).

High levels of quality of income-relevant institutions and policies (IP^y), leadership (L^y), and policy-making process (PMP^y) contribute to high growth and therefore explain growth convergence to the international income frontier. In the latter case, the partial derivative of GDP growth to the GDP level is negative. By contrast, low levels of quality of the latter three sets of variables lead to growth stagnation or low growth –"divergence, big time" (Pritchett 1997). In this case, the partial derivative of GDP growth to the GDP level is positive. Similar arguments apply to the role of the quality of distribution-relevant IP^d, L^d, and PMP^d in determining the corresponding partial derivatives.

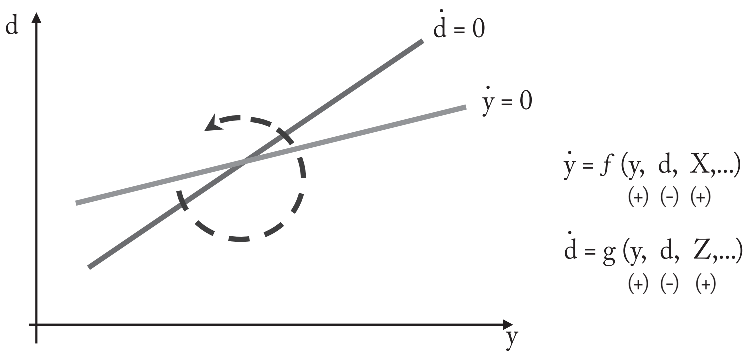
There are many combinations for the dynamics of income growth and income distribution changes, depending on the signs of the corresponding partial derivatives, determined by the levels of the income-related and distribution-related components of IP, L, and PMP. Here I focus only on three possible combinations, selected for their relevance for the international development and growth experience, and for Chile's case discussed below[4].

The first case (Case A, depicted in Figure 4.1) reflects a low income and equity trap, determined by the low quality of IP, L, and PMP, reflected in the corresponding partial derivatives of the growth and distribution

4 I do not discuss comparative dynamics of this model here. This would require identifying which of the two key endogenous variables "jumps" and which "crawls" in order to identify empirically relevant dynamic adjustment paths in response to exogenous shocks.

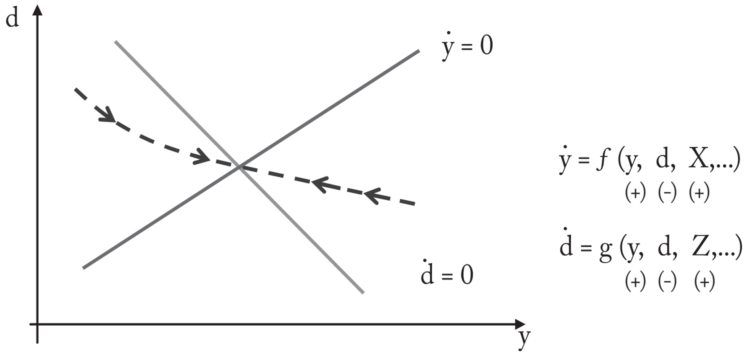
equations summarized in Figure 1. The steady-state equilibrium represents economies trapped at low income and equity levels. Any deviation from the stationary equilibrium will lead to either oscillatory dynamics around the steady–state equilibrium or to diverging (explosive) or converging (implosive) paths for GDP and distribution.

Figure 4.1. Simple Dynamic Model – Case A: Low Income and Low Equity Trap.



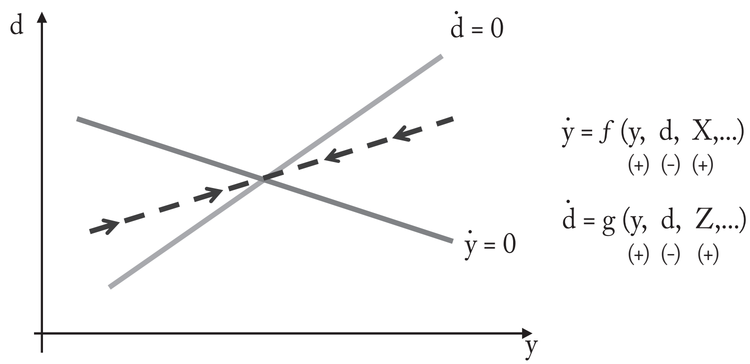
Case B (Figure 4.2) reflects stable development dynamics consistent with growth convergence and deteriorating (improving) income distribution when income is below (above) the corresponding steady-state equilibrium. Growth convergence (the negative partial derivate of GDP growth to GDP levels in the growth equation) is caused by the better quality of IP^y, L^y, and PMP^y, in comparison to the low income and equity trap of Case A.

Figure 4.2. Simple Dynamic Model – Case B: Development Path of High Growth (Growth Convergence) and Deteriorating Distribution.



Case C (Figure 4.3) reflects a second scenario of stable development dynamics, which now are consistent with growth convergence and improving (deteriorating) income distribution when income is below (above) the steady-state equilibrium. The latter distribution dynamics (the negative partial derivative of the change in distribution to the GDP level) are caused by the better quality of IP^d, L^d, and PMP^d, in comparison to the two preceding cases.

Figure 4.3. Simple Dynamic Model – Case C: Development Path of High Growth (Growth Convergence) and Improving Distribution.

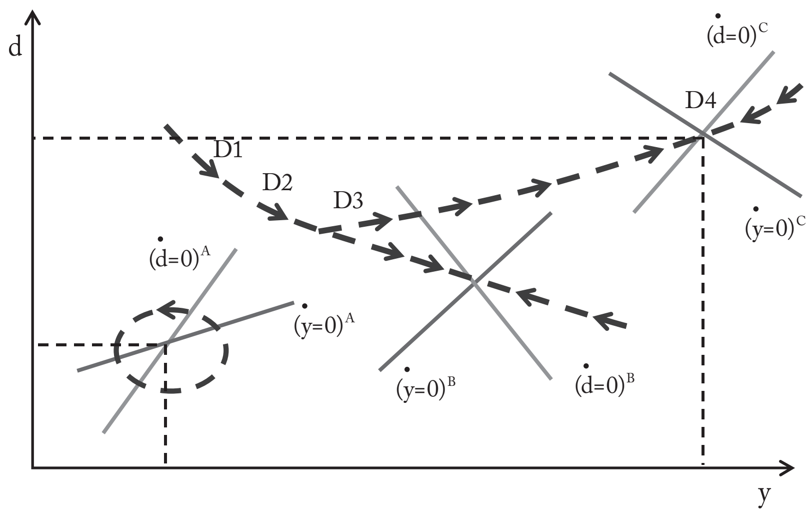


Now let's combine the three preceding cases to generate a development story that is consistent with the Kuznets (1955) interpretation of a non-monotonic (quadratic) relation between per-capita income levels and the distribution of income[5]. Figure 4.4 embeds the dynamics of cases A, B, and C. Case A reflects those countries trapped at low levels of income and income distribution, as a result of the very poor quality of their institutions, policies, leadership, and policy-making process. With improving IP, L, and PMP, low and middle-income countries that are on a growth-convergence-but-distribution-deteriorating dynamic equilibrium move

[5] Several explanations have been provided for an inverted U-shaped relation between inequality and income, including the development transition from agriculture to manufacturing (Kuznets 1955), the existence of European settlers and the transition from subsistence agriculture to commodity exports and to manufacturing (Easterly 1993). However, the evidence on the existence of the Kuznets curve is disputed. For example, Barrios and Strobl (2005) provide supportive evidence while Anand and Kanbur (1993), Adams and Page (2003), and Kustepeli (2006) reject the existence of an inverted U curve in cross-country data. Results seem to be dependent on the country sample, methodology, choice of inequality measure, and the time horizon selected in empirical work –as exemplified by the cross-country evidence reported in section 2.

along the D1-D2 dynamic path toward a steady-state equilibrium that is consistent with case B. Finally, middle-income countries that are on a growth-convergence-and-distribution-improving dynamic equilibrium move along the D3-D4 dynamic path toward steady-state equilibrium that is consistent with case C. The latter stationary equilibrium is depicted in Figure 4.4 as consistent with the high income and good-distribution condition that characterizes industrial countries.

Figure 4.4. Full Development Path: Shifting Dynamics from Case A to B and C.



The shift from the dynamics of case B to those of case C is caused by an improvement in IP, L, and PMP conditions, beyond a threshold level. In other words, when the quality of IP, L, and PMP attains a given threshold, growth convergence continues but income distribution, instead of deteriorating, starts to improve, taking middle-income countries on a virtuous development path. The latter is coherent with the Kuznets' view of development, reflected by the shift in dynamics embedded in the full D1-D2-D3-D4 development path. But other development paths that contradict the Kuznets curve are possible (e.g. Anand and Kanbur, 1993).

5. Leadership, policy-making process, and reforms shaping the dynamics of income distribution and growth in Chile

In this section I qualitatively apply the framework and dynamic model presented in the previous section to Chile, assessing the features and quality of leadership, policy-making process, institutions, and policies, as well as their links to distribution and growth, and their dynamics[6].

The quality and performance of Chile's political leadership under democracy are largely determined by the following legal and political constraints and traditions:

(i) Enforcement of institutional and political constraints imposed on abuse and corruption.
There is generally low tolerance in Chilean society for abuse and corruption at the highest levels of government. However, corruption tends to be observed at some of the lower and more decentralized levels of government, like municipalities and public enterprises.

(ii) Rules of the PMP.
Chile has a highly legalistic approach to the PMP in the tradition of the French legal system, with strong weights attached to formal procedures enshrined by law.

(iii) Interests and goals of government coalitions in government and in opposition.
With a strong emphasis on coalition programs and long-term holding of power, the two dominant political coalitions have a longer-term political horizon than weak parties or coalitions centered on strong charismatic leaders.

(iv) Incentive structure faced by leaders.
Political reputation tends to dominate financial returns from holding power at high government levels, attracting able leaders who are paid moderate wages.

(v) Central government bureaucracy efficiency.
On average (but showing significant dispersion) the bureaucracy of the central government is well trained and provides relatively efficient services to both the leadership and the general public.

(vi) Sensitivity to economic and political results.

[6] Aninat, Landregan, Navia, and Vial (2006) and Chumacero, Fuentes, Lüders, and Vial (2006) present valuable assessments of Chile's politics, reforms, and results.

Leadership is significantly influenced by economic and political performance (including opinion polls and elections), but largely avoiding open populism.

Chile's PMP is determined by the following political-institutional factors:

(1) Democratic organization of government.
Chile has attained a high level of democratic rule in cross-country comparison. Political leadership is effectively bound by constitutional rules of the political game.

(2) Strong presidential system.
The government system is rooted in a presidential system with strong executive dominance in the PMP, reflected in government veto power and government initiative in several domains of lawmaking.

(3) State organization.
Chile has a unitary (non-federal) state organization which endows the central government with all relevant decision-making powers regarding regional government budgets and policies.

(4) Binominal electoral system.
Chile's "two-past-the-post" electoral system results in a stable party system dominated by two party coalitions, avoiding veto powers of small parties outside the two coalitions.

(5) State effectiveness and efficiency.
Adjusted for the country's income level, Chile's state and government powers and functions display reasonably high levels of efficiency (see below).

(6) Negotiations and policy agreements.
The PMP relies frequently on government negotiation and policy agreements with the opposition, responding to both constitutional constraints and the need of policy-making legitimacy.

Following Spiller and Tommasi (2003), I identify next the main features of Chile's PMP which contribute to attaining cooperative outcomes:

i) Relatively high degree of shared interests and views (consensus) among players, as a result of collective memory of the costly high-conflict period (1969-1988) and large influence of professional economists in politics and in policy design and implementation (an exception in cross-country comparison).

ii) Small immediate benefits that accrue to governments that renege on previous agreements attained with the opposition.

iii) Small number of decision makers: two large coalitions and few other influential actors (business associations, public-sector trade unions, Catholic Church, armed forces).
iv) Repeated interaction among key decision makers (repeated games based on reputation).
v) Deviations from agreed-upon behavior are easily observed, due to increasing transparency of political agreements.
vi) Existence of credible enforcement mechanisms.

The stages of Chile's reforms of institutions and policies during democracy display the following features:

a) The first stage of technical preparation of large reforms is frequently entrusted to ad hoc presidential or ministerial commissions responsible for preparing reports with background analysis and very specific technical recommendations about the contents of the reforms. The latter commissions are comprised by a variable number of sector specialists, economists, and interest-group representatives that represent different political and technical views. However, the large share of professional economists in most commissions contributes significantly to reaching agreements on recommendations. Most commissions are required to issue public documents with their detailed reform recommendations.
b) The second stage of preparation of reforms is at the cabinet level, involving internal government commissions under the responsibility of one or several ministers.
c) Government negotiation of reforms with the opposition is highly variable, depending on the needs of parliamentary votes and political legitimacy.
d) Government negotiation with negatively affected groups (reform losers) is highly variable, ranging from nil (example: privatization of public enterprises in the 1990s) to moderate (example: free-trade agreements in the 1990s; teachers' union representatives in the 2006 and 2010 Education Reform Commissions) and very large (workers' vetoes to 2007 public port privatization).
e) There is generally little or no compensation for reform losers (one exception: workers of closed state coal mines and privatized ports were significantly compensated for job losses in the late 1990s and early 2000s).

f) Reform experimentation ranges from nil to very little. For example, there are very few cases of experimentation of new social policies in small communities and pilot cases.
g) Full reform implementation is generally well executed and accords with reform blueprints. (A major exception is the badly designed and implemented 2007 public transport system in Santiago).
h) Corrections and fine-tuning of complex reforms are introduced frequently, ranging from design to implementation (examples: pension system reforms and electric utility pricing and regulation).
i) Long-term reform sustainability is generally ensured by good design, ability to introduce corrections, and political legitimacy of reforms.

Chile's success in reforming economic institutions and policies has been the result of many features. Chile has been and is at the world design and implementation frontier in several reform areas (e.g. pension system, privatization of public services, central bank independence, public-private partnerships such as private concessions of public infrastructure, free-trade agreements, inflation targeting, fiscal policy rules). Radical economic reforms undertaken under autocracy were legitimized and often improved upon under democracy. Subsequent reforms under democracy are legitimized by democratic implementation. Reform design generally represents the interests of majorities. Positive interaction and threshold effects with reforms in complementary areas are often reaped. Reform reversals are unlikely due to weak influence of reform blockers and losers. There is broad political and technical consensus on key reforms (e.g. candidates' programs in presidential elections are largely shaped and written by economists). Policies and institutions are improved by learning from mistakes (e.g. financial reforms and the role of bank regulation and supervision, exchange-rate regimes, pension system). A generally competent bureaucracy in key government institutions supports effective reform implementation. Public-enterprise privatization and public-private partnerships are complemented with generally effective government regulation and supervision in new areas (e.g., pensions, infrastructure concessions). Regarding rules versus discretion, Chile's reforms tend to favor adoption of rules and regulations, limiting the scope for government discretion (e.g., monetary, fiscal, and exchange-rate policies; government pricing, regulation, and supervision of private firms in natural monopolies).

An important feature of Chile's reform success has been the positive interaction between Chile's institutional framework and individual leadership since 1990. Rule-bound political institutions and party strength have limited selection and subsequent election of political leaders –in particular, presidents– among individuals who are qualified and represent broad majorities. This stands in contrast to many middle-income countries in Latin America and Asia, where weaker institutions and political processes are often unable to stop autocratic, populist, and/or corrupt governments from taking power.

Regarding reform features –including reform depth, speed, timing, and gradualism– Chile's experience since the 1970s points toward three conclusions:

1) Reforms have often been deep and broad in scope, and cutting across different reform areas. According to a measure of structural reform progress in different areas, many reforms took place in the late 1970s, were somewhat reversed in the early 1980s, and were continued at a moderate pace since the mid-1980s to the late 1990s, with few structural reforms adopted since the late 1990s (Figure 5.1)[7].

Figure 5.1. Structural Reform Index, 1960-2005.

Source: Author's calculation extending Lora et al., IDB.

[7] The main macroeconomic reforms during the last decade were the adoption of full-fledged inflation targeting and of a fiscal rule in 2001. The pension system reform of 2008 was very likely the key structural and social policy reform introduced since 2001. For a more detailed discussion of reforms see Schmidt-Hebbel (2008).

2) Many reforms have been very gradualist. One extreme case is the most gradualist inflation stabilization experience in world history: it took Chile 28 years to lower inflation from 1000% in 1973 to 3% in 2001. Regarding trade openness, import tariffs were reduced from a 100% average tariff rate in 1974 to a flat 11% in 1991 and to an average close to 2% in recent years[8].

3) Little attention has been paid by reforming governments to optimal timing and optimal sequencing of reforms. Reforms were adopted because of conviction of political leadership, taking into account their perceived reform support and the restrictions and features of the PMP discussed above.

As a result of the reforms started in the mid-1970s and continued in subsequent decades, Chile made a quantum leap in its growth performance (Figure 5.2). After an average annual per-capita GDP growth of 1.5% per year during the 180 years since its independence (1810-1990), per-capita growth rose to 4.1% in 1991-2005, while the world recorded 1.4% average annual per-capita GDP growth in 1991-2005.

Chile's high growth during 1986-1998 reduced its relative income gap with industrial countries and put it at a distance from most developing economies, except the high-growing East Asian economies. There is significant statistical evidence that Chile's improved institutions and policies –brought by the reforms started in the mid-1970s and continued in subsequent decades– are the main driving forces of Chile's quantum leap in GDP (and TFP) growth (e.g., Gallego and Loayza 2002, Fuentes, Larraín, and Schmidt-Hebbel 2006, Calderon and Fuentes 2006).

However, since 1998 Chile's growth performance has weakened significantly. Estimates of potential or trend GDP growth rates declined from close to 6% in 1987-1998 to close to 4.5% in 1998-2011. The proximate cause of this decline is lower TFP growth, which declined to close to nil during 1999-2011. Ultimate causes are likely to include declining returns from past reforms; distorting effects of some social and labor market policies that discourage savings, education, formal market participation; rising crime; sharp increase in energy costs; lack of structural reforms in

8 The current 2% average tariff rate is the average of a flat 6% tariff on the small share of imports not covered by free-trade agreements and the nil tariff on the large share of imports covered by free-trade agreements.

areas that are increasingly binding for growth; and adverse cyclical effects due to the Asian crisis and the global financial crisis.

Figure 5.2. Actual and Trend GDP Growth in Chile, 1987-2014.

Source: Ministry of Finance of Chile.

Nevertheless, somewhat surprisingly, trend GDP growth estimates for 2011-2014 were raised to 5% by the independent Trend GDP Commission of the Ministry of Finance in 2010 (Figure 5.2).

Chile's equity experience is more mixed than its growth record. On the positive side is the massive and systematic reduction in poverty levels (Table 5.1). The population share living in poverty (extreme poverty) has declined from 28% (17%) in 1987 to 11% (4%) in 2009 –a two-decade poverty reduction record that is matched by few other development experiences.

On the negative side is income distribution. Household survey data show that income is highly concentrated in Chile and relative income distribution remained largely unchanged between 1990 and 2003. However, distributional improvement was observed in 2006-2009, compared to 1990-2003 data (Tables 5.2 and 5.3). The same survey also shows that the distribution of household consumption expenditure has become less unequal. However, it is still too early to infer whether the latter improvements mark the start of a trend improvement or reflect a few outliers from Chile's highly concentrated income distribution.

TABLE 5.1. POPULATION SHARE LIVING IN POVERTY IN CHILE, 1987-2009 (%).

	POVERTY	EXTREME Poverty	TOTAL
1987	27.7	17.4	45.1
1990	25.6	13	38.6
1992	23.8	9	32.8
1994	20.1	7.6	27.7
1996	17.5	5.7	23.2
1998	16	5.6	21.6
2000	14.6	5.6	20.2
2003	14	4.7	18.7
2006	10.5	3.2	13.7
2009	11.4	3.7	15.1

Source: CASEN household surveys.

TABLE.5.2. EVOLUTION OF INCOME DISTRIBUTION ACROSS DECILES IN CHILE, 1990-2009.

DECILE	1990	1992	1994	1996	1998	2000	2003	2006	2009
I	1.4	1.5	1.4	1.3	1.2	1.3	1.2	1.2	1.5
II	2.7	2.8	2.7	2.6	2.5	2.7	2.7	2.9	3.1
III	3.6	3.7	3.5	3.5	3.5	3.6	3.6	3.9	4
IV	4.5	4.7	4.5	4.5	4.5	4.5	4.7	4.9	4.8
V	5.4	5.6	5.6	5.4	5.3	5.7	5.4	5.6	5.6
VI	6.9	6.6	6.4	6.3	6.4	6.2	6.6	7	7.1
VII	7.7	8.1	8.1	8.2	8.3	7.9	8.2	8.7	8.5
VIII	10.4	10.5	10.6	11.1	11	10.4	10.7	11.1	11
IX	15.2	14.8	15.4	15.4	16	15.1	15.3	16	15.3
X	42.2	41.8	41.8	41.8	41.4	42.7	41.5	38.6	39.2
	100	100	100	100	100	100	100	100	100

Source: CASEN household surveys.

TABLE 5.3 INCOME DISTRIBUTION INDEXES IN CHILE, 1990–2009.

	1990	1992	1994	1996	1998	2000	2003	2006	2009
Ratio 10/10	30.1	27.9	29.9	32.2	34.5	32.8	34.6	31.3	26.2
Ratio 20/20	14	13.2	14	14.8	15.6	14.4	14.5	13.1	11.8
Ratio 10/40	3.5	3.3	3.5	3.5	3.5	3.5	3.4	3.0	2.9
Gini Coefficient	0.57	0.56	0.57	0.57	0.58	0.58	0.57	0.54	0.55

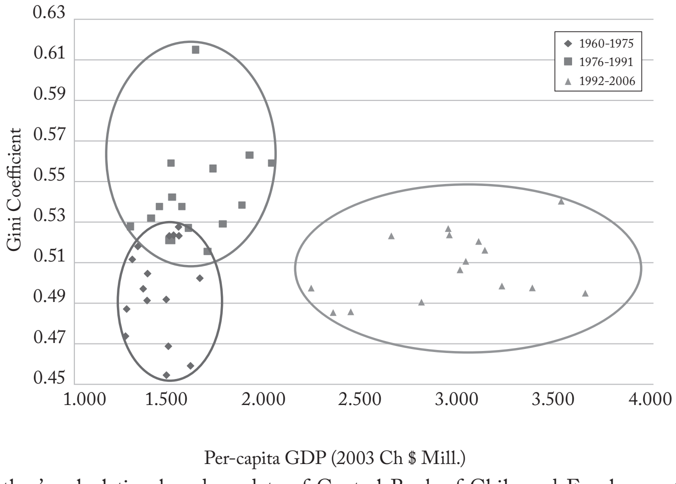
Note: Ratios x/y represent the share in country's income of the x% richest relative to the y% poorest.
Source: CASEN household surveys.

Now I turn back to the relation between average income levels and income distribution, and the dynamics between growth and distribution.

Chile's relation between per-capita GDP and income distribution in cross-country comparison has been documented in section 2. For assessing Chile's time dimension, I now use Chilean income distribution data for a longer time horizon (1960-2006), taken from the University of Chile Employment Survey. This data is less reliable and representative than the 1990-2006 data from the CASEN survey reported above. However, it provides a useful first approximation of the evolution of income distribution from the 1960s through the 1990s. The time-series relation between the Gini coefficient from this survey and per-capita GDP is depicted in Figure 5.3. The data suggests that, compared to 1960-1975, income distribution deteriorated significantly in Chile between the mid-1970s and 1991, with a partial recovery during 1992-2006.

The relation between income distribution and per-capita GDP shown in Figure 5.3 may suggest that Chile's time-series experience is consistent with a Kuznets curve. While this reading of the data is tempting, it is likely to be wrong. Not only because of deficiencies in the 1960-2006 income distribution data, but also because the sample includes deep recession periods in the 1970s and 1980s that raise the distribution indicator (the Gini coefficient behaves counter-cyclically) and is likely to be too short to support significant changes in income distribution.

Figure 5.3. A Kuznets Curve in Chile? Income Distribution (Gini Coefficient) and Per-Capita GDP, 1960–2006.



Source: Author's calculation based on data of Central Bank of Chile and Employment Survey of University of Chile.

Having the latter limitations in mind, now I come back to the simple dynamic framework for growth and distribution spelled out in section 4 to interpret Chile's experience in the light of the latter model. With potential per-capita GDP growth at close to 4% (implying international growth convergence) and a somewhat improving level of (still) high income concentration, Chile may be at some point between D2 and D3 along the stylized growth-distribution path depicted in Figure 4.4. Therefore the country is probably at a juncture where the quality of its PMP, leadership, institutions, and policies could enable it to jump on a dynamic path of improving distribution and high growth. In terms of Figure 4.4, Chile's main development challenge is to get on the D3-D4 train in the near future.

6. Political economy of key reforms to support growth and equity in Chile

Now I focus on ten areas of reform identified in Chile's development and policy literature, and by policy analysts and political parties. Needless to say, both selection of these reforms and exclusion of others are controversial, reflecting my personal views. Similar caveats apply to my subsequent assessment of the possible growth and equity impact of the latter reforms, and the political economy obstacles to their adoption.

The reform areas are the following[9]:

1. *Education*. Unequal access to pre-school education, low quality of primary and secondary education, and large heterogeneity in quality of tertiary education are a major hindrance –possibly the largest– to attain a path of high growth and improved income distribution.
2. *Poverty reduction*. While past governments have significantly expanded social programs and budgetary funding to reduce poverty, both their effectiveness and efficiency are very heterogeneous. Many social programs are not well designed (implying likely and significant disincentive effects for saving, formal work, and education for

[9] The subsequent focus on 11 major reform areas does not mean to leave aside other key sectors which have been reformed but require –due to inadequate reform design or implementation– further adjustments. For example, the new universal health program started by the Lagos administration (Plan Auge) still requires major corrections. The energy sector (after Argentine natural gas cuts and the rise in international oil prices) requires better incentives for an expansion of the private supply of conventional and non-conventional energy sources. Finally, Santiago's new public transport plan –a textbook case of bad design and implementation– is still in need of significant design and implementation corrections.

aid recipients), while others involve duplication and/or are badly implemented leading to wasteful expenditure and cheating. Major streamlining of social programs is required to raise effectiveness in reducing poverty and to provide better opportunities for the poor. Such efforts could imply a rise in aggregate social spending while changing significantly its composition, design, and implementation.

3. *Control of crime and violence.* Like many developing countries, Chile faces escalating crime and violence that impose a costly and largely regressive tax on development. While high growth and improved equity are likely to reduce crime and violence, deep reforms are required to improve prevention, detection, and repression of crime and violence.
4. *State and government reform*. Efficiency of central and decentralized government services is low to moderate on average, and exhibits large dispersion across different services and government levels. Most public enterprises operate in many areas where government productive activity exhibits little comparative advantage. While corruption at decentralized and lower levels of government is not necessarily rampant, it is frequently observed and publicly documented. Therefore a wide-ranging reform of government services and enterprises (including broad privatization) should be high on Chile's reform agenda. Partial reforms for improving somewhat the efficiency of the state and the provision of government services have been tackled by successive governments since 2003. Yet the pending reform agenda is still large, including radically improved transparency and accountability of state administration and provision of government services, professional competitive hiring (i.e., non–political selection) of all government employees up to the level of department directors (just below undersecretary level), training of employees at lower levels of government, and large-scale privatization of public enterprises and services that produce private goods (including education and health).
5. *Labor markets*. Chile's labor market laws and regulations reflect a mixed picture of partial rigidities and incomplete worker protection. Inefficient distortions (high firing costs, constraints on part-time and over-time employment) coexist with low unemployment insurance benefits and minimum wages that are likely to inhibit formal employment of low-skill workers. As a result of the latter rigidities, informal employment and natural unemployment rates are high in comparison to higher-income countries. While the collective bargaining strength of organized labor

and unions in the private sector ranges from weak to moderate, powerful unions dominate industrial relations in government service, public enterprises, and public education and public health. Training programs for young and unskilled workers are few in number and not very effective. Female labor participation is low in international comparison. Current labor market regulations discriminate against employment of low-skilled women and young people. Low employment levels among the poor perpetuate poverty and unequal income distribution. Hence a large agenda of labor market reforms should be tackled to improve employment levels and efficiency, economic growth, and income distribution.

6. *Innovation, research, and development.* To address Chile's weaknesses in innovation, research, and development (very low private spending on research and development, inadequate government incentives and programs, weak innovation and research activities and output), the 2006-2007 Innovation Commission proposed a comprehensive reform strategy that should be revised and then implemented.
7. *Entrepreneurship*. Major weaknesses limit private sector development, including red tape or excessive government regulation of start-ups and existing private firms, inadequate bankruptcy procedures, lack of basic skills of young people to start small businesses, weak enforcement of property rights protection, excessive leniency toward informal production and employment, and lack of access to venture and start-up capital. Major reforms are required to remove the latter obstacles in support of private entrepreneurship.
8. *Tax Reform*. Chile's tax system and administration have not been reformed in several decades. It is beset by complexity, inconsistency, and inefficiencies that lead to inefficient allocation of resources, lower saving and investment, and lower formal employment. A comprehensive tax reform, focused on growth and equity objectives, should be a high policy reform priority.
9. *Environmental Protection*. Chile's environmental protection regulation and enforcement is highly haphazard. A consistent evaluation of environmental externalities is missing. Environmental legislation, regulation, and enforcement is highly erratic and subject to political pressure and actions of private lobbies.
10. *Selective Regional Integration*. Most Chilean governments pay lip service to regional integration, without acting much beyond Latin Americanist

rhetoric. Considering the costs of past failed integration efforts with highly unpredictable neighboring countries, it is likely that a passive policy is in the best interest of Chile. Hence it is advisable to continue Chile's policy of full unilateral integration into the world economy, complemented by deep and broad bilateral free-trade agreements with most countries that are relevant for Chile's foreign trade in goods, services, and capital.

11. *Energy*. Chile faces very high and increasing energy costs, significant risks of future disruptions in energy availability, and strong opposition by interest and citizen's groups to the development of large investment projects in conventional and unconventional energy supply. The country's costly and fragile energy supply imposes a major hindrance to future growth. Therefore Chile is in urgent need of a political agreement to develop a more diversified matrix for its energy supply. This should rely on a legal and political framework adequately balancing economic, social, and environmental concerns, based on stable rules and institutions to assess, review and approve energy investment projects, avoiding excessive and costly intervention of the courts.

As mentioned above, it is hard to assess the expected impact of reforms on Chile's growth and equity prospects. Such an evaluation will depend crucially on actual reform content, design, and implementation, and on interactions with other institutions and policies. Having the latter uncertainty in mind, I present a tentative qualitative assessment of the likely size of reform effects on growth and equity (distribution and poverty improvements) in the ten areas of reform proposals (Table 6.1).

Table 6.1. Qualitative Assessment of Impact of Reforms on Growth and Equity in Chile.

	Growth Impact		
Equity Impact	High	Moderate	Low (Negative)
High	1. Education 2. Poverty Reduction 3. Crime Control		(Highly distorting transfers to the poor)
Moderate	4. State and Government Reform	5. Labor Markets 6. Entrepreneurship	
Low (Negative)	7. Innovation + R&D 8. Tax Reform	9. Environment	10. Regional Integration

Win-win reforms that are likely to yield both high growth and high equity returns are successful reforms in education, social policies that lead to poverty reduction and control of crime. A second set of reforms are those likely to lead to either high growth or moderate equity gains, or the reverse: state and government reform, labor market reform, and development of entrepreneurship. Growth-distribution trade-offs may arise in reforms that promote innovation and R&D, and tax reform. The two latter reforms are likely to have large positive effects on growth but may have low and even negative effects on income distribution, depending on their design and implementation. The growth and distributional impact of reforms that improve environmental protection is also very dependent on reform content and implementation. Regional integration –if it is implemented with erratic neighbors and at the cost of world integration– may yield net losses in equity and growth. Finally, I have added a hypothetical rise in badly designed direct transfers that lead to significant distortions in savings and work decisions on the part of both tax payers and transfer recipients. As shown by the model simulations reported in section 3, such transfers could improve income distribution significantly at the expense of reducing growth.

If reforms have such expected payoffs, why are they not implemented now and why were they not implemented in the past? The political economy literature identifies a host of explanations that point toward different factors explaining the lack of conviction, will or capability of governments to design, negotiate or implement reforms that have positive growth and/or equity payoffs. I refer selectively in Table 6.2 to the main obstacles to reforms identified by the literature and discuss their relevance to the Chilean case.

Chile's main challenge lies in careful design, negotiation, and implementation of institutional and policy changes for future growth and equity gains that complement each other, avoiding stiff growth-equity tradeoffs. To overcome the main obstacles to reform in Chile in the ten areas identified above, I identify a list of selective challenges to strengthen reform analysis and adoption.

1. To overcome reform inhibition by the government:

- 1.1 Make more extensive use of the valuable work of presidential and ministerial commissions for developing reform blueprints.
- 1.2 Raise requirements, staffing, and funding of research units in ministries, superintendent offices, and government agencies.

Table 6.2. Potential Obstacles to Reforms and their Relevance for Chile

Potential Obstacles to Reforms	Relevance for Chile
1. Government inhibition due to:	
Uncertainty about benefits	Moderate in case of world frontier reforms
Costs of reform design	Low (high human capital)
Costs of reform negotiation	Moderate (strong executive)
Costs of reform implementation	Low (but depends on human capital in particular reform area)
2. Distributional factors	
Large difference between median and mean voter (due to high Gini)	Very large
Large influence of median voters exercised by above-median voters (counteract the previous effect)	Large
Large uncertainty about who gains and who loses leads to reform blocking by risk-averse voters	Moderate
Power of lobbies in favor or against reforms, distorting reform content	Depending on reforms, could be very large: strong private sector lobbies, strong public-sector worker unions
Lack of compensation of losers	Standard
3. Principal–agent problems between government and voters	
Government represents special interests that weigh larger than median voter	Moderate
Government disguises its agenda and representation of special interests due to opacity and lack of accountability in government decisions	Moderate
High government discount rate (short planning horizon)	Moderate
Future voters not taken into account	Low–moderate

1.3 Put in charge special teams for reform implementation phase and training of public officials.
1.4 Adopt competitive hiring of all professional staff in government up to one level below undersecretaries.
1.5 Undertake more extensive reform experimentation by implementing reforms (particularly in education, health, and social

programs), in selected municipalities or regions, learning from the latter experience and adapting reforms over time before adopting them nationally.

2. To overcome distributional factors and reform opposition:

   2.1 Consider that policies which improve income distribution reduce the distorting effects of a median-income voter with interests which differ strongly from the mean-income voter.
   2.2 Consider that policies which improve education and policies which allow for more widely dispersed media ownership reduce the distorting effects of above-median voters on the median voter.
   2.3 Extend public and private research on reform proposals to reduce uncertainty about reform losers and winners, in order to weaken anti-reform lobbies.
   2.4 Widen disclosure of private and public-sector lobby influence on the executive and the legislative, including more disclosure of campaign financing.
   2.5 Counteract anti-reform actions in the public sector by government employee associations and public enterprise unions (in particular, the National Association of Public Employees, the national teacher's union, and the unions of public health employees and public enterprises) through disclosure of their benefits and interests, and by strengthening private sector outsourcing and privatization.
   2.6 Overcome reform opposition from labor unions by negotiating a comprehensive labor reform that combines significantly more labor-market flexibility with significantly strengthened bargaining power of labor unions in the private sector.

3. To overcome principal-agent problems (including corruption) between government and voters:

   3.1 Force national, regional, and municipal governments, as well as individual government agencies and officials, to fully disclose their interests and financial positions.
   3.2 Provide full and quick public access to most government documents and actions.
   3.3 To align governments with longer planning horizons and interests

of future generations, require systematic assessment of long–term (inter-generational) effects of reforms with long gestation and return periods.

3.4 To improve voter representation in congress, correct legislative malapportionment, i.e., unequal distribution of parliamentary representation[10].

3.5 To align governments with longer planning horizons of their principals (i.e., to reduce high government discount rates), and reduce stalemate and conflict between government and congress, raise presidential tenure or introduce an option of one presidential reelection. Alternatively, evaluate adoption of a semi-presidential or a parliamentary form of government.

7. *Conclusions*

In this paper I have addressed several positive and normative questions related to the political economy of distribution and growth in Chile.

As a starting point, I noted that Chile is different in two key relations that are observed empirically in cross-country data. First, the size of government appears to be smaller in Chile than in most countries at similar development levels, according to Wagner's Law. However, one should qualify this finding, considering that a much larger share of social and infrastructure –ranging from education and health to pensions and highways– is provided by the private sector in Chile than in most other countries in the world. Second, the degree of income concentration is larger in Chile than in most countries at similar development levels, as suggested by the Kuznets Curve.

Next I reported the simulation results of a political-economy general-equilibrium model for equity, endogenous growth, the size of government, and the composition of government spending based on taxation decided by the median voter. Calibrated to the Chilean economy and its most recent income distribution, the model is able to replicate the size and

[10] The political economy literature suggests that legislative malapportionment can have a negative impact on economic development through three channels: underprovision of public goods for underrepresented groups or parties (Alesina et al., 1999 and Ansolabehere et al., 2003), blocking of growth-enhancing reforms that threaten interests of overrepresented groups (Acemoglu, 2006), and resource extraction by overrepresented parties (Acemoglu, 2006).

structure of government spending and the rate of potential GDP growth. Counter-factual simulation results show that transfers from the rich to the poor are highly sensitive to income distribution. A more concentrated income distribution or higher taxes levied on the rich to finance transfers to the poor weaken incentives for capital accumulation and hence lower growth.

Then I presented a simple stylized model for the dynamics of distribution and growth, shaped by political leadership, the policy-making process (PMP), and the quality of institutions and policies. The model suggests that the higher the quality of the latter, the larger the likelihood of moving from a dynamic path of high growth and worsening incoming distribution to a different path of high growth and improving distribution. Chile, at potential per-capita GDP growth close to 4%, relatively high income concentration, and moderately high quality of its PMP, leadership, institutions, and policies, may be close to jumping on a dynamic path of improving distribution and high growth. Yet that would require successfully implementing an ambitious reform agenda.

Finally I have listed ten required reforms that are frequently identified in Chile's development and policy literature and by policy analysts and political parties. They are in the areas of education, poverty reduction, control of crime and violence, labor markets, state and government reform, innovation-research-development, entrepreneurship, tax reform, environmental protection, and selective regional integration. The latter reforms differ widely in their impact on growth and equity. Moreover, in order to be tackled by governments, significant political–economy hindrances to reform have to be overcome. I ended the paper by discussing of several challenges to strengthen reform adoption in three dimensions: to overcome reform inhibition by the government, to counter–act distributional factors, and to overcome principal–agent problems between government and voters.

Today Chile is at a crossroad on its path to development. At a time of increasing political division, rising populism, and declining support for political parties in government and opposition, Chile faces a triple challenge to overcome the middle-income trap. In order to attain a path of high growth and improve equity, a strong consensus has to be rebuilt in support of political reforms to strengthen voter representation, government efficiency and accountability, growth-enhancing structural changes and equity-improving reforms.

References

Adams, R. H., Jr. and J. Page (2003). "Poverty, Inequality, and Growth in Selected Middle East and North Africa Countries: 1980-2000". World Development 31(12): 2027-48.

Agenor, P-R. and P. J. Montiel (1999). Development Macroeconomics. Princeton University Press: Princeton, New Jersey.

Agenor, P-R. (2004). The Economics of Adjustment and Growth, Second Edition. Harvard University Press: Cambridge, Massachusetts.

Anand, S. and S. M. R. Kanbur (1993). "Inequality and Development: A Critique". Journal of Development Economics, 41(1):19-43.

Aninat, C., J. Landregan, P. Navia and J. Vial (2006). "Political Institutions, Policymaking Processes and Policy Outcomes in Chile". Inter-American Development Bank Working Paper No. 521.

Acemoglu, D. (2003). "A Historical Approach to Assessing the Role of Institutions in Economic Development". Finance and Development 40(2). June.

Acemoglu, D (2006). "A simple model of inefficient institutions", Scandinavian Journal of Economics 108 (4): 515-546.

Acemoglu, D. and J. Robinson (2000). "Why Did the West Extend the Franchise? Democracy, Inequality and Growth in Historical Perspective". Quarterly Journal of Economics, 115:1167-99.

Acemoglu, D., S. Johnson, and J. Robinson (2001). "The Colonial Origins of Comparative Development: An Empirical Investigation". American Economic Review, 91 (December): 1369-1401.

Acemoglu, D., S. Johnson. and J. Robinson (2002). "Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution". Quarterly Journal of Economics, CXVII (November): 1231-94.

Acemoglu, D., S. Johnson and J. Robinson (2005). "Institutions as a Fundamental Cause of Long-Run Growth" in P. Aghion and S.N. Durlauf eds., Handbook of Economic Growth Vol. 1A. Amsterdam: North-Holland.

Alesina, A., R. Baquir, and W. Easterly (1999). "Public goods and Ethnic divisions". The Quarterly Journal of Economics 114(4): 1243-1284.

Ansolabehere, S., J. Snyder Jr, and M. Ting (2003). "Bargaining in Bicameral Legislatures: When and Why Does Malapportionment Matter". The American Political Science Review 97(3): 471-481.

Barrios, S. and E. Strobl (2005). "The Dynamics of Regional Inequalities". European Economy Economic Papers No. 229, European Commission Directorate-General for Economic and Financial Affairs, Brussels.

Chumacero, R., R. Fuentes, R. Lüders and J. Vial (2006). “Understanding Chilean Reforms”. In J. Fanelli ed., Understanding Market Reforms in Latin America, Palgrave McMillan.

Collier, D., and S. Levitsky (1997). “Democracy with adjectives: Conceptual innovation in Comparative Research”. World Politics, 49(3): 430-51.

Contreras, D. (1999). “Distribucion del ingreso en Chile. Nueve hechos y algunos mitos”. Perspectivas 2(2).

Cowan, K. and J. De Gregorio (1996). “Distribucion y pobreza en Chile: ¿Estamos mal? ¿Ha habido progresos? ¿Hemos retrocedido?” Estudios Publicos 64: 26-56.

Díaz, J., R. Lüders and G. Wagner (2003). “La Republica en Cifras: Chile 1810-2000”. Manuscript, Catholic University of Chile.

Di Tella, R., R. J. MacCulloch and A. J. Oswald (2001). “Preferences over Inflation and Unemployment: Evidence from Surveys of Happiness”. American Economic Review, 91: 335-41.

Easterly, W. (2003). “A Tale of Two Kuznets Curves: Inequality in the Old and New Globalizations”. Paper for NBER Pre-Conference on Globalization and Inequality, Cambridge MA, October.

Engel, E., A. Galetovic and C. E. Raddatz (1999). “Taxes and income distribution in Chile: some unpleasant redistributive arithmetic”. Journal of Development Economics, 59(1):155-92.

Eyzaguirre, N. and O. Larrañaga (1991). “Macroeconomía de las operaciones cuasifiscales”. Serie Política Fiscal 21. Santiago, Chile: Economic Commission for Latin America and the Caribbean.

Ferrer-i-Carbonell, A. and P. Frijters (2004). “How Important is Methodology for the Estimates of the Determinants of Happiness?” The Economic Journal, 114(July): 641-59.

Freeman, R. (1995). “Are your wages set in Beijing?” Journal of Economic Perspectives, 9(3): 15-32.

Freeman, R. (2005). “China, India and the Doubling of the Global Labor Force: Who pays the Price of Globalization?” The Globalist, June.

Fuentes R., M. Larraín, and K. Schmidt-Hebbel (2006). “Sources of Growth and Behavior of tfp in Chile”. Cuadernos de Economía, 43 (127): 113-142.

Gallego, F. and N. Loayza (2002). “The Golden Period for Growth in Chile. Explanations and Forecasts”. In Loayza N. and R. Soto (editors), Economic Growth: Sources, Trends and Cycles, Santiago: Banco Central de Chile.

Hausmann, R., D. Rodrik and A. Velasco (2005). “Growth Diagnostics”. Manuscript, John F. Kennedy School of Government, Harvard University.

Kustepeli, Y. (2006). “Income Inequality, Growth, and the Enlargement of the European Union”. Emerging Markets Finance and Trade, Vol. 42, No. 6: 77-88.

Kuznets, S. (1955). "Economic Growth and Income Inequality". American Economic Review 45(1):1–28.

Lane, P. and G. M. Milesi-Ferreti (2006). "Exchange Rates and External Adjustment: Does Financial Globalization Matter?" The Institute for International Integration Studies Discussion Paper Series No. 129.

Larrañaga, O. (2001). "Distribucion de Ingresos en Chile: 1958-2001". Documento de Trabajo No. 178, Departamento de Economía, Universidad de Chile.

Lora, E. (2001). "Structural Reforms in Latin America: What Has Been Reformed and How to Measure it". Interamerican Development Bank Working Paper No. 466.

Ministry of Finance (2007). Acta Resultados del Comite Consultivo del PIB Tendencial (Summary Report of the Consulting Committee on Trend gdp). Santiago, Chile.

Morawetz, D. (1977). "Income distribution and self-rated happiness: some empirical evidence". Economic Journal, 87: 511-22.

Marshall, M. G. and K. Jaggers (2004). "Political Regime Characteristics and Transitions, 1800-2002", Polity IV Project. University of Maryland.

Pritchett, L. (1997). "Divergence, Big Time". Journal of Economic Perspectives 11(3): 3-17.

Przeworski, A., M. E. Alvarez, J. Cheibub, and F. Limongi (2000). Democracy and Development: Political Institutions and Well-Being in the World, 1950-1990. Cambridge, uk: Cambridge University Press.

Rodrik, D. (2005). "Growth Strategies", in P. Aghion and S.N. Durlauf (editors), Handbook of Economic Growth, Vol. 1A. Amsterdam: North-Holland.

Rodrik, D., A. Subramaninan, and F. Trebbi (2002). "Institutions Rule: The Primacy of Institutions over Geography and Integration in Economic Development". NBER Working Paper No. 9305.

Schmidt-Hebbel, K. (2008). "Chile's Growth and Development: Leadership, Policy-Making Process, Policies, and Results". Growth Commission, The World Bank, Washington, DC.

Schmidt-Hebbel, K. (2006). "Chile's Economic Growth". Latin American Journal of Economics, 43 (127): 5-48.

Schmidt-Hebbel, K. and J. Tello (2012). "The Political Economy of Equity, Government Size, and Growth in Chile". Manuscript Catholic University of Chile, forthcoming.

Spiller, P. and M. Tommasi (2003). "The Institutional Foundation of Public Policy: A Transactions Approach with Application to Argentina". Journal of Law, Economics and Organization, 19(2): 281-306.

Sturzenegger, F. and M. Tommasi (1998). "Introduction". In F. Sturzenegger and M. Tommasi (editors): The Political Economy of Reform. The mit Press: Cambridge, Massachusetts.

Williamson, J. (1990), "What Washington Means by Policy Reform". In John Williamson (editor): Latin American Adjustment: How Much Has Happened? Washington, D.C.: Institute for International Economics.

APPENDIX A

A Framework for the Role of Leadership, the Policy-Making Process, Institutions and Policies in Shaping Growth and Equity (Based on Schmidt-Hebbel 2008).

A.1. POLICY HIERARCHY, DEVELOPMENT, AND DEMOCRACY

I start by making distinctions among three levels of the institutional/policy hierarchy: political institutions, economic institutions, and economic policies. This distinction is helpful in subsequently analyzing the links between a society's institutional/policy hierarchy and a society's main achievements: development and democracy. The three levels of the hierarchy are closely related to the new institutional development economics, for example, as reflected in Acemoglu, Johnson, and Robinson (2001, 2002, 2005) and Rodrik, Subramanian, and Trebbi (2002).

At the most basic level of the institutional/policy hierarchy are political institutions, comprised by legal and social organizations, laws, and regulations that define national values and individual rights, state organization, government functions, and the balance of power. Examples of political institutions include constitutions, laws and regulations, and state and government bodies.

Economic institutions are at a second level. They are comprised by constitutional principles and regulations that influence private-sector behavior and decisions, and by government institutions that take economic decisions and/or regulate and supervise private markets and agents. Economic institutions are derived from or embedded in political institutions. Examples of economic institutions are the central bank charter and organization, tax codes, electric utility regulation and supervision, and social insurance laws.

At the hierarchy's third level are economic policies: the regimes and policy principles that shape and limit the contents and daily exercise of economic decisions by government authorities. They are based on, and conform to, economic and political institutions. Examples of economic policies include the choice of exchange-rate regime, price controls, and transfer programs to poor families.

Institutions and policies shape the two fundamental outcomes in a society: development and democracy. Development is defined here in a narrow sense, being reflected in a society's average income (or consumption) level and equity. Equity reflects a combination of the distribution of income (or wealth or consumption) among all members of a society, their opportunities for material progress, and the number of members of society afflicted by poverty. The latter definition of development –reflecting income and equity indicators– represents a widely accepted function of a society's material welfare and its distribution, but is different from even wider measures of ultimate happiness achieved by the members of a society. This study focuses on the latter, more limited concept of development.

Following conventional usage, democracy is defined here as a form of government that combines three essential, interdependent principles: the presence of institutions and procedures through which citizens can express effective preferences about alternative policies and leaders, the existence of institutionalized constraints on the exercise of power by the executive, and the guarantee of civil liberties to all citizens in their daily lives and in acts of political participation (from the Polity IV Project; see Marshall and Jaggers 2004).

Political institutions, as key pillars of the organizational structure of a society, shape the form of government (democracy) and determine both economic institutions and economic policies (Diagram 1). Economic institutions, by shaping economic policies, have a major impact on development (growth and equity). The new institutional development economics underscores the importance of economic institutions for achieving higher growth, in contrast to previous views (i.e. the Washington Consensus, see Williamson, 1990) that focused more narrowly on economic policies and their reforms as triggers for growth. Rodrik (2005) warns against the temptation of policymakers to map first-order (universal) economic principles into unique policy packages, recommending careful consideration of local opportunities and constraints in the design of policies and institutions.

Development and democracy interact positively (e.g., Przeworski et al., 2000). The dual challenge of development and democracy is to trigger sustainable reforms of political and economic institutions to break the vicious circle of underdevelopment and autocracy, in order to start a virtuous and sustainable path of high growth, improving equity and broad–based political participation.

A.2. LEADERSHIP, POLICY-MAKING PROCESS, INSTITUTIONS, AND POLICIES

The preceding framework scratches only at the surface of the links between institutions, policies, democracy, and growth. We have to dig deeper for a better understanding of the processes governing the relations between policy inputs and outcomes. This requires identifying more closely the roles and relations of three key aspects of policies: leadership, the policy-making process, and reforms of institutions and policies.

Leadership (L) –both political and economic leadership– is the ability of authority to initiate and sustain institutions and policies (IP) in support of development and democracy. L entails initiating and reforming IP in a way that translates into an effective policy-making process (PMP).

Leaders are shaped –that is, the quality of leadership is shaped– by:

- institutional and political constraints (i.e.: constraints on corruption)
- rules of the PMP
- interests and goals of groups or parties represented by the leaders
- incentive structure faced by leaders
- efficiency of the state
- economic and political results (elections and other expressions of political legitimacy).

The PMP comprises the ways and stages in the conduct of policies and the reforms of IP by the political leadership. The PMP is determined by the following political-institutional factors:

- democratic organization of government
- government system
- electoral system and resulting party system
- state efficiency: government bureaucracy, judiciary (independence, efficiency), parliament (auditing and control).

The PMP is also shaped by social norms and implicit institutions and rules that characterize the political culture and social capital of a country. However, because they are difficult to define and measure, it is hard to identify causal relationships from these "soft" features to PMP.

I follow the political economy literature based on repeated games (Spiller and Tommasi 2003, applied by Aninat et al. 2006 to Chile) in identifying six features of the PMP that contribute to attaining cooperative outcomes among the main players (government and opposition, as well as other actors):

i) high degree of shared interests and views (consensus) among players,
ii) small immediate benefits from reneging on agreements,
iii) small number of decision makers,
iv) repeated interaction among decision makers (repeated game),
v) easy observation of deviations from agreed-upon behavior, and
vi) availability of credible enforcement mechanisms.

Now let's turn to institutions and policies. The reform of IP –designing and putting in place effective IP– is key for development. Yet underdevelopment itself is often a hindrance to reform. Therefore the main triggers of adoption of programs of IP reform are:

(i) domestic political crises or changes (end of war, new governments) and domestic economic crises, and/or
(ii) foreign triggers, including foreign aid conditionality, political or economic association with other countries, changes in international conditions (i.e., major international trade or financial shocks), demonstration effects of internationally successful policies (policy learning).

Sustainable reforms of IP go through the following stages:

(a) negotiation among main actors and affected groups,
(b) institutional or policy design,
(c) experimentation,
(d) full-scale implementation,
(e) corrections, and
(f) ensuring long–term sustainability.

Reforms could result in failure or reversal because of one or more of the following factors:

- bad technical design
- negative interaction with lack of reform in other areas (a form of bad design)
- poor implementation
- lack of democratic legitimacy and political sustainability (done under autocracy; benefit minorities)
- reform reversal due to growing influence of reform losers (which could be few but powerful*)*.

On the other hand, the likelihood of reform success and sustainability is raised by one or more of the following conditions:

- strong influence of technocrats in reform design
- reforms representing interests of majorities (i.e., the "representative consumer")
- if politically required, reforms allowing for compensation of losers
- reforms enacted democratically
- reforms shaped by a PMP that favors cooperative outcomes.

The main features of reforms of IP are reform strength or depth (shallow or partial vs. deep or comprehensive), speed (gradualism versus cold turkey), timing (when), and sequencing (in relation to other reforms). A significant analytical literature has developed since the 1970s on the latter reform features, focusing on positive and normative (welfare) aspects of reforms, as well as on their political economy. Most of the latter literature focuses on particular reforms (like macroeconomic stabilization, pension-system reform or anti-poverty programs) or on partial aspects of comprehensive reform programs (e.g., sequencing of trade and financial liberalization, speed of macro stabilization).

Not many sturdy inferences can be derived from the latter literature, due to its largely partial and restrictive focus. The latter is largely unavoidable due to the complexity and country-specificity of reforms. Among the exceptions to the latter conclusion are a few lessons on optimal reform sequencing. More recently, Hausmann, Rodrik, and Velasco (2005) have developed a framework of "growth diagnostics" that complements Rodrik's (2005) "growth strategies". Their novel approach focuses on deriving a country's key policy priorities by identifying the most binding constraints on economic activity. While their framework is based on an explicit general-equilibrium model that embeds economic and political constraints, its practical application is still untested.

My inference from the world experience and literature on IP reforms since the 1970s is that effective leadership and the quality of the policy–making process are more important for successful adoption of better IP than reform features like optimal timing, speed, or sequencing of reforms. Timing, speed, and sequencing should not be fine-tuned. As long as good L and PMP are in place, and reform capacity and willingness are not strained beyond their limits, the sooner and the quicker more good reforms of IP are designed, executed, and followed through, the larger will be their development impact.

Now we turn to the complex relations between reform efforts (or the quality of IP) and development results (growth and equity). While there has been analytical and empirical progress in better understanding the latter relations, they are still largely a black box. Among the many possible reasons, I selectively list some of them next:

- Lack of deep macroeconomic foundations that link IP to economic outcomes (particularly true for "soft" institutions, like transparent government, central bank independence or bankruptcy legislation)
- Feedback effects from results to IP (e.g., bad economic results may trigger election losses or, if political institutions are weak, to coups d'etat, leading to further changes in IP)
- Non-linearities and threshold effects between IP and results; critical mass of political will/capability, leadership, human resources in government required for effective reform (e.g., between IP and growth, between IP and democracy)
- Non-monotonicities between economic results (e.g., between equity and growth: the Kuznets curve)
- Path dependence (initial conditions matter both for IP and their reforms, and for economic results)
- Multiple equilibria (similar initial conditions can lead to widely different development paths, depending on particular components of IP and exogenous shocks (good luck, neighborhood and demonstration effects)
- Interaction effects between institutions and policies in different areas: key to consider by governments at reform design and implementation stages

- Interaction effects between institutions and policies in different areas: key in estimation of results (e.g., growing empirical evidence for growth performance).

Without forgetting the latter difficulties, Diagram 2 makes an attempt to depict the complex relations between IP and economic and political results. It represents the key role of L, PMP, and the conditions for attaining cooperative outcomes, as a result of the quality of IP, with feedback effects from the quality of leadership. Social norms and the political culture of a society also shape the PMP and the leaders' own interests and incentives, conditioned by the efficiency of the state, effecting the quality of leadership.

The PMP determines the contents and quality of policies and reforms of IP, and the latter impinge on economic and political outcomes. Good IP lead to good outcomes, with positive feedback for political stability. In contrast, badly designed, implemented or enforced IP lead to bad results. The latter are rejected by the population, leading to electoral rejection and a democratic change in government if political institutions are strong and democracy is entrenched. When political institutions are weak, bad results may lead to political crises, armed domestic conflict, and violent overthrow of government, in turn leading to further change in L, PMP, and IP. Hence the challenge of development and democracy is to get societies on a virtuous path of improved L, PMP, and IP, leading to high growth, better equity, and a stronger democracy.

An Institution for Stimulating Productivity and Public Participation in Chile[1]

Ricardo Gonzalez

1. Introduction

Corbo and Gonzalez in this volume have shown that part of Chile's poor GDP growth over the last decade is due to a declining speed of productivity growth in sharp contrast with the 90s, when productivity expanded, driving output growth. So if Chile wants to return to achieving and sustaining high growth rates, the country must commit to reforms in order to accelerate productivity growth. Since productivity growth is critical for growth and for improving living standards in the long-term, the implementation of this set of reforms has a large expected payoff.

However, despite the large expected payoffs and a broad consensus among policymakers about the reforms the country needs to adopt to boost productivity growth[2], the approval of these types of reforms has become increasingly difficult. Why? The obvious answer is a lack of leadership, conviction, capability or will on the part of the authorities in pursuing the adoption of such reforms. A less obvious answer lies in how policies are formulated by the government and Congress, and the channels of participation for the civil society. In this paper, I advance the hypothesis that the lack of technical skills –the absence of a permanent core of top professionals handling the design of policy reforms– and public participation is complicating the process of designing and adopting the complex reforms the country needs at its current level of development in order to boost productivity.

Section 2 of this paper discusses how policies are designed by the government and the Congress and the pitfalls in this process, mainly related to the lack of technical capacity and public deliberation. Special attention is given to the surge of ad hoc commissions addressing the technical content of reforms. I argue that as they operate outside the

[1] I thank Mario Pradenas for superb research assistance and the valuable comments of Vittorio Corbo and Lucas MacClure. Any remaining errors are my own responsibility.

[2] See Corbo and Gonzalez (2013) and Schmidt-Hebbel (2013), both in this volume.

legislative system, their outcome is largely idiosyncratic: although, in most commissions a broad range of experts are invited, a deficit remains in public participation, affecting the legitimacy of this process. Both factors complicate the design and implementation of productivity-enhancing reforms.

In Section 2, special attention is also given to the recent trend of social organizations expressing their demands in non-institutionalized arenas. They have the power of affecting the formal policymaking process by imposing large social and private costs with their actions. This is an evident sign of the community demanding more participation in the formulation of policies that affect them.

In the remaining sections of the paper I discuss how the incorporation of a special institution into Chile's current policymaking setting could provide the technical skills and create the bridges to encourage community participation in the process of policymaking. Such an institution would have the characteristics of the Australian Productivity Commission (APC), an independent organization to advise the government on policies, stimulating productivity by designing the technical content of reforms in economic, social and environmental issues. In Section 3 I present the founding principles of this institution, how these principles translate into its functioning, whether the commission has been successful in stimulating the adoption of productivity-enhancing reforms in Australia and the experience of New Zealand, which recently adopted such institution.

In Section 4, I analyze separately two key points about the operation of the APC. The first is the focus on productivity. For economists, it is easy to conceive that enhancing productivity will ultimately lead to improvements in income growth and material wellbeing. However, it is not a straightforward proposition for the rest of the community. For this reason, I devote the first part of Section 4 to explaining why productivity is a valuable organizing principle for achieving higher material welfare and how improvements in productivity help in achieving social and environmental goals.

The second key point explained in detail in Section 4 is the public consultation process. This is the channel where the community, all interested stakeholders, can express their views and later confront them in a process of debate. Particularly important is the research performed by the APC's technical staff, providing the facts and empirical evidence, playing both a key role in the reform design process. The permanent core of high-quality professionals and their research skills contribute to strengthen the technical capacity of the state, easing the process of policy formulation. The results of this research are contained in *ex ante* evaluations performed by the commission at the moment of designing the reforms, which are later contrasted with the viewpoints of the community and they are also useful to build support for the reform when discussed in Congress. The commission also performs *ex post* evaluations which are valuable for sustaining reform efforts in affine areas.

In Section 5, I analyze the benefits of adopting an Australian-style productivity commission in Chile for the current policymaking process. I discuss the benefits in light of the deficits identified previously: technical skills and public participation. In addition, I present some criticisms to this approach, to advance discussion in these matters and contrast the adoption of this commission with other institutional innovations suggested by other scholars in Chile.

However, the implementation of an Australian-style productivity commission in Chile is no panacea because the adoption of this institution will neither lead to the immediate approval of the reforms the country needs nor solve the problems in the political system. The reason is that the commission intervenes at the stage where policies are designed, not when these policies are approved and implemented, so there is little the commission can do in overcoming failures in later stages of the policymaking process. In Section 6, I explain briefly what other reforms Chile needs to address, which are perhaps more important than the implementation of an APC, complementing and improving the functioning of the institutional innovation I suggest in this paper.

Finally, Section 7 presents the concluding remarks of this paper.

The main contribution of this paper to the literature is the development of an analysis of the gains of establishing an Australian-style Productivity Commission in the context of an emerging country like Chile. Typically, the analysis of the adoption of such institution refers to developed economies, where the political situation is very different from that of Latin American[3]. As stressed by IADB (2010), Latin American countries are facing low productivity growth as in Chile and, according to Scartascini and Tommasi (2012), the deficits in technical skills of policymakers and

[3] See OECD (2010) for an analysis of how an APC-type of institution could benefit developed economies in pushing and sustaining reform efforts.

public participation are more serious in some countries of the region. In this sense, the lessons drawn for Chile here would be valuable for other Latin American countries as well.

2. The current process of policy formulation

In Chile, the government and members of Congress (individually or in groups of ten or fewer members) have the power of initiating the design of laws or policy reforms. However, the government has the exclusive initiative in reforms where resources from the public budget are involved. So, the Executive holds in its hands the power of pursuing the most important reforms.

When the Congress designs reforms, there are no regulations about how the process must be carried out. Anecdotal evidence suggests that members of Congress suffer from a lack of technical staff to design the technical content of reforms, which is problematic for an adequate design of policies. On the other hand, since Congress represents the views of its members' constituencies, at least in theory, the reforms they design take into account the viewpoints of the community. In this sense, the community participates indirectly in policy reforms. However, in words of Arturo Valenzuela, there is a crisis of representation in Chile[4], where people feel that their senators and deputies do not represent the interests of the community that voted for them and instead tend to favor the interests of well-organized, rent-seeking groups. Therefore, society does not believe that their views are represented effectively in policy outcomes, weakening this indirect form of participation.

In contrast, when the Executive branch designs the reforms, there are norms regulating the process. The legislation, established since April 2000, forces the government to consider the community's points of view at the moment of defining the central ideas underlying the content of any reform. But, what are the mechanisms through which the views of relevant communities are considered? According to Lucas Sierra[5], there is only one channel specified in the law: in some circumstances, some basic elements of the reform can be discussed by the Council of Social Dialogue (*Consejo de Dialogo Social* in Spanish), which is a consultative organism, representative

[4] See Valenzuela (2012).
[5] See Sierra (2003).

of the community, expressing the societal concerns about social and economic matters involved in the formulation of policies. However, the legislation does not specify the topics requiring the consultation of the Council and the government is not even required to ask for the Council's opinion when designing policy reforms. So in practice, this Council does not influence the design of policies and consequently, reforms are formulated without the participation of any interested stakeholder, or what it is worst, the policy can be shaped with the consultation of only a few political actors, biasing the outcome of this process in favor of those participating.

Furthermore, although the Executive enjoys larger technical and human resources than the Congress to perform the task of policy reform, it still falls short of what is needed to formulate the technical content of reforms successfully. One reason is the lack of a permanent core of top professionals in the civil service. When a new government takes office, a recruiting process occurs to bring high-skilled people to support the work of all Ministers. But when a given Minister leaves the job, his or her key advisers leave as well, so the next administration starts from scratch. This is more troublesome when terms are short. In such cases, just when top advisers learn to perform their tasks efficiently, the term ends, leaving the crucial tasks of formulating policy reforms to the next administration that needs to learn the job the exiting advisers have already mastered.

For increasing the technical capacity of the Executive and enhancing the participation of interested individuals (or political actors), in recent years the government has begun to set up ad hoc commissions (the so called Presidential Advisory Councils or *Consejos Asesores Presidenciales* in Spanish) to propose reforms in particular economic and social areas. This process began in March 2006, during the Bachelet administration, when the commission studying the reforms to the pension system was established. Later, new commissions were formed to propose reforms in several other areas: the quality of education, employment and equity, childhood and tertiary education. This practice continued during the Piñera administration with the formation of other commissions addressing topics such as minimum wage, competition and the market of electricity.

In practice, the outcomes of this approach have been largely idiosyncratic. The reason partially lies in the absence of norms regulating the composition and performance of these commissions as they operate outside of the civil service and legislative process. Thus, there are no guarantees that all interested stakeholders participate in the debate of policy reform, that all points of view are confronted and that the outcome adequately represents the interests of the community[6].

Despite the weaknesses in public participation within these first ad hoc commissions, the recommendations they suggested were usually considered by the government of the day and subsequently ratified in Congress. So, to strengthen public participation within this framework of policymaking, the size of subsequent commissions was increased, complicating the coordination and debate of the actors involved in this process. Moreover, the technical skills of the members were highly heterogeneous, benefiting participants with larger resources to perform technical analysis of the issue at hand, typically the think tanks. In spite of the difficulties, more points of view were thoroughly analyzed and political actors, typically ignored in the reform debate, were particularly glad for the opportunity of being heard[7]. However, technical experts were still largely influential at the moment of writing the final report.

In sum, these ad-hoc commissions have been valuable for opening the discussion of policy reforms to part of the community and for gathering experts providing the technical skills required to design the reforms which the government or the Congress does not have for the reasons discussed above. However, this approach of designing policy reforms has many drawbacks: (1) in practice, not all points of view are effectively represented in the policy debate within these commissions; (2) at the time of writing the final report, some interests influence the outcome of this process more than others; (3) as the President set the terms of reference, it is possible that potentially relevant topics end up being excluded from the analysis; (4) there are no guarantees of the commission's independence as the government itself appoints the members of such commissions, generating doubts about how influential the government's own assessment of the reform in the final report could be; (5) often, these commissions do not have enough time, financial and human resources to perform the policy

[6] Garreton et al (2012) conducted interviews to most participants from a wide range of ad hoc commissions set up in Chile. These participants expressed their satisfaction for being invited to the process of policy reform, however, they complained that in some commissions the critics of the system were excluded, that some participants were largely influential at the moment of writing the final report and that other views were not adequately discussed and were poorly considered at the end.

[7] See Garreton et al., (2012).

design efficiently; and (6) the public administration is excluded from the reform design process in most cases.

Thus, the constitution of these commissions is a first step towards more technical capacity and public participation in the process of reform design, allowing the generation of debate and some consensus. However, the transitory reunion of technical experts, the overrepresentation of their views and the *a priori* exclusion of several stakeholders with a relevant opinion about policy issues limit the technical capacity, the public participation and legitimacy of the outcomes derived from these ad hoc commissions[8].

Nevertheless, the structure of the policymaking process in Chile has led to stable, adequately coordinated and coherent policies; a continuing, though slow process of reform; low levels of corruption; and a good implementation of reforms. In fact, this structure is responsible for successfully implementing many of the structural reforms during mid-80s and 90s, which were valuable in sustaining high economic and productivity growth rates over those years[9].

This success is accounted for by several factors, such as: (1) the process features few political actors interacting repeatedly, which encourages them to make credible moves and to sustain long-term commitments; (2) the negotiating arenas, especially the Congress, are relatively transparent; (3) since reforms are implemented by a technical bureaucracy and enforced by independent, politically-insulated judiciary, policy reversals are less likely to occur; (4) as the Executive enjoys a strong agenda-setting power, the degree of public accountability is high; (5) since the power of the two large coalitions is balanced (in terms of the number of seats that both coalitions have in Congress), the government is forced to adopt the consensus view in areas where reforms are agreed upon.

However, this structure has been less successful in adopting microeconomic reforms, oriented to increase productivity growth, which include: improving the quality of education and health services; enhancing the competition in several markets, such as regulated services and both financial and health markets; deregulating the labor market; and stimulating both adoption and innovation of technologies.

[8] Aguilera (2007) critiques how these commissions perform their inquiries, claiming that they operate as a committee of experts instead of a true mechanism to enhance public participation in policy design.

[9] See the introduction of Corbo and Gonzalez (2013) in this volume.

But why has this structure not been suited to deal effectively with these microeconomic reforms? One answer involves the lack of technical skills of the civil service and the political agents in charge of formulating the reforms (i.e. the Executive branch and the Congress) and the low participation of the community in the whole process. These two pitfalls have been revealed by the complexity of the reforms the country needs to address in this stage of development.

When I refer to the lack of technical skills of the Congress and the government, I mean that there is an insufficient capability to design reforms founded on scientific and empirical evidence about how the economy works and the potential effects of the reform on the overall functioning of the economy. These resources include high-quality professionals with the skills to evaluate policy and institutional reforms in the areas of interest and the relevant databases where the information comes from. This allows lifting the veil of ignorance, which sometimes is present when designing economic and social policies.

At the same time, this informed assessment reduces the space of influence of special interest groups at the moment of designing reforms. These stakeholders may exert their influence through the use of technical studies favoring their positions and ideological beliefs, which tends to blur the policy debate and thus contributing to block the discussion of reforms. This action favors the interests they represent and protects the political power they wield, putting aside the interests of the community at large.

However, along with the technical skills and the informed assessment, the participation of the public is also necessary at the moment of formulating policies. Why? Because it is necessary to legitimize the content of major reforms so they can represent effectively the community's interests, reducing the likelihood of being captured by powerful, special interest groups.

Traditionally, the legitimacy of major reforms arises in Congress, at the moment when members of Congress vote for their approval or rejection as they represent the views of their constituencies. However, the crisis of representation in Chile has weakened this indirect form of participation and has led society to express its demands through other less formal channels of participation.

Moreover, the complexity of the design of pending reforms for stimulating productivity sharpens the difficulties within the reform process. These complications arise from difficulties in the identification of reform beneficiaries and the timing of costs and benefits. Generally, benefits tend to be visible in the long term, while the costs are typically up-front, so groups facing these costs have incentives to mobilize against the reform and exert their influence on the design of policies. In a scenario where the government and Congress do not count with enough technical capacity and there is not enough public participation, the public entities may fall prey to interest groups, providing technical advice that supports their narrow interests. In other words, the groups particularly affected by the reform may lobby successfully to favor their interests and block the adoption of productivity –and welfare– enhancing reforms.

Hence, to avoid the risk of capture produced by interest groups, it is necessary to create the mechanisms promoting an effective participation of the community, including all interested stakeholders without exception, so they can be part of the process of reform design that ultimately will affect their lives when implemented. This is especially important over the last couple of years when several social organizations began to claim more participation in the policymaking process and in the design of reforms that affect them.

The lack of public participation in the process of formulating policy proposals and the crisis of representation mentioned above were in part the reasons explaining why many social organizations are still choosing non-institutionalized forms of expressing their demands. Although the frequency of this phenomenon has increased in the last couple of years, they have been present to a limited extent since democracy was restored. Nonetheless, the occurrence of this phenomenon in Chile is still far below the norm in Latin America.

The non-institutionalized forms of expression employed by social organizations to express their demands and influence the policy debate have appeared prominently when discussing energy, educational and regional economic policies in 2011 and 2012. While debating these issues, people have manifested their demands by means of pacific protests, street riots, barricades and even isolated events of violence, all of them examples of non-institutionalized activities, operating outside the traditional platforms of policy debate, yet relevant for the design of economic reforms. In addition, these forms of expression have imposed significant social and private costs for those engaged in such maneuvers as well as for those who do not, and ultimately, they have also delayed the introduction of major policy and institutional reforms.

Overall, Chile faces major challenges to improve the design of economic policies in order to circumvent the technical deficit present in the Executive and Congress and to create mechanisms to encourage public participation in this process. Addressing these challenges effectively will reduce the risk of capture by interest groups that is present today and the costs for the fraction of society engaged in expressing demands in non-institutionalized arenas will decline. Thus, the link between public authorities and the community strengthens and the interests of the community reign over special narrow interests at the moment of formulating major economic reforms, also speeding up the introduction of productivity-enhancing reforms.

3. The Australian Productivity Commission

The Australian Productivity Commission (APC in short) is an independent institution whose objective is to improve the overall performance of the economy by focusing on productivity growth in the public and private sectors to achieve higher living standards for all Australians by providing informed assessments about the reforms Australia needs in several areas[10]. This mandate is expressed explicitly in the law establishing its creation.

The APC plays an advisory role only, so it does not feature any executive, administrative or legislative power. The APC acts when the government or other government bodies –with the explicit authorization of the government– study regulations or institutional arrangements involving a wide range of areas such as the tax regime, environmental policies, educational and health systems, to name a few. But the APC can also undertake its own research projects on topics involving the recommendation of new reforms on a given area. And moreover, social organizations, State governments, the Parliament and other public entities can initiate studies too, so the range of matters which this commission can address is very ample. However, the reports required by the Executive receive high priority. At the end of the process, the APC must issue a report to the government.

The main indicator signaling the areas where economic reforms are needed is productivity. Thus, the APC reports aim to identify reforms with the potential of enhancing productivity. This institution is focused

[10] In Section 4, I will discuss how productivity growth is a valuable organizing principle to guide the achievement of higher welfare for the society as a whole.

on productivity because of its belief that as productivity is one of the central variables underpinning per capita income growth, it is crucial for determining material wellbeing. Likewise, the APC also recognizes that per capita income growth is one of many dimensions of material wellbeing. In particular, it recognizes that social and environmental issues are relevant too as I illustrate in Section 4. Thus, social and environmental concerns are explicitly incorporated at the moment of designing economic reforms.

When APC studies conclude that deep reforms are needed in a given industry, they take into account the interests of consumers, employers, employees and the community as a whole at the moment of formulating the reform package. Thus those reforms usually include assistance policies in order to smooth the adjustment during the implementation of reforms and avoid the social hardships involved in such transitions.

Another issue that the APC studies carefully is the effect of reforms on regional employment. Since one of the objectives of this institution is to encourage employment, especially in regions, the APC designs policy reforms giving special attention to this issue.

Ultimately, the APC is also interested in achieving environmental goals because they are a relevant part of Australians' material wellbeing. Therefore, the APC ensures that they are adequately considered when designing reforms in order to ensure that the development of industries and the overall economy is achieved in an ecological and sustainable way.

It is worth emphasizing that all these objectives are established in the law enacting the creation of the APC in 1998, the same law that gives this institution its independence.

The rest of this section presents the principles that shape the functioning of the APC and how it is held accountable. Then, I discuss some evidence of its successful labor in enhancing productivity growth. Finally, I present the short experience of the New Zealand Productivity Commission, which is a new institution strongly based on its Australian counterpart. The discussion is focused on the similarities and the differences of this institution with the APC and its performance over the few years since its implementation.

3.1. Principles of the Productivity Commission

This commission was founded on the principles of independence, transparency and economy–wide and community focus. These principles come from preceding institutions that also embraced them. In Appendix

A, I briefly describe the development of the past commissions, the role they had in the public policy debate in Australia and their influence on what the APC is today.

Independence, the first founding principle of the APC, is established by law, so APC operates under the rules of its own legislation, aside from the government. The APC and the government are related only when the government asks for APC's advice on a given policy issue. In the beginning of the APC, the Commissioners, heads of the APC, were appointed by the Governor-General, according to their expertise in environmental, industry and social issues, for up to five years and they could not be easily removed by the government of the day. The candidates for this position were suggested by the government, but it was the job of the Governor-General to assess their skills and experience for the job. Thus, the government could bias the nomination of candidates toward people with connections or affiliations with the government. Banks (2012) claims that this kind of appointments had occurred in the past, but the appointees had the technical capacity to perform the job successfully, so this was not an issue in practice.

Recently, the procedure to choose the appointees changed. The candidates now have to go through a merit-based selection process. The panel headed by the Portfolio Secretary selects the candidates and gives their names to the Minister who appoints the candidates. The Minister can also choose candidates outside of this process, but it has to justify the nomination when seeking the Cabinet's approval. This system started in 2008 and has been performed twice at the time of writing with excellent results, according to Banks (2012).

The number of Commissioners varies between four and eleven, including the Chairman and the Deputy Chairman –the most important appointments within the hierarchy of the APC– depending on the projects the APC is handling at a given time. The Chairman and Deputy Chairman are full-time jobs, while the other members may be appointed on a part-time basis[11]. Usually, the background of most Commissioners is the academy, public service or business, areas where they have experience and expertise to perform the analysis of economic, social and environmental matters successfully[12]. This independence gives APC a privileged position

[11] The Assistant Treasurer may also appoint Associate Commissioners to support the process of reform design for a specific task. These Associate Commissioners can be appointed for up to five years or for the duration of the task. The Minister selects these appointments without any constraint.

[12] Note that this requirement of expertise in those three areas is established explicitly by law.

from which it can advise the government effectively, without interference from conflicting or narrow interests. This is a critical element for successful policymaking as I discuss in Section 5.

The second principle is transparency, prominently expressed in the consultative process, and the most important phase of this policymaking framework because all interested stakeholders can interact and debate the pros and cons of reforms in an institutionalized arena such as the APC. Later, all models, reports, submissions and transcripts –in sum, the whole process of discussion– are uploaded to the website of the APC. Thus, the public can monitor the views of all participants, the arguments that prevailed at the end of the debate and the main points of agreement and disagreement.

This public inquiry process is a key feature of the APC, and for that reason, I devote part of Section 4 to explaining how this process encourages public participation in the design of reform packages. In Section 5 I will analyze how this feature would benefit Chile's current policymaking process.

The third founding principle of the APC is the economy-wide and community focus. Keeping in mind that the objective of this institution is to improve the overall economic performance by focusing on productivity growth in public and private sectors in order to achieve higher material living standards for the community. This involves the elaboration of research reports in areas where the commission may suggest new reforms. These *ex ante* evaluations help to identify the likely benefits and costs of the reform, the timing and distribution of both, and the possible compensations for the losers when the reform is implemented. This contributes to reducing the uncertainty over the effects of productivity-enhancing reforms. So, these reports are valuable tools for building support for the reform and beating the resistance of rent-seeking losers. At the end, this may ease the bargaining among decision makers when deciding among several policy options at the legislative stage.

In addition, the APC can elaborate reports evaluating the current performance and development of industries as part of APC's effort to monitor public policies, government services and industries' regulations and assistances. Of particular importance in this regard are the evaluations of reforms recommended by the APC and adopted by the government of the day. These *ex post* evaluations are beneficial in sustaining reforms when these are properly designed and also in removing inefficient regulations currently in place. Furthermore, these evaluations enhance the credibility of the public on the commission's assignments.

The recommendations derived from APC's reports are usually founded on the technical analysis of economic issues and on the public debate engaged with interested stakeholders. Regarding the technical modeling, the law requires that the policy recommendations derived from this exercise must be robust to changes in economic modeling. Thus, in areas where economic modeling is employed, it is mandatory that the topics be analyzed using at least two economic models when possible. When this is not possible, an independent panel has to analyze the assumptions of the modeling and reassess the external validity of the models employed in the reports in order to avoid technical discussions about modeling that add little value to the public policy discussion. This also helps to improve the debate's communication to broader audiences, which is relevant because the law demands that the APC must promote the understanding of productivity and how it is related to the performance of industries, to the overall economy and welfare.

Finally, there are several instances to make the APC accountable: (1) the Management Committee is involved in the operational matters of the APC, which gathers on monthly basis to analyze the progress of APC's main outputs; (2) the Commissioner heading a government–commissioned project is forced to report the advances of the inquiry on a monthly basis; (3) the Research Committee gathers to report advances in the research program on a quarterly basis; (4) the Head of the Office reports on management issues to the Commissioners; (5) the Audit Committee, comprised by a Commissioner and two senior members of the staff, reviews particular areas of the APC's operations at least four times a year. Internal auditors –hired by the APC– and a representative of the Australian National Audit Office are required to attend meetings regularly in order to supervise how the APC performs their assignments[13].

3.2 Has the Productivity Commission been successful?

According to OECD (2010), the APC is the most effective institution in sustaining the promotion of productivity-enhancing reforms within the

[13] The APC has embraced the ethical standards specified in the Australian Public Service Values and Code of Conduct. In consequence, the APC encourages the staff, senior managers and the Commissioners to follow them strictly.

group of OECD economies. In fact, the OECD considers Australia as the paradigm of reform-sequencing among developed countries. Productivity growth averaged about 2 percent per annum over the 1990s in Australia, doubling the figure of the previous decade, and thus the country achieved the top position among OECD countries in terms of productivity expansion.

This jump-start in productivity growth is explained by the series of reforms adopted by several successive governments with the assistance of the APC. In fact, the commission performed an analysis that attempted to unveil how many reforms recommended by the APC the government adopted since 1998, the year the commission started to formally operate. The study found that a high number of policy reforms implemented by the government have been derived from APC assignments[14]. Furthermore, in a follow-up analysis the commission found that the productivity-enhancing reforms –recommended by the commission and later implemented– in energy, water, telecommunications and transport increased Australia's GDP by 2.5%[15]. These productivity gains derived from improvements in prices and in the quality of services in those sectors. These benefits also contributed to reinforce the reform process in other sectors of the economy.

The successful performance of APC is grounded on its founding principles: independency, transparency and community-wide focus. The independence and transparency, along with the technical capacity of the commission's permanent staff, allow the APC to perform credible and realistic assessments of the costs and benefits of reforms, especially those referred to adjustment and distributional effects of reforms. The credibility of the community regarding APC's assessment and the productivity gains derived from APC's previous policy advices are the two pillars helping to sustain reform efforts in Australia.

3.3 The New Zealand version

Based on the successful experience of the Productivity Commission in Australia, New Zealand set up a similar institution in 2010 that began its operations in April 2011. The functions of the New Zealand Productivity Commission (NZPC) are akin to APC's and can be grouped into three categories:

14 See Productivity Commission (2006).
15 See Banks (2005).

1. Conducting research on topics referred to the Commission by the Government;
2. Carrying out productivity-related research that aims to boost productivity over time and
3. Promoting understanding of productivity issues.

Despite the similarity in functions, there are some differences between these two commissions:

1. While the APC is an independent government institution, the NZPC operates outside the government, which is intended to reinforce the principle of independence.
2. NZPC is smaller than APC in terms of employees and resources, even controlling for income. One reason is that NZPC's funding was obtained by a redirection of funds from other ministries, departments and agencies that provided policy advice in productivity-related issues prior to this reform as these organizations were no longer needed according to the New Zealand government.
3. Contrary to the problems experienced by Australia at the moment of enacting the law creating the APC[16], the NZPC was widely accepted. The reason could be New Zealand's sharp decline in productivity charts –in fact, this country fell from the 9th position in 1970 to 20th in the OECD rankings of productivity. Another contributing factor was the favorable view of many policymakers around the world of the success of the Productivity Commission in accelerating productivity growth in Australia.

At the time of writing, the NZPC is just two years old. Although, it is a short time to assess any potential effect of the research conducted by NZPC on productivity, some interesting features stand out from the first two projects. The first two studies analyzed housing affordability and the productivity of services involved in international freight transport. The results of both projects have been evaluated by participant stakeholders and independent experts in terms of the focus, the quality of the analysis, the engagement with interest groups, the management of the process, and the delivery of the final outcome.

[16] See Productivity Commission (2003) for a discussion of the difficulties in enacting the law that created the APC.

The overall appreciation of the work of NZPC is very positive. Participants of the consultation process recognized the high quality of the analysis performed by the Commission and its effect on improving the allocation of public resources. Moreover, most participants agreed that there were many opportunities to participate in the process and that the NZPC listened to their views carefully and understood them, so this institution is effectively promoting public participation in the process of analysis and formulation of reforms. In addition, most participants agreed that working with the NZPC increases the understanding about the issue at hand and why productivity is important in broad terms. This is the result of the Commissions' enormous efforts to clarify its views and the clear language employed in the reports presenting the main findings.

One important complaint about the projects developed so far involves the terms of reference framing the discussion of policy reforms. These terms are set by the government in the New Zealand scheme. However, most participants think that stakeholders should participate in the process of setting the terms of reference because it helps sharpen the focus of the projects and eases their management. Another source of concern was the lack of a standard policy framework to organize the discussion. Stakeholders sometimes did not know why the problem was defined the way it was or why some policy options were disregarded. Participants think that a policy approach that specifies the problem, the range of options to analyze and the explanations underlying the acceptance or rejection of other policy options should be employed in all projects in order to lift the quality of the work and to stimulate the engagement with participants holding disregarded views.

Lastly, the NZPC embraced the principles of independence, transparency, open participation –achieved by the public consultation process– and communitywide focus just like its Australian counterpart. However, it remains to be seen how independent this commission is from the government. The APC can perform inquiries on its own, but may not choose to do so in some sensitive areas –defined by the particular political circumstances– without the government's approval[17]. In spite of this situation, the work of the APC has been successful. But there are no guarantees that the New Zealand version will be as successful as the Australian version. It could well be the case that a government may exert

17 See Banks (2007).

its veto power to avoid the discussion of some policy issues, curtailing part of the commission's de jure independence.

Furthermore, the NZPC is currently building a network of researchers working in the public sector to strengthen its research capacity and to develop a coordinated research program across the public sector. However, these researchers may exert some influence on the views held by the NZPC, introducing the government assessment, which may bias the outcome of the inquiries, affecting the independence of the commission. In practice, it is not clear what will happen at this point. Only time will tell.

4. Relevant elements of this approach

From the discussion in Section 3, two relevant points deserve further analysis. These are: (1) the link between stimulating productivity growth and greater wellbeing, which is the reason why the permanent high-skilled staff of the commission focuses on productivity; and (2) the public inquiry process, which is the mechanism that encourages the participation of all interested stakeholders in the debate about the design of economic reforms in a fluid and transparent way. According to the Australian experience, the focus on productivity and a high-quality policy debate are critical for the adoption of better economic policies. This section deepens the analysis of both issues.

4.1 DOES PRODUCTIVITY GROWTH CONTRIBUTE TO SOCIAL WELFARE?

The focus of the APC is stimulating productivity growth because high rates of productivity growth would be the only way of ensuring a sustained growth and better living standards for the population in the long term. For some economists, this relation is easy to understand because they have traditional models of growth in mind. In these models, aggregate income growth is underpinned by the expansion rate of productivity in the long term therefore, as welfare is strictly increasing in consumption, higher productivity rates imply higher income growth, more consumption and thus, higher welfare in the long term[18]. Although productivity was first conceived as a measure of how efficiently factors of production were

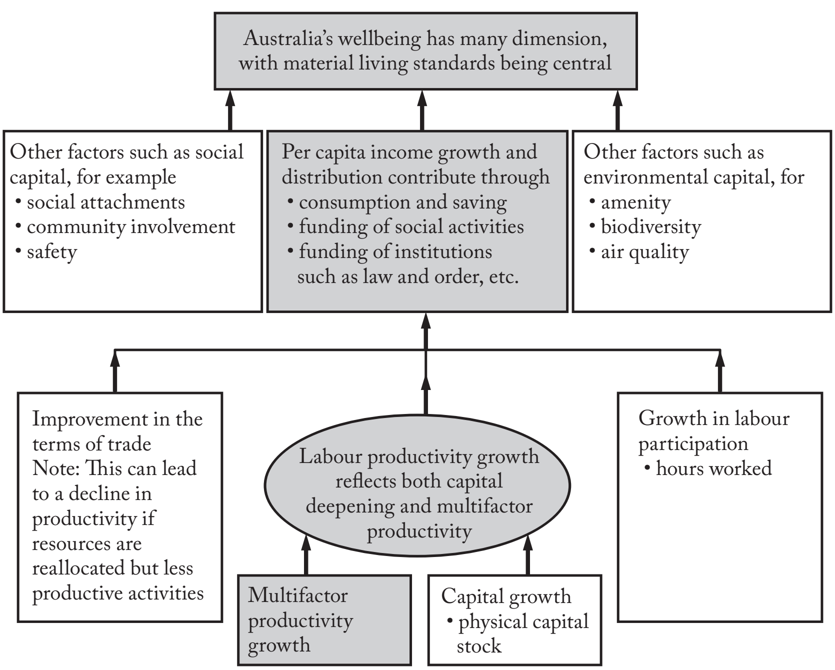
[18] One example of how important is for economists enhancing productivity is the dictum of Paul Krugman, Nobel Prize award winner: "Productivity isn't everything, but in the long run it is almost everything". See Krugman (1992), p. 9.

employed, productivity is now a term encompassing several concepts such as technical progress, skill upgrading, institutions and economic policies, according to object of study. Hence, the term "productivity" is not a narrow concept.

In contrast, for non-economists is difficult to see how productivity and welfare are related. Why should people care about productivity? Why should the government guide its economic policy towards increasing productivity? The answers of both questions are crucial since productivity is at the heart of this institution.

Figure 1 depicts a scheme developed by the APC showing how productivity growth is related to Australia's wellbeing. Productivity growth is at the bottom of the figure, as one of the two factors accounting for the growth of labor productivity. The other factor is the growth of physical capital, which is the outcome of public and private investments.

Figure 1: The link between productivity and wellbeing in Australia.



Source: Productivity Commission (2008), Annual Report 2007–08, Chapter 1, p. 2.

Along with labor productivity, improvements in terms of trade and growth in labor participation are the three determinants of per capita income growth[19]. Note that the APC remarks a potentially harmful effect of terms of trade: higher growth in terms of trade (for example, an increase in the price of copper in Chile) may lead to a reallocation of resources towards less productive, but more profitable activities.

So far, an increase in productivity growth leads to higher rates of labor productivity growth and therefore to higher per capita income growth, which is a crucial determinant of material living standards. More income growth increases the possibilities of consumption and saving for the population, conditional on how the resources are distributed. Furthermore, more income growth augments fiscal revenues and thus, the government can improve the distribution of income through subsides and transfers to the poorest members of society. The government can also invest its resources in public infrastructure and other valuable public goods such as the rule of law, security, legislative and judiciary institutions, to name a few examples.

However, there are other determinants of material welfare not directly related to productivity. They are the social factors, such as social attachments, community involvement and safety, and the environmental capital, such as amenity, biodiversity and air quality. This apparent disconnection with productivity does not mean that they are not considered when formulating economic policies. As I discussed in Section 3, the law requires the APC to consider economic, social and environmental goals when formulating the recommendations of reform, so they are not excluded from the analysis. So, achieving higher productivity and accomplishing social and environmental objectives, defined by the community, are not conflicting goals.

4.2. Why is the Productivity Commission pro-participation?

The APC encourages participation of any stakeholder, interested in the policy design of a given issue through its public consultation. This process allows an adequate confrontation of ideas held by participants, within the context of an institutionalized arena, adding transparency and community focus to the design of policy reforms and preventing policies from being

[19] The scheme of Figure 1 excludes the important role of labor quality as another determinant of labor productivity growth. Thus, in the context of this formulation, labor quality is included in productivity growth.

captured by narrow-minded interests. The technical capacity of APC's permanent staff, its focus on the community and the public consultation promotes a high-quality policy debate.

Both transparency and a sound policy debate are key factors explaining the adoption of policies stimulating productivity growth in Australia, according to Banks (2005). And since the public consultation process is a clear expression of both of these factors, it is worth explaining this process in detail.

The public consultation process begins shortly after the APC receives the terms of reference from the government about an area where reforms are needed. At this stage, the APC sends circulars to all organizations and individuals interested in that area, such as government agencies, business associations, individual companies, unions, community groups, and academics. There are also widespread announcements in the media publicizing the beginning of a study.

To identify the key issues underlying a given area, the APC conducts a few informal interviews to the most relevant stakeholders, such as government agencies and industry representatives. This also identifies the key sources of information and additional relevant actors to consult. One may be tempted to conclude that this stage is highly discretionary as potentially important issues may be intentionally left out by these stakeholders. Nevertheless, this situation may be rectified in later stages of the reform design when additional issues can be included in the analysis. After this process is completed, a report containing the key issues is prepared, published and distributed to all participants.

Then, all stakeholders submit their views, which are also published in the website of the APC, unless the information contained in the submission presents private information or deserves a confidential treatment, which is not usual[20]. This is done to keep the process of policy discussion transparent, which curtails the influence of opaque interests. It is clear that this is a reflection of transparency, one of the key principles underlying the functioning of the commission. According to Banks (2007), a typical inquiry receives between one and two hundred submissions, so it is less likely that key issues are being intentionally left out by the commission.

Then the process of debate begins. The APC employs public hearings, workshops and roundtables to discuss policy reforms. The commission

[20] See Banks (2007).

can set up debates that vary according to the degree of formality and the stage of the reform design. According to Banks (2007) it is usual that the discussion of key issues, included into the terms of reference, takes place in public hearings. The contents of the full discussion, as well as other parts of the process, are published in the website of the commission.

These public hearings and workshops sometimes take place in regions (State and Territories). This is particularly relevant as many reforms involved regional development, one of the objectives the APC must pursue as stated by law. Topics include the construction of railways and the design of domestic air routes, to name a few. People in regions often develop their own terms of reference, which are later considered when designing the reforms. Overall, the creation of the APC has stimulated an increasing participation by regional communities.

Subsequently, a draft is prepared by the commission's technical staff, containing key issues, facts, analytical models employed to address the issue and preliminary policy prescriptions derived from such exercises. This draft is reviewed internally by the Commissioners to check consistency and potential errors before its publication and distribution. After the publication, the APC encourages submitters to present their comments and suggestions to the draft. The APC may then conduct another round of hearings to discuss the policy recommendations if required. This process of feedback is also available to the public.

Ultimately, the final report is prepared, including modifications in light of the comments received when the draft was presented. The report is then sent to the government and made available to the public. Their contents are discussed in the Parliament 25 days later. However, this is not the first contact between the commission and the Parliament. The Chairman of the APC informs the Ministers and the Parliament about the activities and progress of current projects, although he is not allowed to discuss specific details of the projects. Sometimes, when a sensitive area is under study, the APC sends briefings in advance to the government when the report is finished.

When the government commissions a study to the APC, it is mandatory that it announce a decision about the policy reforms described in the commission's report. This announcement occurs when the results of the report are discussed in the Parliament. The government can also ask for more time to think over the issues raised by the report, but it is required to make a decision about the reforms recommended. Once the final decision about the APC's recommendations is taken by the government, the APC does not comment in order to preserve its independence and maintain its advisory role.

When the policy reforms, proposed by the work of the Productivity Commission, are discussed in the Parliament, the commission provides support to the parties involved in the negotiations, which takes the form of further explanations about the report's findings. Naturally, this support is crucial for shaping the policy outcomes. However, in recent years the Parliament has begun to commission work directly to the APC. As Banks (2012) explains, the Parliament has introduced legislation to mandate the commission to perform inquiries in some matters[21], and in other cases, the Parliament has given direct orders to the APC to report in other matters[22]. This latter procedure has been especially problematic as the law forbids the Parliament to give orders to any organism that lies in the Executive as the Productivity Commission.

It is clear that an Australian-style Productivity Commission is a useful platform to coordinate different viewpoints held by stakeholders on the issue at hand. The public consultation process makes the exchange of information transparent, so it is less likely that private and narrow interests or the official assessment will dominate the design of reforms. This is the result of proper execution of the independence and transparency principles. Moreover, both the wide range of views considered at the moment of elaborating the policy recommendations and the independent view of the commission, plus the economy-wide focus of the technical staff when elaborating the reports makes this institution an authentic representative of the community. Furthermore, this policymaking framework helps build support for reforming efforts and achieve consensus, and also supports the legislative process.

5. Implementing a Productivity Commission in Chile

In this section, I discuss the implementation of an Australian–style productivity commission in Chile. I analyze the benefits of adopting such an institution in light of the deficits identified previously: technical skills

[21] It is important to emphasize that the Act enacting the creation of the Productivity Commission does not specify the provision of support to the Parliament.

[22] The relation of the Productivity Commission with the Parliament is generating concern only recently because the government has minority of seats in the Parliament.

and public participation. Also, I present some criticisms to this approach to advance the discussion in these matters and contrast this framework of policymaking with other institutional innovations suggested by other scholars in Chile.

5.1. Benefits of adopting a Productivity Commission

In this part of the section, I will argue that an Australian-style Productivity Commission is the type of institution that Chile should set up to promote public participation and to boost public sector's technical capacity, required for informed assessments of the reforms the country needs to address to stimulate productivity growth, which, as I argued in Section 4, is a valuable organizing principle to pursue improvements in the material wellbeing of the population at large.

The implementation of a Productivity Commission would open a new institutionalized channel of public participation where the formulation of reforms and policies does not occur without the consultation of the community as it happens currently when the design takes place in the government or the Congress. In addition, when the public opinion is not informed about how policies were designed, the feeling that the interests of some stakeholders are not reflected in the reform recommended begins to spread, reducing the legitimacy of this part of the policymaking process.

Likewise, in this setting an independent institution formulates policy instead of a single political authority within the government. This has the advantage of facilitating the access of people to those in charge of designing policies because it is easier to communicate with this kind of institution than with Ministers.

All features that follow the adoption of an Australian-style Productivity Commission contribute to reducing the risks of policies favoring the interests of particular stakeholders without a proper debate about their legitimacy and, at the same time, increasing the likelihood that the outcomes of the policymaking represent the broad interests of the community.

This new channel of public participation can also contribute to reducing the social and private costs created by people currently engaged in expressing their views in non-institutionalized arenas such as street protests and the associated riots. In this setting, all opinions are heard and adequately confronted in a peaceful and respectful environment, which contributes to reducing violence and social conflicts.

Therefore, the dialogue between this independent institution and the community, in a setting, where the procedure rules and the timeline are clear to all participants in the debate and the permanent technical staff provides the skills required to perform the informed analysis successfully, has the potential of generating a high-quality debate, which is crucial for formulating high-quality policies[23]. According to Gary Banks, the Chairman of the APC at the moment of this writing, this is the most important lesson that a country can learn from the Australian experience.

Furthermore, the Productivity Commission has its own permanent staff prepared to conduct the technical analysis of several policy options. This is exactly what the government and the Congress need in Chile to reinvigorate the reform process. Thus, policymaking is founded on an informed assessment based on theory, facts and the empirical evidence available about the potential effects of a given policy. These top professionals do not change with the electoral cycle, so they have the chance of accumulating skills and using them in the analysis of further reforms in the future, building expertise in the study and design of policy reforms.

One of the relevant reports produced by the Productivity Commission are the *ex ante* evaluations I discussed in Section 3, which contribute to identifying the winners and the losers from reforms and the timing of the benefits and the losses, reducing the uncertainty that is pervasive when formulating reforms. Taking into account these effects at the moment of designing the reform package helps to offset the arguments of the losers blocking the reform by, for example, including compensations for them.

In addition, the Productivity Commission also performs *ex post* evaluations. The objectives of such evaluations are to identify the most costly regulations or policies currently in place and to analyze the effects of the reforms suggested by the Commission and implemented by the government. The *ex post* evaluations are valuable for increasing the sustainability of the reform efforts, which helps pursue further reforms and also promotes the credibility of the community on the commission's assignments.

Although, *ex ante* and *ex post* evaluations are two appealing features of the commission, they are not by themselves sufficient to legitimize the outcome of this form of policymaking. The legitimacy and the credibility of this approach are founded on the public consultation, which allows

[23] See Banks (2010).

exchanging and confronting diverse views –including the commission's own assessment based on technical studies– so that the final report adequately reflects the view of the community on this issue.

The independence of the Productivity Commission is important when considering the implementation of such a commission in Chile. Independence makes this institution free from being captured by corporative interests or by the official assessment. The important thing is to provide a technical assessment and a transparent debate where different views are confronted without weighing one opinion more than others. This aspect is crucial to preserving its independence. Part of this principle is reflected on how the members of this commission are appointed, as I discussed in Section 3.1. In Chile, the Council of High Public Direction (*Consejo de Alta Direccion Publica* in Spanish) should pick the candidates for the relevant positions on the commission, according to the expertise they have in the fields required for these assignments, such as industry regulation, social and environmental topics. Later, the President should be responsible for choosing the candidates among those previously selected and the Congress must ratify them, according to the their expertise and experience in relevant areas and with an absence of political bias. The nomination should be dissociated from the political cycle in order to prevent the commission from becoming a political instrument of the government at the time.

In sum, a Productivity Commission for Chile could be valuable for covering the technical deficit present in the Executive and Congress and for setting a mechanism where a direct participation of the community can take place. This contributes to reducing the likelihood that interest groups bias the formulation of policy in their favor. The debate occurs in an arena where other views are respected and carefully analyzed in light of the data and evidence regarding the issue at hand, provided by the technical staff of the commission. This reduces the current costs of debating, mostly for the fraction of society engaged in expressing demands in non-institutionalized arenas. In Australia, this approach to policymaking has led to the design, implementation and sustainability of many reforms that have allowed it to achieve substantial income gains, as I argued in Section 3. For these reasons, adopting this institution in Chile seems to be a promising avenue for making reforms happen.

5.2 Some criticisms of this approach

One possible criticism of this approach is based upon the supposed irrelevance of this institution because it has an advisory role only and therefore its recommendations are not mandatory. Naturally, part of this critique is true as the government is not forced to adopt any of the commission's policy suggestions. These policy proposals are just one input the government may or not take into account when designing a reform. The point is that this input is valuable because the final report that emanates from this process presents all relevant points for the community, discussed during the public consultation, and a final suggestion based on all available evidence and points of view. This is the greatest value of the commission. Moreover, disregarding this institution's policy advice today does not mean that the advice is of no value, since it can be considered in the future when the political authorities change, when the economic and political environment change or when the contents of reforms mature in the heads of the policymakers and the community.

Likewise, if this institution provides advice only, then some people may think that it is just another layer of state bureaucracy. Creating a commission with the resources it needs to operate successfully, technical staff and the time to conduct the public consultation process, will add a significant burden to public finances. However, if the efficiency gains achieved by the commission in Chile are of a similar order of magnitude to the gains achieved by its Australian counterpart, the benefits will outweigh the costs of adopting such commission in Chile, justifying the convenience of this approach.

Moreover, the critics arguing that this consultative institution is irrelevant may claim that this approach will frustrate the participating community as the public participation will not ultimately lead necessarily to a binding reform. Although it is quite possible, I do not think that this or other reasons are strong enough to argue that the recommendations of the commission should be binding. The reason is obvious: there is not automatic binding of any reform in an authentic democracy. When the public system is forced to adopt the reforms designed by the commission, the views of the government and the Congress –where the democratically elected representatives of the community lie– are ignored, and the policies adopted are the outcome of an institution that it is not electorally validated. In such a case, the debate that takes place in Congress between the Executive and the Legislative power, which is at the heart of the democratic system, becomes irrelevant. Therefore, despite the frustration it may generate on the part of the community, the legislative debate should not be bypassed because of the harm it might cause to the country's democracy. In contrast, the legislative debate should be enhanced, which is one of the things that an Australian-style Productivity Commission does when explains the findings of report to the Congress and helps in the negotiation of reforms.

It is also possible that the frustration comes from unmet expectations about the commission's performance. At the moment of discussing the implementation of this institution, the gains in terms of higher GDP achieved by Australia would be quoted as an argument justifying the implementation in Chile, which in turn would generate high expectations about its work in the short-run. However, as the Australian experience illustrates, this success did not come overnight; instead it was the result of a long, arduous and difficult process, featuring opposition by interest groups and political actors and few policy reversals. For example, it took Australia about four decades to lower tariffs and more than a decade to begin the adoption of reforms in infrastructure services and both processes are not even finished yet. Nonetheless, as reforms were designed through a public and transparent consultation process, the outcome was widely agreed by the community, so both processes of reforms were sustained over time.

Another potential concern is the role of technical debate within the public participation process. It is important to provide statistical facts and empirical evidence to support arguments. However, it is possible that other arguments, formulated in a rather different fashion, be disregarded. The commission must be open to receive all kinds of arguments, technical or not. This institution should possess enough resources to process these views and compare them against the evidence about how the Chilean economy works in order to produce a final assessment based on what is good for the community, according to its organizing principle of enhancing productivity growth. This would be a great contribution to improving the level of the debate about reforms in Chile.

Regarding the focus on productivity, some people may claim that by aiming to increase productivity the commission seeks to promote reforms favoring incumbent businesses. However, this stands in sharp contrast with what the commission actually does. The objective of this institution is to stimulate the best conditions for every business-not any particular business–, potential entrants and incumbent businesses, in order to guarantee that the performance of the market benefits consumers and their welfare.

Likewise, the critics may argue that the focus on productivity is a narrow approach to enhance welfare and this institution should aim to stimulate other views of wellbeing as well, for example, by incorporating social elements to the approach. Although it is true that this is one dimension of welfare among many others, this is a valuable organizing principle to conduct an informed assessment about the sectors where reforms are needed, the type of reforms the country should address and whether they have worked once implemented. Furthermore, social and environmental factors are considered when evaluating possible paths of reform. In Australia, the law forces the commission to take into account such factors when formulating reform packages. The Australian experience is also useful in showing how these variables complement the analysis of productivity. That is why, as I argued in Section 4, productivity should be viewed as an organizing principle, important for guiding the reform efforts, but without excluding these other dimensions of wellbeing.

5.3. Comparing other proposals

In this part of the section, I will present some alternatives to an APC–type of organization for Chile that have been proposed by other scholars. The objective in the following paragraphs is not to present an exhaustive list of institutional innovations pointed to ease the process of reforms in Chile, instead, the point here is to clarify what an Australian-style Productivity Commission can do in contrast to other institutional proposals.

Lucas Sierra has suggested establishing the mechanism of the Green and White Papers in Chile[24], which is already available in the UK and other countries with Anglo–Saxon origins. This mechanism seeks to make explicit the government's position on a given policy issue, which is later subject to public debate in order to modify it or extend it, according to the reactions of the community. The Green Papers are reports where a preliminary assessment of government policies in a specific area are put forth, and therefore, the government is not forced to follow this view later

[24] See Sierra (2003).

when designing the definitive reform. The public release of the Green Papers is designed to stimulate the public debate and the consultative process. Typically, the Green Papers are the reports coming from the results of ad hoc commissions such as those used in Chile and discussed at length in Section 2. After the public consultation, the government prepares a White Paper, incorporating the potential concerns of the community, which is later discussed in the Parliament or Congress.

According to Sierra, the procedure of Green and White Papers encourages the participation of the community at the moment of formulating the reform package. However, he recognizes that more mechanisms need to be set for this to operate correctly, such as: a proper form of channeling the opinions and views of the community, the government's obligation to respond to such viewpoints, publishing these opinions and allowing enough time to perform all of these actions successfully. Moreover, in this framework it is necessary to specify how to present the results of this process to Congress and how this complements the tasks of the commissions within the legislative process. He is also aware that congressional legislative commissions and, to a lesser extent, the government, lack enough technical support to perform the design of reforms successfully, and therefore, any reform in the policymaking process should also aim to provide technical assistance for both government and Congress.

An APC-type of institution features all of these desirable characteristics outlined by Sierra. This approach to policymaking includes the institutionalized mechanisms to coordinate a myriad of viewpoints from all stakeholders. As noted in Section 4, the Australian Productivity Commission receives between one and two hundred submissions for a typical inquiry and it has the capacity of processing all of them. This is enough incentive to stimulate public participation. Moreover, the APC has a permanent technical staff with the skills required to design economic reforms. In consequence, this technical advice –provided to the Executive and Congress– and the adequate confrontation of ideas in this arena should be a valuable input when discussing reforms in Congress. The final recommendation and the discussion are contained in a final report, which in spirit is similar to the White Papers procedure described by Sierra. At the end, the government must take a stance regarding the recommendations contained in the final report to Congress or may ask for more time to think over the suggested proposals.

Another interesting debate regarding institutions for addressing economic reforms deals with the role of Presidential Advisory Councils (*Consejos Asesores Presidenciales* in Spanish), which are the ad hoc commissions I described in Section 2 and the creation of a new institution, the Council of Social and Economic Dialogue (*Consejo de Dialogo Economico Social* in Spanish). This debate took place within the framework of the commission addressing employment and equity reforms, led by Patricio Meller[25].

This commission concluded that the Presidential Advisory Councils should be preserved and should not be institutionalized because this lack of regulations provide autonomy to speed up the process of discussion and allows them to perform their assignments efficiently. Moreover, the commission claimed that as the creation of these Councils is the President's prerogative, setting the terms of reference and nominating the members of the commission –who tend to be experts in the topics at hand–, there is no need for rules to regulate their performance and their ad hoc nature. Ultimately, the commission affirms that the (anecdotal) evidence about the successful performance of these commissions supports the fact that these Councils do not need specific institutionalization, without providing the explicit arguments about how their performance was measured[26].

I do not agree with this view. The results of these Councils have been largely idiosyncratic. These ad hoc commissions have been successful in gathering experts providing the technical skills required for formulating economic reforms, but sometimes these Councils have failed in confronting relevant viewpoints of some stakeholders, because they are excluded *a priori* from these commissions. Also, it is not clear how independent or autonomous these commissions are from the official assessment, since the government itself sets the terms of reference that the Council should address, leaving potentially important topics excluded from the debate. Furthermore, the limited time of work that the commission views as a strength, in my opinion, it is a weakness because it is unclear that the time dedicated to these matters is enough to provide a long-run assessment about what the country needs in the areas under analysis, mostly when the government is facing pressure from political actors. Likewise, it is

[25] See Consejo Asesor Presidencial del Trabajo y la Equidad (2008).

[26] In fact, there is more evidence of skepticism about the relative success of these commissions. See, for example, Aguilera (2007) and Garreton et al (2012).

unclear whether these commissions have enough resources, in a broad sense, to perform their tasks efficiently. For all of these reasons, I prefer that the reform design takes place in an independent and institutionalized arena, such as an Australian-style Productivity Commission, where all stakeholders can participate and present their views, where they can be adequately debated and with enough time and technical resources to perform this assignment effectively, in a context where the long term interest of the community is the main objective.

Moreover, the Australian experience suggests that technical capacity alone is not enough for successful policymaking. In 1973, an ancestor of the APC, the Industry Assistance Commission (IAC) concluded, based on a rigorous technical analysis, that tariffs should decline 25 percent. The new incoming government took the advice and implemented this reform without public consultation, which made this policy hard to sustain politically. The government had to undo this policy and go against the general direction of the trade policy at that time-removing the assistance of inefficient industries. So, the government had to implement import quotas to protect the industries affected by the sharp decline in tariffs[27]. Thus, the sustainability of the reform package is another reason why the public consultation must be considered at the moment of designing policies.

Lastly, an institution like a Productivity Commission has also an educative role about reforms, which is not specified in the mandate of Presidential Advisory Councils. Through workshops and roundtables, this institution can explain the reform, its costs and benefits, their main implications for the overall functioning of the economy and most importantly, what is the likely effect on people's lives. This promotion of the understanding of the reforms is important to stimulate the participation of community members in the decisions affecting them. Since these debates take place in regions as well, this institution also encourages also the public participation throughout the country.

On the other hand, the proponents of the Council of Social and Economic Dialogue conceive this commission as an advisory institution where debate about social and economic matters at the national level should take place. This institution would be independent, although related to the President, operating under its own legislation and budget. It would have the attribution of proposing reforms in social or economic issues to

[27] See Banks (2007).

the government or the Congress through institutionalized mechanisms, which would set the procedure and timeline of the public consultative process. However, this commission might not suggest financial, budgetary and tax reforms nor recommend the creation or suppression of public entities nor suggest changes to the attributions of public organisms. This Council would develop studies by the government requirement or by own initiative.

The objectives of the Council of Social and Economic Dialogue are broader than those of the Australian-style Productivity Commission. The first objective is to provide space for social debate in Chile in order to generate reciprocal trust among political actors, especially among the groups representing the interest of workers and businesses. Thus, this commission would provide a fertile ground to advance an agenda of consensus. The second objective is to establish the commission as the main arena where underrepresented people can present their views. And the third objective is to provide the space where long-term strategies for the future of Chile can be debated and developed.

The members of the Council would be established by law to secure an equal representation of business groups, unions, other corporate interests and the community thus ensuring that no particular interest is overrepresented at the Council.

As the reader can see, there are similarities and differences when contrasting the Council of Social and Economic Dialogue with a Productivity Commission. Among similarities, I highlight the advisory and independent role of the Council in recommending policy reforms required by the government or other public bodies and in own initiative. However, this Council would feature a strong political character that an Australian-style Productivity Commission does not have. The mission of the Australian-style Productivity Commission is to stimulate productivity growth, as an organizing principle of the reforms needed, and at the same time, take into account social and environmental considerations when recommending reforms. An important part of the process of reform design is the public consultation process where the technical proposals of the APC's staff encounter the viewpoints of all interested stakeholders, not only those interests gathered in corporative groups. Therefore, as the report of the commission of employment and equity recognizes, it is quite likely that this Council would be captured by one of these corporative interests *de facto*, despite the fact that the law would secure an equal representation.

Furthermore, some of the participants of the commission of employment and equity claim that there is not enough evidence of the success of these institutions in promoting social pacts, which is the main objective of the Council.

In the end, the Council of Social and Economic Dialogue would follow a rather different approach to policymaking than the Australian-style Productivity Commission. The Council would be strongly focused on the participation of traditional political actors, such as unions and business groups, who do not necessary represent the interests of their constituencies. Therefore, such a Council would replicate exactly the same structure of policymaking we currently have, which has not been successful in pushing complex and necessary reforms. This helps to highlight the relevance of the technical character of the Australian-style Productivity Commission and its public consultation process, which helps avoid the risk of capture of policy reforms by narrow interests and thus safeguards the interests of the community.

6. Why is a Productivity Commission no panacea for Chile?

Despite the benefits described in the previous section, the commission is not a silver bullet. Hence, the adoption of such an independent institution will not lead to an immediate approval of reforms designed to boost productivity or increase public participation overnight because other factors, complementary to this approach, should be addressed as well. In this section, I will briefly discuss these factors.

In this paper, I argue that the adoption of an Australian-style Productivity Commission will provide a channel for enhancing community participation in formulating policies. However, this will not occur if the society is not truly involved in these matters. It is usual that public participation takes place without proper information, leaving no room to pursue an effective representation in such a process. An APC-type institution can ameliorate this issue. As I discussed above, this institution provides information of reforms and promotes the understanding of their main effects on the overall functioning of the economy and on people's lives. All this is important to strengthen the capacity of civil society in engaging in public debate. However, it may not be enough. In consequence, a complementary reform to the adoption of a Productivity Commission should address this significant issue.

Moreover, this is only one way of public participation. There are other forms of participation that the adoption of the commission will not encourage such as the participation of the community in political parties, non-governmental and non-for-profit organizations and in other political instances. So, other reforms should be directed towards addressing deficits in all of these areas.

Another potential concern complicating the operation of the commission in Chile is the independence from the government. In the Australian case, although the law establishes this independence, some "sensitive" projects, defined by the government, should be addressed only by an explicit mandate of the public authorities according to Banks (2007), reducing part of the independence. Also, the government may force the commission to circumscribe the debate to some topics –specified in the initial terms of reference–, excluding some "sensitive" areas. Both situations add an important amount of discretion that is inherent to any process of policy design.

The independence of the commission from the government would be very relevant for Chile. Since the government possesses large agenda-setting powers, it may shorten the scope of issues the commission can address and therefore, may reduce the impact of the adoption of such institution. It could be the case that the government is reluctant to legislate in "sensitive" areas despite the potential gains of implementing reforms because these topics may be outside the agenda or are difficult to push through in the political context of the day. Although the Australian experience has been positive despite this constraint, the situation in Chile can be the opposite. However, this inconvenience is partially ameliorated because the Executive is not the only organism that can originate studies for the analysis of the Productivity Commission. Social organizations, State governments, the Parliament and other public entities can originate studies too, so the range of matters that this commission can address is very wide in spite of the constraints.

Perhaps the most important reason why this commission is no panacea is that the commission intervenes at the stage where policies are designed, not when these policies are approved and implemented, so there is little the commission can do in overcoming failures in later stages of the policymaking process. Although the commission provides well-analyzed and discussed proposals of reform –the first step of any successful reform– and features mechanisms to reduce the possibility of policies being captured by interest groups, it could be the case that these groups end up capturing the regulation when it is legislated in Congress, for example, through lobbying and the financing of political parties. This capture is avoided when members of Congress effectively represent the interests of the community; however, when there is low competition for political seats in Congress, the representation tends to vanish as the electoral punishment of such behavior is low. Consequently, reforms addressing such issues are strongly needed and they are a valuable complement to the approach of policymaking suggested here.

One interesting complement to the Productivity Commission would be a system of parliamentary advice. This system provides technical staff to members of Congress to help them in legislative matters[28]. Thus, Congress would have the appropriate tools to confront the technical studies received from interest groups, helping reduce the risk of policies and reforms being captured by narrow interests potentially reflected in those studies. The interaction of this scheme with the Australian-style Productivity Commission would work like this: the Productivity Commission would provide technical advice based on empirical evidence and confront this assessment with the viewpoints of all interested stakeholders. All this debate would be summarized in a final report. When this report is discussed in Congress, the technical staff of the parliamentary system would help members of Congress go through the technical details of the report, easing the understanding and the legislative process. In sum, providing technical capacity to Congress would be a valuable complement to the policymaking process and to the approach outlined in this paper and it would definitely enhance the Productivity Commission's assignments and thus, the quality of the public policy debate will grow further[29].

Overall, the final success of any policy reform relies heavily on the capability of political leadership in pursuing reforms in tough policy issues where gains are larger. It is frequent to hear that democracies are not prone to implementing long term reforms because electoral cycles make them focused on pressing issues such as short-term social and businesses demands. However, having an institution making credible and

[28] More details about the benefits and operation of a parliamentary advisory system in Chile can be found in Valdes and Soto (2009).

[29] The reader should bear in mind that the APC provides support to the legislative negotiation by explaining the findings of the inquiries it develops. However, the parliamentary assistance points to support the tasks of members of Congress in other matters as well.

realistic assessments of policies and reforms, provided by the permanent core of high-skilled staff this institution has, and representing effectively the interests of the community' through its public consultation process is a great countervailing force against such short-term focus. A strong political leadership and the establishment of this institution are a good combination for overcoming political economy drawbacks blocking productivity-enhancing reforms and thus, both contribute to achieve larger long-term welfare gains.

7. *Final remarks*

In this paper, I have proposed that two deficits in the process of policy formulation have complicated the adoption of complex and necessary reforms in Chile. These are the lack of technical skills –the absence of a permanent core of high-quality professionals in charge of designing reforms– and insufficient public participation. For improving the status quo, I suggested the adoption of an Australian-style Productivity Commission, which is an independent institution, created to advise the government on reforms oriented to boost productivity. Its functions are strongly based on the principles founding this institution, namely independence, transparency and communitywide focus.

The most relevant characteristic about the commission is probably the public consultation. Within this process, a myriad of viewpoints are confronted transparently, so it is less likely that narrow interests or the government view dominate the outcome of the policy design. These views are also contrasted against the facts and empirical evidence provided by the commission's permanent technical staff. Both the technical advice and the participation of the community increase the quality of the debate, which is crucial for designing, approving and sustaining better economic policies stimulating productivity growth.

This public consultation process is even more important in the current social and political context of Chile, when political actors express their views using non-institutional avenues. These forms of expression have imposed large social and private economic costs to society. In this context, the commission is a natural platform where this debate can take place, leading to a high-quality discussion of ideas in an institutionalized arena.

In addition, the commission performs ex ante and ex post evaluations, which are useful to identify the magnitude and timing of both benefits and costs of pursuing a given reform and the winners and losers from such reform, thus lowering the uncertainty about the effects of the reform, helping to build support to the reform. The *ex post* evaluations are helpful to sustain reform efforts over time and support the removal of inefficient regulations.

However, the creation of the commission is no panacea. Although, it helps a lot during the design phase, there is no guarantee that the Congress will adopt and implement the reform as exactly as it was designed. It is important to reform the political system in order to increase the representation of the community in the policymaking process and avoid the capture of policies by groups representing special narrow interests. This will reinforce the commission's assignments. Likewise, a strong leadership is necessary to lead the process of reform, by asking for inquiries to the commission and supporting its outcome during discussion in Congress. Overcoming political economy drawbacks and short-term demands is tough, but it is necessary for implementing reforms oriented to enhance productivity and the community welfare in the long term. Leadership and an Australian-style Productivity Commission are a powerful combination in pursuing such purpose.

Finally, in a rather anecdotal note, the creation of a productivity commission in Chile has a pleasant presentational advantage. It combines a right-wing concern –increasing productivity and preserving the institutional order– with a point more congenial to the left-wing –empowering the masses. So, at least in theory, everyone should love the idea of having an Australian-style Productivity Commission in Chile.

References

Aguilera, C. (2007). "Participacion Ciudadana en el Gobierno de Bachelet: Los Consejos Asesores Presidenciales". America Latina Hoy, vol. 46, August.

Banks, G. (2005), "Structural Reform Australian-Style: Lessons for Others?", Presentation to the imf, World Bank and oecd, May 2005.

Banks, G. (2007), "Public inquiries in policy formulation: Australia's Productivity Commission", Address to the International Workshop: Australia's Public Inquiry Experience and Economic System Reform in China, China-Australia Governance Program, Beijing, September 2007.

Banks, G. (2010). "An Economy-wide View: Speeches on Structural Reform". Productivity Commission, Melbourne.

Banks, G. (2012). "Independent policy advice and the Productivity Commission". Chapter 7 in Banks, G. Advancing the Reform Agenda: Selected Speeches, Productivity Commission, Canberra.

Consejo Asesor Presidencial del Trabajo y la Equidad (2008). Informe del Consejo Asesor Presidencial, Trabajo y Equidad.

Corbo, V. and R. Gonzalez (2013). "Economic and Productivity Growth in Chile". This volume.

Garreton, M. A., M. A. Cruz and F. Aguirre (2012). "La experiencia de los consejos asesores presidenciales en Chile y la construccion de los problemas publicos". Revista Mexicana de Sociología 74, Number 2 (April-June, 2012): 303-340. Mexico, D.F.

iadb (Inter-American Development Bank) (2010). "The Age of Productivity". Washington, DC, United States.

Krugman, P. (1992). "Age of Diminished Expectations: us Economic Policy in the 1980s", mit Press, Cambridge.

oecd (Organization for Economic Cooperation and Development) (2010), "Opening markets to competition", Making Reform Happen: Lessons from oecd Countries, Chapter 2, oecd Publishing.

Productivity Commission (2003), "From industry assistance to productivity: 30 years of 'the Commission'", Productivity Commission, Canberra.

Productivity Commission (2006), "Potential Benefits of the National Reform Agenda", Report to the Council of Australian Governments, Canberra.

Productivity Commission (2008), Annual Report 2007-08, AusInfo, Canberra.

Scartascini, C., and M. Tommasi (2012), "The making of policy: Institutionalized or not?" American Journal of Political Science. Forthcoming.

Schmidt–Hebbel, K. (2013), "The Political Economy of Distribution and Growth in Chile". This volume.

Sierra, L. (2003). "La Iniciativa en la Potestad Legislativa Chilena". Foco, 5. Expansiva–udp.

Valdes, S. and S. Soto (2009). "¿Como Fortalecer la Labor Legislativa del Congreso? Propuesta para un Nuevo Sistema de Asesoría Parlamentaria". Estudio Publicos 114. Centro de Estudios Publicos.

Valenzuela, A. (2012). "Crisis de Representacion y Reforma Política en Chile". En F. Díaz y L. Sierra (editors). Democracia con Partidos: Informe para la reforma de los partidos políticos en Chile. Centro de Estudios Publicos y Corporacion de Estudios para Latinoamerica. Santiago.

Appendix A: The origins of the Australian Productivity Commission[30]

The origins of the Productivity Commission in Australia can be traced back to 1921, when the Tariff Board was set up. The mission of this institution was evaluating trade policy in order to benefit domestic import-competing industries. If the responsible Minister wanted to propose a reform in trade matters, the Minister had to request a report from the Board, studying the subject at hand. But the Board not only acted on request, it could also start research on its own. Other two relevant features of the Board were its independence from sectorial influence and the public character of its labor as the process of inquiries and hearings were open to the public opinion.

Although the Tariff Board Act contained clauses establishing a broader assessment of trade policy, trade reforms were analyzed on a case-by-case basis, mostly focused on demands for more protection in particular manufacturing industries and products. Throughout the years, this process created a highly distorted economy because a larger number of tariffs, quantitative controls and assistance made the overall trade policy complex and internally inconsistent. Many of these distortions were hidden behind the overall performance of the economy, which was in good standing, thanks to the larger demand for Australian commodities post-World War II. In fact, Australia was the 5th country of OECD countries in terms of labor productivity at the 1950s, a measure greatly influenced by the contribution of commodity production to GDP.

However, the foreign push of Australia's growth ended slowly over the 1960s. The long-run trend of terms of trade followed a declining path and the growth in external demand subsided at the end of that decade. Under this scenario, many tradable industries were not profitable because they were uncompetitive. They required even more assistance from the government, which usually handed the resources asked. As a result, Australia descended from the 5th to 9th spot in terms of labor productivity in 1973.

30 This section is strongly based on Productivity Commission (2003).

In this context, from the 1960s to the early 1970s, the Board realized that the approach followed until then created a highly distorted productive system, at the expense of high costs to the government. The Board began to review Australia's trade policy arrangements, suggesting lower levels of protection and focusing on industries instead of products. Obviously, this engendered strong opposition from manufacturing producers, their political supporters and even within the government. The political obstacles subsided in late 1972, after a new government took office willing to end the protectionism under the belief that the resources deployed to protect industries may be redirected towards achieving other economic and social objectives. At the same time, the government realized that the Board had a limited scope for action and wanted to expand its range of topics and economic activities under study. That was the birth of the Industry Assistance Commission (IAC).

IAC was a commission oriented to advise the government in suggesting all forms of assistance to all economic activities, including services and mining, which were excluded from the scrutiny of the Tariff Board. IAC was focused on achieving long-term social and economic goals in an efficient way. For that reason, the commission had a broader perspective of tackling the relevant issues by analyzing the topics in a comprehensive way, recognizing that several economic policies interact at the same time and should not be studied in isolation. Now, instead of studying the assistance for unproductive industries, the target was encouraging the productive sectors because they promote the efficiency in the resource allocation. Thus, the IAC intention was stimulating an efficient use of public funds. In fact, the commission had to prepare an annual report, evaluating the cost of economic policies in place.

This commission was founded on the principles of independence and transparency, both present already in the times of the Tariff Board. The independence gave IAC a privileged position to advise the government without conflicting interests and the public focus was crucial to making the population aware of the costs these policies had for the country. Furthermore, the Minister had to refer to the IAC for any proposal of assistance to industries before taking action, just like with the Tariff Board. These elements were also part of the principles underlying the creation of the Productivity Commission later.

The beginning of IAC's task was difficult. In 1973, the IAC endorsed the removal of all forms of protectionism except tariffs, although they had to be reduced 25 percent. This reform was implemented by the incoming government, unleashing the fury of manufacturing industries and labor unions, both fierce opponents of this policy. Unfortunately, the government could not handle the pressure and began to provide other forms of temporary assistance to suffering industries, such as import quotas, which tended to be quite persistent, despite the temporary character of this policy. Over the second half of the 1970s, it was clear that any reform in this area and others should account for the adjustment costs, especially those concerned with employment dismissals, the product of uncompetitive manufacturing industries that had to leave the market.

At the beginning of the 1980s, the recession was another factor contributing to slowing down the process of adjustment. The economic context plus the still pervasive distortions in the economy resulted in a still–declining path in the labor productivity ranking. In fact, Australia descended to the 15th position over the second half of this decade. The IAC was facing a lot of political pressure as import-competing industries were weak and protection seemed to be the silver bullet to make them competitive enough to end the recession. But IAC was committed to its long-term approach, insisting that less protection was the best policy option for the long-run performance of the economy. Time would prove IAC right.

IAC's focus was on long-term economic and social goals. This broad mission expanded the range of topics the commission could address. In consequence, the IAC began to produce reports addressing not only the trade policy, but also the labor market, management practices, innovation, skill upgrading and the performance of regulated services such as electricity, transport and communications. Problems in these areas were identified as drivers of Australia's poor productivity performance in a context where these weaknesses have been exposed by increased international competition.

In order to address these weaknesses and strengthen the overall economy, the IAC suggested policies labeled "microeconomic reforms". For the commission, this set of reforms was defined as institutional arrangements and policies affecting the structure and performance of industries. As a result, over the mid-1980s, Australia followed a process of structural reform leading to the exit of inefficient activities involving high labor costs, mainly manufacturing industries previously protected by the government. Contrary to what was argued then, this led to an increase in firms engaged in international trade. In fact, trade openness moved from

27 to 44 percent of GDP. This was the result of the commission's strong belief that a modern economy had to reap the benefits the global economy has to offer.

This transformation was also the fruit of new businesses and labor practices and the rise in R&D spending and innovation within the private sector, taking the country to the leading position among OECD countries in the 1990s in several indicators of technological acquisition. This allowed the elaboration and trade of new products and lower prices for existing goods. Capital deepening implied by technology acquisition led to an increase in labor productivity, mostly in firms engaged in international trade.

Microeconomic reforms also addressed the poor productivity performance of regulated services, such as electricity, transport and communication. A report performed by the commission calculated gains of about 2.5 percent of GDP because of lower prices and productivity gains in these services[31]. Furthermore, the structural transformation also reached commerce and financial services. These sectors benefited from high technology, which allowed them to reorganize the way their businesses were managed, also resulting in high productivity gains for both sectors.

At January 1990, IAC was merged with the Inter-State Commission and Business Regulation Review Unit to form the Industry Commission (IC). The objective was similar to its predecessors. Also, similar to previous commissions, independence in advising, transparency and public inquiry processes continued to be prominent features of the development of economic policies, pursuing productivity and efficiency gains from a community–wide perspective.

In addition, the range of issues the commission could analyze expanded even further, including for the first time social as well as environmental policies. The variety of social topics ranged from public housing to health and safety of workers and their compensation for workplace accidents, to charitable organizations and urban transport. The reports involving environmental policies addressed topics such as greenhouse gas emissions, recycling, mining, water resources, environmental waste management industries and urban transport.

As it was described above, labor productivity was in free fall from the high levels reached over the 1950s. Australia was 15th out of 22 OECD countries in terms of labor productivity at the end of the 1980s. The

[31] See Banks (2005).

incoming government at the beginning of the 1990s required a series of reports intending to deepen structural change by tackling microeconomic bottlenecks. The reports over these years included studies involving the market of energy generation, transport and public-private partnerships for increasing the supply of infrastructure, trade of services, improvement of management practices, the efficiency of state-owned enterprises, achievement of environmental objectives and regulations generating inefficient allocations within industries.

Nevertheless, Australia's 1991-1992 recession generated a demand for slowing the process of structural change, in part because the conditions were not optimal for facing the short-term costs involved in microeconomic reforms. In spite of the recession, the country further deepened the trade liberalization by decreasing assistance for some sectors and reducing tariffs. To be politically viable, however, assistance kept at high levels in some key sectors to avoid massive employment dismissals in an environment of already high overall unemployment. Also, within the recession, it was the first time the commission committed enormous efforts to addressing the topic of regional adjustment costs, especially studying labor market regulations hindering the adjustment of employment across regions.

After the recession, unemployment rates remained at high levels. At that time, public opinion held the belief that if the country wanted to reduce unemployment, it had to recommit again to pursuing microeconomic reforms. Of course, IC's reports and reviews contributed a lot to diffuse that belief. This strategy was fruitful as Australia re-engaged in its structural change process. Overall, Australia's Multi-factor Productivity growth averaged about 2 percent per annum over the 1990s, more than doubling its previous record, taking the country to the leading position in terms of productivity expansion among OECD countries over that decade.

And the commission would expand one more time again at the second half of the 1990s. Now, the IC would merge with the Bureau of Industry Economics and the Economic Planning and Advisory Commission to form the Productivity Commission. Principles remained the same as its predecessors, namely: independence, transparency and an economy-wide focus. At this point of the analysis, this change seems like a cosmetic modification, but it was more than that. Government's objective of widening the scope of the commission transformed IC into the main advisory institution on all relevant characteristics of microeconomic reform. The focus would be stimulating productivity growth because high productivity growth contributes to sustained growth and better living standards for the population in the long-run. This guiding principle was important at the moment of the parliamentary discussion for enacting the law specifying the duties of the commission as the political environment was reacting negatively to many of the commissions' past recommendations, especially those involving the higher exposure of industries and workers to international competition. This was the birth of the Australian Productivity Commission as we know it today.

Panel Discussion: The Way Forward[1]

Daron Acemoglu: Thank you, this was an extremely instructive day for me, I enjoyed all of the presentations and I feel I know more about the Chilean economy now than I did –and of course that may be an illusion. I want to give you my thoughts on the discussions we had today and where I see important avenues for policy and for future research especially.

When I started working on institutions, one of the things I first realized was that we can talk of specific institutions, such as credit markets, contract law, labor markets, but in cross-country data you have no chance of identifying the separate effects of these things because they move together. Instead you may want look to a cluster of institutions: countries that have good property rights often tend to have good contract laws, regulations that do not discourage entry, better credit markets and so on.

Thinking about the presentations today, they reminded me that these specific institutions interact in subtle ways. The right model, even when these things move together, would be one of the weakest link–type so if a country had fairly good and secure property rights, things might look good on paper, but in the end, if some dimension of the institutional framework is missing it affects all of them. Thinking about it that way, there is a lot of different emphasis on the papers presented in this conference, for example, on the school quality, the credit market, R&D, and labor market, but I wonder which one is the biggest bottleneck. Are those bottlenecks important?

For instance, one reason for thinking that this might be important is Professor Gallego's very good case that school quality and even the level of schooling might be important barriers to moving forward. One thing that the market would do in such case is to increase the returns of schooling so it acts as a signal for people to actually get more schooling and higher quality schooling. These kinds of complementarities are

[1] This is a transcript of the discussions of the conference panel "Raising the growth rate of Chile: Where are the opportunities?" held at CEP on November 8, 2010. The participants of this panel were Daron Acemoglu (MIT), Ricardo Caballero (MIT), Vittorio Corbo (CEP), Jorge Marshall (Expansiva) and Patricio Meller (Universidad de Chile and CIEPLAN).

important. You might have a situation where the education level is low and the schooling is low, but on the other hand the institutional structure also discourages entrepreneurship, especially if it does not provide credit to new entrepreneurs who are going to be the new blood line for the system. Then, you have these two complementarities supporting each other and in the end you might not even get market prices because the entrepreneurship is not there, the demand for human capital is not that high so it does not encourage entrepreneurship as much as it would have done otherwise. So I wonder where those kinds of complementarities and specific institutions and their interactions might actually be important in this dimension. I think this is particularly important as Professor Gallego and other papers emphasized, there is a lot of evidence that technology–education complementarities are important: if one part is not working and the price signals are not being sent, there is a significant slowdown in technology.

This leads to my second point. The problem that Chile is facing, at a very simplistic level, I could label as the transition from catch up to convergence. When you have an economy that is relatively integrated into the world economy and have some institutional problems, not too severe –we are not talking about instability, total lack of property rights or the impossibility of writing any kind of contracts–, then it is pretty likely that the country can grow in today's income per capita from one thousand to about fifteen or even twenty thousand. That is a really easy catch up. The next step is convergence and that is much harder. A lot of the concerns people have around the room here is exactly how to realize this convergence process. I think one of the issues here is the role of certain things which might be different in the convergence process than in the catch up process.

Based on my reading and most importantly based on what I have heard, I think there are three important things. One is the quality of human capital. I have talked about it already so I will not say more. The second one is entrepreneurship, especially entry of new blood into the system, which is very important and becomes more important in the convergence stage than in the catch up stage. The third one, which was emphasized today, is R&D.

I think R&D is very important. If you think about it in this simplistic manner, even in a country with a twenty thousand income per capita, most of the technology will not be created by itself, but imitated. Then one may say that R&D is not so important for imitation. You can buy the latest software or machinery and then install it. This is true for very simple technologies like tractors: buy it and bring it. But this is not true when we talk about technologies that change the way you do business or organize production. In such cases, there is no process of imitation, or in other words, the process of imitation has an adaptation in it. The technologies have to be adapted so they can work in the conditions of the country and the company in which they are being introduced. For that you need a process that looks like R&D. This is not the R&D you do in a lab, but it still needs a mindset that I think is very much R&D-like. You need to think about how to solve problems of a high level of abstraction, how to combine them with new technology. I think that many countries in the convergence stage do not really make that transition. I think that this transition requires public-private cooperation because you cannot have that kind of R&D in a country that does not have a high-quality public education system at both the high school and the tertiary level. The society as a whole needs to develop a research-based environment, not the research that is going to win the Nobel Prize, but the people, the research mindset and the fluency at the frontier to facilitate the process of importing technologies from the frontier.

The third point I want to make quickly, which I also tried to make during my presentation in the morning about why is Latin America poor, is that inequality is very important. There are a lot of theories out there, which emphasize how inequality could be a barrier to economic growth and I think that some of them have validity, but I think that there are two particular reasons, which are also emphasized by the literature, though not as much as I think they should be. One of them is that inequality really makes the growth process less broad based. If there is great inequality, for those who come from poorer backgrounds, it becomes harder to rise to a relative position in society in which they can also become participants in the process. Essentially, if you think that talent is relatively broadly distributed, then every time you cut out sixty or seventy percent of the population, you are reducing the probability that somebody like Edison, Einstein or Bill Gates is going to emerge with a probability of sixty or seventy percent. Of course, it is possible that societies are unequal, but still you provide such great education to poor people so that they have their full potential of becoming the Edisons or the Einsteins. It is a hard thing and it is also made harder by the fact that Francisco Gallego emphasized:

education is not just provided by the school, but by the interaction of school and families and inequality gets on the way of that.

The second channel is that a highly unequal society has greater distributional conflicts, which is something that Klaus [Schmidt–Hebbel], for example, emphasized also. And greater distributional conflicts create a lot of instability. Not only create high distortionary taxes, it does so, but I think more importantly it creates a lot of instability. This is a big problem of many Latin American countries with high inequality, as every now and then they fall into a populist trap and the frustration that comes from the pain of growing with inequality. It is important to deal with the problem of inequality, but not in a distortionary way. Again, this is a point that Klaus [Schmidt–Hebbel] emphasized. You can deal with inequality through things like education, which I think Brazil and Chile have done lately or you can try to deal with them as Argentina has done over the past sixty years through redistribution that is very ephemeral as it deals with the problem temporarily, but creates much deeper problems. I think there is a very thin line between them. You create a system that slowly reduces inequality and creates the right expectations, but does not run into the very distortionary system that stops business creation, entrepreneurship and investment.

I also mentioned that countries like Chile and Brazil are really making great strides towards inclusiveness. That is a very important thing and it poses very well for the future. The fact that you can have governments of very different ideologies and world views, which peacefully transfer power, is very important. But I think there is one thing that is more slowly developing. Chile needs the State to be stronger in some areas. One of these areas, which is important for business, entrepreneurship and for the evolution of democracy and laws, is to have a real technocracy. I guess Klaus [Schmidt-Hebbel] was also hinting it. Having a technocracy playing an intermediating role in policymaking is extremely important. A counterexample of this is the image of the "Yes, Minister" of all British comedies. You appoint a Minister and he comes up with all of these ideas, he goes to the civil servant and he says "of course, I will implement your policy" and goes ahead to implement something else. You may feel that is a kind of failure in democracy, but also in some sense, it is a success of democracy because you do not want the policies to change with the ideological points or pet projects of every Minister. You want some pressure on public officials and more reasoned choices. You also want to impose some checks on the technocracy, so it does not develop its own dynamics, divorced from anything else.

The final point I want to make is that market access is extremely important for an economy like Chile, which does not have a large internal market. Chile cannot compete in the world with countries like China, Pakistan or Indonesia nor does not want to because those countries are into a low-skill, low-wage production. That is a losing proposition. Chile has to compete with the next stage of higher-tech products, but for those products a bigger market is needed. I think trying to manufacture bigger markets by some kind of industrial policy is a really bad idea because governments are not good at picking winners and it is a very political process. Even if there is good economics, and I am not sure whether it is good economics, it is definitively bad politics. The alternative to that is enlarging the market for companies that eventually will introduce more capital-intensive and more skill-intensive technologies. Something like regional integration may actually have bigger returns for a country like Chile than many other policies because it widens the market. But the aim should be higher. The market should not be South America or Latin America only; it should be the entire America or the world. In some products, I think that Chilean companies managed that but that has to be facilitated through more emphasis on openness and exporting and if it is necessary regional integration, although because of the politics, that is more complicated.

Thank you.

Patricio Meller: First, I would like to congratulate the CEP for its 30th birthday. Second, I want to thank Vittorio [Corbo] for the invitation to participate in this exciting conference.

I want to make four points about why the Chilean economy, since 1998, has had a low growth rate. This is an empirical fact, difficult to discuss. However, there is a second empirical fact, linked to the previous one, suggesting that all explanations point out that the growth of Total Factor Productivity (TFP) has not only been slow, but negative.

Here I want to argue the values calculated for the growth of TFP post–1998. To be honest, the truth is that it is not clear for me how can it be that the growth of TFP has been negative for a long period of time from the theoretical and empirical view. Conceptually, what could be happening is that new technology is being replaced by old technology.

Has the audience seen anything like typewriters replacing notebooks? Or modern institutions being replaced by old institutions? We have not seen a reversal of that type. So it's rare to find that growth of TFP is negative for a long period.

Another thing shown by Vittorio [Corbo] in his presentation is a review of the studies that have been done for Chile regarding the decomposition of GDP growth into the contributions of inputs and TFP. If you look at that table, there are several calculations. I will focus only on the growth of TFP. There is a paper written by Vergara in 2005, calculating an average growth of TFP of 0.4 percent per year between 2001 and 2004. Another paper by Fuentes, Larraín and Schmidt-Hebbel calculates an average growth of TFP of 1.9 percent per year between 1997 and 2005, if I'm looking at the right numbers. Negative figures appear in the work of the *Comite del PIB Tendencial*, showing an average decline of 0.3 between 1997 and 2005, and a decline of 0.8, on average, from 2005 to 2008. If one takes the entire range of figures for a roughly equivalent period, the average growth of TFP fluctuates between –0.8 and 1.9 percent for the same period.

The second table that caught my attention from what Vittorio [Corbo] presented is the table showing his refined calculations for the period 1960–2008. Between 1997 and 2008, the growth of TFP would be –0.3 percent and Vittorio [Corbo] said in his presentation that the figure is not very different from the growth of TFP of the Chilean economy in the period 1960–1973, which was –0.2 percent, virtually the same. But the question I ask myself is can anyone in this audience believe that the political and institutional environment from 1997 to 2008 generated an average growth of TFP similar to that between 1960 and 1973? What is my point with this? The point is that in reality, I do not trust the calculations of the growth of TFP. Although I do not know what data and numbers should be used, I think that something is happening with productivity in this economy and that productivity expansion is low, however, calculations of the growth of TFP do not give us a clue, at least empirically, about what is going on. To be more precise, it does not give us any idea of what needs to be done to increase the productivity of the economy.

The second point I want to make can be seen in a recent IDB book titled "The Age of Productivity". To validate the calculations, the book estimates the growth of TFP and what happens to growth rates, but then the book suggests that what should be done to try to increase productivity in a country is to study the problem of economic sectors. If you look at the sectors of the Chilean economy, you can see that, for example, mining has nothing to learn from the rest of the world because the productivity in this sector in Chile is the highest of the world and it is no coincidence that a third of the global copper production is located in Chile and will remain in this country for the next ten to twenty years.

So where does Chile have the largest gaps in terms of productivity? Unsurprisingly, they are located in the service sector. That's where the largest gaps in productivity lie. The service sector is intensive in unskilled labor in most cases. Well, then we should increase the productivity of the service sector, but the bulk of services are not tradable, then what good will it do to us? Does it increase productivity in the tradable sector, which today is exporting, if the nontradable sector –not linked to it directly as a supplier of inputs– increases its productivity? How do you make this country more competitive when productivity increases in nontradable sectors?

The third point I want to make involves microeconomic policies and the black box view of the firm by economists. Under this view, factors of production are inputs, output is the outcome and the relation between input and output is mediated by productivity. But, the focus of the management literature lies inside the black box, i.e. studying what's going on inside the boundaries of the companies. With regard to this, I want to note two points. The first is about how the company is structured: Fordist style, where decisions are taken centrally on top and orders given downstream or Toyotist style in which information is distributed from top to bottom and horizontally, and everybody working in the company is involved in generating innovations in the areas where they work. The second aspect is the relationship between workers and management. This relationship could be seen as a class war, a zero-sum game in which gains for the management are perceived as losses for workers and vice versa. However, we are in a globalized world where games are not zero-sum, they are positive or negative sum. When these games are negative sum, the company goes bankrupt, workers lose their jobs and the capital of employers is lost. In contrast, when games are positive sum, improvements in productivity, generating the extra profits, are somehow shared with workers and everybody wins.

I want to conclude by raising a last point related to human capital. We all agree on the importance of human capital for growth, but the bulk of the discussion is still focused on what happens to the quality of education at the school level, although we have made a great progress because today what happens with the quality of education before entering the school –from one to five years old– also matters. I believe that if something does happen to improve the quality of education in pre-school, we will see results no sooner than twenty years. So, the question is what do we do from here to twenty years from now?

But let me be even more pessimistic. The problem lies not only in school education, but also in higher education. A reading comprehension test performed by OECD, measured the reading comprehension of Chilean managers and professionals, all university graduates. We were fortunate to participate in this test and that Portugal was among the participating countries, because if it were not for Portugal, Chile would be the country with the greatest deficiency in reading comprehension. What is striking is that only ten percent of professionals and business managers scored on levels four and five, which are the highest, and that a sixty percent scored in levels one and two, i.e. they are virtually digital illiterate because they have no ability to process information and understand the memos they read. So, Chile not only has a problem with the quality of education at schools. Those who will carry out the R&D are higher education graduates and when they cannot understand the information of a text, then how could they be able to perform the innovation Chile needs?

Thank you.

Vittorio Corbo: I want to make three points. The first is that all studies measuring productivity as TFP calculate it as the fraction of GDP growth unexplained by the growth of labor and capital. All international studies performed by the World Bank, OECD, IMF and national studies performed by the Central Bank, the Committee of Experts invited by the Ministry of Finance, national scholars and our article in this conference –in which we take into account the contribution of information technology and communications to GDP growth–, show it is true that the contribution of productivity to GDP growth –measured as a residual after deducting the contributions of capital and labor growth– has been close to zero over the recent years. In other words, productivity has fallen significantly, no matter the method followed to calculate TFP.

In this conference, we discuss the factors underlying this drop in productivity. This productivity slump is not the result of a regression in technology or that we forgot how to do things. Chile has been very efficient in the last twenty years to create a favorable environment for investment. In fact, an important part of the growth of the last twenty years is explained by investment in physical capital. The creation of this environment has been greatly influenced by the macroeconomic stability, the depth of the capital market and the improvement in the definition of property rights.

Employment was very important in the early years because Chile started with a large deficit in this area, after the crisis of 1975. But, it has lost momentum in the last decade compared to those years. The "perspiration" that the country has performed –as a consequence of more employment and the sacrifice in consumption for greater investment– explains the lion's share of Chile's GDP growth. An insignificant share of output growth is explained by the fact that we made things better. From this perspective, we should analyze why, having done the hard work, there has been no room for "inspiration". The advantage of inspiration is that it gives us output growth without much effort, but unfortunately, there has not been a lot of inspiration in the Chilean economy for a long time.

Another issue discussed in this conference is Chile's limited ability to deal with foreign shocks. When we had the recessive shock of 1998–1999, Chile not only suffered from the worsening of the external situation in Asia, but also by higher domestic interest rates which were close to 100 percent at the worst moment of the recession, forcing several companies to exit the market. In the article by Alejandro Micco and Andrea Repetto it is evident that such shocks create productivity differences between firms. When firms were recovering from the recession of 1998–1999, they suffered the shock of energy prices. This shock reduces production because the utilization of the capital falls. Although there is plenty of capital in the economy with the potential of increasing GDP growth, it cannot contribute to higher output growth because high energy prices induce less utilization of capital, implying lower production.

Another hypothesis emerging from this conference to explain the drop in productivity growth in Chile is the poor regulation complicating the entry and exit from markets. Another topic also discussed in this conference is that this poor regulation is not located at the central level, but rather at the municipal level. Many times this leads to the idea that the government should implement policies for companies to remain in the market –e.g. credit policy–, regardless of the productivity levels they have. However, an important fraction of the productivity gains arises when unproductive businesses disappear and new high–productivity firms grow. This is the so called Schumpeterian growth process. In Chile, this process is quite aborted. This is what is behind the successive declines in the growth rate of TFP in Chile, found by the academic literature. Of course, it is not about possible reversals to technologies used in the past.

The labor market is also quite rigid in Chile, making it difficult to adjust to foreign shocks. In Germany, for example, it is easier to adapt to adverse situations because they can rearrange the schedule of work because more working hours are flexible, they have telecommuting and many other labor market policies in place.

Having clarified that point, I will discuss three or four possible areas that require urgent reforms and that emerged from the discussions throughout this conference, so Chile can jump–start productivity growth. One problem is the low level of human capital in this country. Patricio Meller already said this in his remarks. If students could finish university better prepared, they could better teach old managers. However, the university has to invest at least two years to level deficits of previous educational stages, generating a vicious circle. So, eliminating weaknesses in human capital is essential for a country like Chile. Improvements in this area will improve the distribution of income, one of the concerns of Daron [Acemoglu] for the Chilean economy. Education is what allows people to access more opportunities and reduce income inequality. However, poor–quality education worsens income distribution because technological change is biased towards high human capital jobs.

Other factor discussed in this conference to raise the growth of productivity is the creation of entrepreneurs. Entrepreneurship is very difficult in Chile because of the barriers to entry and exit from markets mentioned above. Bankruptcy in Chile is very expensive. In fact, in Chile, a person lending to a company gets less than a third of what is recovered in the OECD when the company goes bankrupt. When people say in Chile that lending to SMEs is expensive, it must be, because the probability to recover the loan and the fraction recovered are low. The high costs of bankruptcy and credit have slowed the creation of entrepreneurs. Therefore, further reforms should be implemented to reduce these costs.

Other limitations are the labor market restrictions. As posed by Klaus [Schmidt–Hebbel] in his presentation, these restrictions cannot be eliminated for political economy issues. This also affects the distribution of income because less qualified employment is the most affected by such restrictions.

All these identified areas require urgent reforms, whose effects will show in the long term. Nevertheless, Chile has a window of opportunity in the short term by improving the participation of the labor force, which is very low for women and young people. If we want to have a labor force participation rate similar to OECD countries, the country should incorporate about seven hundred thousand persons to the labor force. Minimum wage has risen aggressively in Chile, which added to the poor quality of education, has limited the inclusion of women and young people in the labor market. Moreover, people who received poor quality education could accumulate human capital through formal employment, but the possibility of getting a job for them is quite limited. If the country could bring more people to the labor market, we might have ten years of high GDP growth, through the inclusion of women and youth in the labor market. Policies aimed to achieve this goal were studied by the *Comision de Trabajo y Equidad* led by Patricio Meller.

Thank you.

Jorge Marshall: Thank you very much for the invitation to participate in this panel. Congratulations also to the CEP for its anniversary.

There is something that bothers me about the topic of this conference because the main question is why productivity fell in Chile. The fact of the matter is that I still do not understand why it went up in the first place. I think the relevant question is why we are a poor country, why there is still a large gap compared to developed countries, why, as Rodrigo [Fuentes] said, GDP per capita in Chile is 40 percent of U.S. GDP per capita. Looking through this lens, the truth is that we should congratulate ourselves and be satisfied for closing part of this gap in the last thirty years. Chile is a successful country. Since we do not understand well the dynamics of the TFP, it makes no sense to discuss whether or not TFP grew in the last year.

I think the Professor [Daron] Acemoglu's presentation poses something that should bother us. Professor [Daron] Acemoglu raised in his remarks that if we want to close the gap in income per capita between Chile and developed countries, we have to look to the fundamental causes, linked to the institutions, and not the proximate causes. I think that is the novelty of this conference and I think if we could push the discussion in that direction, the conference would be a great success.

If we take the factors Vittorio [Corbo] summarized in his presentation, as the labor market, one wonders why the labor market has a certain level of rigidity? Because people like it. And why do people like it? Because they believe that their neighbors may have uncivil behavior and therefore prefer rules regulating such behavior, both in the neighborhood and at home. In the same way that Klaus [Schmidt–Hebbel] made a political economy analysis of the transfers, you could also make an analysis of why people demand regulation. My answer is that it is because people do not trust the neighbors. There are aspects of the labor market that cannot be solved without bargaining power, which is necessary to achieve understanding and interaction. If employers do not interact with workers, it is because everything is controlled by a referee. There is bargaining up to a certain limit, at which point the referee intervenes to resolve the conflict, but it builds no confidence and therefore workers demand more regulation. Among economists there is much agreement on the policies needed to solve the problems of the labor market, but these are difficult to solve if there is a lack of trust. In a CEP publication, in which Andrea [Repetto] participated, this fact was discovered.

In the profession there is agreement that innovation is the foundation of higher productivity. We have five and a half years since the *Consejo Nacional de la Innovacion* was launched. During that time, this institution has had four presidents. Each of them has written a plan, which has been scrapped by the incoming president. All plans have been very different from each other. In all preparations of plans the private sector has been involved and they have agreed with the proposed plans, which is absolutely incomprehensible. Currently, innovation policies are being dismantled, until the new president takes office and proposes another new plan. Professor [Daron] Acemoglu tells us that R&D is very important. We built a structure to operate the R&D and later, we dismantled to build another one.

With regards to innovation, collaboration is a key factor for the operation of companies, and it is low in Chile. Without collaboration and the work of business, there is no venture capital, which means less entrepreneurship.

The main factor underlying high productivity growth of countries is the performance of medium–size businesses, not small businesses. The latter are irrelevant from the point of view of product, although they can be relevant in terms of employment. But, from the point of view of growth, what matters are the medium–size enterprises growing strong. Many of these companies are family businesses, with lower productivity than Chile's average because they do not open themselves, do not trust and have fear of creating alliances and interactions with other companies. These fears and suspicions are rooted into our institutions and the only possible way to move forward is improving Chile's institutional quality and for that, I think Chile needs to implement the reforms suggested by Klaus [Schmidt–Hebbel]. An interactive space that belongs to us all is the State and, therefore, this interaction should take place within the State, trusting that the State does the right thing and that is composed of people of high standards. Therefore, I fully subscribe to the approach recommended by Klaus [Schmidt–Hebbel] in his presentation.

In short, what has been done in this conference is to explore a number of issues that I think are of utmost importance. The issues are competition, human capital, etc., and not others. However, I think we should deepen our understanding of the fundamental causes producing the restrictions that prevent progress in these areas. The goal is simply to close the income gap with developed countries.

Thank you.

Ricardo Caballero: Thank you very much. It is a pleasure to be here, celebrating CEP's thirtieth anniversary. Thanks to the organizers and Vittorio [Corbo] in particular. I am not a producer of growth research, although today, with nostalgia, I knew I had written an article about R&D and patents in 1993, but I forgot. Today I am essentially a consumer of these issues and consequently, I learned a lot at this conference about the growth literature in general and its application to the Chilean context.

My purpose in this brief intervention is to connect the topics of growth of this conference with the international economic context. That is, I want to talk about growth in the next ten years, more than the Chile's growth to fifty years from now. In particular, I want to refer to the macroeconomic situations of China and the United States.

With regard to China, they fought the crisis using fiscal policies implemented through their banks and were very successful in stabilizing the adverse foreign cycle. But the big challenge came after the crisis, during the process of slowdown of the huge fiscal expansion through the financial system. The big question, a couple of months ago, was whether China would be able to slow its economy smoothly, something few countries do well. The evidence mounts daily that China has been successful once again, surprising the rest of the world which did not expect that to be possible. The Chinese have done many things gradually, when the general advice was not to. This time they have applied this principle to the stabilization of the economic cycle and have done very well.

Perhaps China's growth in the coming years is different than what we have seen. There is a clear intention to reorient growth towards domestic sector producing nontradables. I do not think that this change has a great impact on China's growth because the relevance of the external sector is far less important than what the world thinks. The reason is that at least half of its exports are processed products in which less than twenty percent is Chinese value added. The rest are exports from Asia and Europe, passing through China and then migrating to other parts of the world. Consequently, I believe that this restructuring of the Chinese economy will not be a bigger problem.

In the baseline scenario, we expect China to continue to grow between 8–10% for a while longer. Five to six years from now, people expect that growth will begin to slow. But at least for the next few years, China will grow quite strong, although not without risk because it is very difficult to sustain this growth rate and the transition has many complications, such as those described at this conference. But the baseline scenario still features China growing strong and playing a central role in the growth of emerging economies and commodity producers in particular.

With regard to the U.S., the mediocre recovery will take time, as an important part of the financial system vanished –securitized asset market and various investment banks– and there was a sharp fall in consumers' wealth. The Federal Reserve is working to offset these two mechanisms: on one hand, it is trying to replace and support the parts of the financial system that are not working well, and on the other, it is trying to rebuild part of private sector's wealth. Somehow, quantitative easing is inflating balance sheets and the collateral of the private sector, so the industry begins to invest again and small businesses can get funding. The truth is that there are more efficient mechanisms than those used by the Federal Reserve to achieve the same objectives. It is easier to directly support the markets in trouble, but political constraints are so great at this time in the U.S., that these instruments are not available. Therefore, quantitative easing is the best this country can do given the constraints it faces. As this instrument is imperfect, the Federal Reserve will use it more intensively and more than desirable, affecting liquidity worldwide. This excess of liquidity is inefficient, but it is the only thing the Federal Reserve can do given the constraints it faces. Both high growth in China and the mediocre recovery in the U.S. will be present in the global economy for a while.

What is the point of my discussion? And how does it connect with the topics of this conference? The connection is through the real exchange rate. This is the price that connects Chile's growth to the global context. Both forces –the strong Chinese growth and the monetary policy followed by the Federal Reserve– put pressure on Chile's real exchange rate and will continue to do so for a while. These two forces produce what is generically known as "Dutch Disease", i.e. the negative effect of a strong foreign capital inflow on manufacturing and non-commodities exports, as well as on import–substituting industries. However, this external pressure has many favorable dimensions. In fact, the competitive pressure on sectors mentioned above can accelerate the process of technology adoption. There is empirical evidence suggesting that the industries subject to intense competition face complications initially, but over time they become technologically-advanced industries. But there is also enough evidence accumulated that if this process of foreign capital inflows occurs very fast, it can destroy the export sector of the economy and may adversely affect growth if it aborts the growth process of export sectors with increasing returns to scale, which requires reaching high production levels. There is the tension: on the one hand, the "Dutch Disease" has favorable effects, but if this process occurs rapidly, it damages the export sector, which as mentioned by Daron [Acemoglu] in his presentation, is very important for the medium-term growth of the Chilean economy.

The central question is, then, in an external environment that creates a strong appreciation of the real exchange rate, what economic policies should be adopted to protect the export sector. When thinking about economic policies, it is important to remember that the underlying problem in a real appreciation has little to do with how many dollars are sold in the domestic market or other problems of relative liquidity. The real problem is the reallocation of resources. When there are massive foreign capital inflows because the commodity price rises or because the assets of the Chilean economy become more attractive to the rest of the world, there is a wealth effect on our economy, which increases the consumption of imported and domestically-produced goods. To increase domestic production, it is necessary to hire productive factors, coming from the non-commodity tradable sector. The real exchange rate is the market mechanism that generates such reallocation of resources from the tradable to non-tradable sectors.

Under this view, it becomes clear that we have roughly two types of policies to reduce this problem: those that reduce the consumption of nontradables, and those that increase the effective supply of factors of production, especially the factors used more intensively in the production of non-tradables. Regarding the first, there are policies of setting spending levels and policies of expenditure redistribution. Regarding the latter, there are policies that increase the quantity and others the quality of other factors of production.

Some expenditure policies are encouraging private savings and setting the least expansive fiscal possible, according to the conditions of the economic cycle. This is an additional factor to consider when setting fiscal policy for its effects on the appreciation of the real exchange rate. The redistribution of expenditure relates mainly to the reorientation of public spending towards tradable goods, although I do not know how much scope there is for this in Chile. You can also think of differential VAT, but you have to be very careful with this type of policy because it creates a series of perverse incentives and distortions. The same applies to industrial policies and interventions in the exchange rate market by the Central Bank. All these policies have many side effects which should be analyzed carefully before being implemented.

On the other hand, the most obvious and rapid margin we have in Chile to expand the quantity of productive resources was already discussed by Vittorio [Corbo], that is, the increase in female labor participation. Here we have a huge untapped resource. This is an issue that has to be the first priority. It is not simple, since it has to overcome cultural, logistical and infrastructure problems of nurseries, but the return is high in the short term. And not just in the short-term, because one of the great sources of education is employment, therefore, increasing labor participation will boost productivity in the medium-term. It also has an additional benefit in children: instead of being at home watching television, they will be at the nurseries and kindergartens. As argued by Francisco Gallego in his presentation, there are nurseries that have many shortcomings, but we must work to solve those problems. Undoubtedly, this will be an important source of growth.

Most of the successful Irish expansion during recent decades was due to its ability to absorb labor migration. For this reason, the negative effect of diminishing returns to scale on growth was not reached in the short-term in Ireland, allowing them to expand production by additional time. A third of the growth rate that Chile lost in recent years was due to the fall in employment growth. This can be completely reversed, as happened in Ireland, by increasing the contribution of labor to growth. One important aspect of the Irish phenomenon is that they received migration from England, with high levels of qualification. If women join the labor market in Chile, Patricio Meller's productivity puzzle would be even greater, because the growth of TFP would be even more negative in the short-term, because people without prior training would be incorporated into the labor market.

In sum, Chile is in a very favorable external environment, which will last for a long time. The great danger in this context for growth is an excessive appreciation of the real exchange rate, but the solution is not a Central Bank short-term prescription because there is little this institution can do about the level of the real exchange rate, which will undoubtedly be appreciated in the coming years. Real solutions involve the expansion of the labor market. There is no other solution.

Thank you.

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