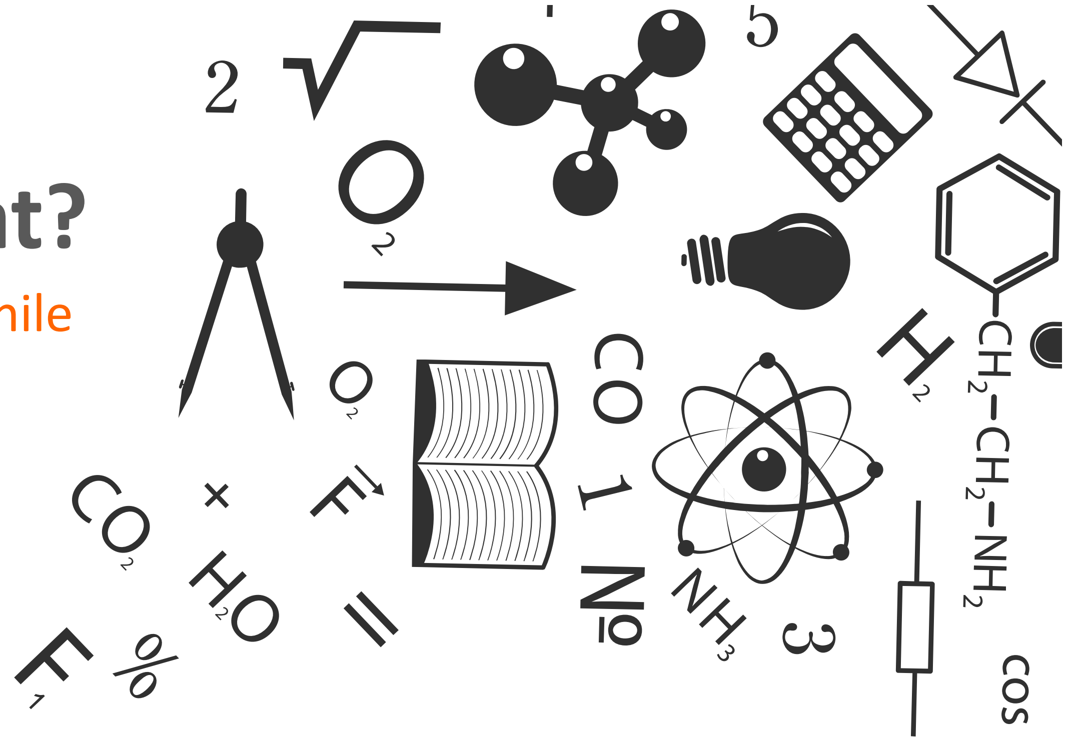
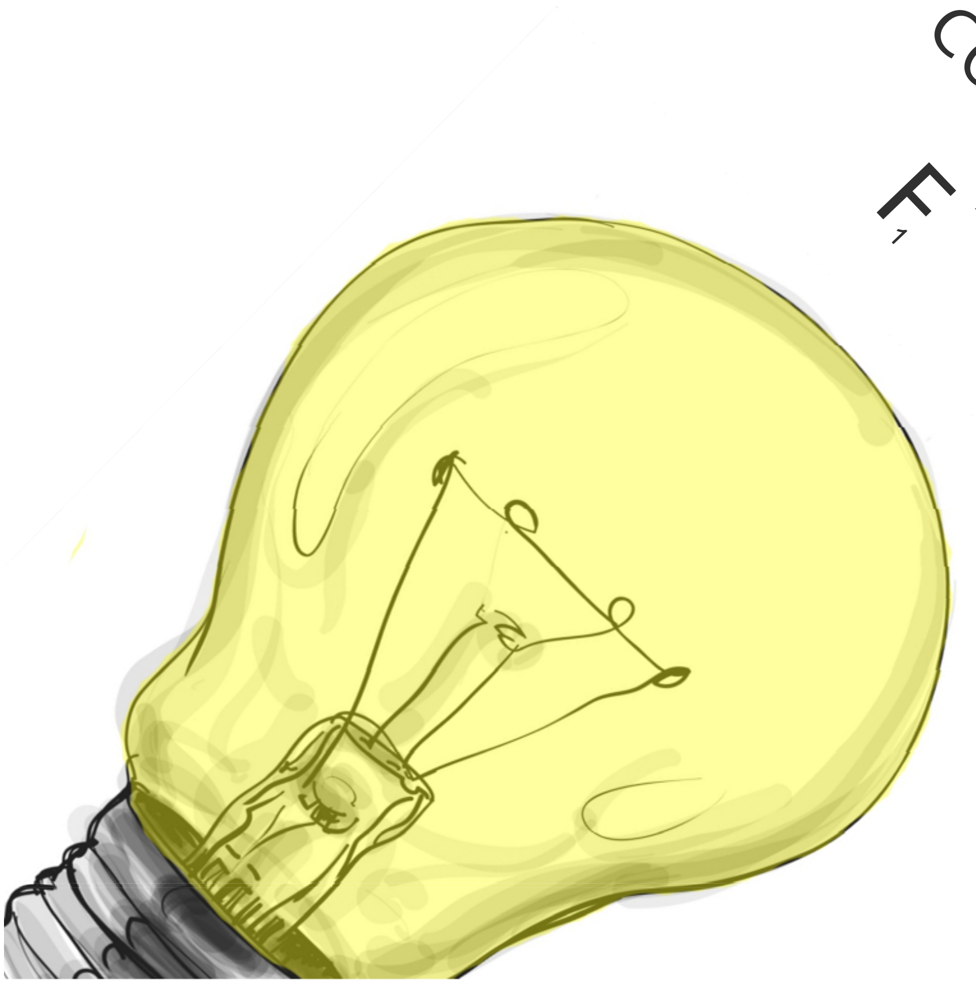
Besides Copper, What?

Policies for Productivity Growth in Chile





Addressing The Skills Challenge

Juan Carlos de la Llera

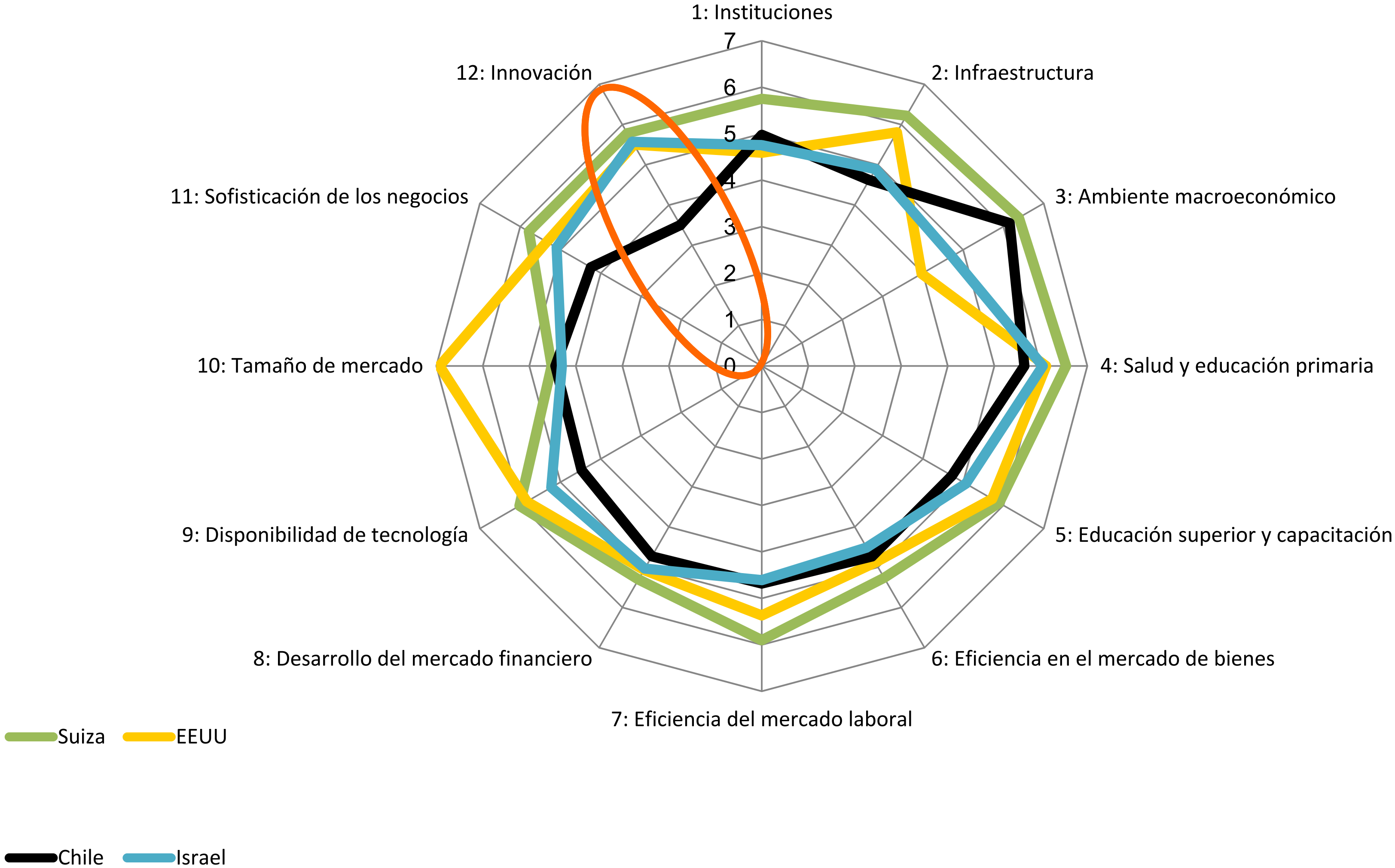
23.04.2014



Not just Copper…

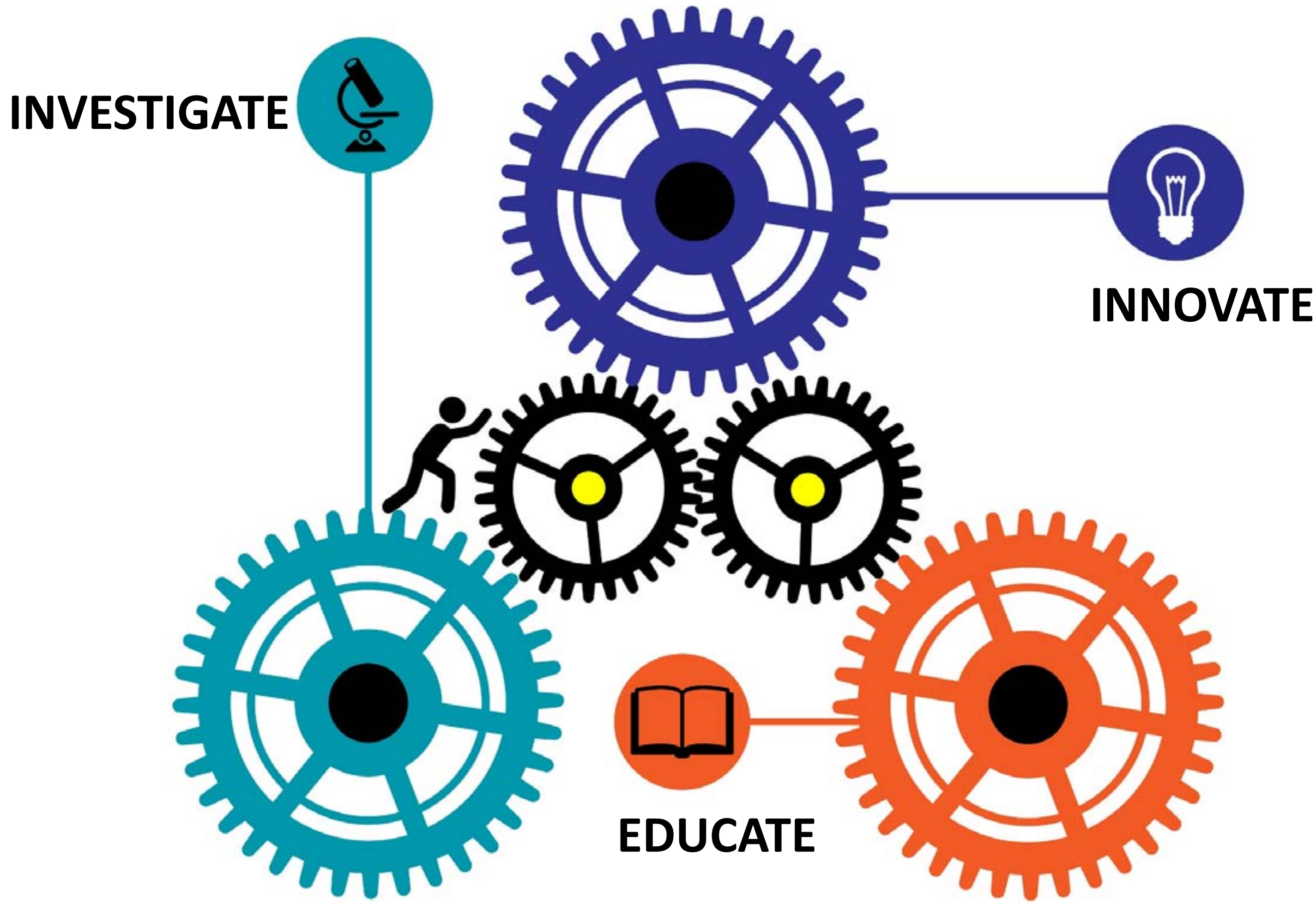
Chile´s endowment

First piece: Global Competitiveness Index



Source: Global Competitiveness Report 2012-2013, World Economic Forum

Second piece: The University

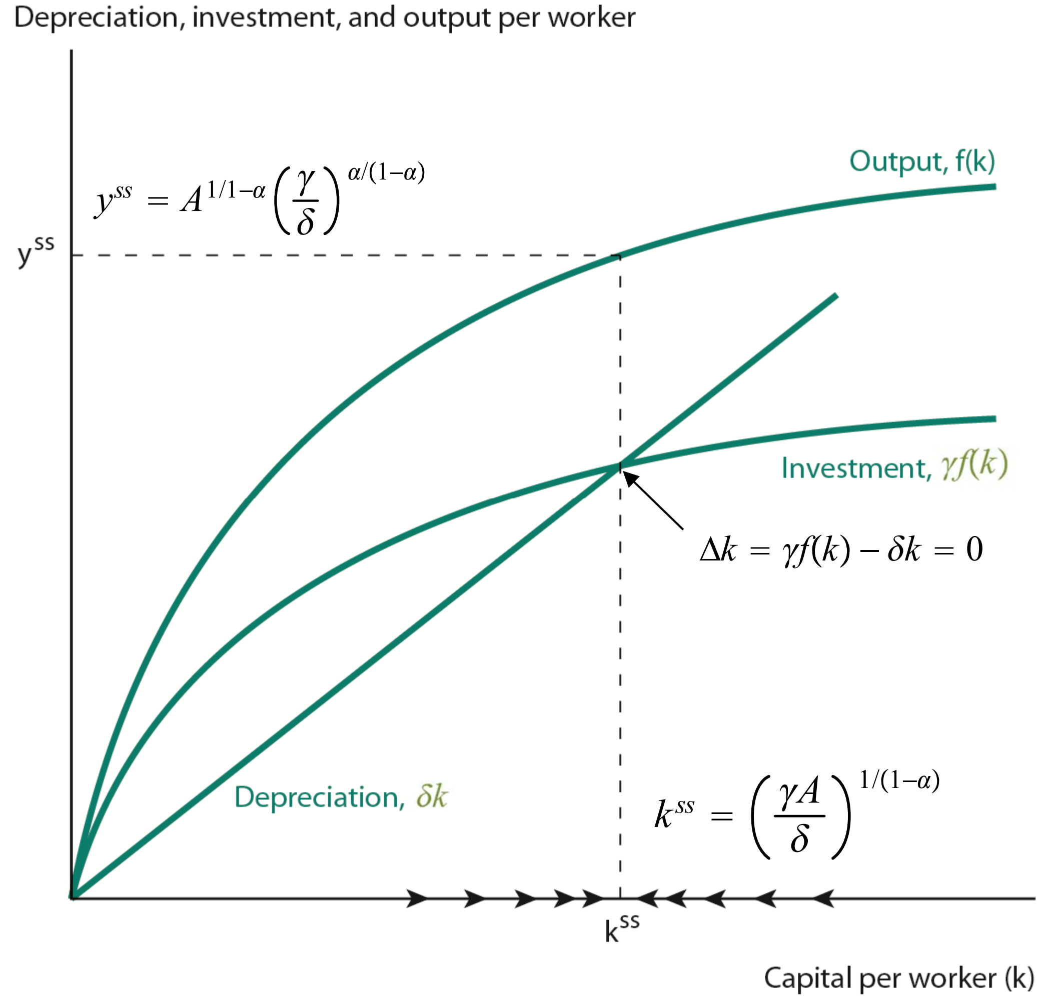


Third piece: The Solow Model

Cobb-Douglas production function

$$Y = AK^{\alpha}(hL)^{1-\alpha}$$

Robert Solow (Nobel prize 1987)



Our formal goal is to tackle:

$$Y = AK^{\alpha}(hL)^{1-\alpha} \xrightarrow[\text{(per worker)}]{\div L} \boxed{y = Ak^{\alpha}h^{1-\alpha}}$$

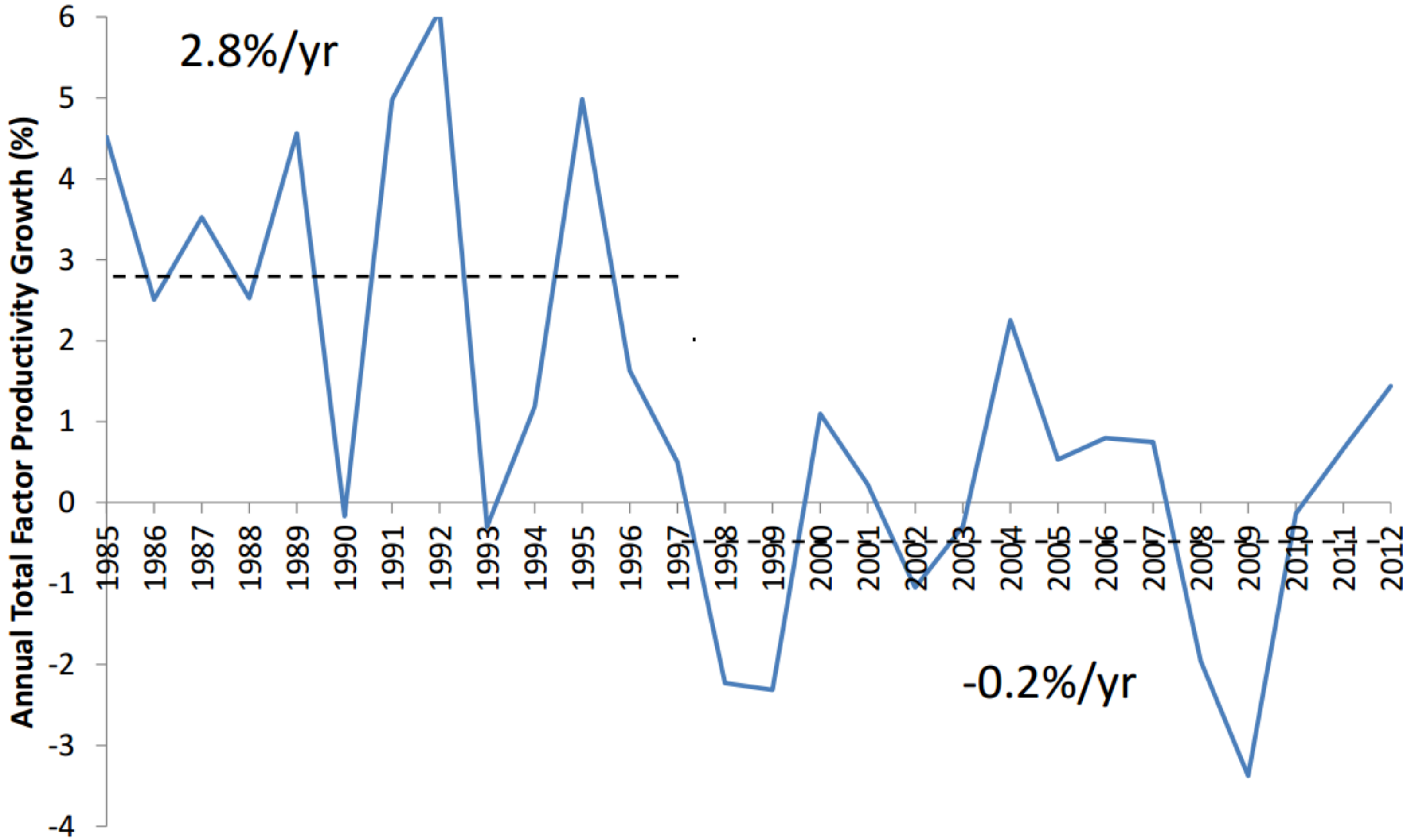
From the University $\left\{ \begin{array}{l} \text{Human capital: } \boxed{h} \\ \text{Productivity: } A = \boxed{T} \times E \end{array} \right.$

T ↑ Technology (Knowledge)

E ↑ Efficiency

Source:Weil, David N. (2013-03-20). Economic Growth: International Edition. Pearson Education Limited.

The productivity issue with Chile



After C. Syverson, 2014

Universities leading Engineering and Technology…

1. MIT
2. Stanford University
3. University of Cambridge
4. Berkeley
5. ETH Zurich
6. Imperial College London
7. NUS
8. EPFL
9. University of Oxford
10. Caltech

Leaders in entrepreneurial ecosystems

Source:QS Ranking, 2013, Science and Enginnering
World's leading entrepreneurial ecosystems, rhgraham.org

OECD & WB recommendations

S&T and R&D:

- Increase **contribution of government and productive sector**
- **Increase funding** for doctoral students and expensive scientific equipment
- Encourage **university-industry linkages**

Access and equity:

- Review **admission system**
- Improve chances of **less advantaged students** to enroll in preferred institution

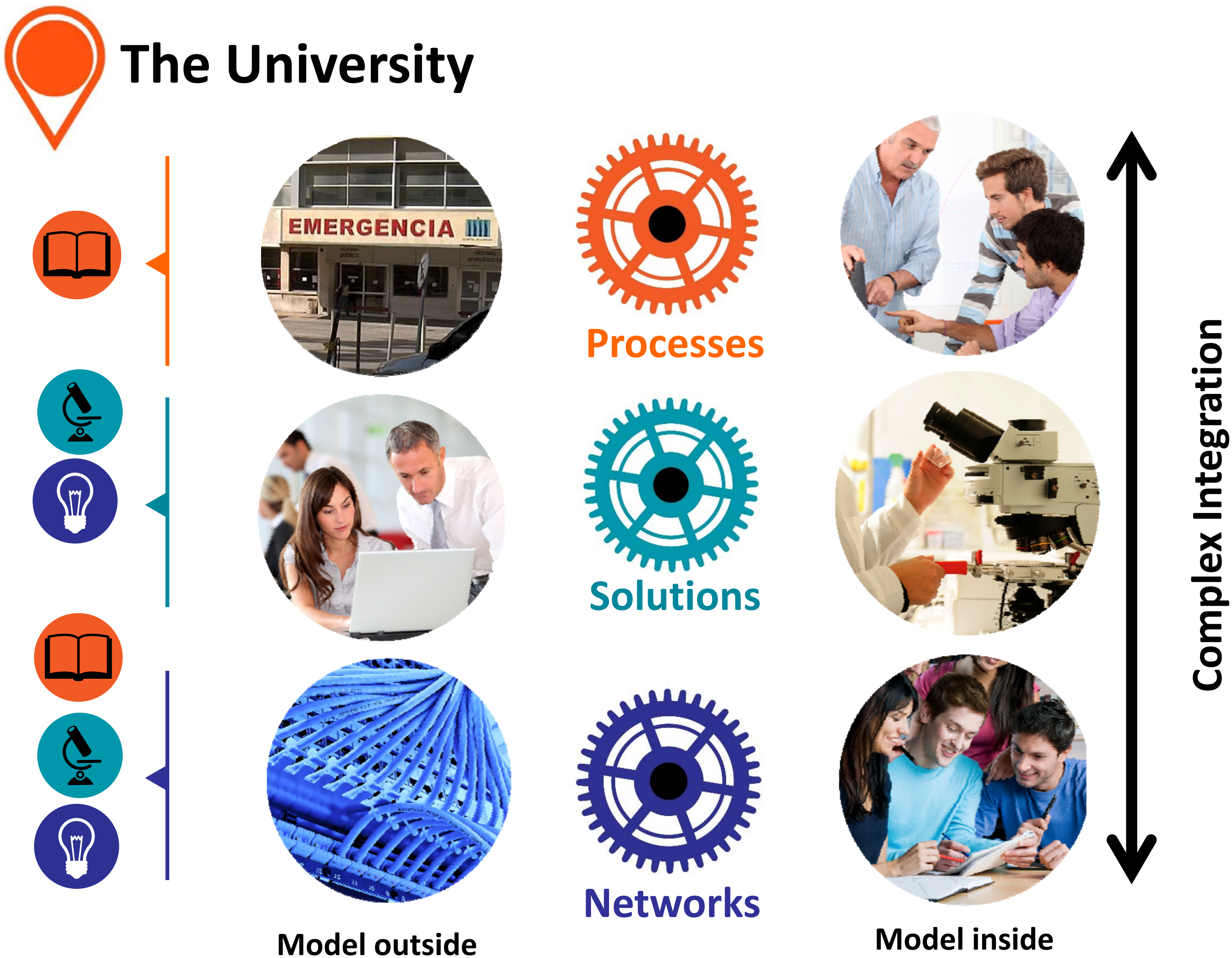
Relevance:

- Develop stronger needs between **employers' needs and academic programs** of HEIs
- Review the curriculum introducing elements such as **teamwork, intercultural awareness and entrepreneurship**
- Greater national commitment to incorporating **second language** in undergraduate programs
- Strategy to position Chile as a preferred **destination for international education**

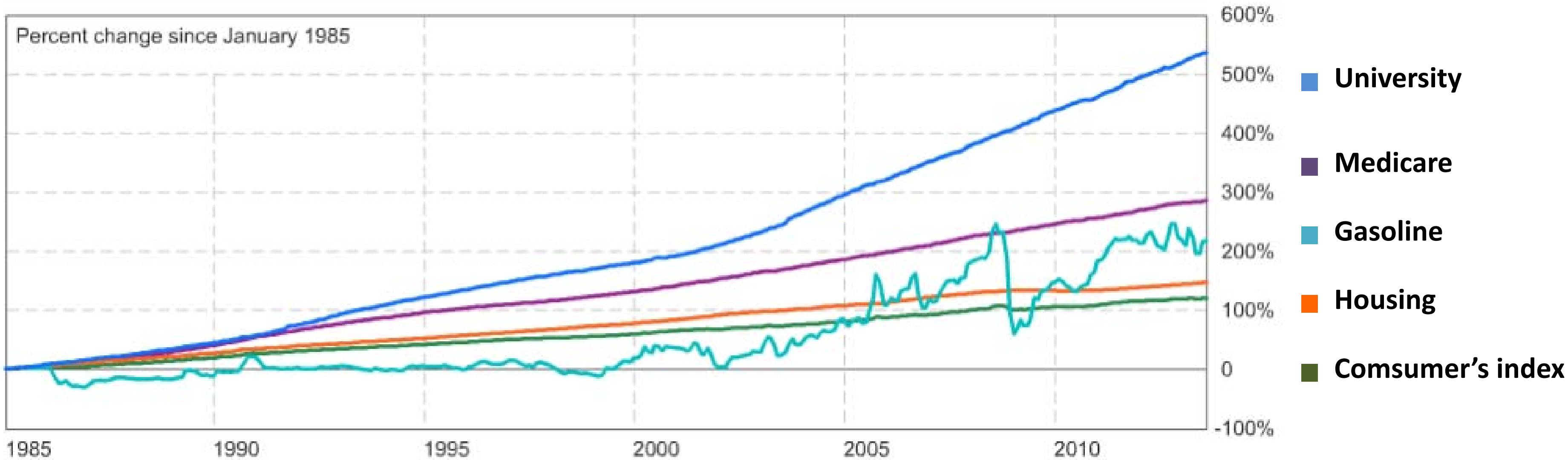
Governance & financing

- Improve **flexibility and articulation**
- Clear **separation between education degrees and professional licensing**
- Introduce **modern management practices**
- Move towards **shorter first degrees** according to worldwide trend

* Source: Tertiary Education in Chile, OECD & WB, 2009

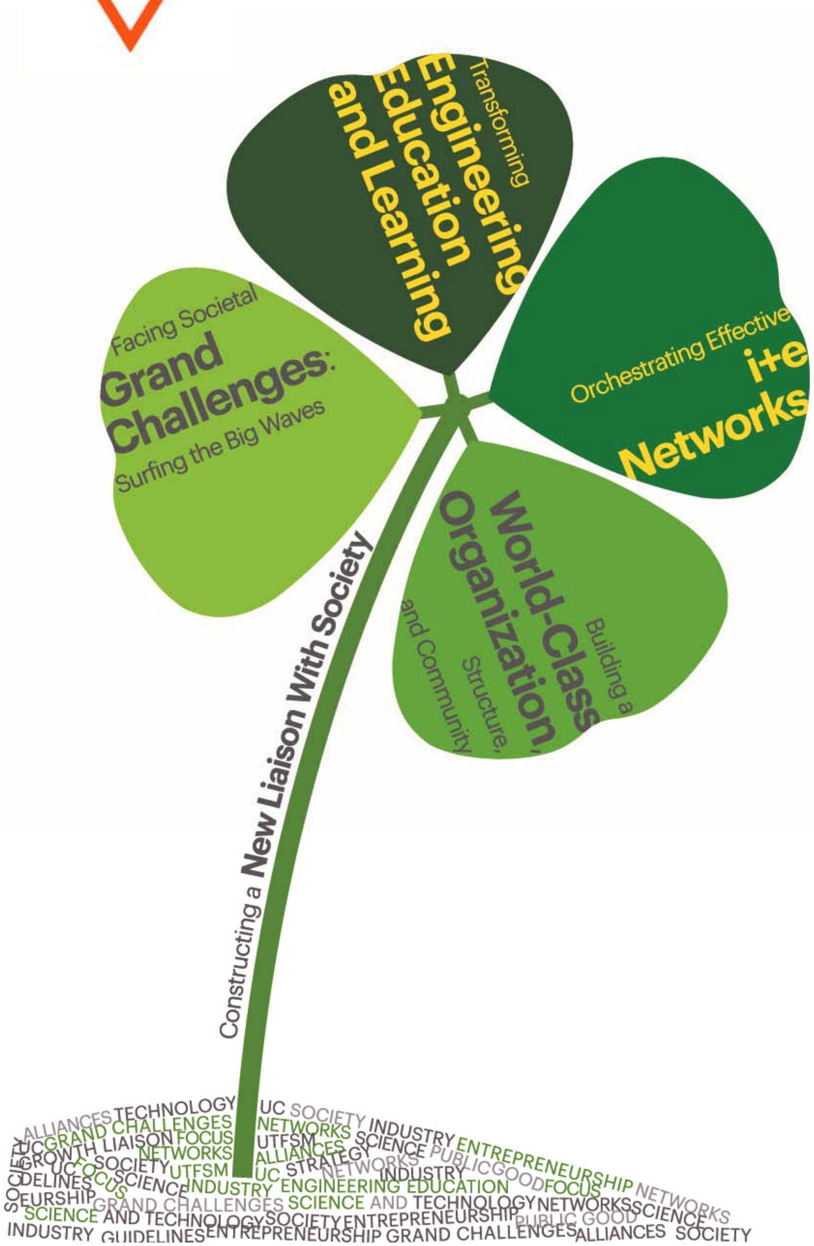

The University
EMERGENCIA
Processes
Solutions
Networks
Model outside
Model inside
Complex Integration

Evolution of cost of education (US)



Source: http://www.bloomberg.com/news/2013-08-26/college-costs-surge-500-in-u-s-since-1985-chart-of-the-day.html (2013)

Our response



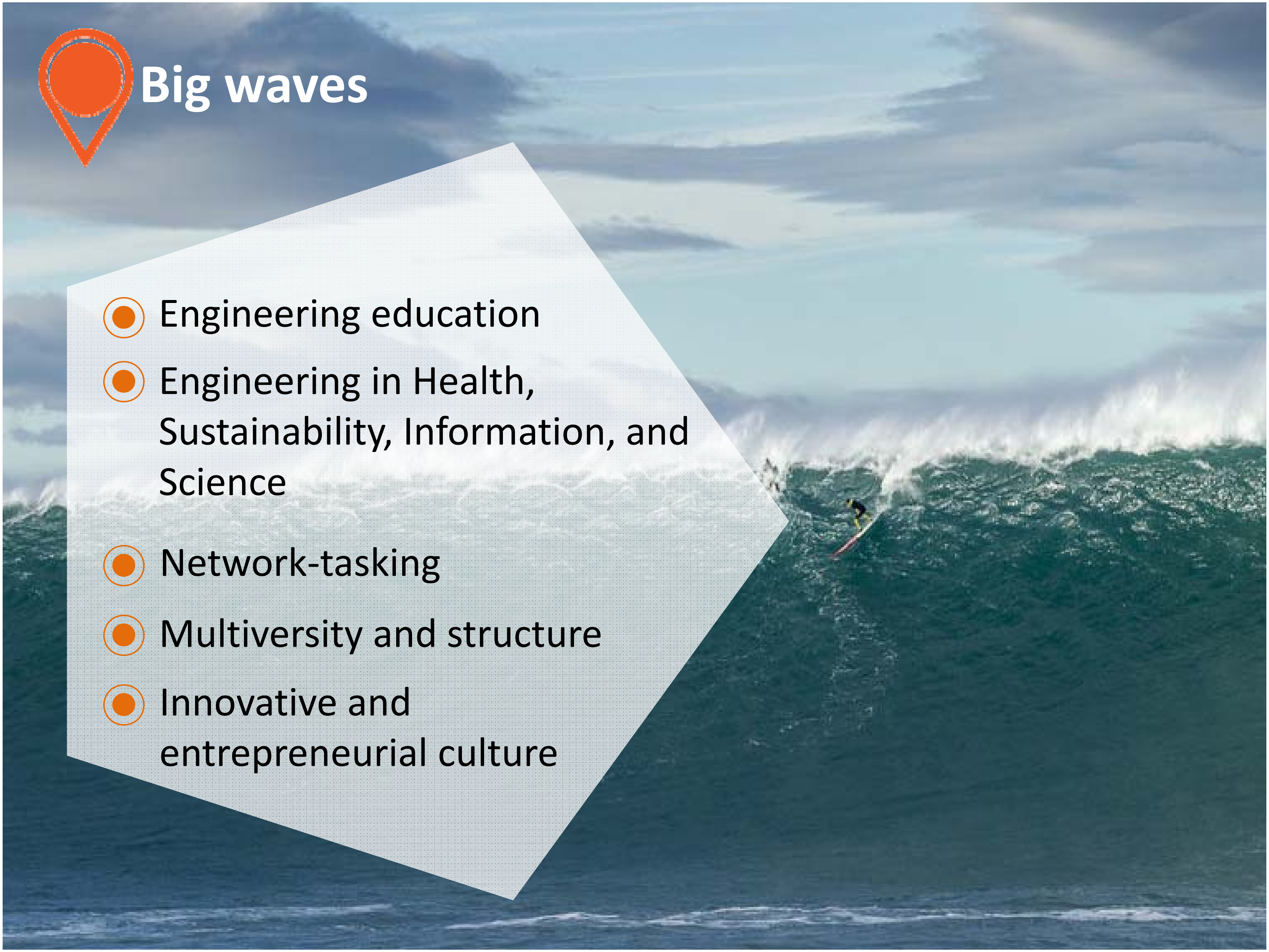
PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE

UNIVERSIDAD TECNICA FEDERICO SANTA MARIA

THE "CLOVER" 2030 ENGINEERING STRATEGY:

An Engine to Surf the Waves for Chile´s Development

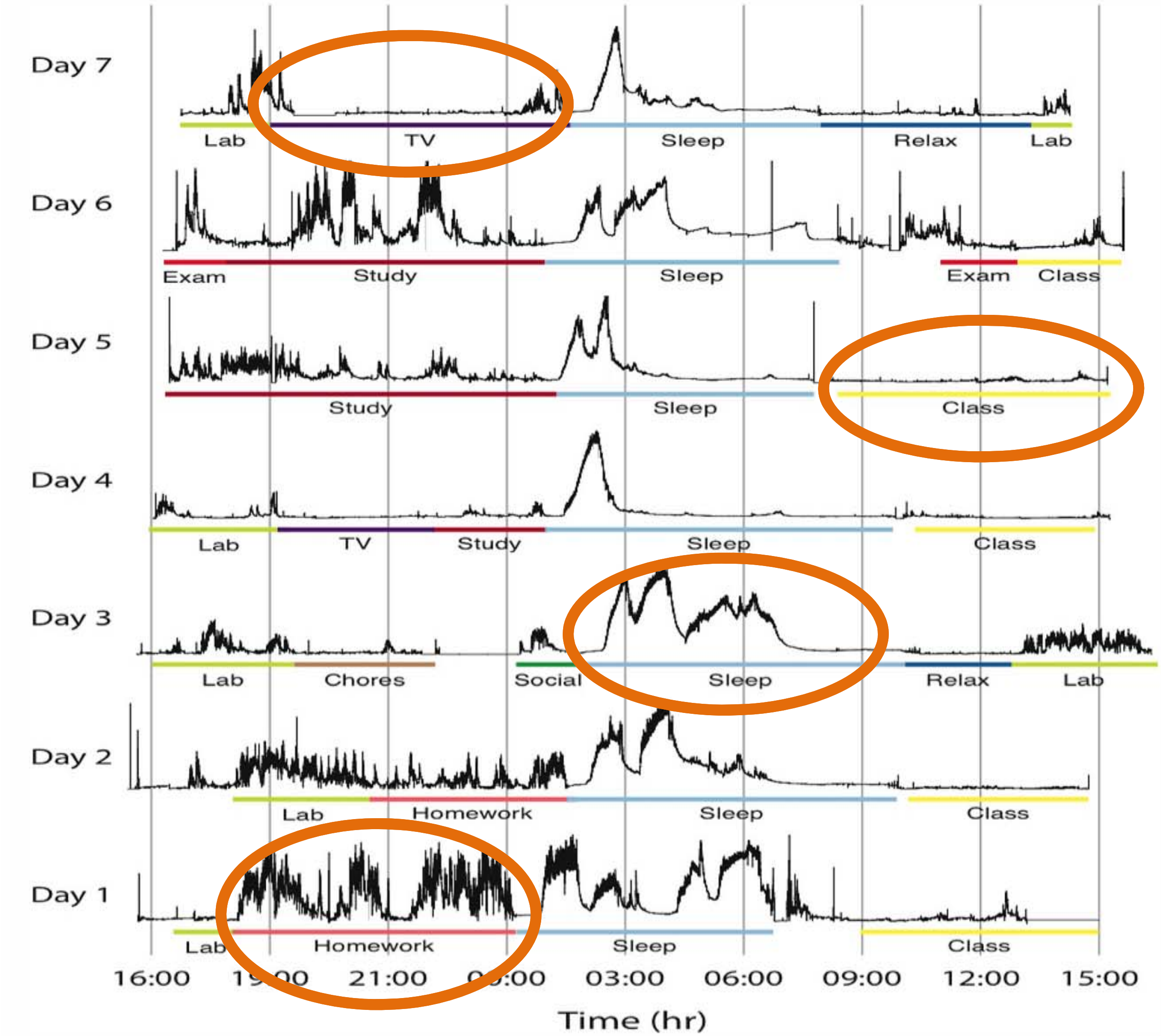
CORFO
sueña emprende crece

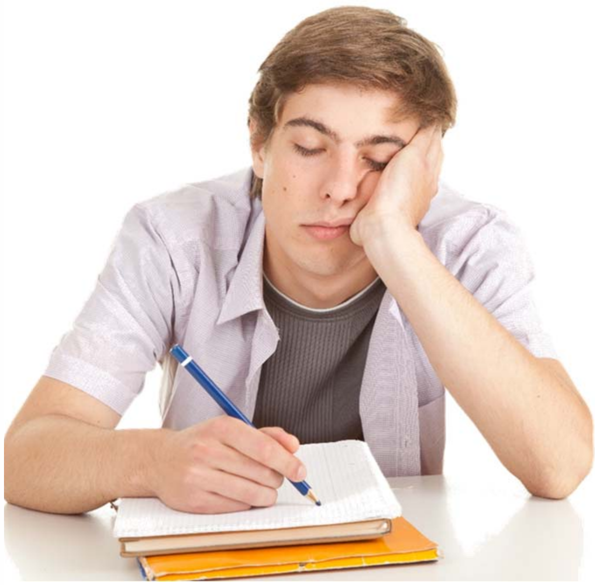


Big waves

- Engineering education
- Engineering in Health, Sustainability, Information, and Science
- Network-tasking
- Multiversity and structure
- Innovative and entrepreneurial culture

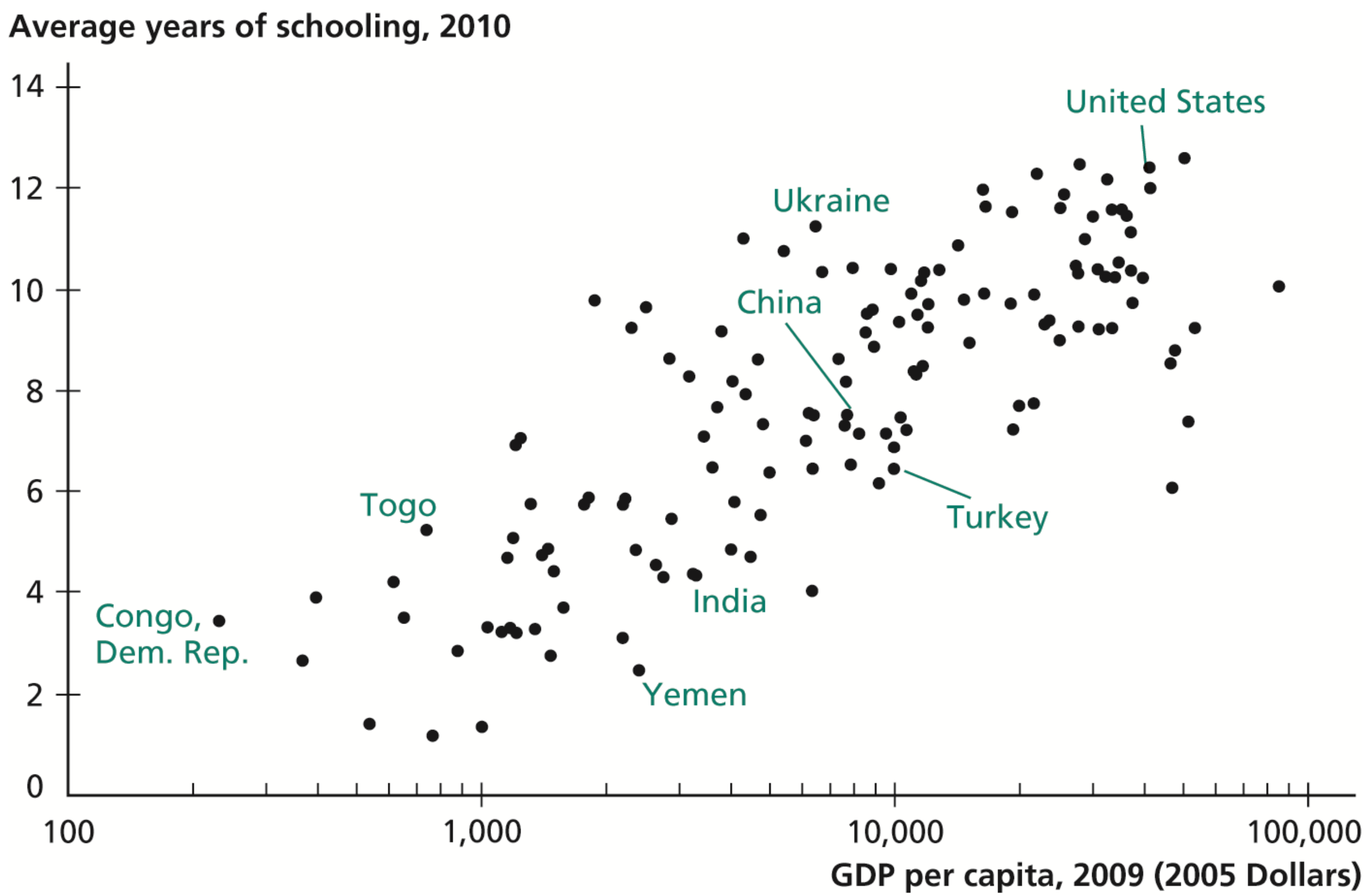
Dealing with *h*





Source: Poh, M.Z., Swenson, N.C., Picard, R.W., "A Wearable Sensor for Unobtrusive, Long-term Assessment of Electrodermal Activity " (2010)

Education versus GDP per capita



Source: Barro and Lee (2010), Heston, Summers, and Aten (2011)

Education and the Cobb-Douglas model

Output per worker

Productivity

Capital per worker

Amount of labor input per worker

$$y = Ak^{\alpha}h^{1-\alpha}$$

Capital share´s of income $\approx 1/3$

Factors of production

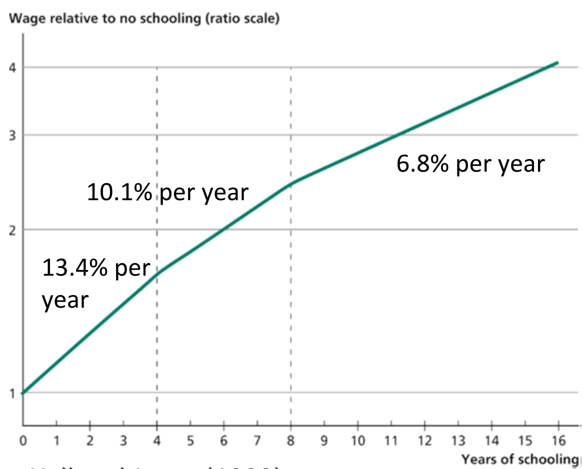
Steady state: $$y^{ss} = h \times \left[A^{1/(1-\alpha)} \left(\frac{\gamma}{n+\delta} \right)^{\alpha/(1-\alpha)} \right]$$

All other parameters fixed

$$\frac{y_1^{ss}}{y_2^{ss}} = \frac{h_1}{h_2}$$

Source: Weil, David N. (2013-03-20). Economic Growth: International Edition. Pearson Education Limited.

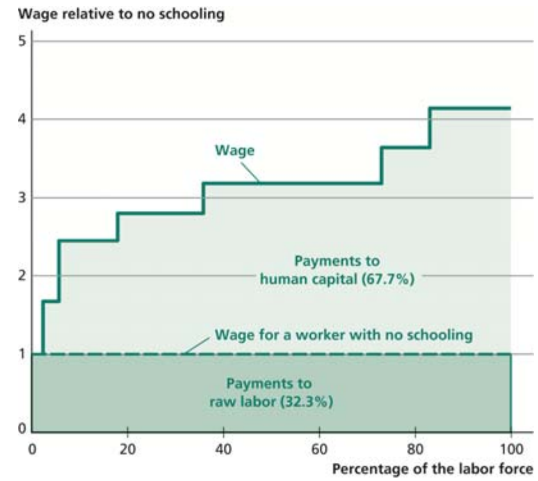
Output (*y*) versus amount of labor input per worker (*h*)



Hall and Jones (1999)

Developing countries

Advanced countries



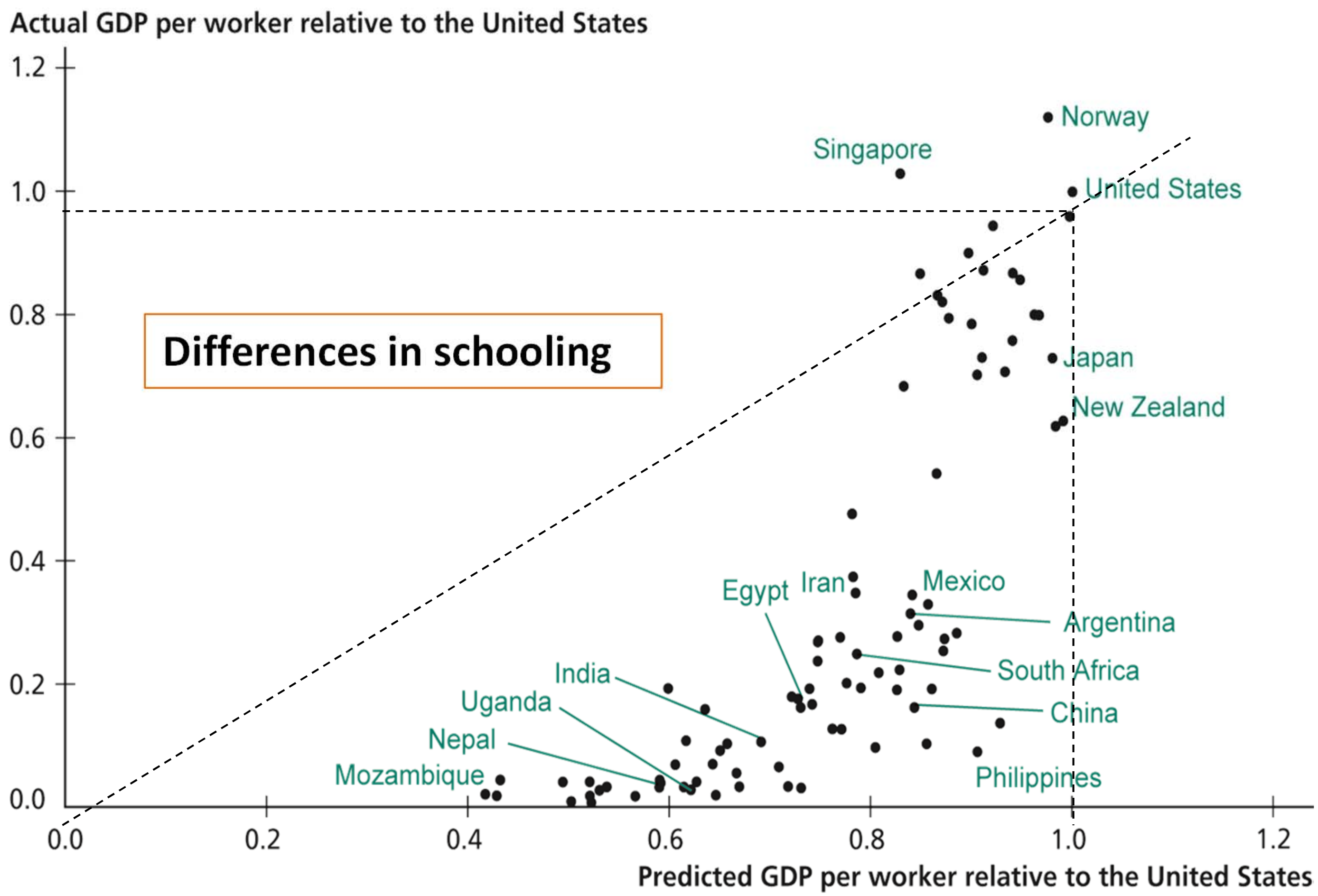
			Percentage of the Adult Population with			
		Average Years of Schooling	No Schooling	Complete Primary Education	Complete Secondary Education	Complete Higher Education
Developing Countries	1975	3.2	47.4	32.9	8.1	1.6
	2010	6.7	20.8	68.8	31.5	5.3
Advanced Countries	1975	8.0	6.2	78.8	34.9	8.0
	2010	11.0	2.5	94.0	63.9	16.6
United States	1975	11.4	1.3	94.1	71.1	16.1
	2010	12.4	0.4	98.8	85.4	20.0

Source: Barro and Lee (2010). Data for population 25+.

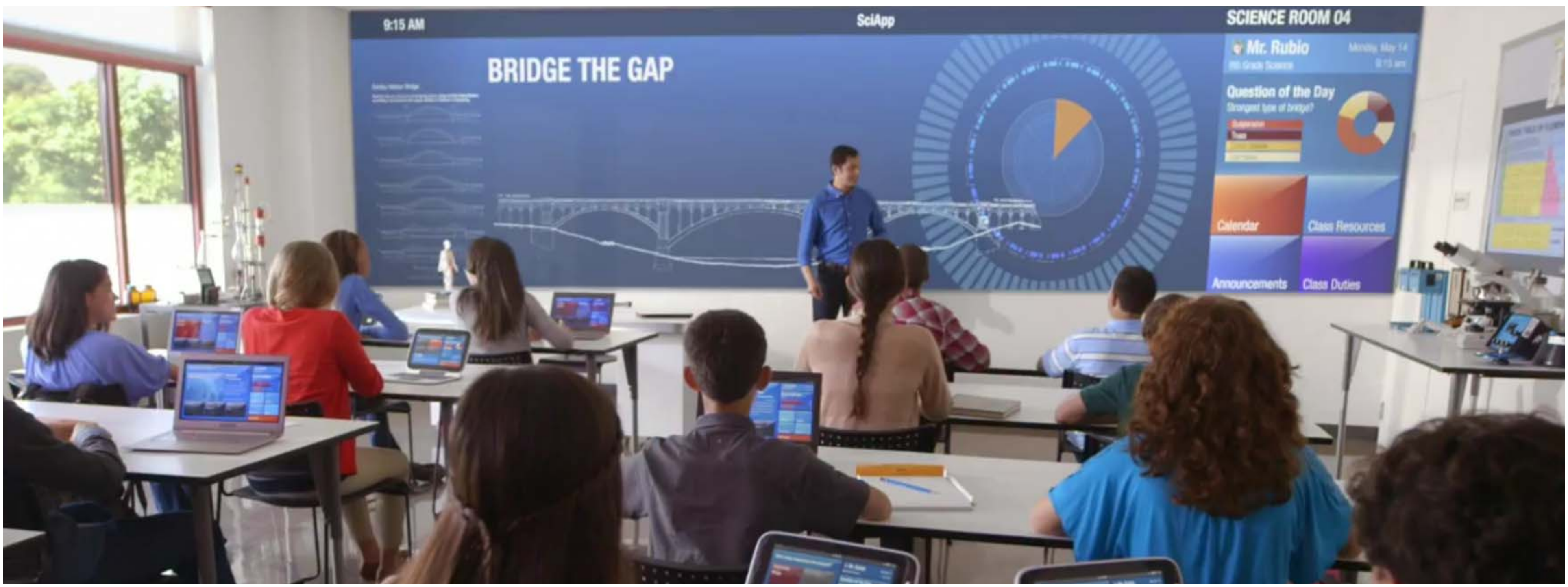
$$\frac{y_1^{ss}}{y_2^{ss}} = \frac{h_{US}}{h_{dc}} = \frac{1.134^4 \times 1.101^4 \times 1.068^{4.4}}{1.134^4 \times 1.101^{2.7}} = 1.51$$

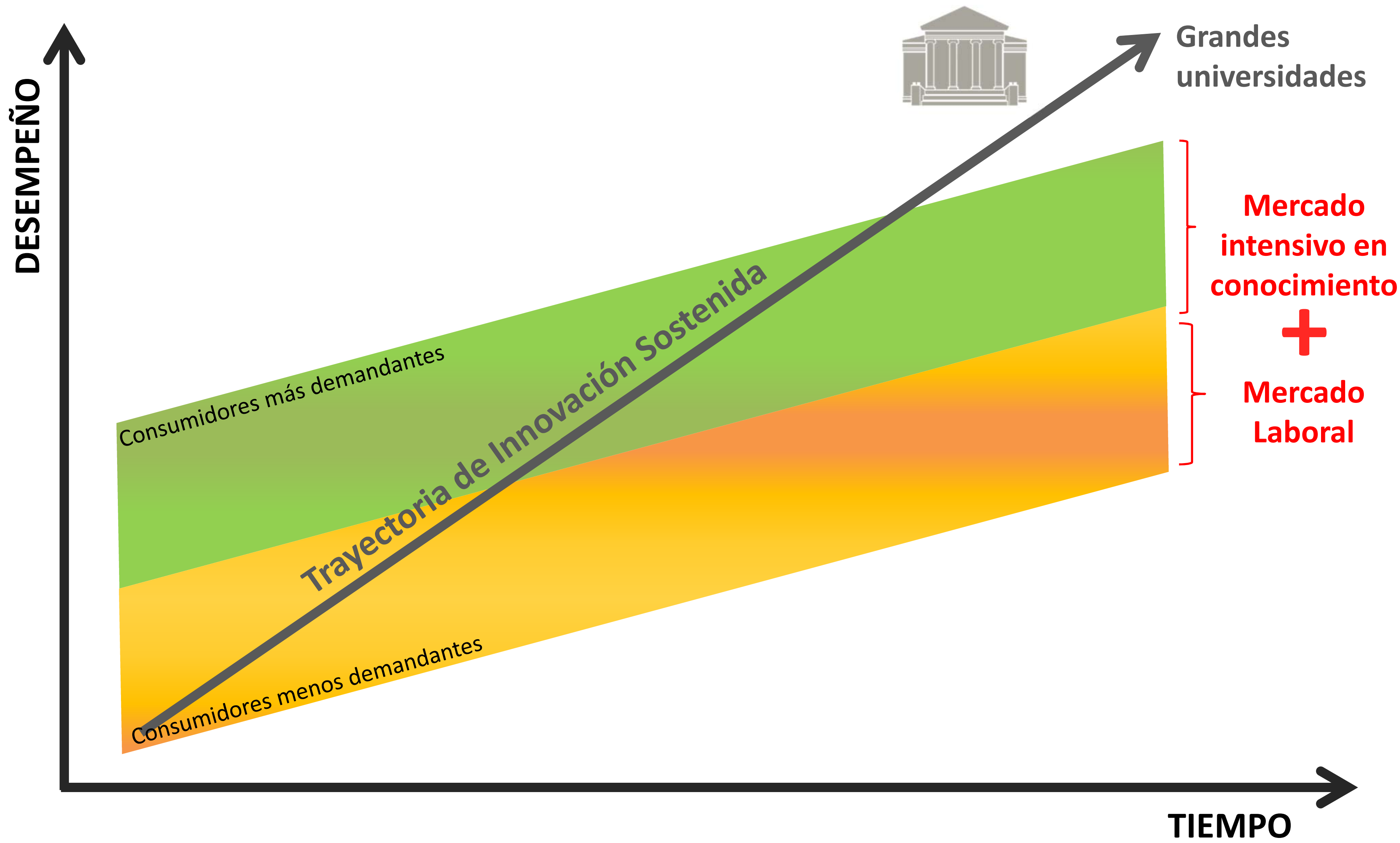
Source: Weil, David N. (2013-03-20). Economic Growth: International Edition

Predicted versus actual GDP per worker: *h*

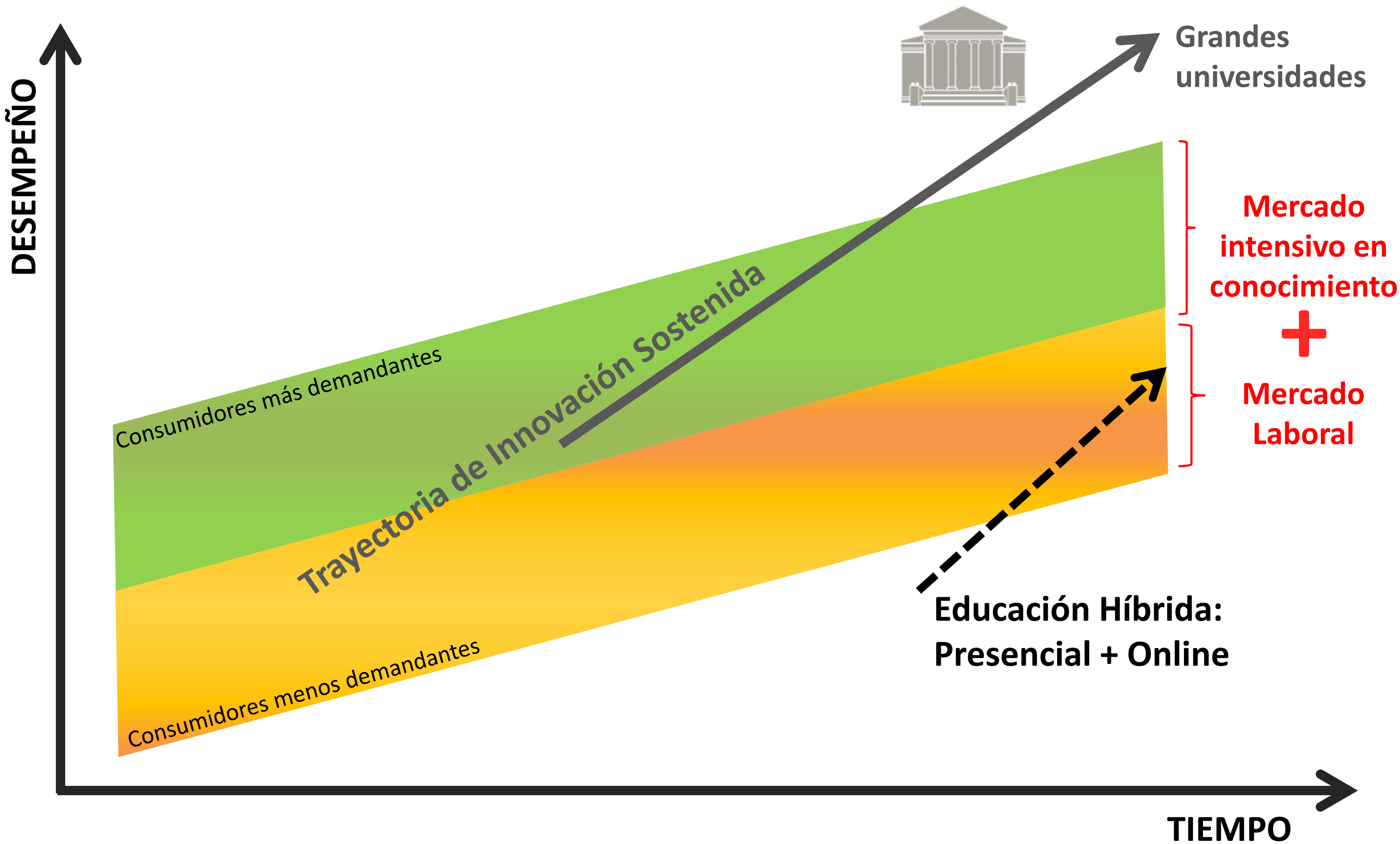


Source: Weil, David N. (2013-03-20). Economic Growth: International Edition


9:15 AM
SciApp
SCIENCE ROOM 04
BRIDGE THE GAP
Mr. Rubio
Question of the Day
Calendar
Class Resources
Announcements
Class Duties

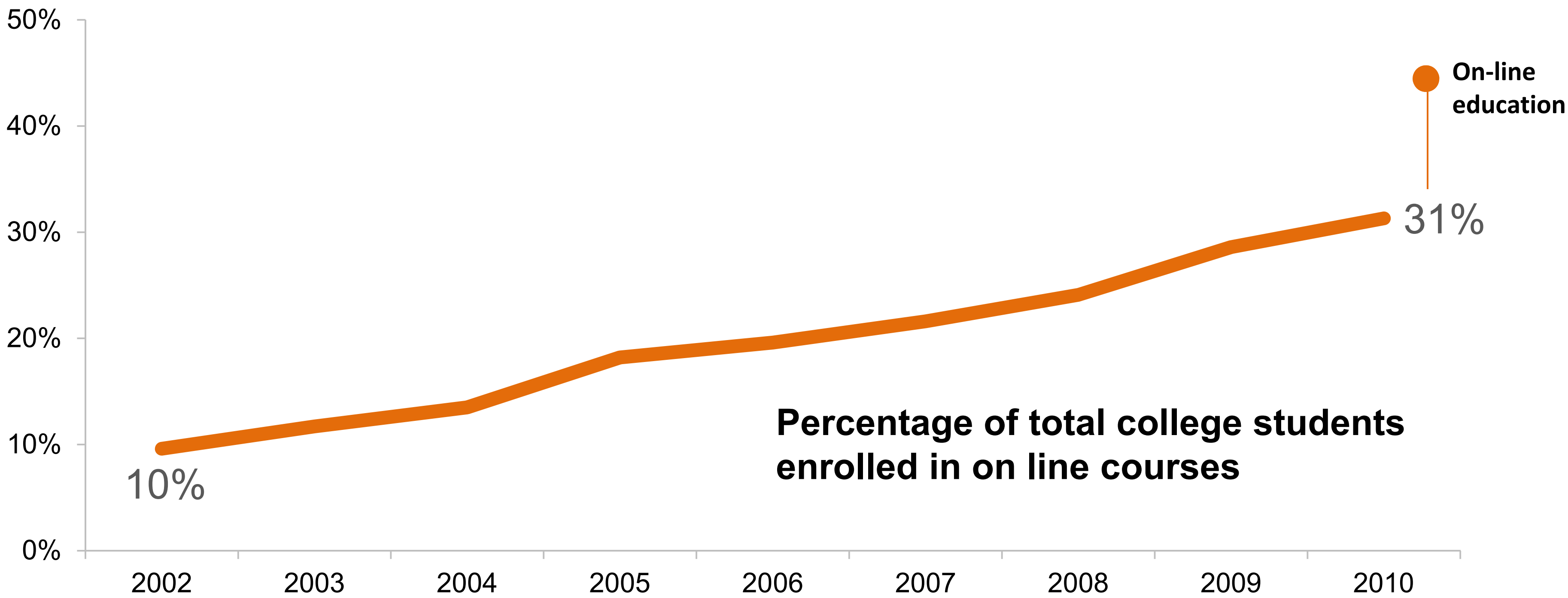


Source: C. M. Christensen, H. J. Eyring. The Innovative University: Changing the DNA of Higher Education from the Inside Out (2011)



Source: C. M. Christensen, H. J. Eyring. The Innovative University: Changing the DNA of Higher Education from the Inside Out (2011)

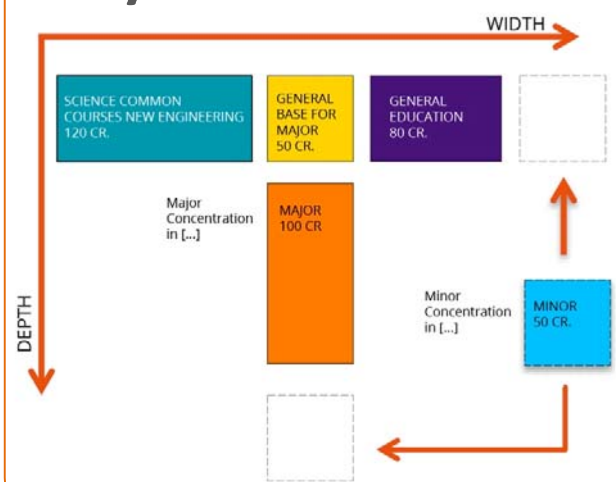
On line course evolution



Source: Babson Survey Research Group

A New Engineering Education

- Education
  4 years B.Sc.



- Job Market Search
- Entre-preneurship

- Professional Degree
  (1 – 2 years)
- M.Sc., Ph.D
  (1 – 4 years)

1 CYCLE
(4 years)

2 CYCLE
(0 – 3 years)

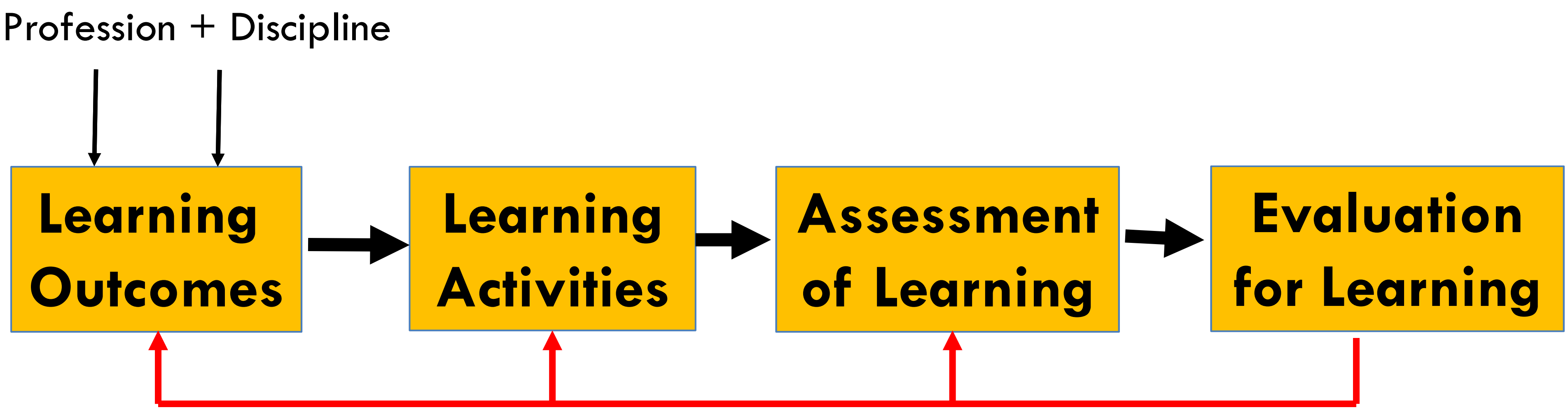
3 CYCLE
(1 – 4 years)

Competence based curriculum

- **Competency** can be broadly defined as the **ability of a student/worker enabling him to accomplish tasks adequately, to find solutions, and to realize them in work situations**. This definition fits in with the need for describing competencies and assessing them.

- Competencies consist of **components that are trainable** (knowledge, skills) and **components that are more difficult to alter** (attitudes, believes)**.** In addition competencies **refer to a profession in an organizational context**.

Student centric activity (learning)



Constructive Alignment

Course objectives, teaching and assessments aligned around the construction of deep learnings

(Light G., Cox R. & Calkins S. 2009)

Lower income students

2 **out of** **10**

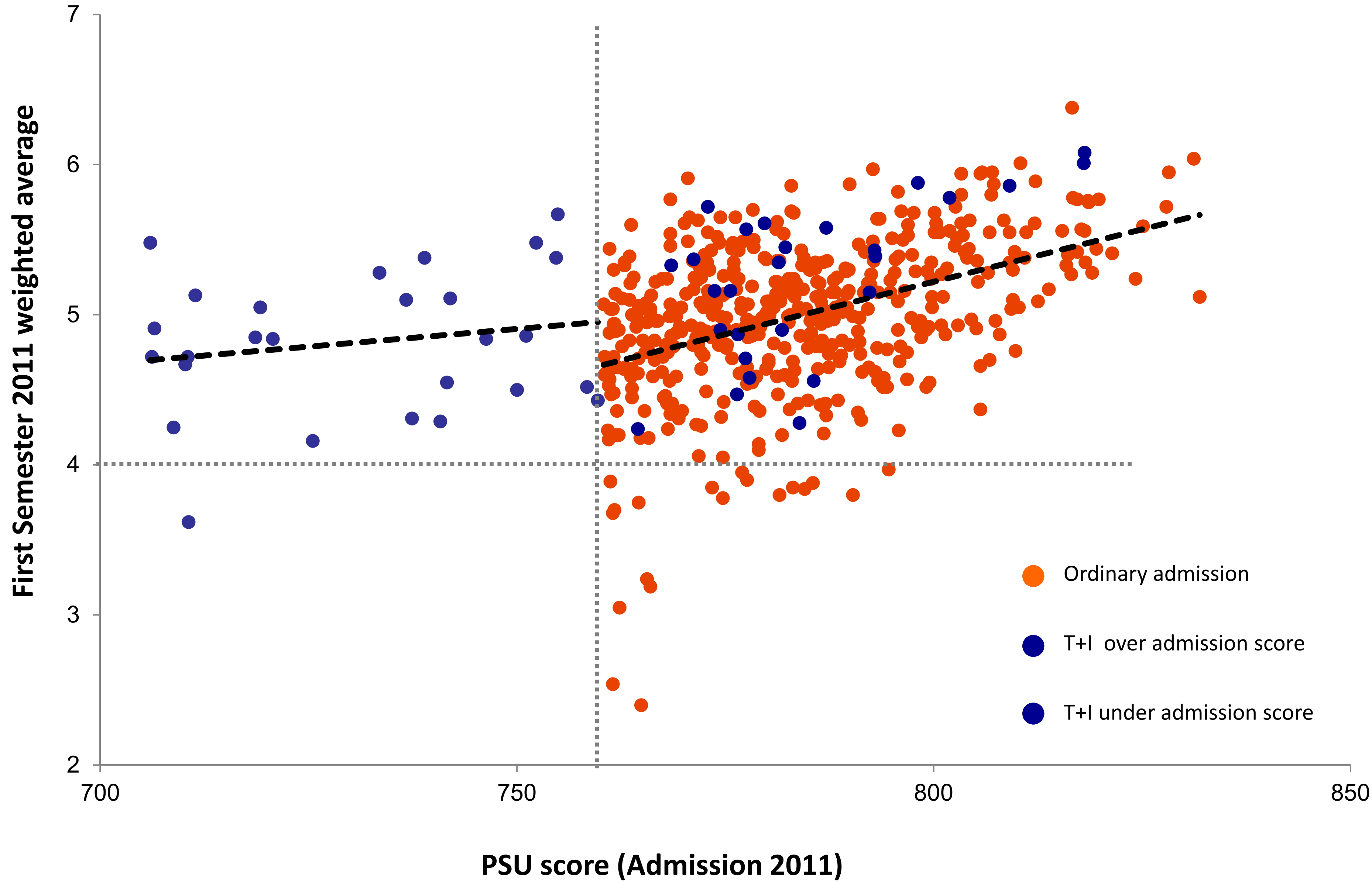
Access to higher education

Higher income students

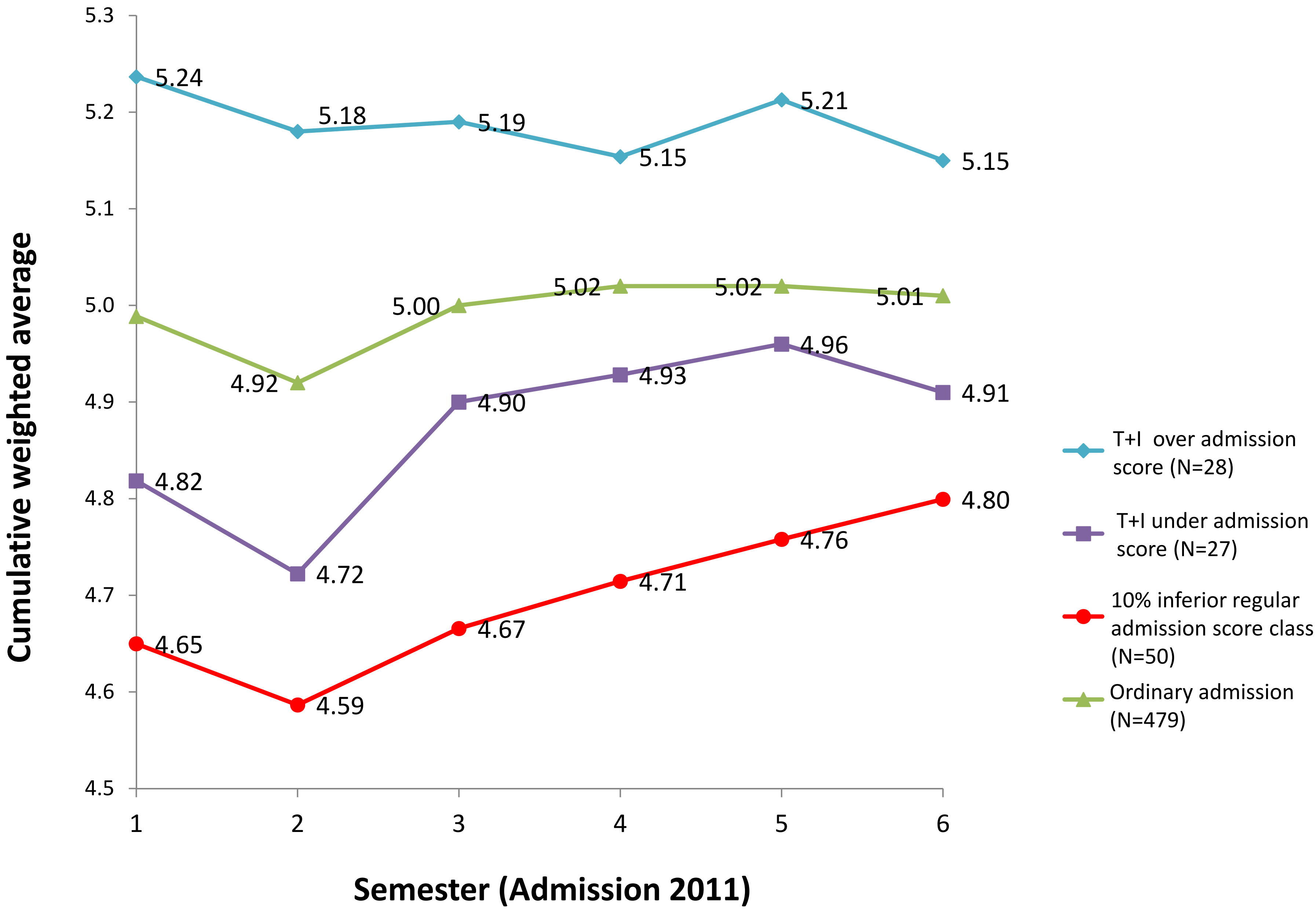
9 **out of** **10**

Access to higher education

Source: PPT "Innovación en Instituciones de Educación Superior", Mineduc. Seminario Ideahaz (2013)



Source: Ingeniería UC



Source: Ingeniería UC, 2014

Dealing with *T*

Technology and the Cobb-Douglas model

Output per worker

Productivity

Capital per worker

Amount of labor input per worker

$$y = Ak^{\alpha}h^{1-\alpha}$$ ← Capital share´s of income $\approx 1/3$

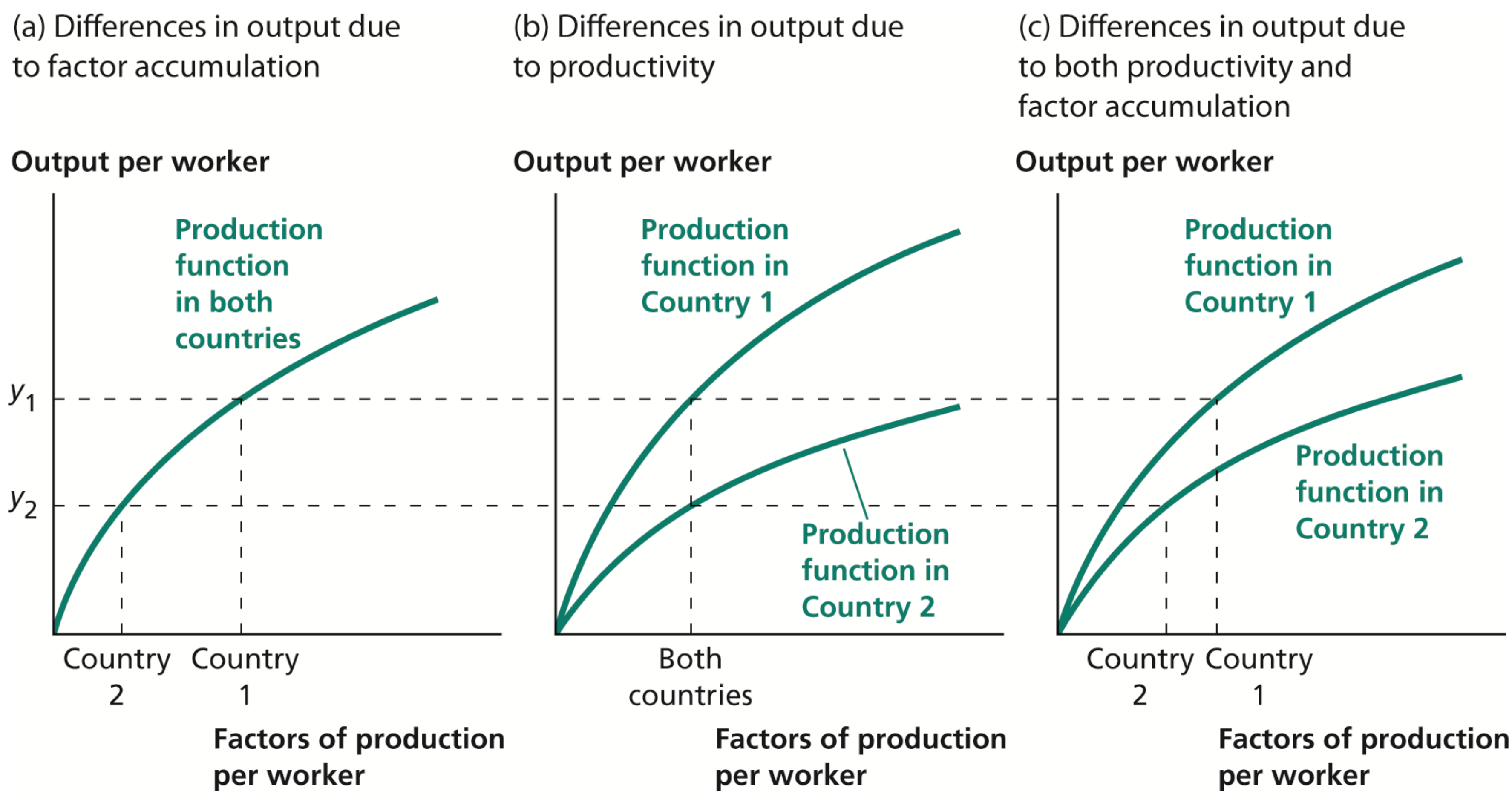
Output = Productivity x Factors of production

$$\hat{y} = \hat{A} + \underbrace{\alpha\hat{k} + (1-\alpha)\hat{h}}$$

Growth rate of output = **Growth rate of productivity** + **Growth rate of factors of production**

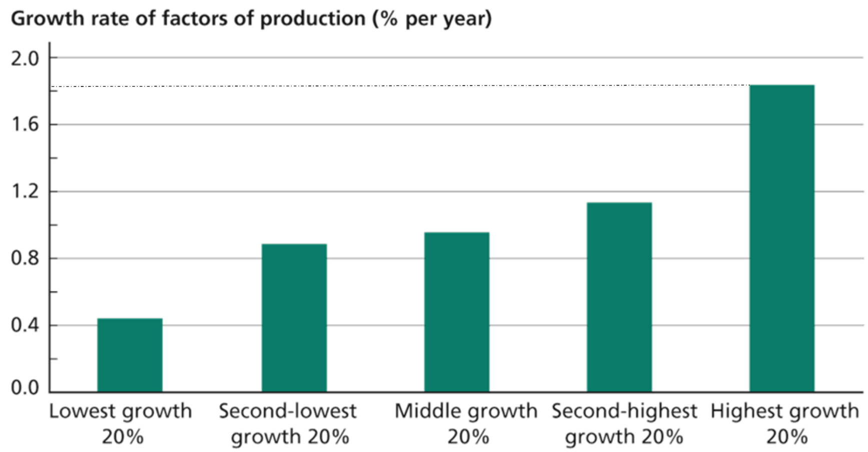
Source: Weil, David N. (2013-03-20). Economic Growth: International Edition

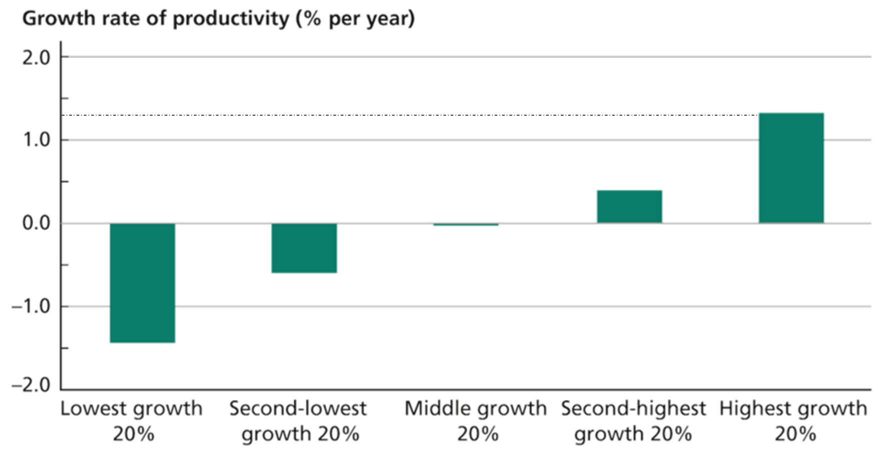
Sources of Differences in Output per Worker



Source: Weil, David N. (2013-03-20). Economic Growth: International Edition

Growth rates: 1975-2009





$$\hat{y} = \hat{A} + \alpha\hat{k} + (1-\alpha)\hat{h}$$

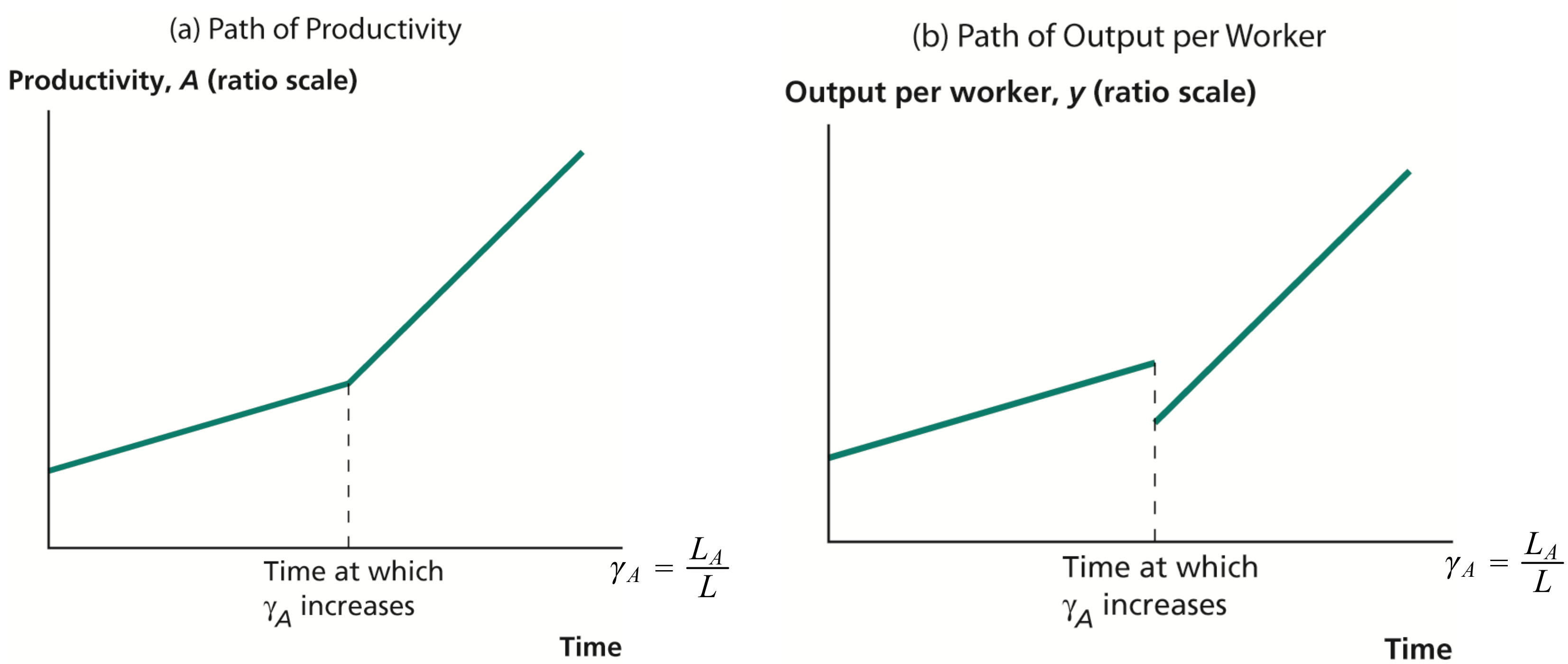
Growth rate of output = **Growth rate of productivity** + **Growth rate of factors of production**

20% Highest growth →

$$\frac{\hat{A}}{\hat{y}} \approx 1.35/(1.83 + 1.35) = 42\%$$

Source: Weil, David N. (2013-03-20). Economic Growth: International Edition

Effect of Shifting Labor into R&D



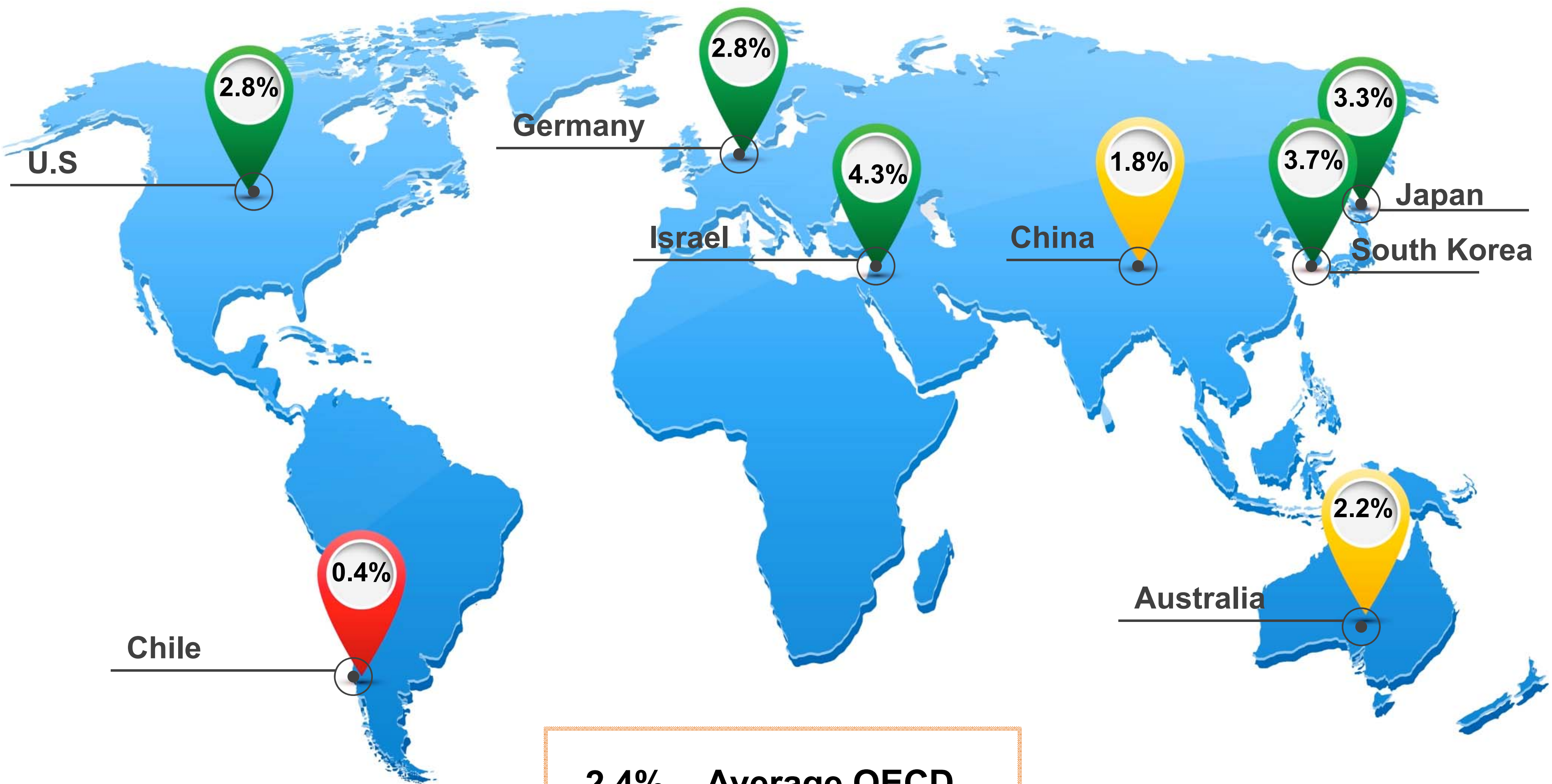
Solow model (only labor):

$$Y = A(1-\gamma_A)L \Rightarrow y = A(1-\gamma_A)$$

Rate of technological progress:

$$\hat{A} = \frac{L_A}{\mu} = \frac{\gamma_A}{\mu}L \xrightarrow{\gamma_A = const.} \hat{y} = \hat{A} = \frac{\gamma_A}{\mu}L$$

Investment in R&D ÷ GDP (%)



2,4% Average OECD

Source: http://stats.oecd.org/ (2010)

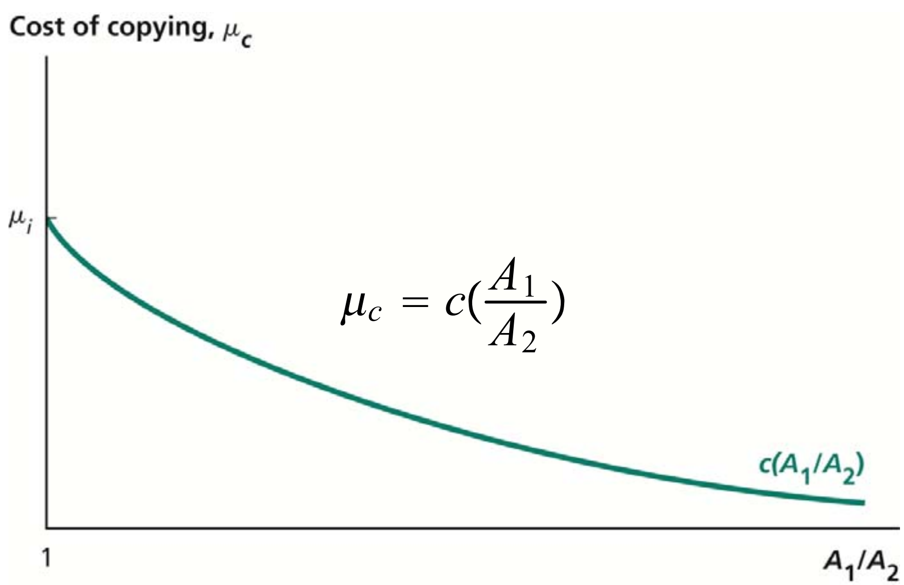
Researchers and research spending

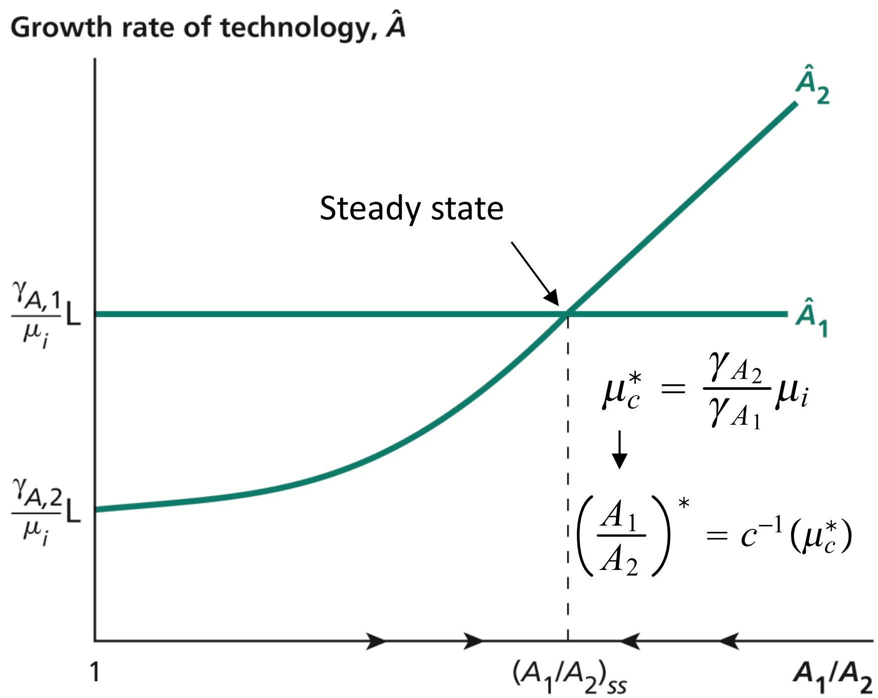
Country	Number of Researchers	Researchers as a Percentage of the Labor Force	Research Spending ($ billions)	Research Spending as a Percentage of GDP
United States	1,412,639	0.89%	398.2	2.8%
Japan	655,530	1.00%	137.9	3.4%
Germany	311,519	0.74%	82.7	2.8%
France	229,130	0.80%	48	2.2%
Korea	236,137	0.96%	43.9	3.3%
OECD Total	4,199,512	0.70%	965.6	2.4%

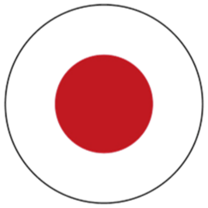
Source: OECD Main Science and Technology Indicators database.

Based on Chilean labor force above 8 million, we should have 50K-80K researchers. We have 1/10th of that!

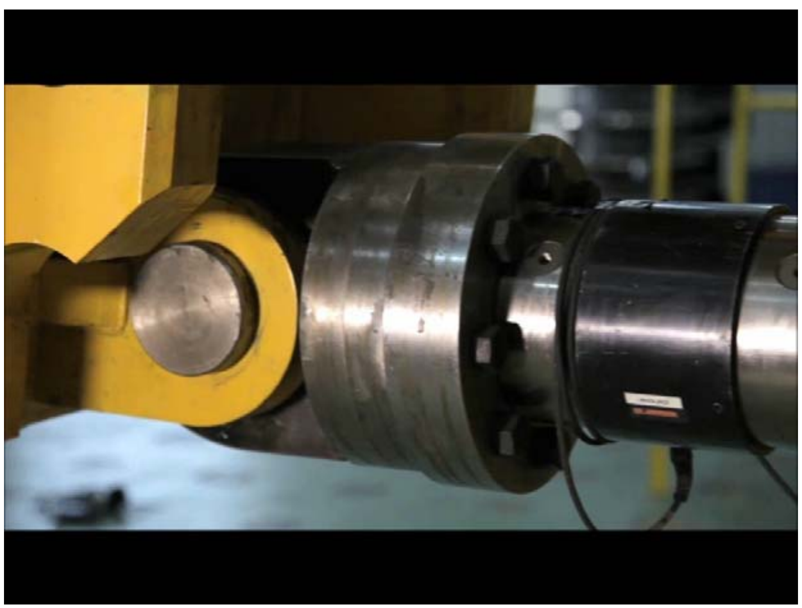
Technology Leader and Follower in Equilibrium

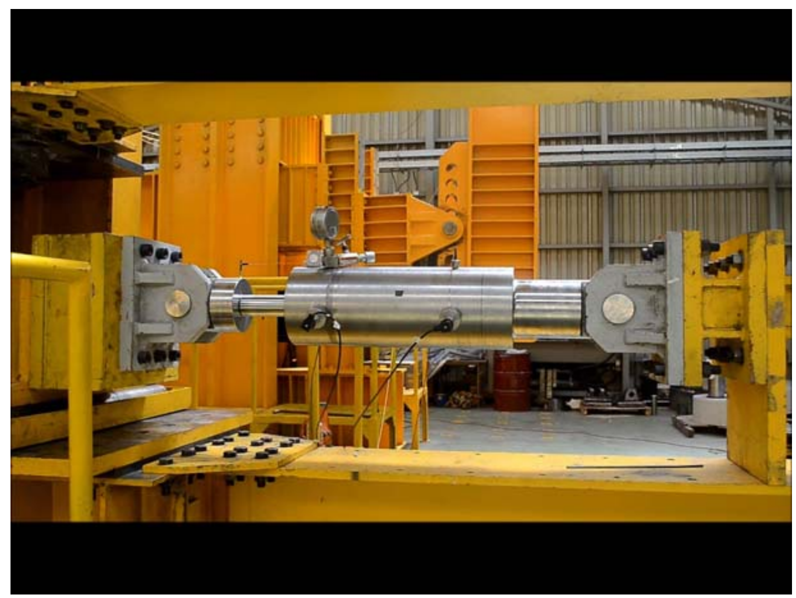







sirve

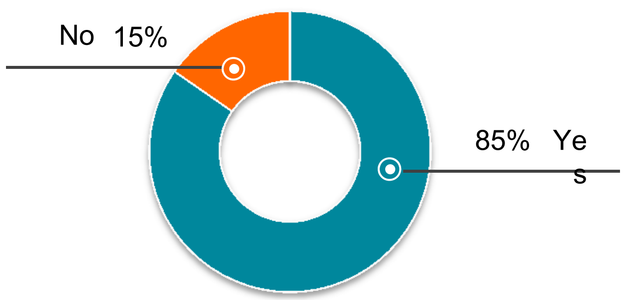




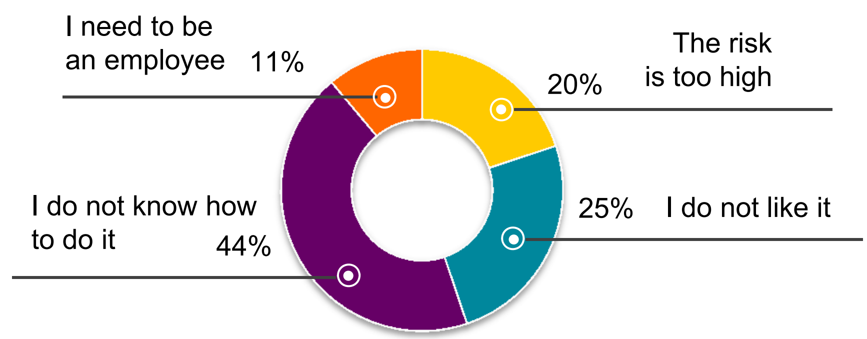
A new culture (values, attitudes, and beliefs)

Entrepreneurship survey – 1540 students surveyed

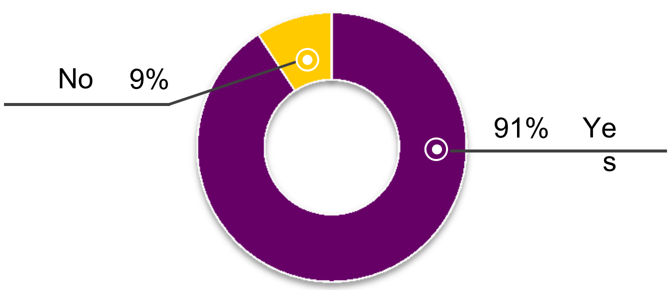
Do you consider entrepreneurship as a real possibility for your future?



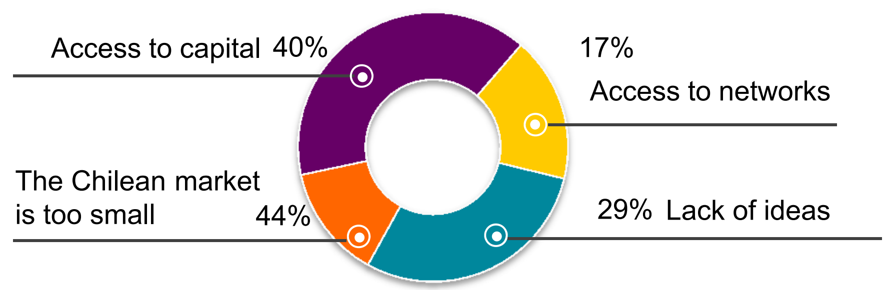
Why not?



Is it possible to succeed in entrepreneurship using Science and Technology?



Main difficulty?



Source: Encuesta Escuela de Ingeniería UC (2013)








Addressing The Skills Challenge

Juan Carlos de la Llera
23.04.2014