The Latin American experience in S&T

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Educational, Scientific and
Cultural Organization

EAST / NORTH AFRICA

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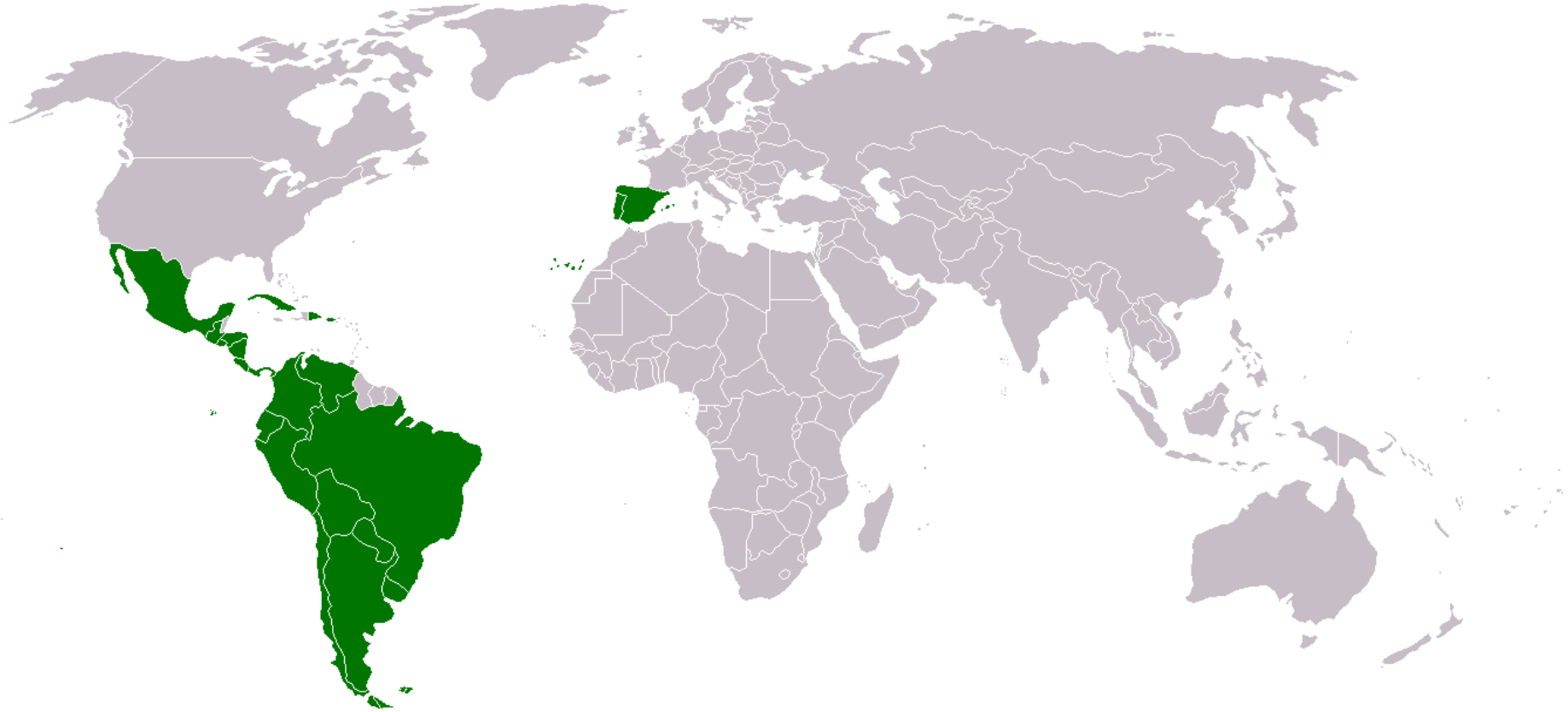
Ibero-America: 21 countries



CUIB = Ibero-American Universities Council

Ibero-American Map of Strengths and Opportunities in Science and Technology

- Introduction
- Methodology
- Example of individual analysis
- Group analysis of R&D in Ibero-American countries
- Summary of the overview
- Conclusions

Introduction

Project Characteristics

❖ Support: CRUE Funding: GOBIERNO DE ESPAÑA · MINISTERIO DE ASUNTOS EXTERIORES Y DE COOPERACIÓN · aecid

❖ Director: Irene Ramos, Ph.D. (IESA-CSIC), Spain

❖ Collaboration requested from the national associations of higher education

❖ Information regarding R&D systems was sent by: 11 countries (of 21)

❖ Participating countries: Argentina, Chile, Colombia, Costa Rica, Dominican Republic, Spain, Guatemala, Mexico, Panama, Paraguay and Venezuela

❖ Part 1: individual analysis of R&D situation - diagnostic and SWOT analysis -

❖ Part 2: exploratory analysis of the group

Goals

General: Instruments to design actions

Foster *Ibero-American* scientific &Technological cooperation

Specific: Map of strengths and opportunities in S&T

Policies, actions and future strategies: *Ibero-American Area of Knowledge*

Activities:

1. Gather & review the literature about the R&D situation in those countries
2. Create an analytical framework adapted *ad hoc* for the application of R&D indicators
3. Collect, contrast and validate the information from each of the countries participating
4. Include the opinions from national experts in R&D
5. Perform an individual analysis of each participating country (quantitative & qualitative data)
6. Realize a joint exploratory analysis (comparative indicators)
7. Draw conclusions: from individual diagnosis and joint analysis

Methodology

A combination of different methodological approaches:

- "Desk research" or analysis of secondary information sources
  - Gathering / selection, organization and subsequent **critical review** of the content
  - Obtained **corpus** basis for the research (scientific contributions & data) (information deficiencies)
  - **Key for the phases of the study**: identification of the most relevant components for S&T development

- Participatory methodology: national associations of HE & opinions of experts
  - **Associations (11)** : contribute to contrasting and validating the study
  - **Experts (31)** : higher quality analysis by including their knowledge about the specifics of each country
    - Government / public administration
    - Scientific and university institutions
    - Positions in management, advisory and evaluation activities in S&T

- Processing quantitative and qualitative data (primary and secondary)
  - Application of quantitative and qualitative **analysis techniques**
  - Provides **an integrated view** of the state of R&D in each country and in Ibero-America as a whole

Table 1. Types of analysis and project sources

	Analysis		Sources	
State of R&D in each participating country	Diagnosis	Quantitative indicators	RICYT Data (and other sources)	
		National system agents	National Assoc. of Higher Education	secondary
		Lines of national policy		
	SWOT		Expert opinions	
Group analysis of R&D in Ibero-American countries	♦ Institutional system ♦ Capacity for R&D ♦ Scientific and technological production		RICYT (reports and data)	secondary

Source: By the author

RICYT= Science and Technology Indicators Network - Ibero-American and Inter-American -

Systematization of individual analysis

1. Diagnosis of state of R&D

a)- Quantitative indicators

Analytical framework: European Commission report (2006) SWOT analysis for Spanish Regions

Adaptation for the project: most suitable indicators (availability and applicability)

Table 2. Individual R&D diagnosis quantitative indicators

Aspects that drive development	
"Knowledge drivers"	Refers to structural elements, especially higher education
"Investment in knowledge"	Refers to investment in R&D activities needed to create a knowledge based economy
"Implication of the private sector"	Refers to R&D efforts by firms and other private agents
Results achieved	
"Applications"	Refers to results in terms of R&D employment
"Intellectual property"	Refers to results achieved in terms of know how

Source: adapted from COM, 2006

b)- Main agents in each national R&D system

Exhaustive listing of the competent authorities + brief description of their general functions

Table 3. Individual R&D diagnosis national system agents

Public Administration
Agencies with R&D competencies
State
Regional
Other
Scientific-Technological Infrastructure
Public Universities
Private Universities
Public Research Centers
Private Research Centers
Public Innovation and Technology Centers
Private Innovation and Technology Centers
Technology Transfer and Innovation Support Infrastructures
Interface Structures
OTTs (Office of Technology Transfer)
Technological Parks
Other

Source: By the author

c)- Main lines of national R&D policy in force in each country

General legislation, regulations for development and strategic plans in this area

2. SWOT Analysis (Strengths, Weaknesses, Opportunities, and Threats)

- Study methodology of competitive status
- Comes from the business domain - applicable to other domains
- Simple tool for decision making
- Help an institution, organization or business find its critical strategic factors
- Once identified, base the organizational changes on them

Strength	S	Favorable position of internal nature.
Weakness	W	Unfavorable position of internal nature.
Opportunity	O	Favorable situation created by the environment.
Threat	T	Unfavorable situation in the environment.

Source: http://www2.uca.es/serv/dafo/DAFOhelp.html

- Base: diagnosis of the main characteristics of each national R&D system

All of the information is brought together:

(quantitative data, description of the system, expert opinions, published literature)

Conditioning factors for the study

- Significant scattering of information and disparity of the quantitative data

Table 4. Ibero-American countries in data bases

	CUIB Project Ibero-America R&D SWOT	RICYT S&T Indicators 2005	CINDA Higher Education 2007	BID Macroeconomic & social indicators	UN Serie 25660 R&D researchers	World Bank Edstats Education at a glance
1	Argentina	X	X	X	X	X
2	Bolivia	X	X	X	X	X
3	Brasil	X	X	X	X	X
4	Chile	X	X	X	X	X
5	Colombia	X	X	X	X	X
6	Costa Rica	X	X	X	X	X
7	Cuba	X	--	--	--	X
8	Ecuador	X	--	X	X	X
9	El Salvador	X	--	X	X	X
10	España	X	X	--	X	--
11	Guatemala	X	--	X	--	X
12	Honduras	X	--	X	X	X
13	México	X	X	X	X	X
14	Nicaragua	X	--	X	X	X
15	Panamá	X	X	X	X	X
16	Paraguay	X	--	X	X	X
17	Perú	X	X	X	X	X
18	Portugal	X	X	--	X	--
19	R. Dominicana	X	X	X	--	X
20	Uruguay	X	X	X	X	X
21	Venezuela	X	X	X	X	X
		21	14	18	18	19

Source: By the author

CUIB: Ibero-American University Council
RICYT: S&T Indicators Network – Ibero-American and Inter-American-
CINDA: Center for Inter-university Development
BID: Inter-American Development Bank
UN: United Nations

Note: Countries included. BUT THERE ARE NEITHER DATA FOR ALL THE COUNTRIES NOR FOR ALL THE YEARS

RICYT (1995): annually

-Basic indicators Frascati Manual

-Patents

2005

Final data gathered and thoroughly checked

- Assure uniformity and do comparison:
  - Deficiencies in some national statistics
  - Different mechanisms for gathering information and doing calculations
  - Surveys or secondary information sources to create their R&D indicators
  - Interruptions in the series in several countries

RICYT: Reliable and perfectly comparable indicators

- Management and participation of R&D experts from each country – at least three –

National Associations HE - advantages:

- Unified management in each country (21)
- Active implication of the national associations in project achievements
- More informed selection -according to knowledge of national reality-
- Greater communication capacity: administrative, professional or personal links and relationships

They were asked to identify the main strong points, weak points and future challenges

Structure of the report

1. *State of R&D in each participating country*
    1.1. Diagnosis:
        1.1.a. Main quantitative indicators
        1.1.b. Main players in the national system
        1.1.c. Main lines of national policy
    1.2. SWOT Analysis:
        1.2.a. Synoptic table
        1.2.b Some keys to its scientific and technological development

2. *Group analysis R&D in Ibero-American countries*
    2.1. Institutional system
    2.2. Capacity for R&D
    2.3. Scientific and technological production

3. *Summary of the overview*

Example of individual analysis

Panama

1.1. Diagnosis of state of R&D

1.1.a. Main quantitative indicators

Table 29. Indicators Panama I

	PANAMA	IB	% / IB	IB = 100	Ranking
2005					
A. Indicators "KNOWLEDGE DRIVERS"					
A.1. Reference					
• Population (millions of inhabitants)	º	585.82	0.55	--	11/11
• Economically Active Population (EAP) (mill. inhab.)	1.40	271.33	0.52	--	10/10
A.2. Higher Education					
• Total graduates (in this year)	17,800	144,1432	1.23	--	5/7
• Total doctors (in this year)	--	21,887	--	--	--
A.3. R&D expense by higher education					
• Funded by higher education (% / R&D expense)	1.44	2.36	--	61.02	6/8
• Run by higher education (% / R&D expense)	8.63	32.03	--	26.94	10/10
B. Indicators "INVESTMENT IN KNOWLEDGE"					
B.1. Reference					
• GDP (billions $)	15.47	3,856.15	0.40	--	10/11
• GDP-purchasing power parity (PPP) (billions $)	24.67	5,952.86	0.41	--	10/11
B.2. General R&D expense					
• R&D expense (mill. $)	38.00	27,759.69	0.14	--	8/10
• R&D expense according to PPP (bill. $)	60.60	38,630.27	0.16	--	8/10
• R&D expense as percentage of GDP (%)	0.25	0.73	--	34.25	6/10
• R&D expense per inhabitant ($)	11.75	48.16	--	24.40	7/10
• R&D expense per inhabitant – PPP ($)	18.75	67.03	--	27.97	6/10
• R&D expense per researcher NP* (thou. $)	74.87	49.31	--	151.83	1/9
• R&D expense per researcher FTE** (thou. $)	--	80.90	--	--	--
• R&D expense per researcher NP – PPP (thou. $)	119.40	68.94	--	173.20	2/9
• R&D expense per researcher FTE – PPP (thou. $)	--	113.10	--	--	--
B.3. Public expense in R&D					
• Funded by Government (% / R&D expense)	38.55	51.57	--	74.75	7/8
• Run by Government (% / R&D expense)	37.13	20.22	--	183.63	3/10
C. Indicators "IMPLICATION OF THE PRIVATE SECTOR"					
C.1. Private expense in R&D					
• Funded by firms (% / R&D expense)	0.42	41.73	--	1.01	6/7
• Funded by PNP*** (% / R&D expense)	0.65	0.79	--	82.28	5/6
• Funded by foreign bodies (% / R&D expense)	58.94	3.56	--	1,655.62	1/5
• Run by firms (% / R&D expense)	--	46.07	--	--	--
• Run by PNP (% / R&D expense)	54.24	1.69	--	3,209.47	1/8

IB RICYT estimation for Ibero-American countries as a group

* NP = Natural persons

** FTE = Full-Time Equivalent (work day)

*** PNP = Private Non-Profit Organizations

Data provided by the Panamanian Council of Chancellors

Source: By the Author based on data from RICYT

Table 30. Indicators Panama II

	PANAMA	IB	% / IB	IB = 100	Ranking
2005					
D. Indicators "APPLICATIONS"					
D.1. Human resources employed in R&D					
• People in science and technology (S&T) activities - NP*	2,959	--	--	--	5/7
• People in science and technology activities – FTE**	--	--	--	--	--
• Researchers NP	507	560,368	0.09	--	9/9
• Researchers FTE	--	341,556	--	--	--
• Researchers NA per thousand members EAP***	0.36	2.10	--	17.16	7/9
• Researchers FTE per thousand members EAP	--	1.28	--	--	--
• Male personnel in S&T activities (%)	63.10	--	--	--	3/10
• Female personnel in S&T activities (%)	36.90	--	--	--	8/10
• Research doctors in S&T activities (%)	3.66	--	--	--	5/5
E. Indicators "INTELLECTUAL PROPERTY"					
E.1. Patents					
• Total patents applied for by residents	24	16,609	0.14	--	9/10
• Total patents granted to residents	13	6,467	0.20	--	5/10
• Dependence ratio (^)	15,80	79,98	5.93	--	7/10
• Invention coefficient (#)	0.74	2.84	26.10	--	6/10
E.2. Scientific Production					
• Publications in SciSearch	180	76.822	0.23	--	8/11
• Publications in SciSearch for each thousand inhabitants	5.57	13.11	--	42.47	6/11
• Publications in SciSearch / GDP (each bill. $)	11.64	19.92	--	58.43	5/11
• Publications in SciSearch / R&D expense (each bill. $)	4.74	2.77	--	171.28	4/7
• Publications in SciSearch / NP (each 100 researchers)	35.50	22.49	--	157.84	1/8
• Publications in SciSearch / FTE (each 100 researchers)	--	13.71	--	--	--

Source: By the Author based on data from RICYT

IB RICYT estimation for Ibero-American countries as a group

* NP = Natural persons

** FTE = Full-Time Equivalent (work day)

*** EAP = Economically Active Population

(^) Applied for by non-residents / applied for by residents

(#) Applied for by residents for each one hundred thousand inhabitants

Data provided by the Panamanian Council of Chancellors

1.1.b. Main agents in the national system

Public Administration: agencies with R&D competencies
State
Regional
Other

Scientific-Technological Infrastructure (public and private)
Universities
Research Centers
Innovation and Technology Centers

Technology Transfer and Innovation Support Infrastructures
Interface Structures
OTTS (Offices of Technology Transfer)
Science / Technological Parks
Others

Info collected:

- Year they were created
- RoI in the system
- Interrelations
- Functions
- Important achievements
- Website
- Charts

Largely vary from one country to another

1.1.c. Main lines of national policy

- General legislation

▪ Law 13 of April, 15, 1997 (modified by law 50 of December 21, 2005)

Establishes instruments for the development of science, technology and innovation. Creates the National Secretary of Science, Technology and Innovation (SENACYT) as an autonomous institution and announces other previsions.

▪ Law number 56 of December 14, 2007

Creates the National Research System and establishes incentives for research and scientific and technological development.

- R&D Plans

▪ National Strategic Plan for the Development of Science, Technology and Innovation 2006-2010

Is made up of two important elements:

1. Specific and sectorial support actions to establish lines of basic applied scientific research, which generate and transfer technology.
2. Actions aimed at strengthening the generation and transfer of technology, ongoing training of human resources and stimuli for the innovation process.

2. SWOT analysis for Panama

2.a. Synoptic table

Table 31. SWOT in R&D in Panama

Weaknesses	Strengths
• Insufficient development of institutional science and technology system. Specialized organisms, which contribute to efficient coordination and management, are lacking • Weak infrastructures (for example laboratories) and also in high technology in areas such as biotechnology, genomics, proteonics, biocomputing, etc. • Scarce funding/investment in R&D activities. Need greater amounts and more efficient process. • Lack of critical mass of researchers, especially in some scientific fields of the country. Difficulty for teachers to do researcher. Incentives and jobs for quality HR lacking. Very few female personnel in science and technology activities. • Low activity in R&D in general. • Little implication of business sector in RD&I. Scarce private business investment in this area. Weak university-firm links. Absence of interface structures. • Deficient generation and application of patents. Scarce information and weak general culture by professionals with regard to the patent system and its advantages. • Insufficient scientific production.	• Efforts by Panama's institutions to favor transversal and inter-sectorial links. • Centralized system in SENACYT with regard to management of national funding. Selective resource assignment mechanism based on merit and with expert participation. • Strong communications, internet and logistics infrastructures. • Important effort in R&D expense in relation to the number of researchers. • Notable participation in funding R&D expense by foreign organisms. High implication of non-profit organizations in the executing R&D expenditures. • Awareness, recognition and acceptance of the need for greater technological innovation activity as a driver of development with more business participation in R&D and better university-firm relationships.
Threats	**Opportunities**
common: • Environment of world economic crisis and budget cuts. Global context. • High international competition – general and regional-. • Acceleration of competition from emerging countries (Eastern Europe and Asia). • Insufficient capacity to assimilate highly qualified human capital which returns from abroad. Do not achieve a balance between the training of scientific personnel and the ability to give them employment when it is available. No competitive salaries. Risk of brain drain. • Lack of alignment between international growth trends and own internal needs. • Isolation and inability to access international circles and to cause an impact due to the real difficulties and the lack of high technology equipment in some fields (for example Environmental Engineering).	• Achieve the incorporation of R&D investment by foreign firms in line with the scientific-technological internal capacity. • Take advantage of the strategic geographical situation to attract investment in infrastructures and technologies. • Tend towards meeting international quality standards. • Increase visibility of national science in forums and international scientific publications. • Presence of universities and research centers with foreign participation (example Smithsonian Institute of Tropical Research) attracts visiting scientists and that facilitates exchange. Creation of intra- and inter-institutional networks. • Few limitation for international researchers to access national R&D funds.

Source: By the author based on national expert opinions and diverse secondary sources

2.b. Some keys to scientific and technological development

► Institutionalization of science and technology

Its institutional system **has not reached an optimal level of development**
Specialized agencies are missing (evaluation, interface structures)
Consolidation of the R&D system **beyond changes in the government is needed** (expert Pan-1)

► Limitations in R&D capacity

- Insufficient investment in R&D / Lack of financial support
- Limited no. of Ph.D.s
- Limited social legitimacy of science / Lack of an incentive system for researchers
- Weak links university-industry
- Little capacity for innovation
- Insufficient research infrastructures
- Reduced capacity of the national education system to foster S&T capacity
- Infrequent access of scientists to other activities

Advances, but Panama must intensify **efforts** to increase and strengthen R&D capacity
National Strategic Science, Technology and Innovation Plan 2006-2010 could be a useful tool in this sense

► Possibilities in the international context

Strategic geographical position of Panama: interest (e.g. biodiversity). **Wide range of possibilities to obtain returns**:

- Incorporation of R&D investment from foreign companies to the internal S&T capacities
- Creation of intra- and inter-institutional international networks

Bring more vitality and prominence to the system:

- Promote an increase in productive exchanges
- Visibility of national science in forums and publications with a wider audience
- Integration of high technology in its business sector

Group analysis of R&D in Ibero-American countries

INSTITUTIONAL SYSTEM

▪ In **Latin America** (≠ the industrialized countries) the **design of science policy** was done by imitation
1st institutions for the promotion of science (late 50s): not a large lag -NSF 1950- (Albornoz, 1999)
Large difference: there was no social demand – exclusive role and relative isolation of the scientific community

▪ **Institutionalization of science policy**: in most of the **Latin American countries** from the mid-70s
- UNESCO Model: a National Science and Technology Council
  Competencies for planning, direction and coordination as well as distribution and management of funding
- OAS Model (Central American countries): within a "planning" ministry, a directorate for science and technology
  Option more closely connected to a vision of fostering R&D linked to development programs

▪ **Evolution of the institutionalization of science policy**:
- 70s and 80s: *supply* model for financing the spontaneous demand of the scientific community (Sebastián, 2007)
- 90s: A national system of *innovation* as a priority
  Tendencies for approaches based on *demand* and a prominent role for businesses

They adopt "without criteria models that require preconditions and economic and cultural environments that do not always exist in **Latin American countries**" (Sebastián 2006: 51)

▪ **Research and innovation not a priority in the political agendas of the Latin American countries:**
Persistence of structural issues:
- ♦ Reduced number of researchers and major concentration in universities (Vessuri, 2007)
- ♦ Gender inequality in the Latin American scientific community (Zubieta, 2007)
- ♦ Influence of the IDB: loans, science policy focus and R&D promotional instruments (Sebastián, 2007)

"*The **rhetorical nature** that science policy had (and has) in Latin American, and the isolation of the academic community in relation to other social actors, are a reflection, more than the cause, of the **lack of policies** capable of helping science make a tangible contribution to the achievement of economic and social goals*"

(Albornoz, 1999: 7)

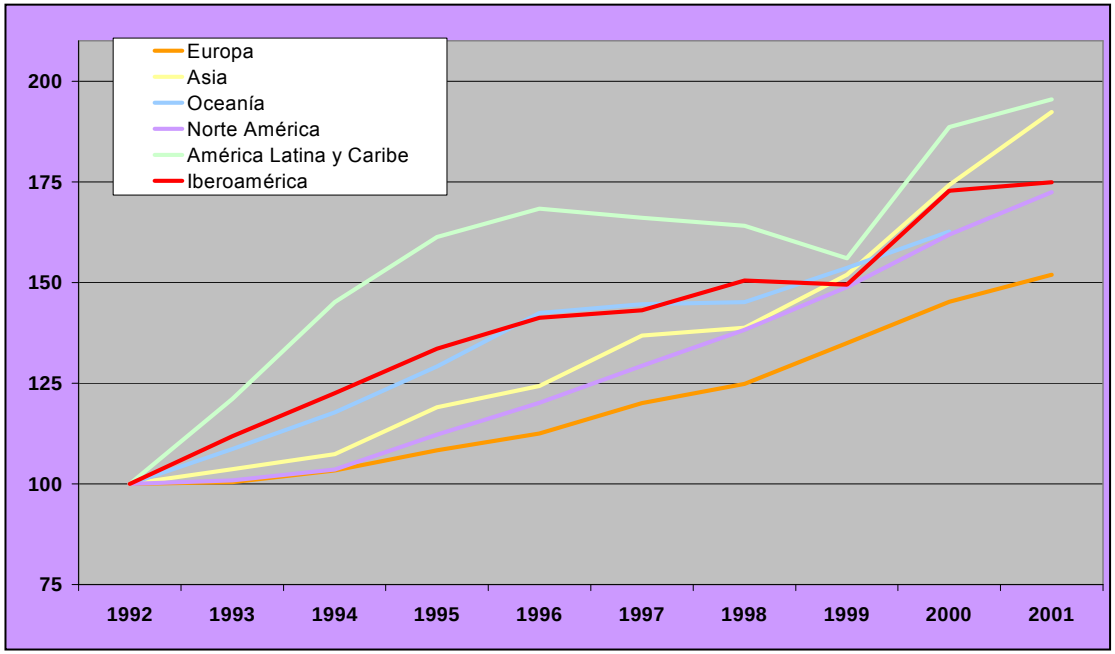
CAPACITY FOR R&D

Expenditure in R&D

- Low level of R&D investment compared to countries with greater relative development
- Cause of the problems & consequences of structural configuration of countries in the region
- Needed conditions for launch of science, technology and innovation in Ibero-American countries

(RICYT, 2007)

Graph 6. Evolution of expenditure in R&D by regions in the world 1992-2001



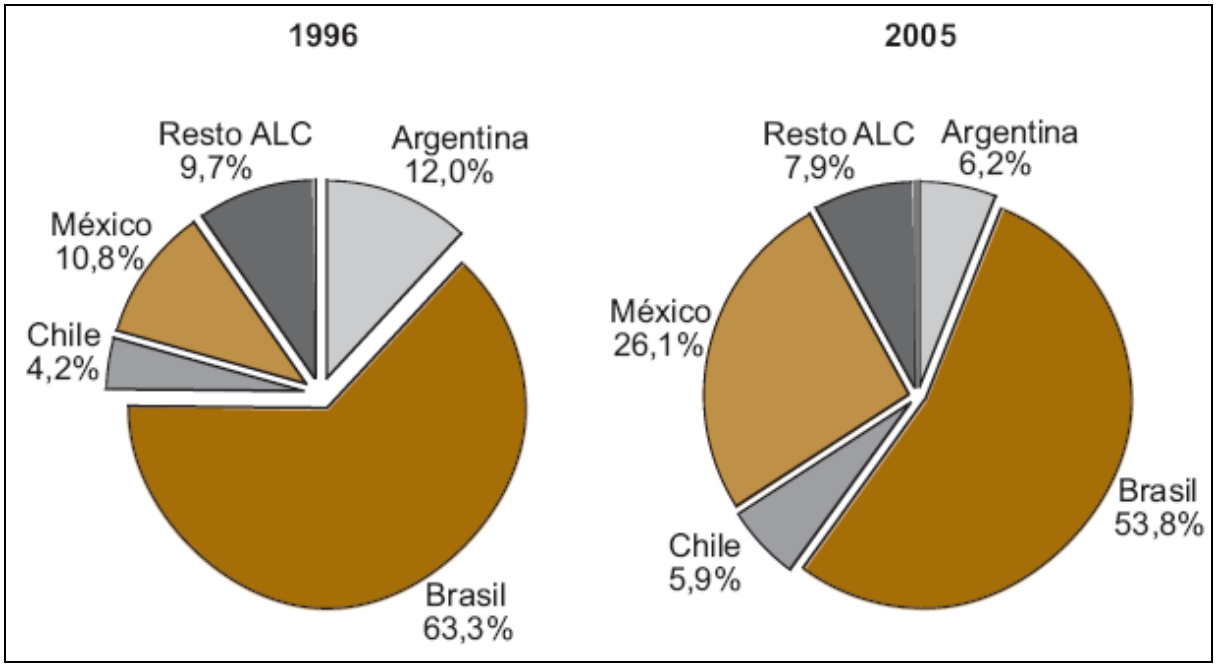
Source: RICYT

In current dollars (base 1992=100)

Comparative evolution of R&D expenditure 1996-2005 for main countries in the region

México: the greatest growth

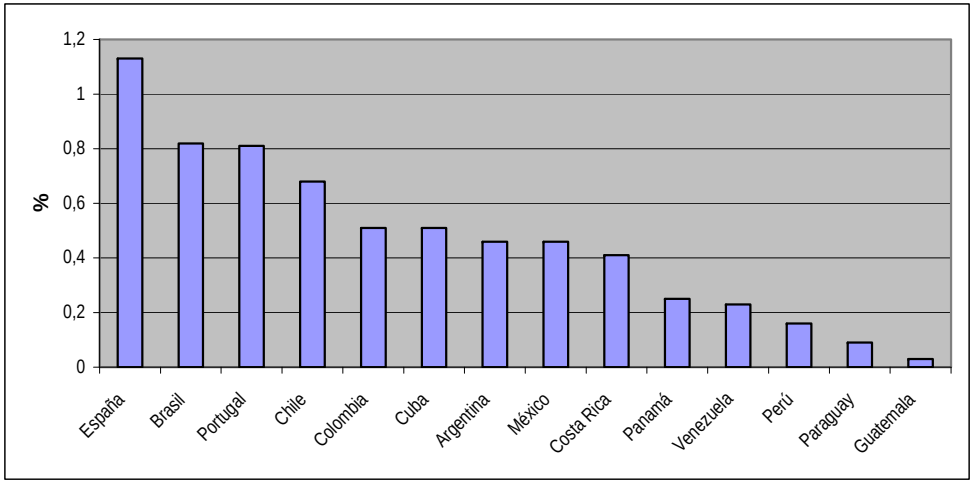
Graph 8. Distribution of the R&D expenditure in Latin America and the Caribbean 1996 and 2005



Source: Estado de la Ciencia, RICYT, 2007: 14

In current dollars

Graph 9. R&D expenditure / GDP in Ibero-American countries 2005

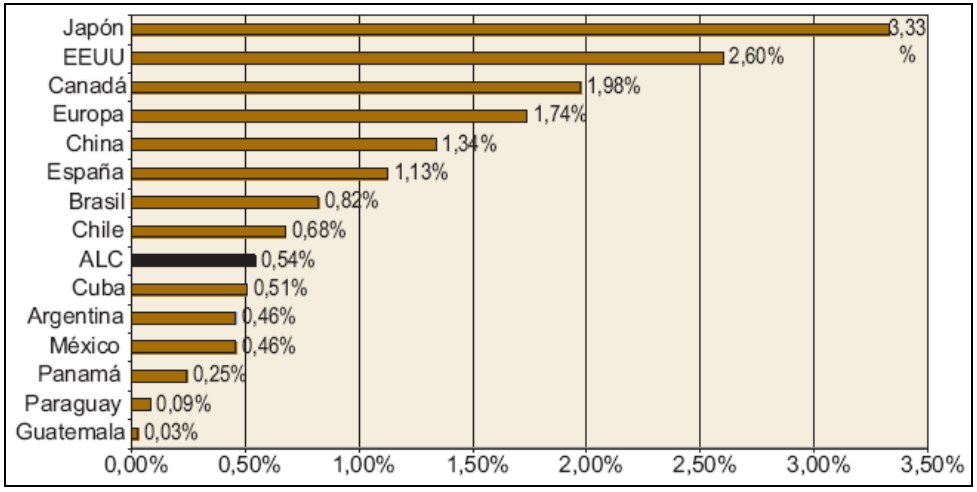


Source: By the author with RICYT data

Colombia and Venezuela: S&T activities

Chile, Costa Rica and Peru: Data from 2004

Graph 10. Percentage of R&D expenditure / GDP 2005



Source: Estado de la Ciencia, RICYT, 2007: 14

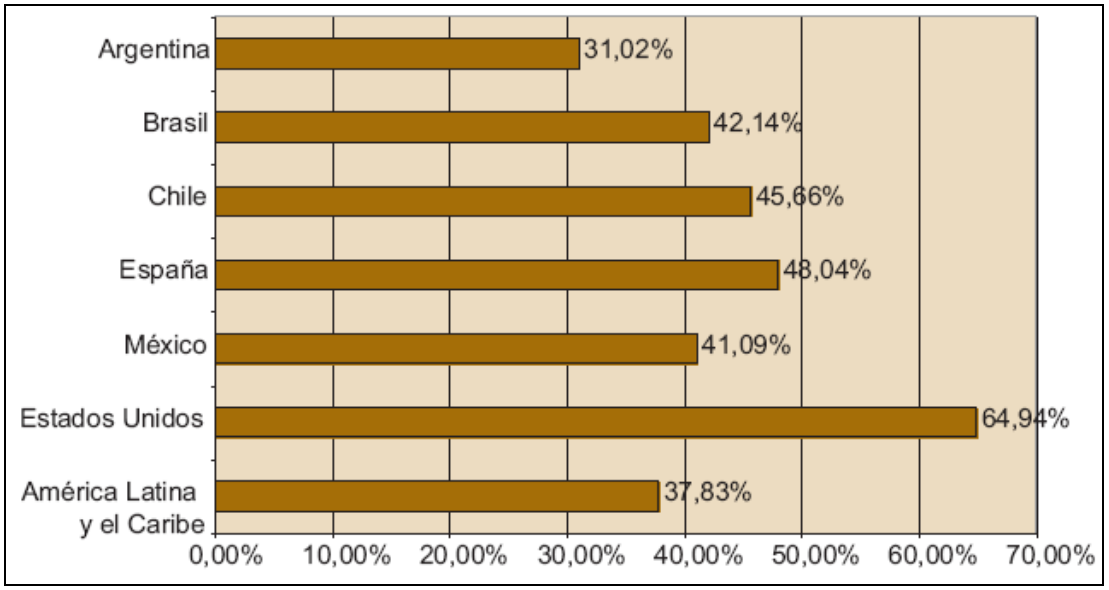
Chile: Data from 2004

Spain: 1.40% of GDP in 2007

Venezuela: 2.11% of GDP in 2007

(Mandatory economic contribution by private companies to science, technology and innovation activities)

Graph 11. Percentage of R&D expenditure funded by firms 2005



Source: Estado de la Ciencia, RICYT, 2007: 16

Spain and Chile: Data from 2004

Human resources in R&D

General growth in the 90s

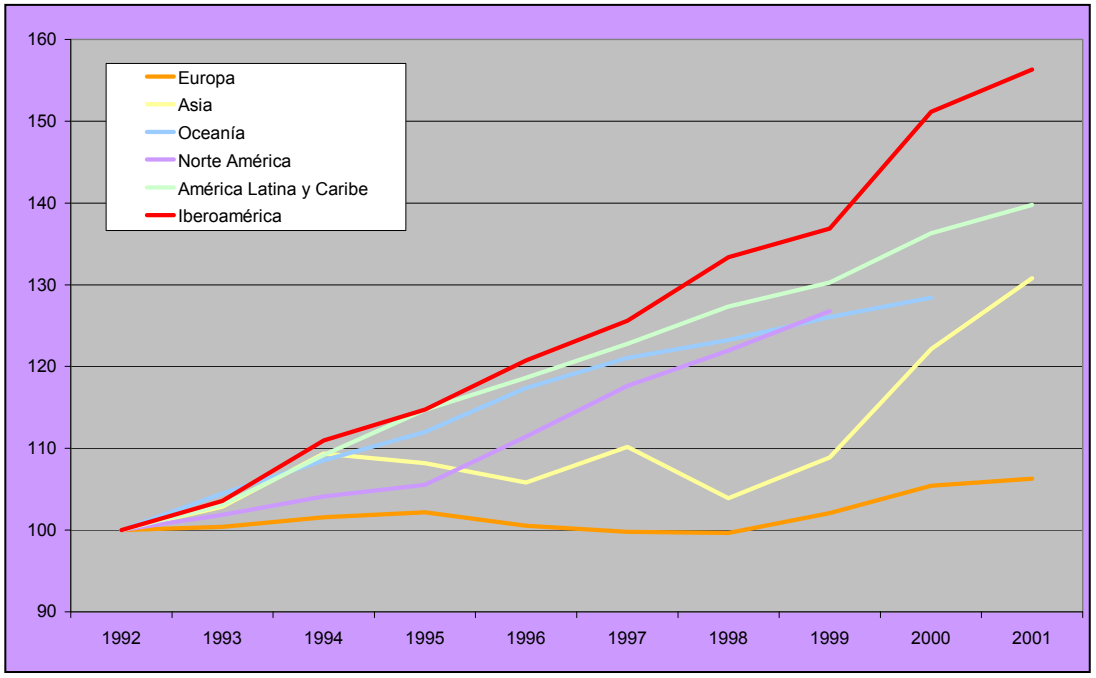
Sustainable increase until 2005

Ibero-American differences less pronounced

Region of the world with greatest increase

Policies to strengthen R&D human resources

Graph 12. Evolution of number of researchers by regions in the world 1992-2001



Source: RICYT

Base 1992=100

Evolution of researchers & technologists FTE

General growth period 1996-2005

Mexico: the most prominent

Spain: 2nd place

Argentina: economic crisis 2001-2002

Brazil: slight increase, but 50% LAC

Higher Education is the sector that has the most R&D human resources in LAC

Its relative weight has been falling (10 percentage points)

The number of researchers and technologists absorbed by business has increased

(16% in 1996 has doubled to 32% in 2005)

By areas of knowledge:

- Positive tendency increase in graduates in engineering and technology
- Notable increase in **social sciences**: future threat (does not coincide with the production conditions)

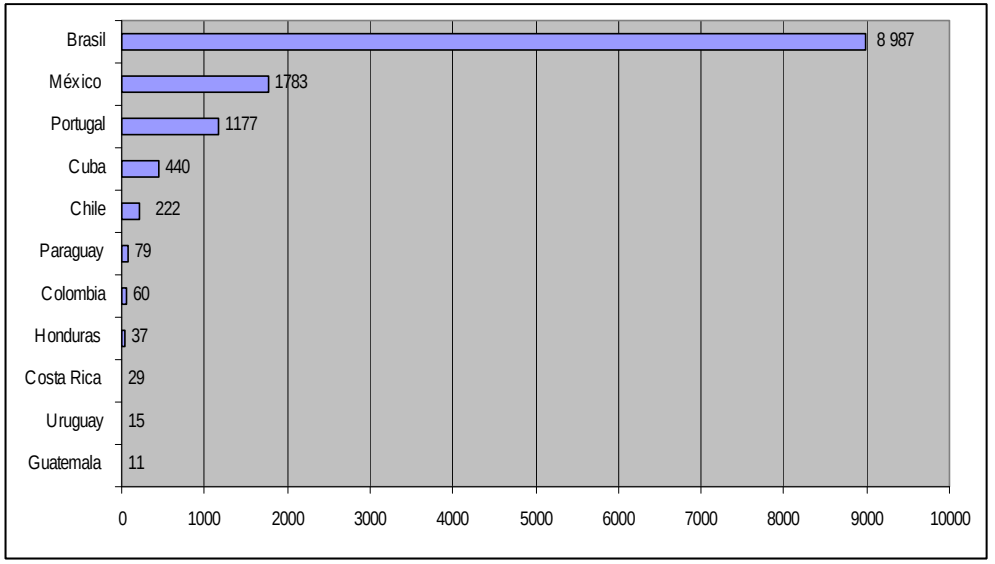
Clear weakness:

- Low number of **Ph.Ds**: needed to increase the No. of researchers and technologists (**critical mass**)
- One exception: **Brazil**
- Increase 1996-2005, but does not resolve general shortage: absolute number still insufficient
- Plausible explanation: tradition and historic evolution
- Late start on standardization of university systems following the prevailing international trends
- **Dependence on foreign doctorate training**

Absorbing researchers:

- Most work at universities and PROs
- A small **minority in companies**
- This asymmetry complicates:
  - Demand from productive sectors
  - Links and cooperation

Graph 14. Number of Ph.D.s in 2005



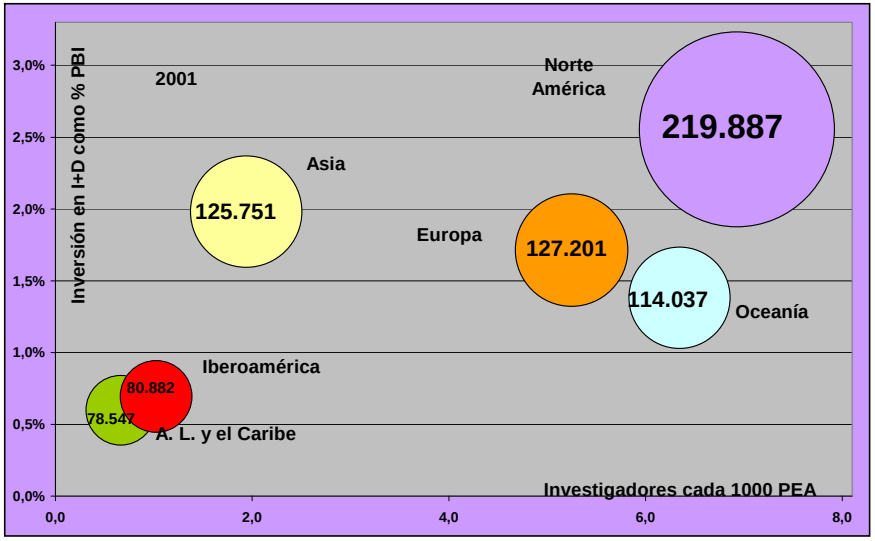
Source: By the author with RICYT data

R&D Expenditure / researcher ratio

Europe, Asia and North America: sustained growth since 1994

Ibero-America: important highs and lows, no recovery after 1996

Graph 16. Gaps R&D expenditure / researcher 2001



source: RICYT

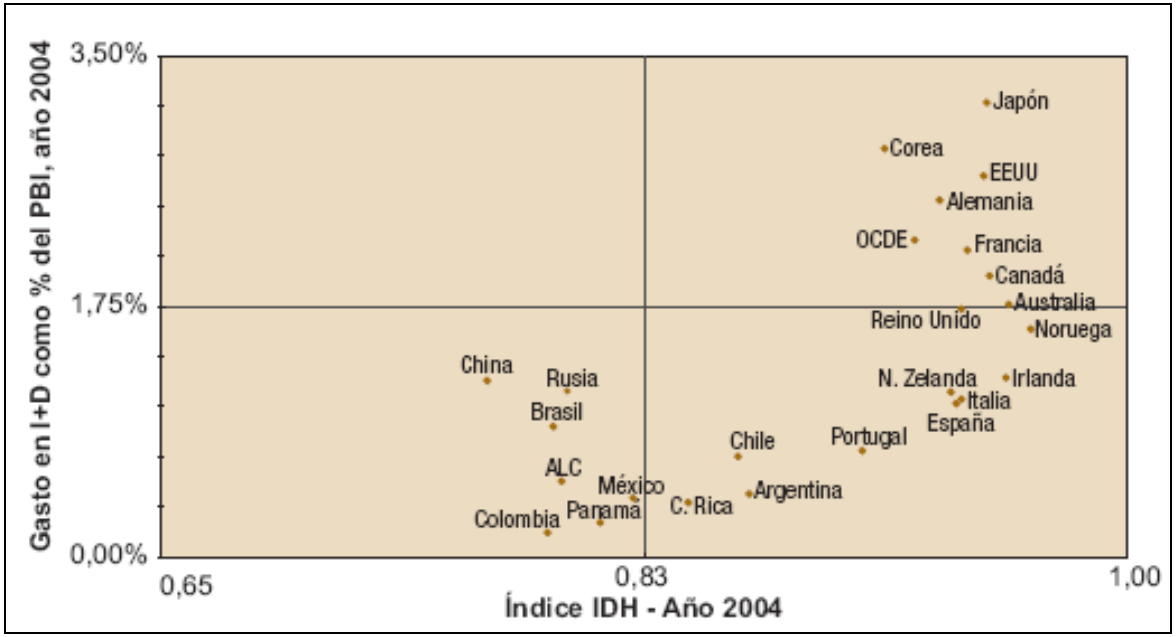
PEA= Economically Active Population

World regional gaps:

- North America stands out above the other regions
- Europe and Oceania same trends but lower levels
- Asia - high expense with low proportion of researchers/EAP
- Ibero-America and LAC **both components very small**: negative

relative capacity of each country for research: notable diversity

Graph 17. Relation between RD&D expenditure (%GDP) and human development index (IDH) 2004



Source: Estado de la Ciencia, RICYT, 2007: 16

1. Positive balance: most developed countries (Japan, Korea, United States, Germany and members of the OCDE stand out): high investment in R&D and high level in the human development index.

2. High expenditure in R&D and low HDI: no country has this profile - inherent contradiction this combination represents.

3. High HDI and low expenditure in R&D: several European countries -United Kingdom, Norway, Ireland, Italy-. and New Zealand. The Ibero-Americans in less favorable positions (in order): Spain, Portugal, Chile, Argentina and Costa Rica.

4. Unfavorable balance: both variables have relatively low values. We can find China, Russia, LAC and several Ibero-American countries: Brazil, México, Panama y Colombia.

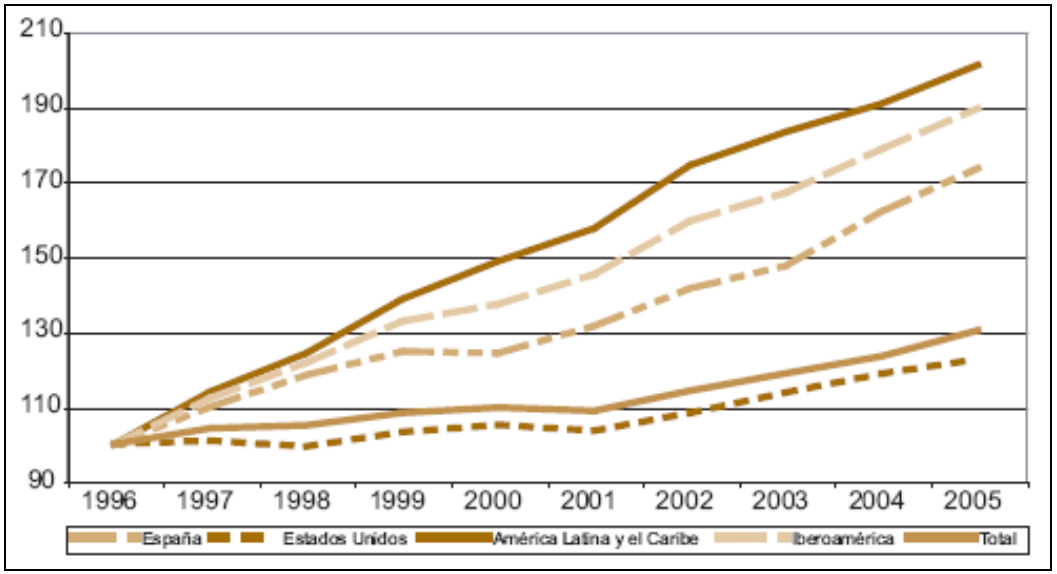
SCIENTIFIC AND TECHNOLOGICAL PRODUCTION

Scientific Production

Limitations for measuring the social impact of research

International comparability

Graph 18. Evolution in Science Citation Index Publications 1996-2005



Source: Estado de la Ciencia, RICYT, 2007: 22

Base 1996=100

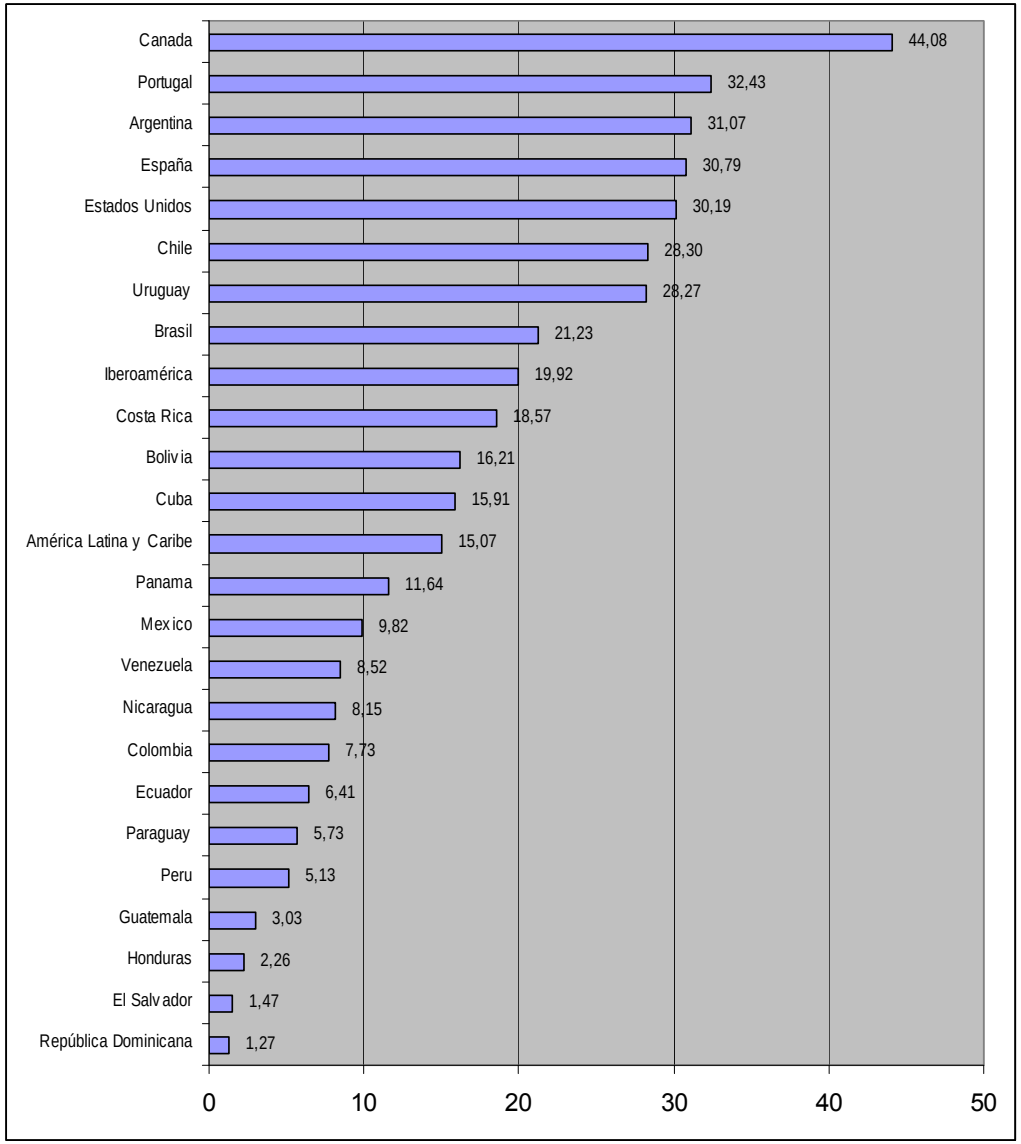
LAC doubled its SCI 1996-2005

The characteristics of Latin America:

- concentration at universities
- incentives for research

mean that **results are directed at publications**

Graph 19. Science Citation Index Publications / GDP 2005



Source: By the author with RICYT data

Each billion $

Eleven countries do not reach 10 publications for each USD1bn of GDP (in descending order: Mexico, Venezuela, Nicaragua, Colombia, Ecuador, Paraguay, Peru, Guatemala, Honduras, El Salvador, and in last place, Dominican Republic)

Table 40. Science Citation Index Scientific production in Latin America by countries 2002

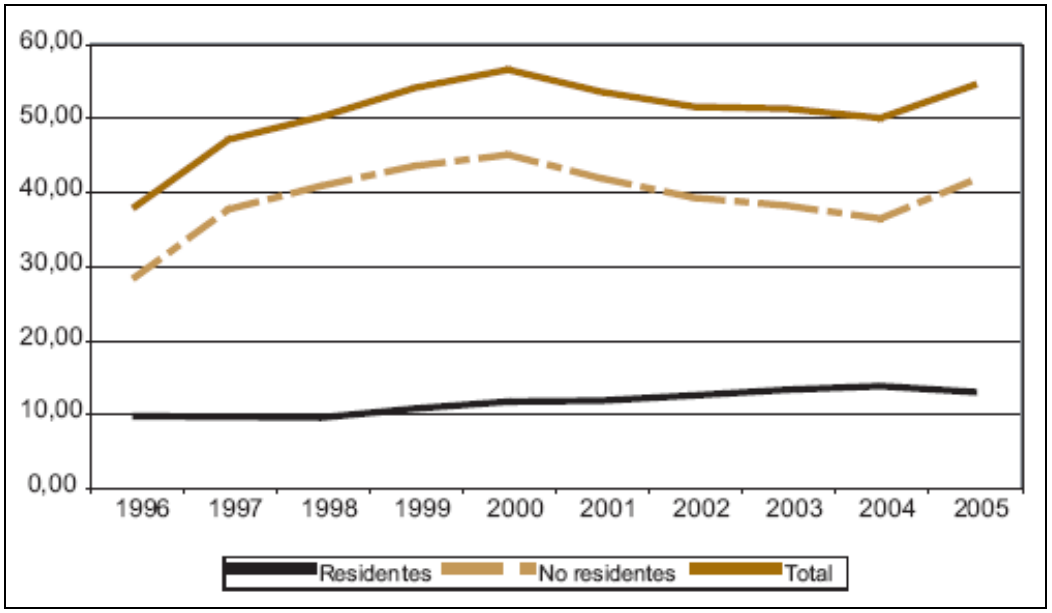
% Publicaciones de América Latina en la base de datos SCI en 2002									
Brasil	México	Argentina	Chile	Venezuela	Colombia	Cuba	Uruguay	Perú	Resto 10 países
46,0	17,4	16,2	7,7	3,5	2,4	1,8	1,1	1,0	2,7

Source: Sebastián, 2006: 56

80%

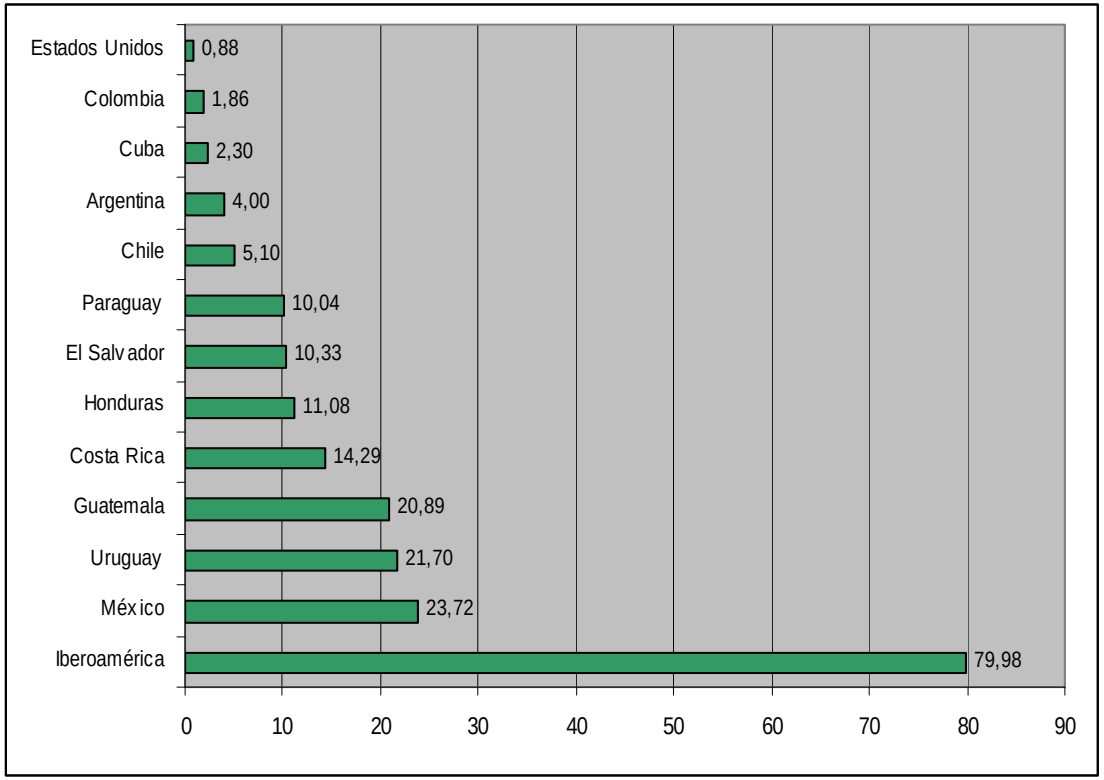
Technological production

Graph 21. Evolution of applied patents in Latin America and the Caribbean 1996-2005



Source: Estado de la Ciencia, RICYT, 2007: 22

Graph 23. Dependence ratio 2005



Source: By the author with RICYT data

patents applied for by no residents /applied for by residents

Table 41. Invention Coefficient 2005

Guatemala	0,14
Honduras	0,18
Colombia	0,22
Paraguay	0,41
El Salvador	0,48
México	0,56
Cuba	0,65
Uruguay	0,82
Costa Rica	0,88
Argentina	2,79
Chile	3,52
Iberoamérica	2,84
Estados Unidos	70,11

Source: By the author with RICYTdata

Patents applied for by residents by each 100.000 inhabitants

Summary of the overview

- *Low political priority for R&D*
- *Weak institutional framework*
- *Scarcity of well trained researchers*
- *Concentration of research in universities*
- *Scarce participation by business*
- *High foreign dependence: technology and funding*
- *Very weak link and cooperation university-firms*

Summary of the overview

1. Low political priority for R&D

- Initiatives depend on isolated willingness and **impulses** / on varying political and economic situations
- Science policy **ups and downs**:

  in detriment of coherent, cohesive, goal oriented advances and have a cumulative effect
- Low public investment, lack of mid & long-term planning and insufficient policy and instrument implementation
- **Rhetoric**: stimulus of R&D as basis for economic and social growth
- Political and economic agenda (most countries) have not included R&D as an explicit development strategy
- Cuba: successful policies in biomedicine and biotechnology / Brazil: development last 10 years

2. Weak institutional framework

- More sophisticated institutional structure, does not always reach suitable level of configuration

  (extensive, diversified, organized)
- On occasions is **fragile, fragmented and suffer from lack of coordination**
- Good correlation between achieved institutional consolidation and degree of scientific development
- **More institutional strengthening needed**: organization, interactions, managers (bottleneck)

3. Scarcity of well trained researchers

- Lacking researchers / varying qualifications
- Serious **need for Ph.D.s**: doctoral education does not exist, minimum or concentrated in science areas
- Foreign dependence: exchange opportunities - agreements with universities - positive synergies
- Increase the national capacity for training qualified personnel, diversify what is offered and improve quality

4. Concentration of research in universities

- Comprise a large part of the infrastructures and research capability (40% of the resources)
- **Massive concentration**:
  structural problem if there is not a balanced development of other research institutions
- Upsurge of private universities: efforts to correct the asymmetry
- **Offset the excessive research concentration in universities in favor or a more balanced growth**

5. Scarce participation by business

- Participation of the productive sector, both in funding and performing R&D activities is **extremely low** (differential criteria)
- Some passivity and lack of interest in national firms to get truly involved in these types of activities
- Associated with **the productive structure**: implementation of macro and microeconomic polices, stimulus, business culture

6. High foreign dependence: technology and funding

A. - Very high dependence ratio / very small invention coefficient (**patents**)

- Negative technology balance of payments
- On occasion **not good assimilation and transformation of imported technology**
- Consequences for endogenous technological development demand (in line with the economic model)

B. **Sources of R&D funding come from loans and donations from international institutions**

In exchange, certain conditions and a specific view on how to distribute and employ the funds is imposed

Negotiation capacity to make them suitable for national objectives (rigidity of international organizations)

7. Very weak link and cooperation university-firms

Some advances in this linkage, but also **barriers** to is extension and generalization (Sutz, 2007)

- Weak demand and low absorption capacity of the productive sector
- Interface structures are missing: creation of professional training units for specialized personnel
- No favorable conditions: weak culture of innovation both in the public and private domain
- Governmental stimulus: scarce and poorly focused (businesses concerned: access to financial benefits)
- Low presence of researchers in firms

↓

- Possible **agencies, proposals and initiatives**: increase business responsiveness (rationality, funds, evaluation)
- Encourage **entrepreneurial culture** in young people

8. Persistence of poverty levels and social exclusion

- Extreme conditioning factor when making economic efforts needed for science policy
- Inter- and intra-regional cooperation: integration framework in R&D
- Social impact of scientific and technological development: **necessary condition for social cohesion**

Conclusions

Diversity among countries

- Political discourse: capacity in S&T -and innovation- to operate in the world economy
- Enormous differences in social, economic, cultural and demographic structures: S&T development
- Influence of political and economic situation

- Spain and Portugal in the EU: differentiating characteristics
- Among Latin Americans: Brazil with almost half of investment in R&D and num. of researchers
- A few specific performances stand out comparatively: Mexico, Chile, Argentina, Costa Rica or Cuba

Enormous accumulated delay: efforts to increase R&D capacity always seem insufficient
Required: political will, good planning, rational use of resources, take advantage of potentialities and opportunities

General deficiencies in the individual SWOT analysis
Differences lie in the degree of intensity and existing room for improvement, which vary significantly from one case to the other

Most significant characteristics of R&D in the Ibero-American countries as a group
Pre-existing features are confirmed through individual and collective analysis and linking different sources

Clear view of the existing complexity for R&D in the Ibero-American countries
Comparative aspects: needed to capture idiosyncrasies and point out main challenges

Ibero-American Area of Knowledge
Strong political decision, suitable financial backing, set of common action lines, cooperation instruments

Thank you

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