The Latin American experience in S&T

Irene Ramos

EAST / NORTH AFRICA

Regional Science, Technology and Policy Reviews Workshop
Mombasa, Kenya, April 2, 2009
Ibero-America: 21 countries
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:
- Director: Irene Ramos, Ph.D. (IESA-CSIC), Spain © 2008
- 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

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>State of R&amp;D in each participating country</strong></td>
<td>RICYT Data (and other sources)</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Quantitative indicators</td>
</tr>
<tr>
<td></td>
<td>National system agents</td>
</tr>
<tr>
<td></td>
<td>Lines of national policy</td>
</tr>
<tr>
<td>SWOT</td>
<td>National Assoc. of Higher Education secondary</td>
</tr>
<tr>
<td><strong>Group analysis of R&amp;D in Ibero-American countries</strong></td>
<td>RICYT (reports and data) secondary</td>
</tr>
<tr>
<td>♦ Institutional system</td>
<td></td>
</tr>
<tr>
<td>♦ Capacity for R&amp;D</td>
<td></td>
</tr>
<tr>
<td>♦ Scientific and technological production</td>
<td></td>
</tr>
</tbody>
</table>
Systematization of individual analysis

1. Diagnosis of state of R&D

   a)- Quantitative indicators


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

<table>
<thead>
<tr>
<th>Aspects that drive development</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Knowledge drivers”</td>
<td>Refers to structural elements, especially higher education</td>
</tr>
<tr>
<td>“Investment in knowledge”</td>
<td>Refers to investment in R&amp;D activities needed to create a knowledge based economy</td>
</tr>
<tr>
<td>“Implication of the private sector”</td>
<td>Refers to R&amp;D efforts by firms and other private agents</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Applications”</td>
</tr>
<tr>
<td>&quot;Intellectual property&quot;</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Public Administration</th>
<th>Agencies with R&amp;D competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>State</td>
</tr>
<tr>
<td></td>
<td>Regional</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scientific-Technological Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Universities</td>
</tr>
<tr>
<td>Private Universities</td>
</tr>
<tr>
<td>Public Research Centers</td>
</tr>
<tr>
<td>Private Research Centers</td>
</tr>
<tr>
<td>Public Innovation and Technology Centers</td>
</tr>
<tr>
<td>Private Innovation and Technology Centers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology Transfer and Innovation Support Infrastructures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Structures</td>
</tr>
<tr>
<td>OTTs (Office of Technology Transfer)</td>
</tr>
<tr>
<td>Technological Parks</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Strength</th>
<th>S</th>
<th>Favorable position of internal nature.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weakness</td>
<td>W</td>
<td>Unfavorable position of internal nature.</td>
</tr>
<tr>
<td>Opportunity</td>
<td>O</td>
<td>Favorable situation created by the environment.</td>
</tr>
<tr>
<td>Threat</td>
<td>T</td>
<td>Unfavorable situation in the environment.</td>
</tr>
</tbody>
</table>

Source: [http://www2.uca.es/servidafo/DAFOhelp.html](http://www2.uca.es/servidafo/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

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

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

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
Panama

1.1. Diagnosis of state of R&D

1.1.a. Main quantitative indicators

<table>
<thead>
<tr>
<th>A. Indicators &quot;KNOWLEDGE DRIVERS&quot;</th>
<th>2005</th>
<th>PANAMA</th>
<th>% / IB</th>
<th>IB = 100</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A.1. Reference</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Population (millions of inhabitants)</td>
<td>*</td>
<td>585.82</td>
<td>0.55</td>
<td>--</td>
<td>11/11</td>
</tr>
<tr>
<td>• Economically Active Population (EAP) (mill. inhab.)</td>
<td>1.40</td>
<td>271.33</td>
<td>0.52</td>
<td>--</td>
<td>10/10</td>
</tr>
<tr>
<td><strong>A.2. Higher Education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Total graduates (in this year)</td>
<td>17,800</td>
<td>144,143</td>
<td>1.23</td>
<td>--</td>
<td>5/7</td>
</tr>
<tr>
<td>• Total doctors (in this year)</td>
<td>--</td>
<td>21,887</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td><strong>A.3. R&amp;D expense by higher education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Funded by higher education (% / R&amp;D expense)</td>
<td>1.44</td>
<td>2.36</td>
<td>--</td>
<td>61.02</td>
<td>6/8</td>
</tr>
<tr>
<td>• Run by higher education (% / R&amp;D expense)</td>
<td>8.63</td>
<td>32.03</td>
<td>--</td>
<td>26.94</td>
<td>10/10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Indicators &quot;INVESTMENT IN KNOWLEDGE&quot;</th>
<th>2005</th>
<th>PANAMA</th>
<th>% / IB</th>
<th>IB = 100</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B.1. Reference</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• GDP (billions $)</td>
<td>15.47</td>
<td>3,856.15</td>
<td>0.40</td>
<td>--</td>
<td>10/11</td>
</tr>
<tr>
<td>• GDP in PPP (billions $)</td>
<td>24.67</td>
<td>5,952.86</td>
<td>0.41</td>
<td>--</td>
<td>10/11</td>
</tr>
<tr>
<td><strong>B.2. General R&amp;D expense</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• R&amp;D expense (mill. $)</td>
<td>38.00</td>
<td>27,798.69</td>
<td>0.14</td>
<td>--</td>
<td>8/10</td>
</tr>
<tr>
<td>• R&amp;D expense according to PPP (bll. $)</td>
<td>60.60</td>
<td>36,680.27</td>
<td>0.16</td>
<td>--</td>
<td>8/10</td>
</tr>
<tr>
<td>• R&amp;D expense as percentage of GDP (%)</td>
<td>0.25</td>
<td>0.73</td>
<td>--</td>
<td>34.25</td>
<td>6/10</td>
</tr>
<tr>
<td>• R&amp;D expense per inhabitant ($)</td>
<td>11.75</td>
<td>45.16</td>
<td>--</td>
<td>24.40</td>
<td>7/10</td>
</tr>
<tr>
<td>• R&amp;D expense per inhabitant – PPP ($)</td>
<td>18.75</td>
<td>67.03</td>
<td>--</td>
<td>27.97</td>
<td>6/10</td>
</tr>
<tr>
<td>• R&amp;D expense per researcher NP* (thou. $)</td>
<td>74.87</td>
<td>49.31</td>
<td>151.83</td>
<td>26.94</td>
<td>1/9</td>
</tr>
<tr>
<td>• R&amp;D expense per researcher FTE** (thou. $)</td>
<td>--</td>
<td>32.03</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>• R&amp;D expense per researcher NP – PPP (thou. $)</td>
<td>119.40</td>
<td>68.94</td>
<td>--</td>
<td>173.20</td>
<td>2/9</td>
</tr>
<tr>
<td>• R&amp;D expense per researcher FTE – PPP (thou. $)</td>
<td>--</td>
<td>113.10</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. Indicators &quot;IMPLICATION OF THE PRIVATE SECTOR&quot;</th>
<th>2005</th>
<th>PANAMA</th>
<th>% / IB</th>
<th>IB = 100</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C.1. Private expense in R&amp;D</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Funded by firms (% / R&amp;D expense)</td>
<td>0.42</td>
<td>41.73</td>
<td>--</td>
<td>1.01</td>
<td>6/7</td>
</tr>
<tr>
<td>• Funded by PNP*** (% / R&amp;D expense)</td>
<td>0.65</td>
<td>0.79</td>
<td>--</td>
<td>82.28</td>
<td>5/6</td>
</tr>
<tr>
<td>• Funded by foreign bodies (% / R&amp;D expense)</td>
<td>58.94</td>
<td>3.56</td>
<td>--</td>
<td>1,655.62</td>
<td>1/5</td>
</tr>
<tr>
<td>• Run by firms (% / R&amp;D expense)</td>
<td>--</td>
<td>46.07</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>• Run by PNP (% / R&amp;D expense)</td>
<td>54.24</td>
<td>1.69</td>
<td>--</td>
<td>3,209.47</td>
<td>1/8</td>
</tr>
</tbody>
</table>

Source: By the Author based on data from RICYT

Data provided by the Panamanian Council of Chancellors

* RICYT estimation for Ibero-American countries as a group
* NP = Natural persons
** FTE = Full-Time Equivalent (work day)
*** PNP = Private Non-Profit Organizations
<table>
<thead>
<tr>
<th>D. Indicators “APPLICATIONS”</th>
<th>PANAMA</th>
<th>IB</th>
<th>% / IB</th>
<th>IB = 100</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D.1. Human resources employed in R&amp;D</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• People in science and technology (S&amp;T) activities - NP*</td>
<td>2,959</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>5/7</td>
</tr>
<tr>
<td>• People in science and technology activities – FTE**</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>• Researchers NP</td>
<td>507</td>
<td>560,368</td>
<td>0.09</td>
<td>--</td>
<td>9/9</td>
</tr>
<tr>
<td>• Researchers FTE</td>
<td>--</td>
<td>341,556</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>• Researchers NA per thousand members EAP***</td>
<td>0.36</td>
<td>2.10</td>
<td>--</td>
<td>17.16</td>
<td>7/9</td>
</tr>
<tr>
<td>• Researchers FTE per thousand members EAP</td>
<td>--</td>
<td>1.28</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>• Male personnel in S&amp;T activities (%)</td>
<td>63.10</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>3/10</td>
</tr>
<tr>
<td>• Female personnel in S&amp;T activities (%)</td>
<td>36.90</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>8/10</td>
</tr>
<tr>
<td>• Research doctors in S&amp;T activities (%)</td>
<td>3.66</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>5/5</td>
</tr>
</tbody>
</table>

**E. Indicators “INTELLECTUAL PROPERTY”**

<table>
<thead>
<tr>
<th><strong>E.1. Patents</strong></th>
<th>PANAMA</th>
<th>IB</th>
<th>% / IB</th>
<th>IB = 100</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Total patents applied for by residents</td>
<td>24</td>
<td>16,609</td>
<td>0.14</td>
<td>--</td>
<td>9/10</td>
</tr>
<tr>
<td>• Total patents granted to residents</td>
<td>13</td>
<td>6,467</td>
<td>0.20</td>
<td>--</td>
<td>5/10</td>
</tr>
<tr>
<td>• Dependence ratio (*)</td>
<td>15.80</td>
<td>79.98</td>
<td>5.93</td>
<td>--</td>
<td>7/10</td>
</tr>
<tr>
<td>• Invention coefficient (#)</td>
<td>0.74</td>
<td>2.84</td>
<td>26.10</td>
<td>--</td>
<td>6/10</td>
</tr>
</tbody>
</table>

**E.2. Scientific Production**

<table>
<thead>
<tr>
<th><strong>E.2. Scientific Production</strong></th>
<th>PANAMA</th>
<th>IB</th>
<th>% / IB</th>
<th>IB = 100</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Publications in SciSearch</td>
<td>180</td>
<td>76,822</td>
<td>0.23</td>
<td>--</td>
<td>8/11</td>
</tr>
<tr>
<td>• Publications in SciSearch for each thousand inhabitants</td>
<td>5.57</td>
<td>13.11</td>
<td>--</td>
<td>42.47</td>
<td>6/11</td>
</tr>
<tr>
<td>• Publications in SciSearch / GDP (each bill. $)</td>
<td>11.64</td>
<td>19.92</td>
<td>--</td>
<td>58.43</td>
<td>5/11</td>
</tr>
<tr>
<td>• Publications in SciSearch / R&amp;D expense (each bill. $)</td>
<td>4.74</td>
<td>2.77</td>
<td>--</td>
<td>171.28</td>
<td>4/7</td>
</tr>
<tr>
<td>• Publications in SciSearch / NP (each 100 researchers)</td>
<td>35.50</td>
<td>22.49</td>
<td>--</td>
<td>157.84</td>
<td>1/8</td>
</tr>
<tr>
<td>• Publications in SciSearch / FTE (each 100 researchers)</td>
<td>--</td>
<td>13.71</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
</tbody>
</table>

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
- Role 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 provisions.
  - **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>
<thead>
<tr>
<th>Weaknesses</th>
<th>Strengths</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Insufficient development of institutional science and technology system. Specialized organisms, which contribute to efficient coordination and management, are lacking.</td>
<td>- Efforts by Panama's institutions to favor transversal and inter-sectoral links.</td>
</tr>
<tr>
<td>- Weak infrastructures (for example laboratories) and also in high technology in areas such as biotechnology, genomics, proteomics, biocomputing, etc.</td>
<td>- Centralized system in SENACYT with regard to management of national funding. Selective resource assignment mechanism based on merit and with expert participation.</td>
</tr>
<tr>
<td>- Scarce funding/investment in R&amp;D activities. Need greater amounts and more efficient process.</td>
<td>- Strong communications, internet and logistics infrastructures.</td>
</tr>
<tr>
<td>- Lack of critical mass of researchers, especially in some scientific fields of the country. Difficulty for teachers to do research. Incentives and jobs for quality HR lacking. Very few female personnel in science and technology activities.</td>
<td>- Important effort in R&amp;D expense in relation to the number of researchers.</td>
</tr>
<tr>
<td>- Low activity in R&amp;D in general.</td>
<td>- Notable participation in funding R&amp;D expense by foreign organisms. High implication of non-profit organizations in the executing R&amp;D expenditures.</td>
</tr>
<tr>
<td>- Little implication of business sector in RD&amp;I. Scarce private business investment in this area. Weak university-firm links. Absence of interface structures.</td>
<td>- Awareness, recognition and acceptance of the need for greater technological innovation activity as a driver of development with more business participation in R&amp;D and better university-firm relationships.</td>
</tr>
<tr>
<td>- Deficient generation and application of patents. Scarce information and weak general culture by professionals with regard to the patent system and its advantages.</td>
<td></td>
</tr>
<tr>
<td>- Insufficient scientific production.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Threats</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Environment of world economic crisis and budget cuts. Global context.</td>
<td>- Achieve the incorporation of R&amp;D investment by foreign firms in line with the scientific-technological internal capacity.</td>
</tr>
<tr>
<td>- High international competition – general and regional.</td>
<td>- Take advantage of the strategic geographical situation to attract investment in infrastructures and technologies.</td>
</tr>
<tr>
<td>- Acceleration of competition from emerging countries (Eastern Europe and Asia).</td>
<td>- Tend towards meeting international quality standards.</td>
</tr>
<tr>
<td>- 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.</td>
<td>- Increase visibility of national science in forums and international scientific publications.</td>
</tr>
<tr>
<td>- Lack of alignment between international growth trends and own internal needs.</td>
<td>- 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.</td>
</tr>
<tr>
<td>- 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).</td>
<td>- Few limitation for international researchers to access national R&amp;D funds.</td>
</tr>
</tbody>
</table>

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)
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
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.Ds 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**

- 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

---

**World regional gaps:**

**Source:** RICYT

**PEA:** Economically Active Population

---

**Relative capacity of each country for research:** notable diversity
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

The characteristics of Latin America:
- concentration at universities
- incentives for research
mean that results are directed at publications

LAC doubled its SCI 1996-2005

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

Source: Estado de la Ciencia, RICYT, 2007: 22
Base 1996=100
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)

Source: By the author with RICYT data
Table 40. Science Citation Index Scientific production in Latin America by countries 2002

<table>
<thead>
<tr>
<th>Country</th>
<th>% Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brasil</td>
<td>46.0</td>
</tr>
<tr>
<td>México</td>
<td>17.4</td>
</tr>
<tr>
<td>Argentina</td>
<td>16.2</td>
</tr>
<tr>
<td>Chile</td>
<td>7.7</td>
</tr>
<tr>
<td>Venezuela</td>
<td>3.5</td>
</tr>
<tr>
<td>Colombia</td>
<td>2.4</td>
</tr>
<tr>
<td>Cuba</td>
<td>1.8</td>
</tr>
<tr>
<td>Uruguay</td>
<td>1.1</td>
</tr>
<tr>
<td>Perú</td>
<td>1.0</td>
</tr>
<tr>
<td>Resto 10 países</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Source: Sebastián, 2006: 56
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

Table 41. Invention Coefficient 2005

<table>
<thead>
<tr>
<th>Country</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guatemala</td>
<td>0.14</td>
</tr>
<tr>
<td>Honduras</td>
<td>0.18</td>
</tr>
<tr>
<td>Colombia</td>
<td>0.22</td>
</tr>
<tr>
<td>Paraguay</td>
<td>0.41</td>
</tr>
<tr>
<td>El Salvador</td>
<td>0.48</td>
</tr>
<tr>
<td>México</td>
<td>0.56</td>
</tr>
<tr>
<td>Cuba</td>
<td>0.65</td>
</tr>
<tr>
<td>Uruguay</td>
<td>0.82</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>0.88</td>
</tr>
<tr>
<td>Argentina</td>
<td>2.79</td>
</tr>
<tr>
<td>Chile</td>
<td>3.52</td>
</tr>
<tr>
<td>Iberoamérica</td>
<td>2.84</td>
</tr>
<tr>
<td>Estados Unidos</td>
<td>70.11</td>
</tr>
</tbody>
</table>

Source: By the author with RICYT data

Patents applied for by residents by each 100,000 inhabitants

Source: By the author with RICYT data

- Guatemala
- Honduras
- Colombia
- Paraguay
- El Salvador
- México
- Cuba
- Uruguay
- Costa Rica
- Argentina
- Chile
- Iberoamérica
- Estados Unidos

Source: By the author with RICYT data

Patents applied for by no residents / applied for by residents
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
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 policies, 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 its 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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