

## CHAPTER 11 – LATIN AMERICAN HUMAN RESOURCES ON SCIENCE AND TECHNOLOGY: THE EXPERIENCE OF THE IBERO AMERICAN / INTER AMERICAN S&T INDICATORS NETWORK (RICYT)

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The main goal of RICYT is to promote the development of instruments to measure and analyze science and technology in our region, because we have a huge lack of those instruments; and in the framework of international cooperation, in order to achieve a deep understanding of its nature and applicability as instruments for the decision making process in a knowledge-based society.

Our résumé is that we were created in 1995. We are a network – we are not an institution – so our network is filled by different members. Most of them are national ministries of science and technology or the equivalent, such as departments and secretariats. Also, we have universities and other academic and scientific institutions and regional scientific commissions and councils, such as the Caribbean one, the Central American one, and the MERCOSUR one, which is the region that contains Argentina, Brazil, Paraguay and Uruguay and has two observers, Chile and Bolivia. Network members also include extra-regional institutions that give us more than we give them, but we are very glad to have them in our network. The National Science Foundation is one of them; OECD is another one, EUROSTAT is another one, and so on.

Our main activities are publishing science and technology innovation indicators. We conduct workshops for discussing methodologies and for interchanging experience. We also do a compilation of indicators, and we publish them on our web page and also in our annual yearbook. We also do regional capacity-building, not only in seminars, but we also go on special missions and teach how to produce the indicators, which may seem strange, but it was a very important activity at the beginning of the network. Also, we do some research and development, such as producing new methodologies of measurement.

### Main goal

- To promote the development of instruments to measure and analyze S&T in our region, in the frame of international cooperation, in order to achieve a deep understanding of its nature and applicability as instruments for the decision making process in a knowledge based society.



### RICYT's résumé

- Created in 1995
- Network members:
  - National ministries of S&T (or equivalent)
  - Universities and other academic and scientific institutions
  - Regional scientific commissions and councils (CCST, CTCAP, RECYT, etc)
  - Extra Regional institutions (NSF, OECD, EUROSTAT, etc)
- Main Activities
  - STI Indicators Workshops
  - STI Indicators compilation and publication
  - Regional capacity building
  - Research and Development



### RICYT's S&T Indicators Regional Program

- **Regional Sub networks**  
(Caribbean, Central America, Andean Region, North America and MERCOSUR)
- **Thematic Sub networks of STI Indicators**  
(Science public perception and Scientific culture, Information society, Innovation, *Human resources on S&T*, Social impact of science, Bibliometrics and High technology commerce and TBP)
- **Information production and International insertion and spreading**
- **Gender approach on STI Indicators**



Our new strategy has made some specific changes, such as making regional sub-networks. We are going to set up regional offices, which is a huge advance because we are decentralizing activities. We are going to set up a regional office in the Caribbean, another one in Central America, and one in the Indian region, which is Peru, Ecuador, Colombia, etc. We will also set up regional offices in North America and in MERCOSUR as well.

Also, we are trying to construct thematic sub-networks of science and technology indicators. The main topics RICYT faces are science public perception and scientific culture, information society, innovation, human resources science and technology, social impact of science, bibliometrics, high-technology commerce and balance-of-payments.

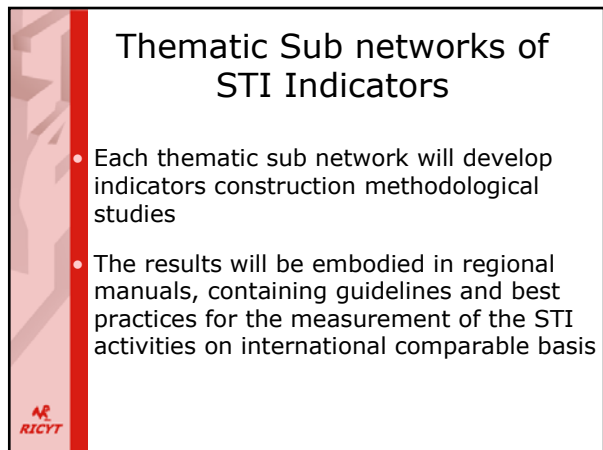
We are also going to make an information production on international insertion and spreading, because we have switched too much inside the region, and now we are trying to show other countries what we have done. Also, we are trying to make a specific program on gender approach in science and technology indicators, which was an issue, but now we are going to give a much broader space.

Each thematic sub-network will develop indicators, construct methodological studies, and the results will be embodied in regional manuals containing guidelines and best practices for the measurement of the science and technology activities on an internationally comparable basis.

The human resources sub-network action plan is to survey the existing information sources in the Latin America and Caribbean countries and the international ones, verifying their data comparability, in order to build human resources indicators such as some of those presented today. Additionally, the human resources sub-network action plan is to propose the indicators set for expressing the highly-skilled human resource stock, employment, mobility and migration; and to formulate the regional methodology, aiming to bring about a best practices guide for the human resources science and technology indicators construction.

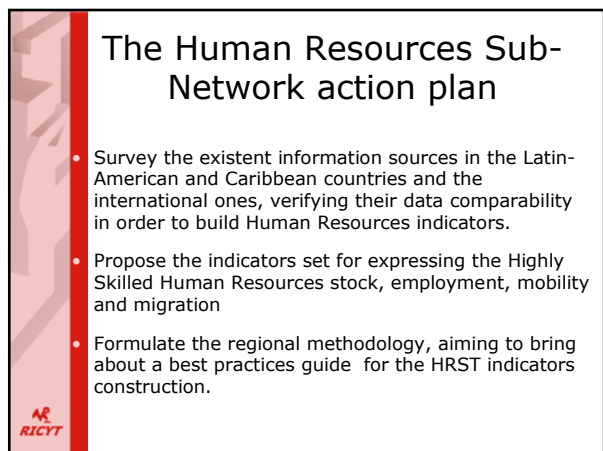
RICYT has already collected some data, which is available on our web page for public use. Of course, we are very critical about our own data because it has a lot of methodological problems which we are also going to stress here.

Our data on human resources and research and development (HRRD) is mainly research, because there are a lot of problems in gathering the other subsets. Also, we have data on graduates, with disaggregation by degree level – bachelor's, master's, and Ph.D.



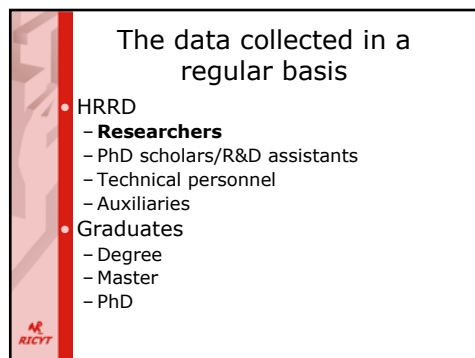
### Thematic Sub networks of STI Indicators

- Each thematic sub network will develop indicators construction methodological studies
- The results will be embodied in regional manuals, containing guidelines and best practices for the measurement of the STI activities on international comparable basis



### The Human Resources Sub-Network action plan

- Survey the existent information sources in the Latin-American and Caribbean countries and the international ones, verifying their data comparability in order to build Human Resources indicators.
- Propose the indicators set for expressing the Highly Skilled Human Resources stock, employment, mobility and migration
- Formulate the regional methodology, aiming to bring about a best practices guide for the HRST indicators construction.



### The data collected in a regular basis

- HRRD
  - **Researchers**
  - PhD scholars/R&D assistants
  - Technical personnel
  - Auxiliaries
- Graduates
  - Degree
  - Master
  - PhD

### The breakdown units

- HRRD
  - Gender
  - Head count or FTE
- Only Researchers
  - Degree
  - FOS
  - Sector
- Graduates
  - FOS

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What are the breakdown units? For HRRD, we have data by gender and headcount/full-time equivalent. For researchers, we have the degree, field of science only for researchers and the sector only for researchers, not for the other research and development personnel. And we have graduates by field of science – that is the only disaggregation we have.

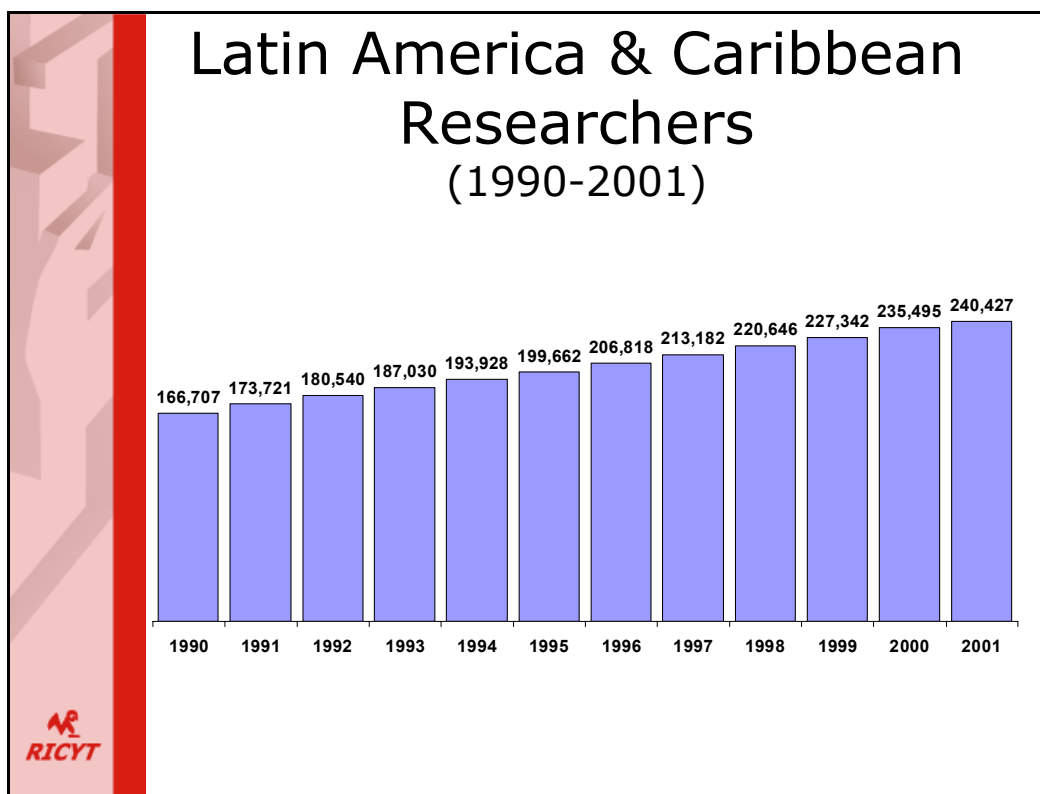
We also have some contextual data on labor force or population, as well as research

### Contextual data

- Labor force / Population
- R&D expenditure / STA expenditure
- SCI publications
- PASCAL publications

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and development expenditure or science and technology activities expenditure. We have SCI publications, and also we have PASCAL publications, which is a multidisciplinary database of publications compiled by France. Comparing the two helps to correct for the English-speaking bias.

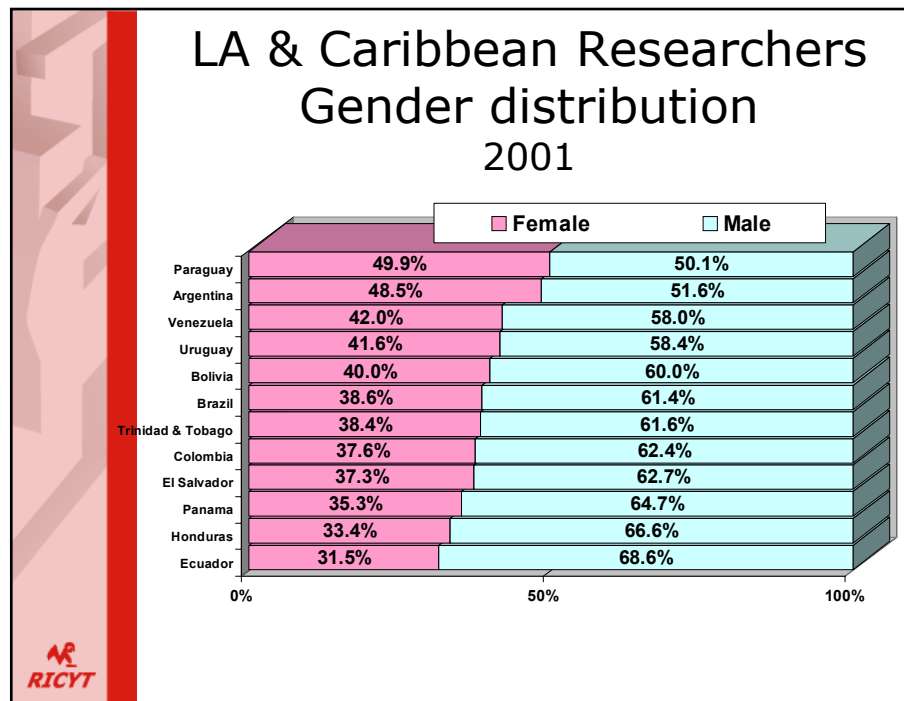
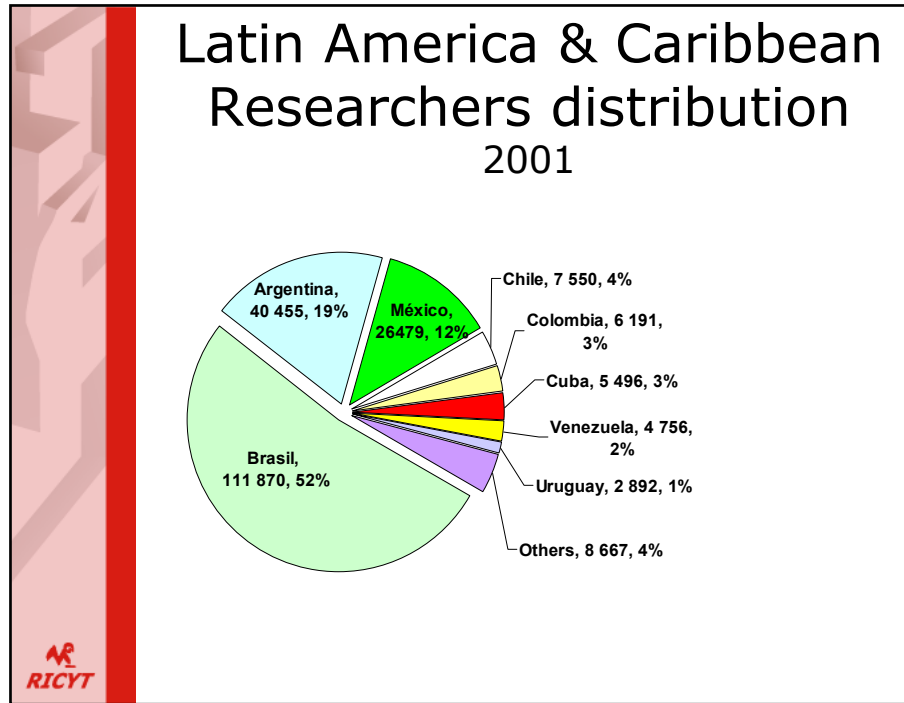


What are the main trends about research? It is growing. Of course, we cannot yet separate which of this growth is really the growth of the population and which is the growth of the research capacities. Also, the quality of the data-gathering is improving in the countries, so it is very difficult to separate both. Please note that this is an estimate of Latin America and the Caribbean, because we do not have all the data for all the years for each country.

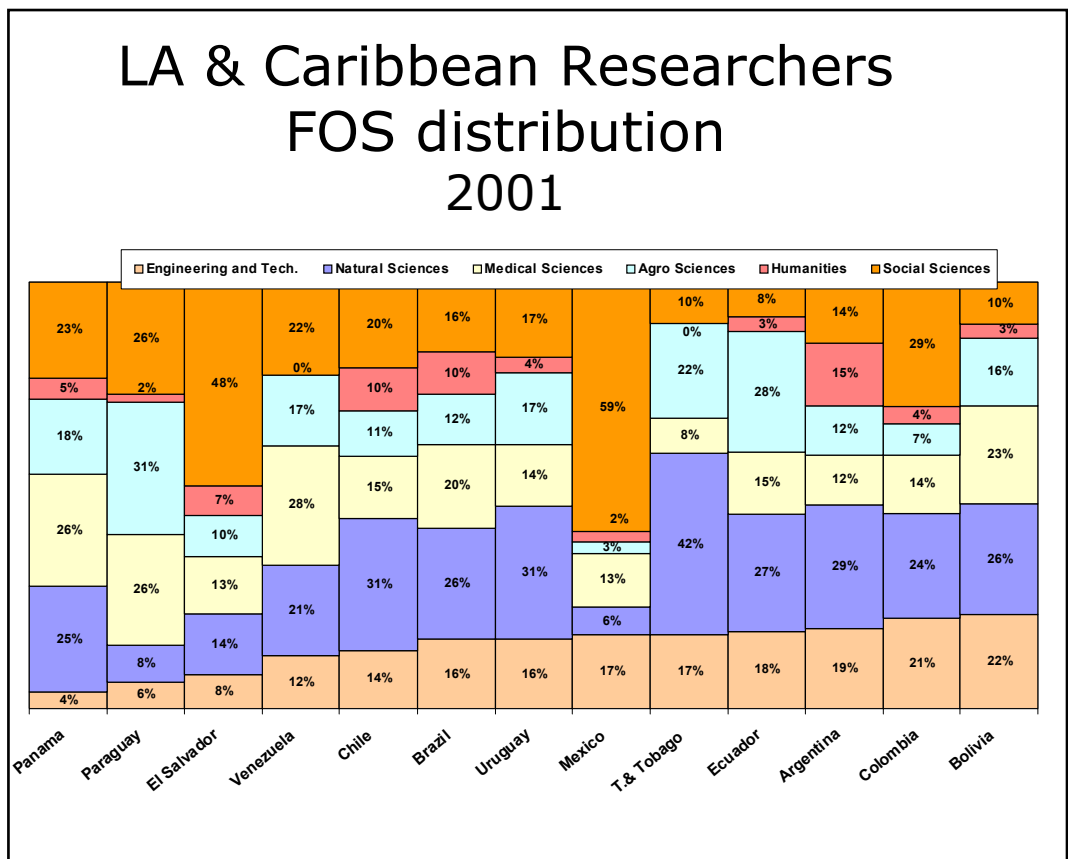
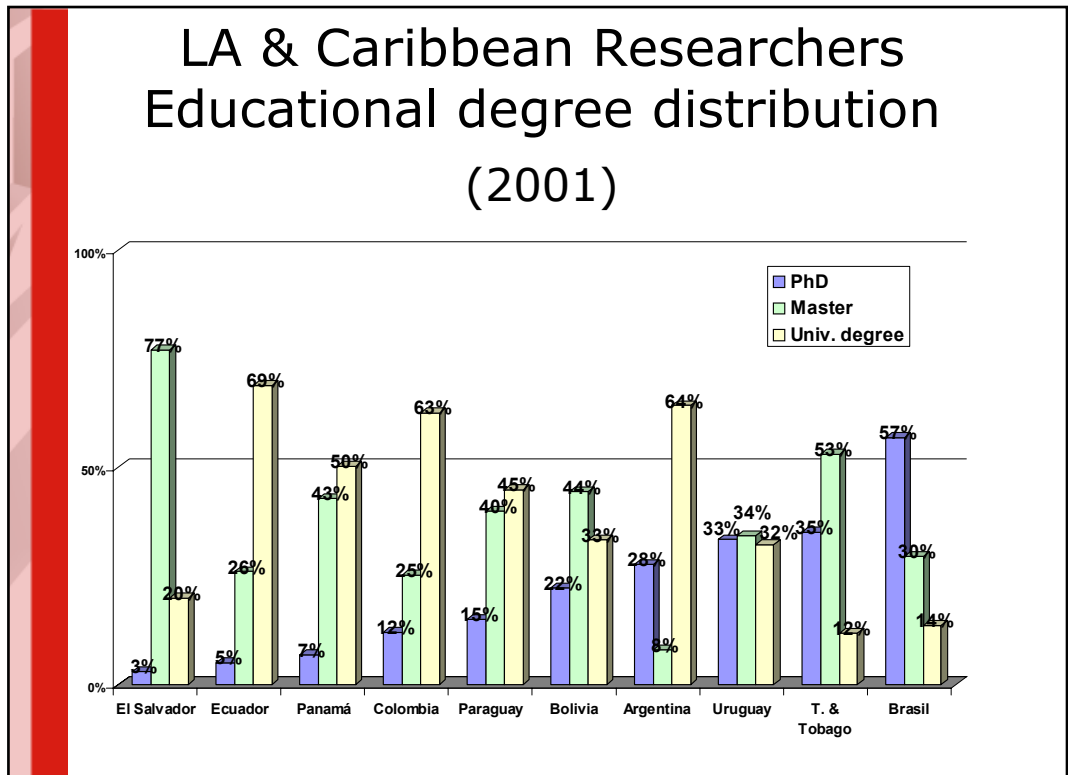
How is this research distributed by the country? As shown above, Brazil is the big player here, with more than 50 percent, followed by Argentina and Mexico, which are generally always battling for second and third place. Next, are Chile and Colombia, and then Cuba, Venezuela, Uruguay and all the others. As you can see by the numbers expressed here and in the previous chart, we are speaking about a tiny portion of all the indicators discussed in this workshop. Everything included in the chart here would have been included in the "other countries" section in earlier presentations in this workshop, so the amount of research we are talking about here is very tiny.

As shown to the right, no country in Latin America and the Caribbean has more females than males in research. Overall, the gender distribution is quite balanced in some countries, such as Paraguay and Argentina, but there is more of an imbalance at the higher stages of research.

The slide on the following page shows that by educational degree distribution, the Ph.D. is not the common degree for Latin American researchers. Latin America has a very different educational system from industrialized countries, but there are also a lot of differences between the Latin American countries as well. Brazil has a lot of Ph.D. researchers, but Argentina, in contrast, does not have a tradition of Ph.D. researchers. It has a very young tradition of granting doctorates. So you will see a significant difference among countries, but that is more an expression of the difference between the educational systems in those countries than the research systems.



By field of science, (see chart below) researchers in the social sciences (shown in the top bar of each column) make up a large percentage of the researchers in many countries. Including the humanities as well further increases the percentage. Engineers and natural scientists, which also includes mathematical science, are shown in the bottom two bars of each column.



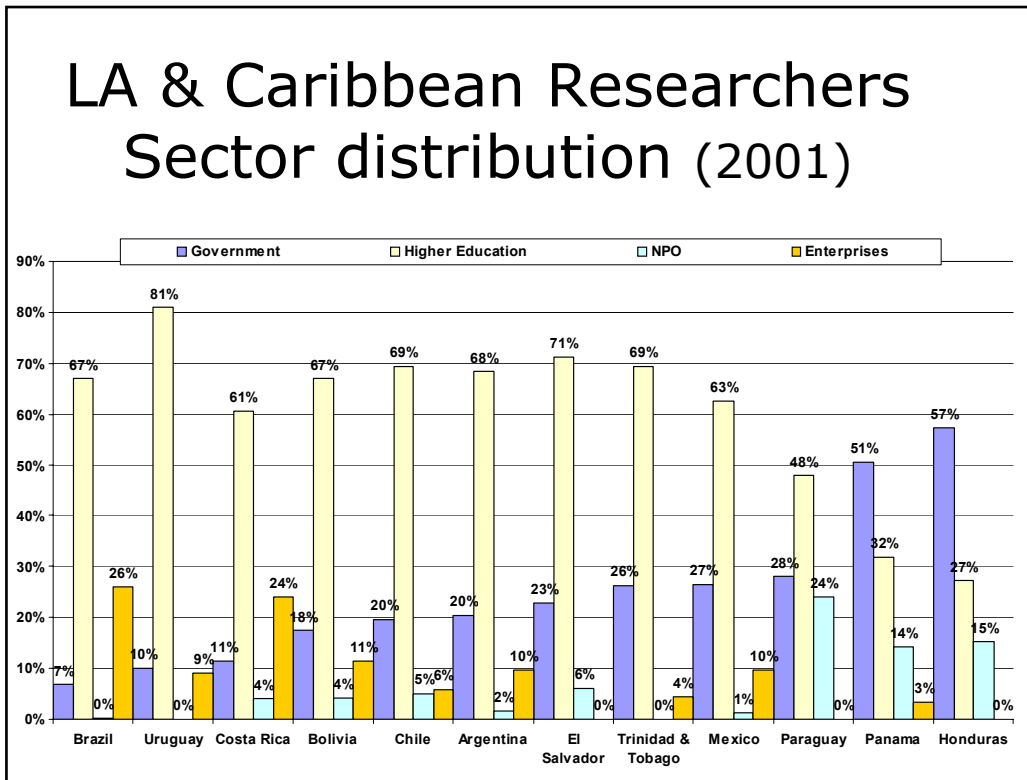
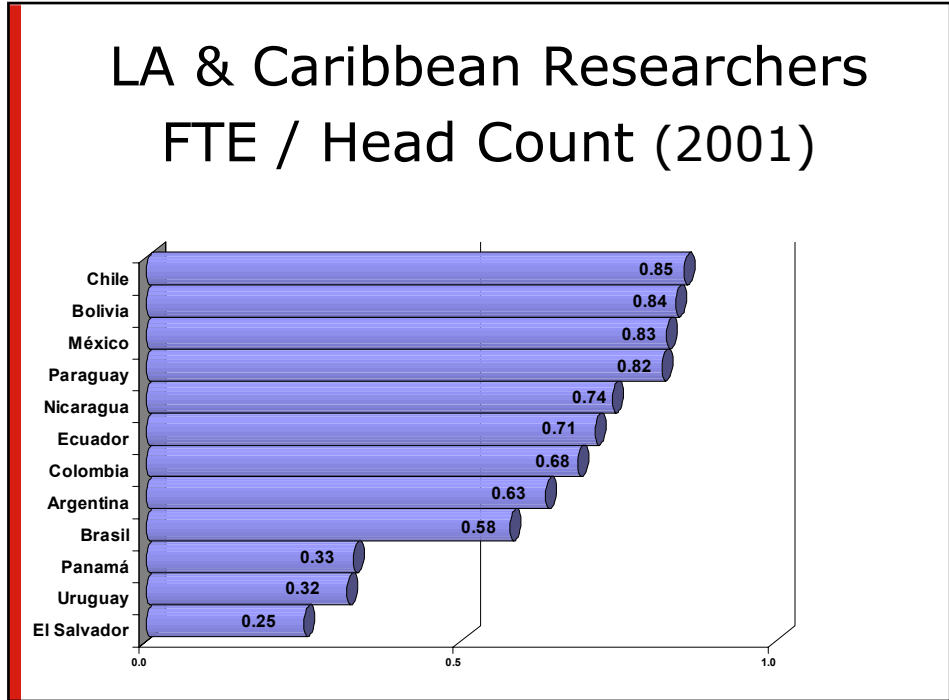
The indicator shown here is problematic. The slide shows the relationship between full-time-equivalence and the headcount of researchers, and you will note that there is a difference between countries. But, full-time-equivalence is a vague indicator in Latin American countries.

By sector, we see two important things – one, that enterprises (companies) are not big players in the research systems,

although we have to put a footnote about that, because it is very difficult to gather information in the enterprise system.

Research and development laboratories inside enterprises are not common, at least not on a formal basis, but also, if they have them, they will sometimes not release that information, so it is very difficult to gather

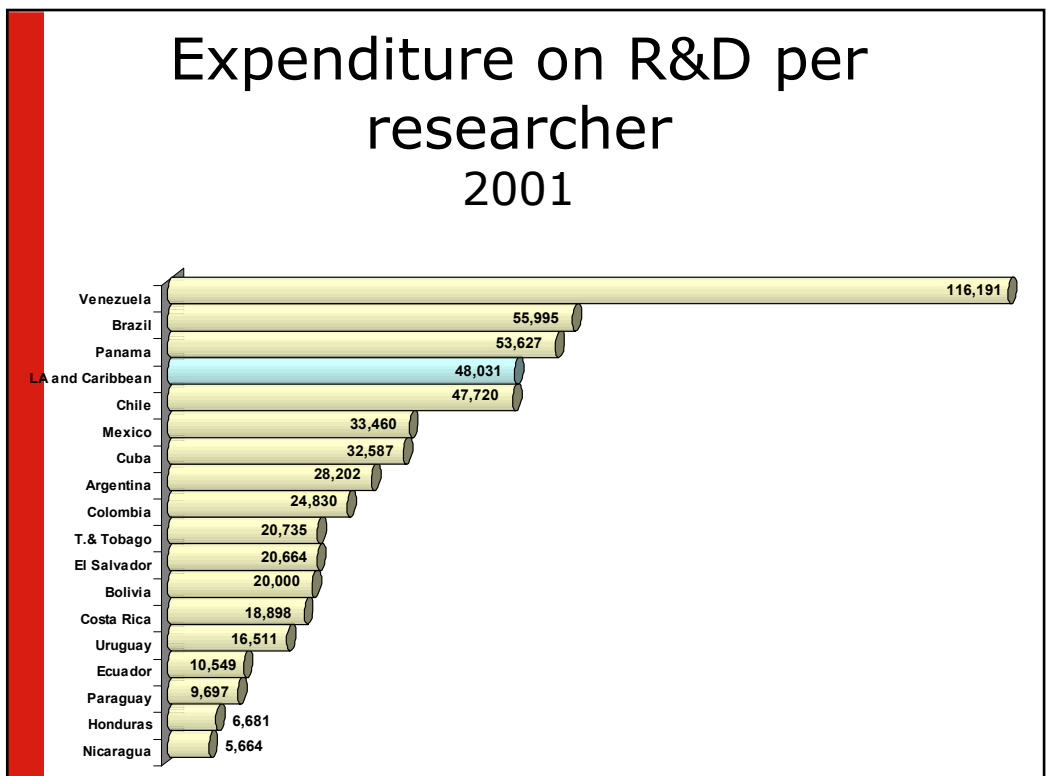
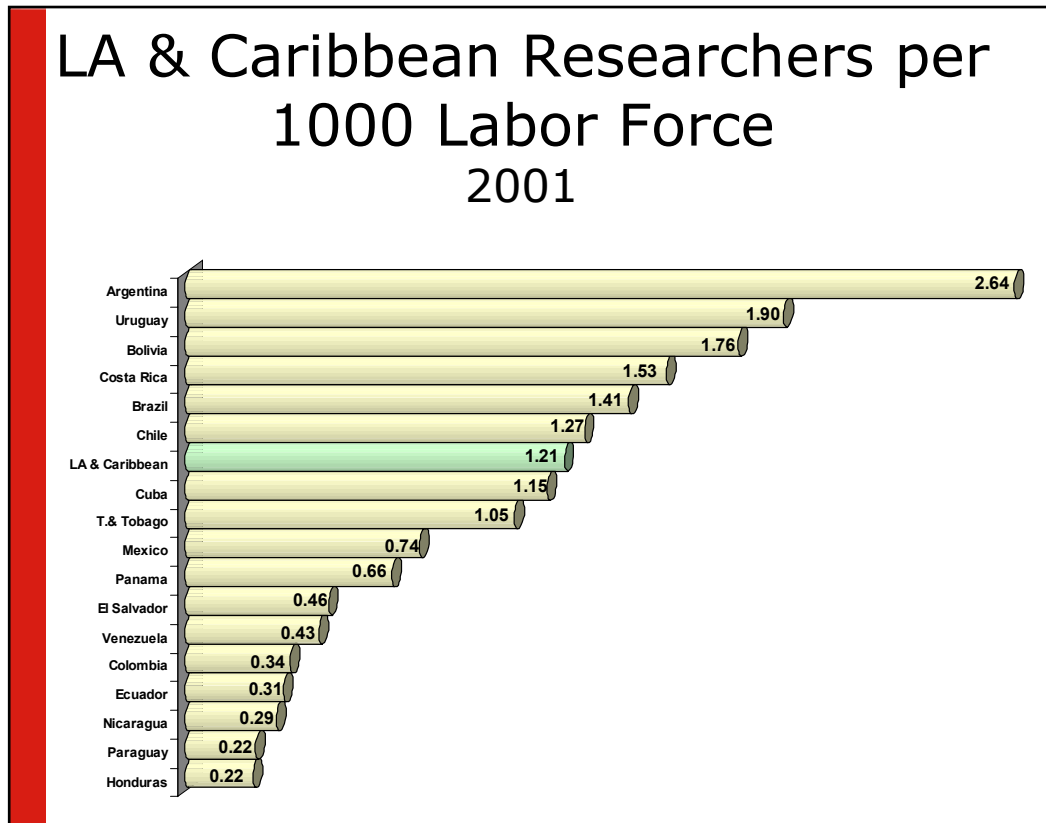
information about that. Another thing that is quite interesting to note in this slide is that the science and technology systems in Latin American countries have two models. In one model, the researchers are mainly in the higher education systems, in countries such as Uruguay and Brazil. In the other model, the researchers are mainly in the government system, which means the national councils, centers and labs. This is the case in Honduras.



There has been a change since the early fifties, when all the national systems changed from the French model to a more American model of research, where the labs moved from national departments to universities.

The average Latin American/Caribbean country has 1.21 researchers per 1,000 individuals in the labor force, as shown in the green bar to the right, more or less one and one-fifth persons per 1,000 workers. Most of the countries have much smaller ratios. Argentina has a high proportion, but that is much more the result of a low population than a big research system.

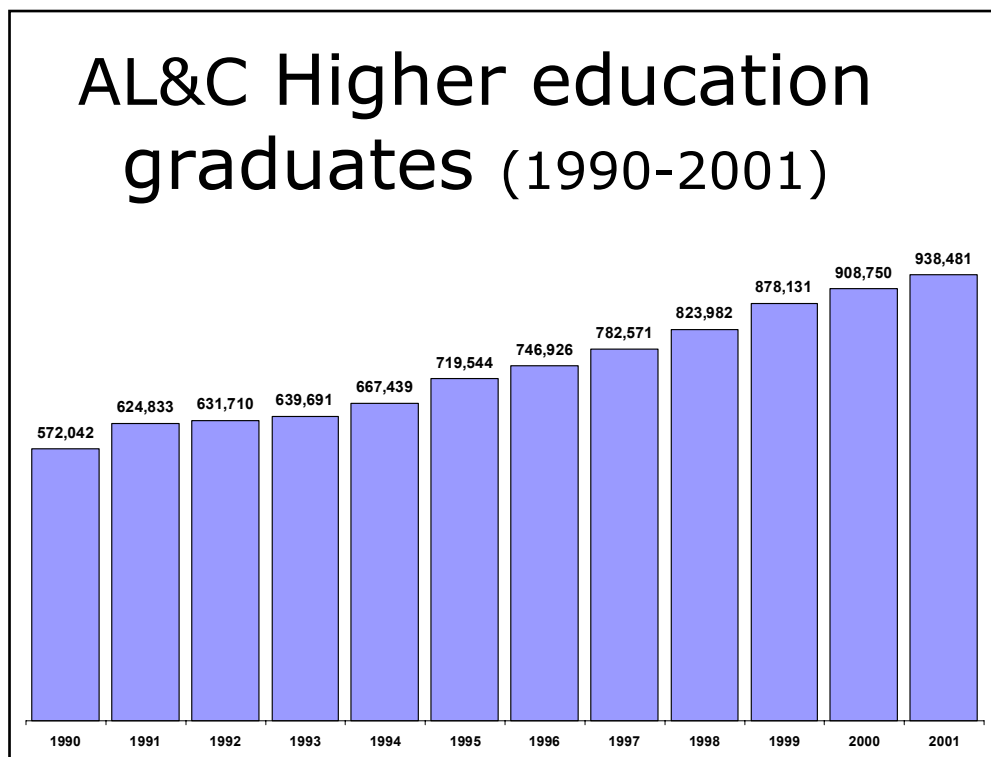
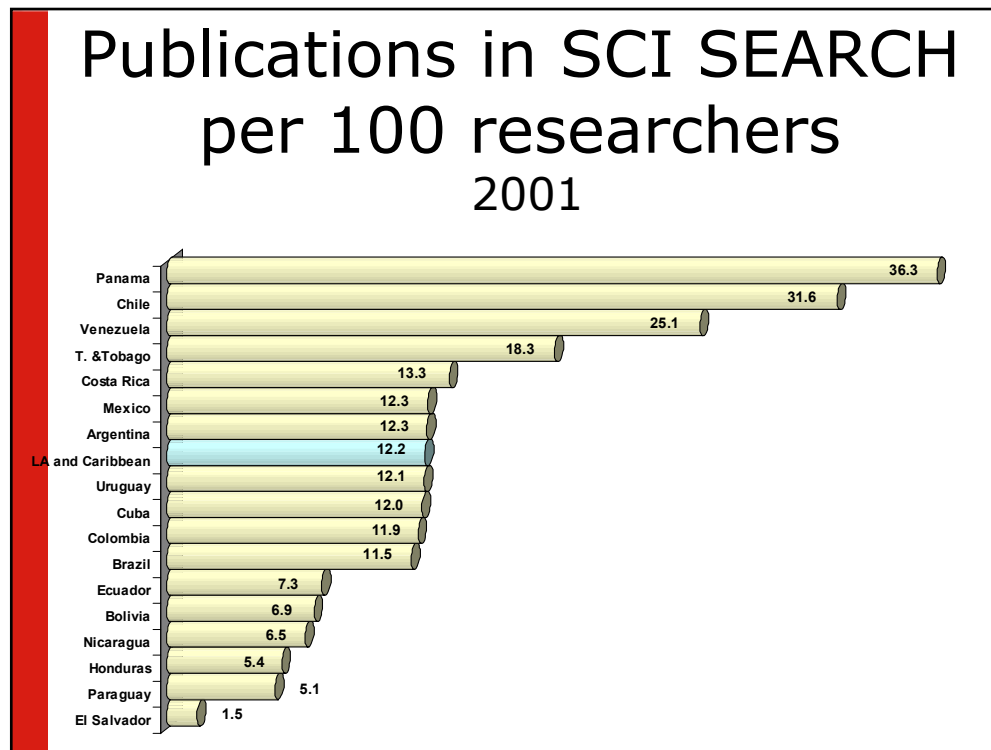
If we look at expenditures for research and development per researcher in 2001, the Latin American and Caribbean average is more or less \$50,000 US



per year per researcher. It is not that much money, but it does not include salary – that figure includes just the research budget for instruments, assets, etc. The figure for Venezuela is outstanding, but there is probably a petroleum subsidy there affecting the statistics a little bit.

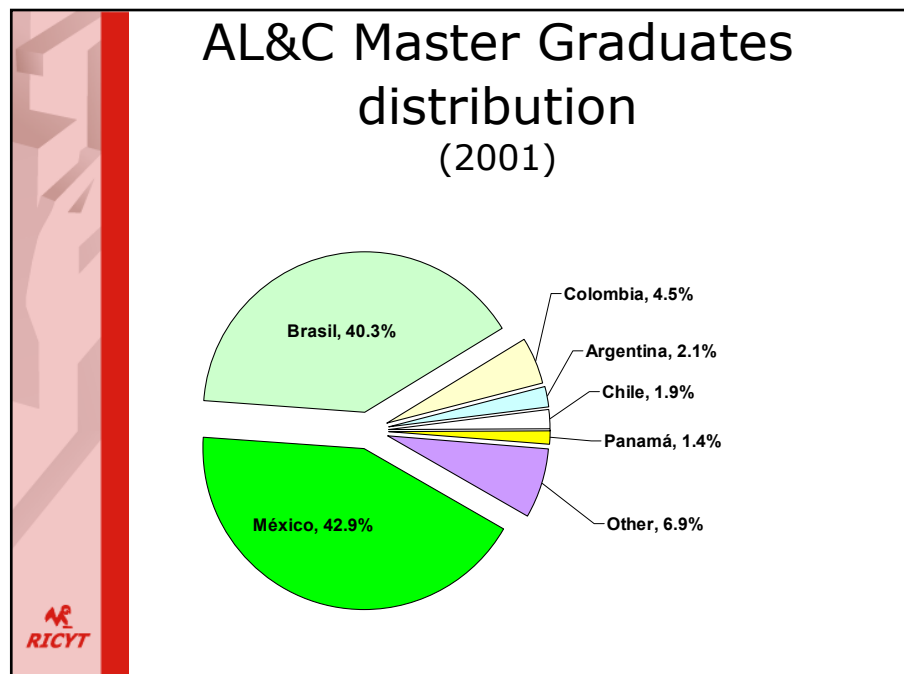
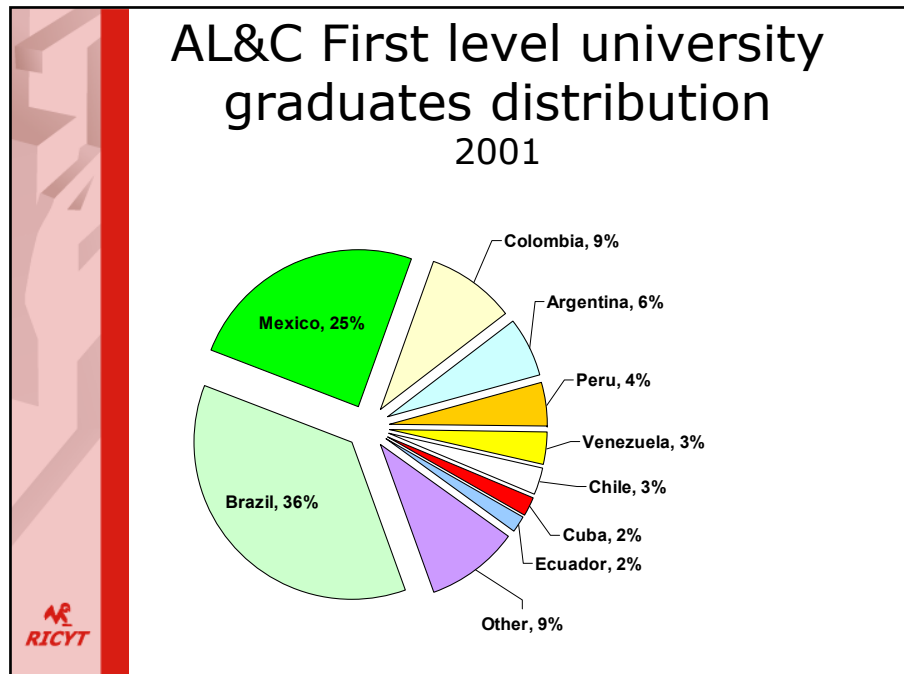
This slide shows publications per 100 researchers. The average is more or less 12 publications per 100 researchers. That means less than one publication per researcher. Of course, this varies a lot. There are some countries with outstanding researchers. For example, Panama and Chile have more than one-third of publications per researcher, and most other countries are near the average, such as Brazil and Mexico and Argentina, which are the main players in absolute numbers.

Moving to the graduate statistics, we see that the number of graduates in Latin America has gone up from the 1990s until now. In this case, the statistics are much more reliable, because the graduate statistics are compiled by the universities, with much less estimation.



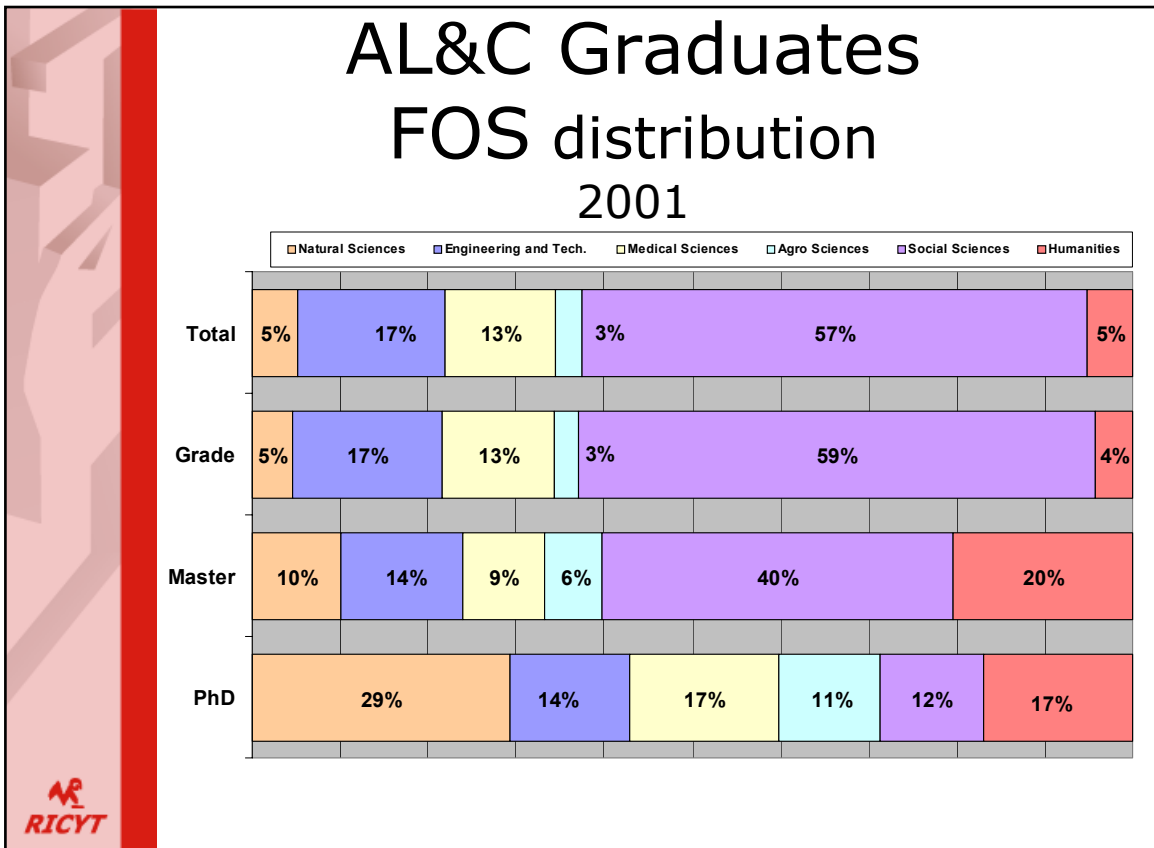
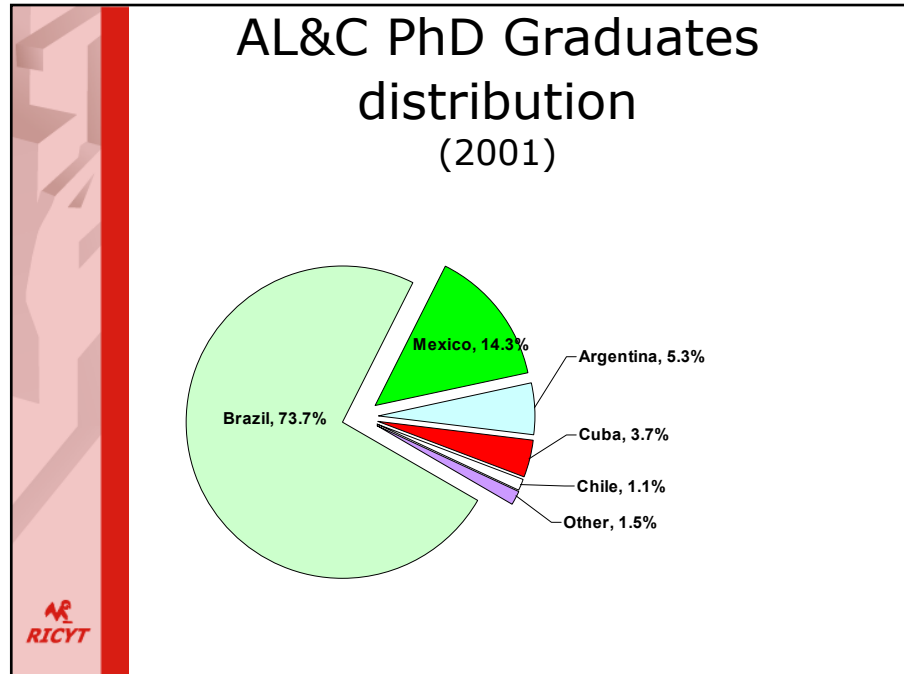
When we break it down to only the bachelor's graduates, we see that Brazil and Mexico account for most of the bachelor's graduates, and Colombia, Argentina, Peru, and Venezuela have a much lesser proportion. So, all the statistics presented earlier in this presentation are very much influenced by these two countries – Brazil and Mexico.

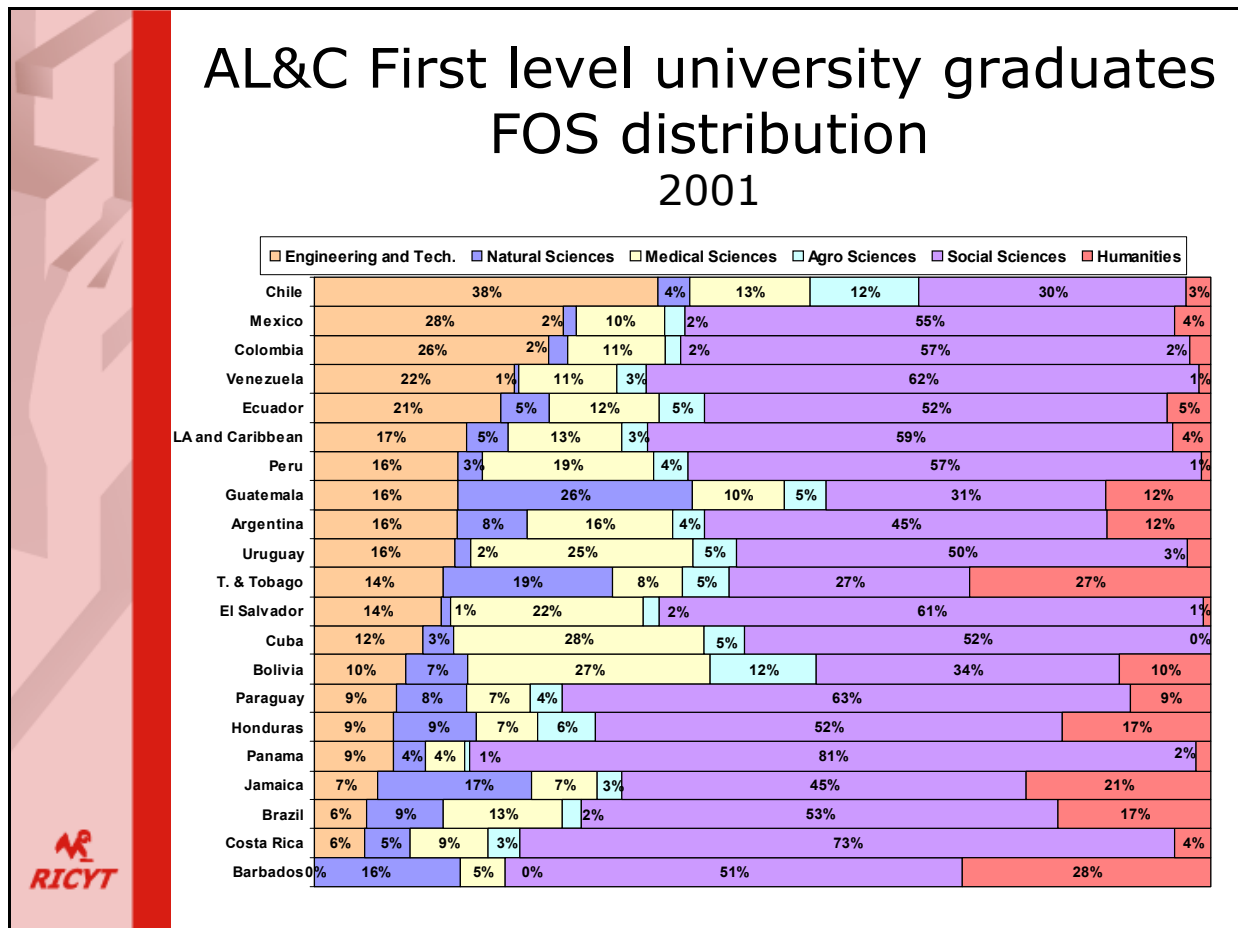
At the master's level, the distribution is even worse. Brazil and Mexico have a longer tradition of granting master's degrees than other countries. They are also larger in population, so this gives little participation to other countries in the whole program.



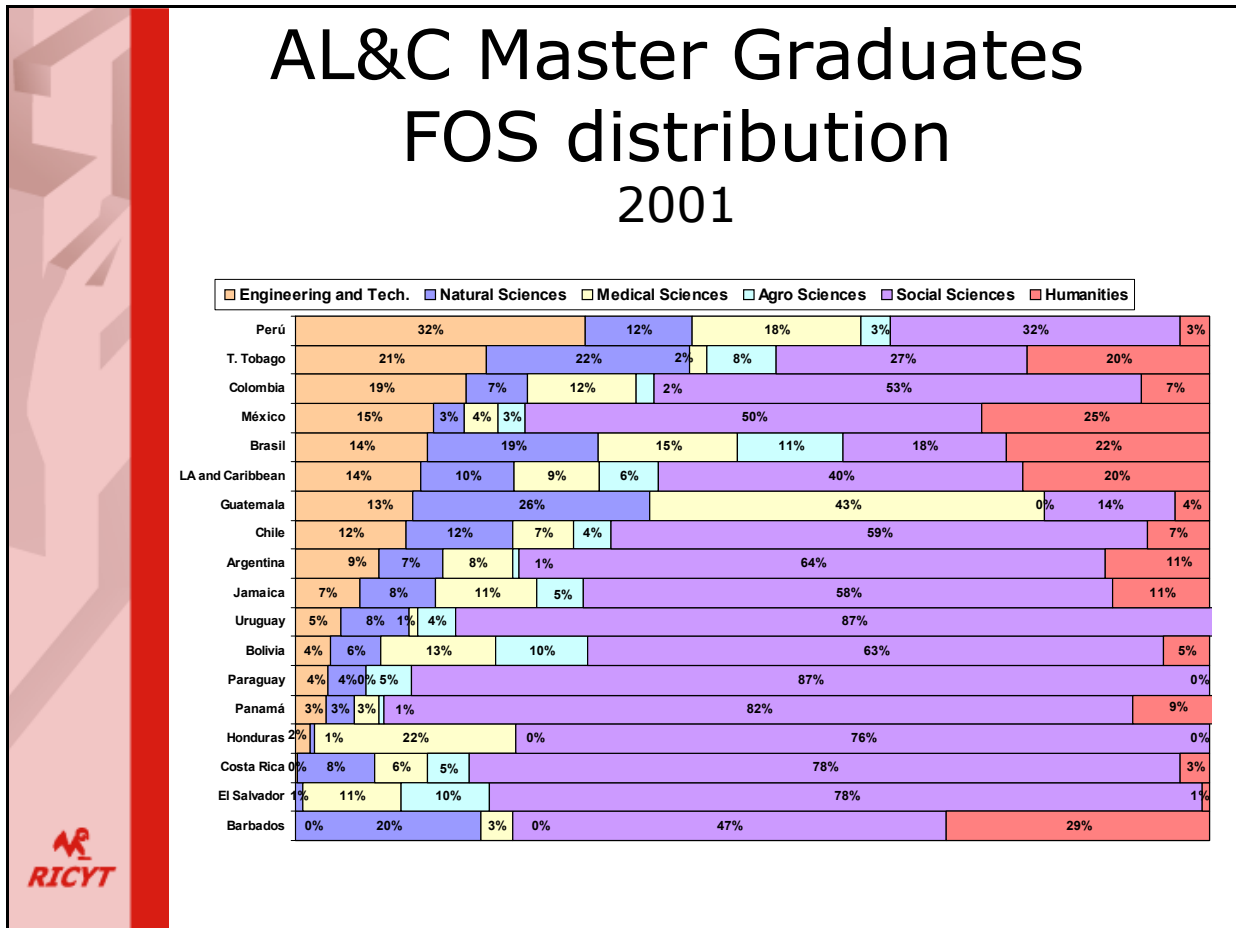
At the doctorate level, it is even worse. You can see that Brazil grants most of the doctorates. Also, it should be said that in Brazil, it is easier to skip the master's and go directly to the Ph.D., than in other countries in Latin America.

Looking at field of science, we see something quite interesting. The bachelor's and the total have quite similar results, but we see that the trend varies a lot at the master's and Ph.D. levels, where the social sciences start to decrease and the natural sciences (on the left) increase.

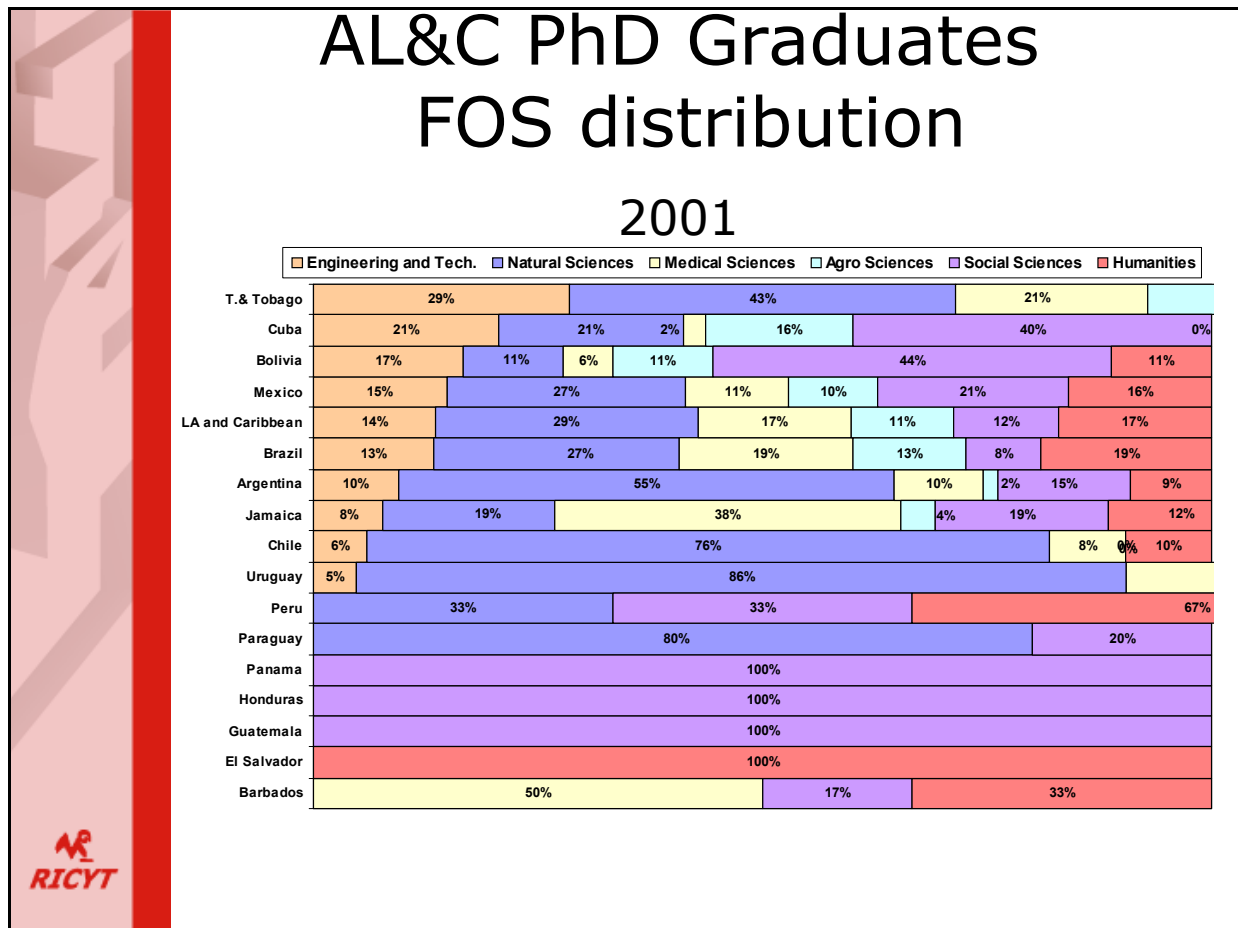




When we do the same distribution by country, we see some very interesting results. For example, Chile has many more first-level graduates in engineering than in other disciplines. For the countries at the bottom of the chart, the engineering percentage gets lower, and we see that the social sciences make up the largest share.



At the master's level, Brazil and Mexico are the big players. Brazil awards a large percentage of its bachelor's degrees in the social sciences, but at the master's level, this percentage drops considerably.



The distribution at the doctoral level is shown above. The amount of Ph.D. graduates in some of these countries is very low – in some cases as few as five Ph.D.s per year – so some of the data are not relevant statistically.

What are the problems? It is difficult to achieve data on R&D personnel other than for researchers. The full-time equivalent data under- or overestimates them. In the private sector, there is a huge

### The problems

- Difficulties in achieving other R&D personnel than researchers
- FTE under or over estimation
- Private sector underestimation
- Multi-institutional researcher duplication
- Etc

underestimation. The multi-institutional researcher duplication problem is very common in Latin American countries. If a researcher is a chair in the university, a chair in the national council, and works in an enterprise, he/she could be counted three times.

### The new approaches

- Highly Skilled Labor on S&T (OECD/RICYT)
  - The available information sources and data (Argentina, Brazil, Chile and Colombia)
  - The 2000 Census round data (Argentina, Brazil, Chile and Mexico)
- SCienti Network
  - Latin-American CVs
  - Latin-American Research Groups

We are trying new approaches to improve our

information. First, we are working with OECD on a project on high-skilled labor in science and technology, specifically in our region. We already did a survey of the available information sources, and we are now doing a

2000 Census data study of Argentina, Brazil, Chile, and Mexico. The 2000 Census was not done in all Latin American countries, so it is not possible to check data for all the countries.

Another project going on now is the SCienTI Network. The SCienTI Network is a huge database of resumes. It is already operational in Brazil and in Colombia. Researchers send their resumes to this database, and the database seems to be a very interesting source of indicators – much better than surveys and much less costly. The network includes Latin American resumes, as well as Latin American research groups.

The webpage for RICYT is <http://www.ricyt.org>. We are going to do a regional workshop in September, so please check out the website if you are interested.

### **Audience Questions/Comments:**

- Jean Johnson, National Science Foundation – You said that your higher education data was the strongest data that you have. What does RICYT do about the growth of private institutions and the difficulty of what to count in engineering, say, for Colombia, given the large number of private institutions in engineering?

Response – RICYT takes the national data reported by the country, but it also revises the data. We ask for all the educational institution graduates, even the private ones, although some countries may not have that data and will not send it. The specifics are detailed in footnotes on the RICYT webpage.

- Jill Karsten, American Geophysical Union – Is it your sense that most countries are basically at capacity in terms of the number of people going into these fields, or are they trying to keep up with growth as these countries are developing further? Secondly, to what extent is there or isn't there mobility between the countries in terms of the science workforce?

Response – On capacity, we have some data about what we call the supply of knowledge or the supply of the research system. We do not know about the demand, so we do not know about this capacity or how to measure it. In regard to publications, it seems like the capacity of Latin America is on average very comparable to other countries. In terms of production of science articles, Latin America grows much more steeply than other regions. But, a very low proportion of the population is involved in this knowledge production.

Regarding mobility, we want to conduct research more about that. This is one of the projects we are conducting with OECD. It is sometimes difficult in international studies, because they do not differentiate between mobility and migration. There is a big difference between someone who goes abroad to study and stays five or ten years and then returns, than someone who goes abroad and never returns. That happens a lot in Latin America. For example, Latin Americans are going to other countries just to study or conduct some research, and their coordinators in their home countries are saying, "Please, don't come back; stay there and connect us." So this phenomenon is happening, and it is very interesting.

- Marta Sahelsky, Inter-American Development Bank – Might you consider doing some of your data summaries so as to segregate out the humanities. It is very hard to make a case for what needs to be done with respect to science and technology from a policy perspective if the data are inflated from the arts and the humanities. I know that you have a country contribution problem, and you need to respect that, but some of your second-order analysis might be very helpful for other purposes.

Secondly, it would be very helpful also if you might be able to provide a snapshot of what degree programs are like in the region. In other words, how many doctorate-producing institutions there are, master's-producing, private/public, etc. Thirdly, I was quite surprised by the publication performance of Trinidad, Tobago, and Panama. Could you please explain that?

Response – Concerning educational systems, we are more focused on research and development systems, so we look at the research and development capabilities of each country, but not at the education systems, because there are other networks and other institutions doing that. It is very difficult to get information on research and development from the private sector, but this is not the case for private universities. In general, private universities in Latin America are willing to give information and to say that they are better than the public universities, so you have plenty of data about that.

Concerning publications in Panama, one of the things that makes some noise in the data is that the Smithsonian has one base in Panama. Publications produced there would be counted as Panama, even though Panama presents in their publications the statistics with and without the Smithsonian Institution. About Trinidad and Tobago, there could be several explanations. The first one is that they speak English, so they are more likely to appear in publications databases, which is not that easy for other Latin American countries. The second thing is that Trinidad and Tobago is the home office for several journals of the Caribbean, so their statistics are probably inflated by other Caribbean countries. Thirdly, a lack of quality data could be the explanation.

Concerning your first point about the humanities, usually, we do not present data without humanities because we use the Frascati Manual, which includes humanities. Raw data are available on the RICYT webpage.

- Linda Lopez, American Political Science Association – Could you tell us why there has not been a long tradition in Latin America of developing master's-level programs?

Response – I am not an expert in education, but the answer that I can figure out is that in general, the Latin American higher education is similar to the European higher education system. So for instance, in Argentina, which is the most attached to that tradition, you will find that most first university degrees are at least five or six years, where here in the U.S., they are four years. So, that two years more is basically equivalent to a master's. So in several programs, when an Argentinean comes here, he or she jumps directly to the Ph.D., and not to the master's.

- Derek Hill, National Science Foundation – The definition of "researcher" in these surveys, is it the Frascati Manual one?

Response – Yes, the definition of "researcher" is the one stressed in the Frascati Manual of OECD. Those definitions are on RICYT's webpage.

- Bruno Schmitz, European Commission – We are using the definition of the Frascati Manual as well, and I would be interested to know why is it so important, or why is it so difficult for you to work with the definition of "researcher" and not restrict it to science and engineering, and leave out arts and humanities? If I understood you right, you said that for policy purposes, it is impossible to work with the overpopulation of researchers?
- Marta Sahelsky, Inter-American Development Bank – No, I did not say it was impossible. It is just a question of utility. And when you are looking at the issue from the perspective of the economic system, the utility of the research that is performed by a member of the humanities faculties does not

quite have the same bearing as engineering and the physical sciences. It is nice to have that entire snapshot of the educational system, but if you are really looking at economic impacts, as someone who deals with this kind of policy issue within an institution that looks for results in competitiveness and productivity, it inflates the data in a way that is not terribly useful for us.

Response – I think that the European vision is much more near to giving social policies, and the American vision is much more near to give economic policies. I think that would be the shift.

- Roberta Spalter-Roth, American Sociological Association – So, one could argue that when you say "policy," it is a narrow definition, an economic-based definition.

Response – Yes, but that is not the only policy you should take.

- Bruno Schmitz, European Commission – I do not see the split as being concentrated purely on economic policy. I also believe that in the modern world, since 10 years ago or so, arts and humanities are really playing a more important role in economic development and competitiveness. For this reason, I think there is no rationale for splitting the two categories.