Higher Eductation in
Ibero-America | **2015 Report**

Knowledge transfer activities, innovation and entrepreneurship in universities.
EXECUTIVE SUMMARY

Senén Barro Ameneiro (Ed.)

REDEMPRENDIA

universia

cinda

EXECUTIVE SUMMARY: Knowledge transfer activities, innovation and entrepreneurship in universities

Higher Education in Ibero-America
2015 Report

This document is the **Executive Summary** of the book: *Knowledge transfer activities, innovation and entrepreneurship in universities. Higher Education in Ibero-America. 2015 Report*, available at http://www.cinda.cl/wp-content/uploads/2014/02/LIBRO-INFORME-TRANSFERENCIA-DE-I-D-2015.pdf.

This report should be referenced as follows: Barro, S. (ed.) (2015). *La transferencia de I+D, la innovación y el emprendimiento en las universidades. Educación superior en Iberoamérica. Informe 2015.* Chile: CINDA.

.

INDEX

EXECUTIVE SUMMARY: Knowledge transfer activities, innovation and entrepreneurship in universities. Higher Education in Ibero-America. 2015 Report.

Senén Barro
Researcher at Centro de Investigación en Tecnologías de la Información (CiTIUS) from the University of Santiago de Compostela and President of RedEmprendia

Sara Fernández
Associate professor at the University of Santiago de Compostela

1. INTRODUCTION

Universities need to provide solutions to the social and economic needs of the region where they are based. Their mission is no longer limited to research and education; instead, they have included a "third" dimension, namely to contribute to the economic growth of their regions (Branscomb, Kodama, & Florida, 1999; Etzkowitz et al., 2000). As a consequence, the role of universities in the national Science and Innovation System (SIS) is undeniable.

In the specific context of Ibero-America, they gain even further relevance, as the other agents making up the ecosystem of innovation -mainly firms or the private industry- play a secondary role compared to regions with a similar level of development. This is why it is fundamental to study the contribution of Higher Education Institutions (HEIs) in such aspects.

The following is an Executive Summary of the book *Higher Education in Ibero-America. 2015 Report*, which analyzes the transfer of knowledge, the innovation and the entrepreneurship of the Ibero-American Higher Education Systems (HESs) during the first decade of the 21st century. In order to improve related aspects, first we need to perform an accurate diagnosis from which to lay the foundation for the appropriate recommendations leading to public and university policies.

The report is divided into chapters analyzing the processes and the contribution of academic R&D. Due to the inconsistencies in the amount of information and its availability among Ibero-American HESs, the analysis has been made individually (country by country), for Argentina, Brazil, Chile, Colombia, Spain, Mexico and Portugal, or jointly, by groups of countries, thus identifying on one side a group formed by Costa Rica, Ecuador, Panama, Peru and Uruguay (Group 1), and, on the other, a group formed by Bolivia, Guatemala, Honduras, Nicaragua, Paraguay, the Dominican Republic, El Salvador and Venezuela (Group 2).

These country studies are the basis which the penultimate chapter stems from. It refers to the strong and weak points of the connections between university R&D (Research and Development) and the industry, and it develops a group analysis of the region, allowing us to draw fundamental conclusions and recommend actions to improve the situation, summarized in the last chapter, *Considerations and Recommendations for the Design of Policies in R&D&I&E (Research and Development and Innovation and Entrepreneurship).* The Executive Summary presented in this document is the result of both chapters.

Following this introduction, the next section describes the human and financial resource endowment allocated to academic R&D. The third section studies to which extent the support of transfer from universities has been institutionalized. Sections four to six present the main results from the HESs measured in terms of publications, patenting activity and entrepreneurship, respectively. Finally, we present the main considerations regarding knowledge transfer, innovation and entrepreneurship in the HESs of the region, as well as the main recommendations that can be drawn from the trends detected in these processes.

2. R&D RESOURCES IN HIGHER EDUCATION SYSTEMS

During the decade 2000-2010, the financial and human R&D resources of Ibero-American HESs have risen significantly. With regards to financial resources, every country, except Guatemala, has considerably increased the expenditure on university R&D. In fact, this amount has doubled in most countries and even multiplied by three in Portugal and Costa Rica, and by four in Colombia and Uruguay (Figure 1). However, we must note that in Spain and Portugal, for which we have data for 2011 and 2012, this indicator is falling as a consequence of the severe crisis their economies have suffered since 2008.

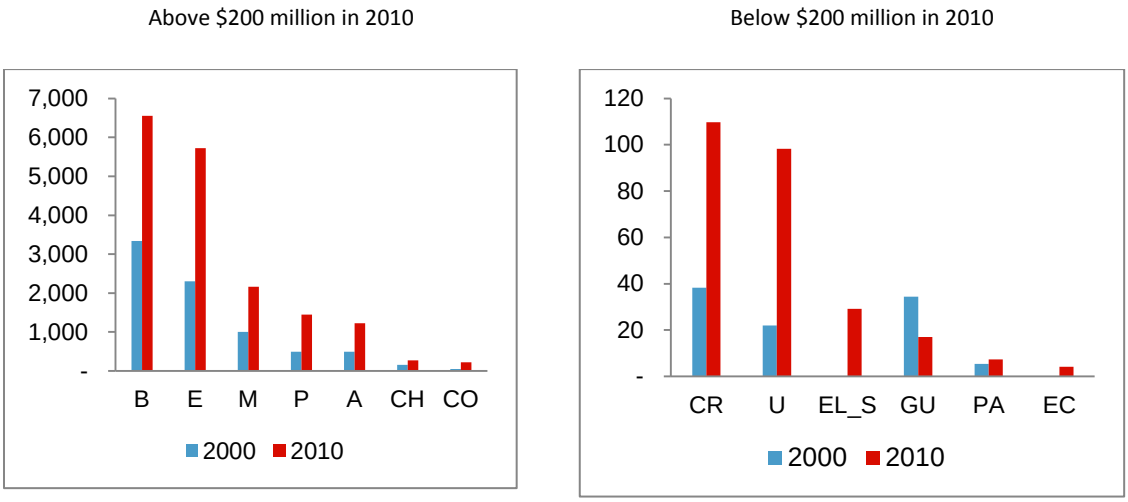


Figure 1. R&D expenditure at current prices and PPPs performed by the HES in some countries of the region (2000-2010).

Similarly, the number of researchers in full-time equivalent (FTE) experienced significant growth rates. This indicator has multiplied by two in Argentina, Brazil, Colombia and Costa Rica and by three in Portugal and Venezuela, whereas this growth has been more moderate in the rest of countries (Figure 2). Growth has been accompanied by an improvement in the quality of human resources due to the admission of PhD students and can also be explained by: 1) the increase in the number of doctorate scholarships (in Argentina); 2) the increase in the number of higher education institutions (in Brazil and Mexico); 3) the design of academic careers providing more stability for researchers (in Brazil and, since the introduction of recent changes in policies, in Mexico as well) and 4) repatriation policies designed to attract researchers working abroad (in Mexico).

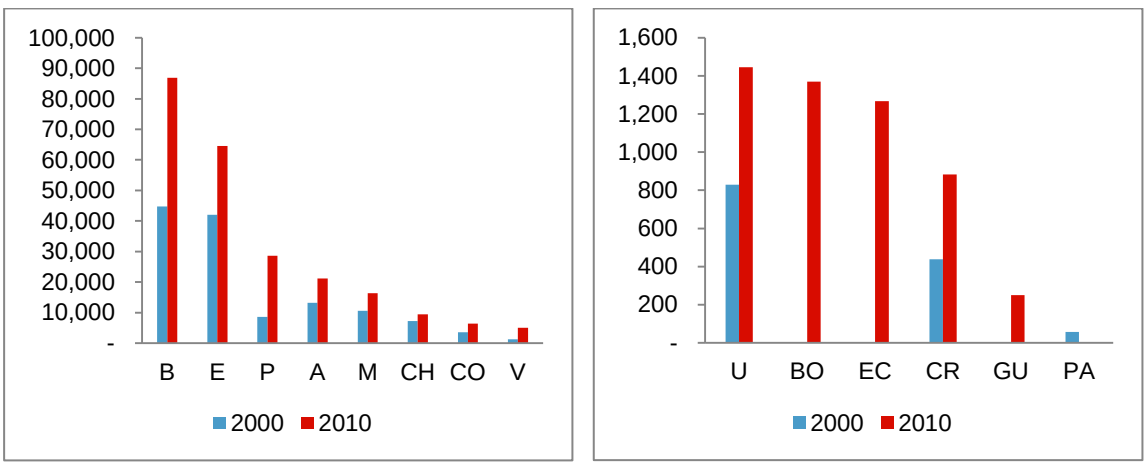
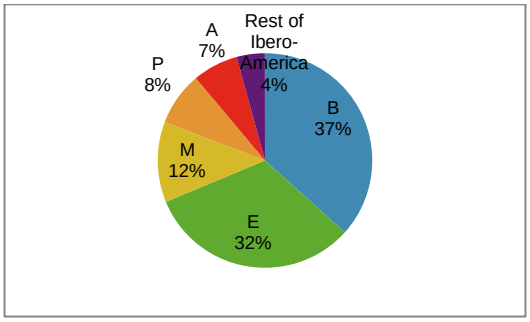


Figure 2. Researchers (FTE) in the HES in some countries of the region (2000-2010).

The HESs of Brazil and Spain represent nearly 70% of the total expenditure on R&D performed by the HESs analyzed, as well as 62% of FTE researchers. When adding Mexico, Portugal and Argentina, these percentages would exceed 90% for both indicators and these figures have been reasonably stable throughout the decade 2000-2010 (Figure 3).

Shares of R&D expenditure by selected countries as a percentage of total R&D expenditure performed by the HES of Ibero-America (in millions of PPPs)



Shares of R&D researchers (FTE) by selected countries as a percentage of total researchers (FTE) in the HES of Ibero-America

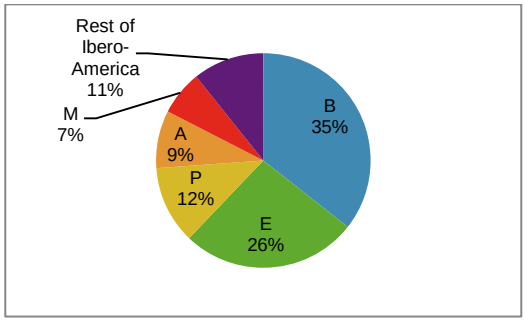


Figure 3. Shares of R&D expenditure and researchers (FTE) of the HES (2010).

There is, however, a clear gap in the human R&D resources between countries. While Spain and Portugal -mainly the latter- report a number of researchers per 1,000 labor force (FTE) similar to that of developed countries, and Chile maintained the proportion of over one researcher throughout the decade, only Argentina managed to reach this level in 2010 and Brazil came near to this figure. On the contrary, Colombia, Costa Rica, Ecuador, Mexico and Venezuela are far behind, with indicators not reaching one researcher per 3,000 labor force (FTE).

Meanwhile, the ratio of professional and support personnel per researcher for those HESs where information is available shows a shortage of R&D support staff. Therefore, researchers are usually forced to accept the huge bureaucratic workload of running R&D activities, undermining the overall system's efficiency.

In several of the HESs analyzed, in particular those from Latin America and the Caribbean (LAC), R&D resources tend to concentrate in a few universities, while the rest of HEIs have hardly any involvement in R&D activities. Furthermore, this concentration usually follows a centralizing trend around large cities (in Argentina, Brazil or Chile), as well as public universities, because private HEIs, with a few exceptions, still focus their offer on teaching (in Mexico).

Apart from the differences in size, the Ibero-American HESs are crucial agents within the national SIS, due to the importance of their share both in R&D expenditure and researchers (FTE). Thus, in 2010 they performed around 30% of the R&D expenditure. In Colombia, Costa Rica, Portugal and Uruguay this percentage raised to 40%, and over 90% in Guatemala. Besides, they concentrated the majority of researchers (FTE), except, on one hand, Costa Rica, where its HES gatherer around 15% of all researchers in the SIS, and, on the other hand, Argentina, Spain and Mexico, where their HESs gathered around 35%, and sometimes more, of all researchers. These figures follow the same trend detected in the decade 1997-2007 (Santelices, 2010).

In addition, for some of the region's countries, experts have also pointed that HESs concentrate a high part of the infrastructure and facilities their governments allocate to R&D activities.

This leads to two intangible values making HESs essential: they are virtually the only ones responsible for qualifying advanced human capital and, due to the lack of researchers in the private industry of the region's countries, they support innovation in the private industry far more than HESs in more developed countries.

3. THE INSTITUTIONALIZATION OF THE SUPPORT OF KNOWLEDGE AND TECHNOLOGY TRANSFER

We have analyzed two aspects concerning the institutionalization of the support of knowledge and technology transfer: infrastructures or interface structures providing this service and the regulations applicable.

3.1. THE TECHNOLOGY TRANSFER OFFICES (TTOs)

The interface structures bridging academia and industry have adopted numerous legal and organizational forms in the region's countries. The most common one, though under different names, is the Technology Transfer Office (TTO), known as Oficinas de Transferencia de Resultados de Investigación (OTRI) in the Iberian Peninsula.

This kind of infrastructure has appeared progressively in the region's HESs. Their appearance sequence has several elements in common; at the beginning, the TTOs generally appear in a few universities to fulfil the need for a "professional manager" to transfer research results. At that moment, their tasks focus on protecting the universities' research results and on strengthening links with industry. Later, as this "motivation" is shared by other HEIs, there is an increase in the number of TTOs, though often not attached to a strategic plan. When some TTOs settle down, the nature of their work leads to the creation of a national TTO network. In so doing, TTOs aim to take advantage of their limited resources by combining their efforts and sharing experiences in order to foster knowledge transfer. As a result of this process, the TTOs are created when the "third mission of universities becomes more relevant in the region's HESs" (Figure 4).

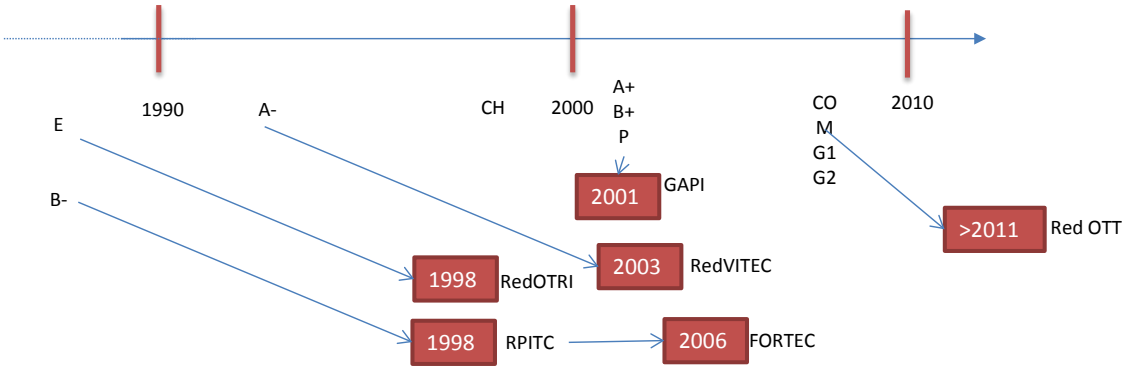


Figure 4. Chronology of the TTOs and the national TTO networks in some countries of the region.

Notes: The figure places each HES in the approximate decade when the TTOs appear. It is possible that some universities already had a TTO before that. However, we do not reflect this situation as it is not illustrative in the HES. The symbols - / + reflect the appearance of some/many TTOs in the country. The dates in which the TTO networks appear are displayed in the boxes.

It has been difficult to obtain information regarding the interface structures from some HESs both from a quantitative and a descriptive point of view, due to a lack of systematic data (Table 1).

Table 1

Interface Structures in Some Countries of the Region

	B	CH	CO	ES	M[2]	P
Indicators	2012	2012	2014	2011	2012	2010
% of universities with TTOs	34.14%	36.70%	48%	92%	77.16%	87.50%
Age of TTOs in years (mean)	n.a.	4.7	5	> 15	5.6	<10
Number of staff (FTE) of TTOs (mean)	7	n.a.	3	12.6	17.9	1 to 14
Technical staff of TTOs (%)	60%	n.a.	28%	75%	57%	n.a.
Administrative staff of TTOs (%)	40%	n.a.	72%	25%	43%	n.a.
% of universities with incubators	37.96%[1]	31.70%	27.00%	48.10%	57.41%	n.a.
Age of incubators in years (mean)	7[1]	6.9[1]	3	n.a.	7	n.a.
% of universities with science/technology parks	7.93%[1]	n.a.	5.00%	40.50%	3.09%	n.a.
Age of science/technology parks in years (mean)	n.a.	n.a.	8	n.a.	7.73	n.a.

Notes: n.a. Not available. [1] In reference to 2010. [2] Based on a sample of 162 Mexican HEIs which concentrate the 70% of the members of the National System of Researchers.

Age is usually an extremely relevant indicator for interface structures, and more so for TTOs, as this variable reveals to a great extent the abilities developed; the older the TTO, the better their personnel's abilities and skills to run commercialization processes (Roberts & Malone, 1996; Rodeiro, Fernández, Otero, & Rodríguez, 2010; Siegel, Waldman, Atwater, & Link, 2003). Table 1 shows that, except in Spain and Portugal, the average age of TTOs in the region is five years old. Therefore, most TTOs in the Latin American HESs are only emerging.

As a general rule, they can be described as small structures with a staff dedicated to technical and administrative tasks, though the former represents over 60% of the total staff in countries where there are data available, except in Colombia.

Their staff's limited experience has been thoroughly discussed. This is due to the fact that they have been hired when the TTO was created and their skills improved together with the tasks that were commissioned with. This lack of experience is particularly evident in the commercialization of new technologies. TTO staff has also been associated with temporary positions and high staff turnovers, because they usually depend on the funds received for projects of a limited duration (this is the case of Spain and Portugal). Once the projects conclude, there is no budget to justify keeping these workers who are then experienced and skilled. In this sense, some HES's have made considerable efforts to train the TTOs' staff. The fact that one of the main activities of the national TTO networks has been supporting their workers' training is proof thereof.

3.2. OTHER INTERFACE STRUCTURES: INCUBATORS AND SCIENCE/TECHNOLOGY PARKS

Recently, new types of interface structures have appeared. This is the case of incubators, science/technology parks and entrepreneurship centers, which started opening in the context of the Ibero-American HESs around the first decade of the 21st century.

Overall, the second most common support infrastructure is the incubator (Table 2). On the contrary, science/technology parks are interface structures with little presence in the region's HESs, except in Spain, where they exist in 40% of the universities. The disparity in the availability of science/technology parks reflects the different innovation policies that countries have been applying at a national level, rather than the strategies of the HESs as such.

Table 2

HESs by the Percentage of Universities with TTOs, Incubators and Science/Technology Parks

% of universities	TTOs	Incubators	Science /Technology parks
>75%	Spain, Mexico and Portugal		
51%-75%		Mexico	
25%-50%	Brazil, Chile, Colombia and Uruguay	Brazil, Chile, Colombia, Spain and Uruguay	Spain
<25%	Group 1: Costa Rica, Cuba, Ecuador, Panama and Peru Group 2: Bolivia, Guatemala, Honduras, Nicaragua, Paraguay, Dominican Republic, El Salvador and Venezuela	Group 1: Costa Rica, Cuba, Ecuador, Panama and Peru Group 2: Bolivia, Guatemala, Nicaragua, Paraguay, Dominican Republic and Venezuela	Brazil, Colombia and Mexico Group 1: Cuba, Ecuador, Panama and Uruguay Group 2: Bolivia, Honduras, Nicaragua, Paraguay, Dominican Republic, El Salvador and Venezuela
No information		Group 2: Honduras and El Salvador	Group 1: Costa Rica and Peru Group 2: Guatemala

Notes: For Mexico data are based on a sample of 162 Mexican HEIs which concentrate the 70% of the members of the National System of Researchers.

Lastly, though not reflected in Table 2, some HESs have worked with entrepreneurship centers. In particular, Colombia and Mexico, the only two countries providing quantitative data in this respect, admit that entrepreneurship centers are present in 64% and 84% respectively of the universities subject to study. Although Chile, Colombia, Spain and Portugal do not provide data, Cruz (2014) points out that some of their universities have entrepreneurship centers. Their presence is also significant in Ecuador (4 HEIs), Panama (4 HEIs), Bolivia (2 HEIs), Guatemala (2 HEIs), Nicaragua (5 HEIs), Paraguay (1 HEIs), the Dominican Republic (3 HEIs) and El Salvador (1 HEIs). The existence of entrepreneurship centers means that their HEIs have chosen to develop abilities to encourage and facilitate entrepreneurship among their students and scholars (Cruz, 2014).

Similarly to what happened with R&D resources, interface structures tend to concentrate around the HEIs with a higher level of R&D activities, and this is due to a centralizing trend around publicly-funded universities.

3.3. TECHNOLOGY TRANSFER REGULATIONS

The level of regulation of the universities' knowledge transfer activities gives an idea of how developed they are in the academic context. Thus, as university interface structures have yielded experience, there has been a gradual increase in the regulation of technology transfer processes. These regulations appear slightly later than interface centers and as a response to the need to establish protocols for the main activities they perform.

Intellectual property is the most regulated activity (Table 3), followed by norms on licensing activities and the creation of spin-offs, both just as important. While the Spanish HES has explicitly regulated the creation of spin-offs in half their universities, other HESs, such as the Brazilian and Mexican ones, focus on licensing activities instead.

Table 3

HESs by the Percentage of Universities with Regulations on Intellectual Property, Licensing and Spin-Offs Activity

% of universities	Intellectual property	Licensing activity	Creation of spin-offs
>75%	Portugal		
51%-75%	Brazil, Chile, Colombia, Spain and Mexico		Spain
25%-50%	Ecuador and Uruguay	Brazil and Mexico	Colombia
<25%	Group 1: Costa Rica, Cuba, Panama and Peru Group 2: Guatemala, Honduras, Nicaragua, Paraguay, Dominican Republic, El Salvador and Venezuela	Colombia Group 1: Costa Rica and Panama Group 2: Guatemala, Dominican Republic, El Salvador and Venezuela	Brazil and Mexico Group 1: Costa Rica, Panama and Peru Group 2: Guatemala, Dominican Republic and Venezuela
No information	Bolivia	Group 1: Cuba, Ecuador, Peru and Uruguay Group 2: Bolivia, Nicaragua and Paraguay	Group 1: Cuba, Ecuador and Uruguay Group 2: Bolivia, Nicaragua, El Salvador and Paraguay

Notes: For Mexico, data are based on a sample of 162 Mexican HEIs which concentrate the 70% of the members of the National System of Researchers.

4. RESULTS FROM UNIVERSITY RESEARCH

In this section we analyze the research results bearing no relation to knowledge transfer in a strict sense. As a general rule, these results are related to basic or fundamental research instead and are mainly based on bibliometric indicators, as well as on qualifying advanced human capital.

4.1. ADVANCED HUMAN CAPITAL

The formation of advanced human capital has considerably progressed in the past few years (Figure 5). All HESs for which data are available, except the Spanish HES, have at least doubled the number of PhD graduates over the period 2000-2010, and this represents average annual growth rates beyond two digits for most countries (Argentina, Chile, Colombia, Mexico, Costa Rica and Ecuador). These growth rates are around 8% in Brazil, Portugal, Cuba and Uruguay, while in Spain they are 3%. In this sense, in the past decade, all HESs have focused their policies on the growth of advanced human capital, as they are aware that it is a key aspect insofar as it acts as facilitators for a subsequent development of R&D results.

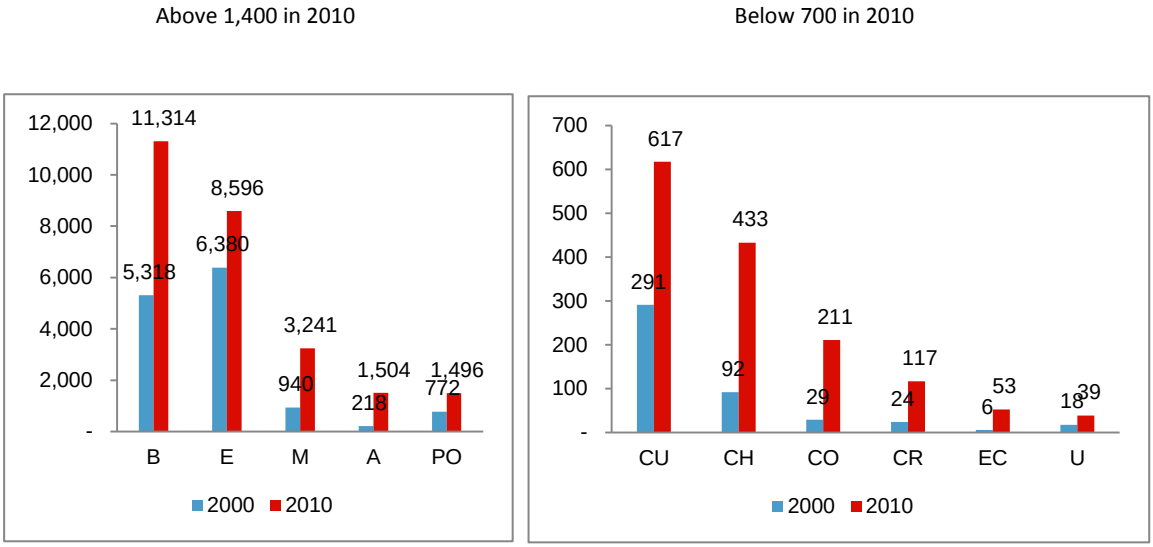


Figure 5. PhD graduates in some countries of the region (2000-2010).

As opposed to the trend to train PhD students abroad, which used to be the main policy in the past decades in LAC and Portugal, today the larger HESs have strongly promoted training them through national programs. This is not the case of the HESs included in Group 2, except Venezuela, where most PhD graduates have studied abroad or through co-operation programs with foreign universities, mainly Spanish universities.

The growth in the number of PhD graduates is consistent with three issues mentioned earlier. Firstly, only a few HESs concentrate 95% of the total number of the region's PhD graduates (Brazil, Spain, Mexico, Argentina and Portugal). The size of these HESs and their research backgrounds explain the differences in this indicator.

Secondly, when considering the number of PhD graduates to the labor force, the gap becomes more evident. While at the beginning of the decade, Spain and Portugal already had around 350 and 150 PhD graduates per million in the labor force, respectively, in 2010 the rest of the countries were still under 100 PhD graduates, except Argentina, Brazil and Cuba, and even less than 10 PhD graduates in Colombia and Ecuador.

Thirdly, despite the growth in the amount of PhD graduates, there is not enough "researcher density" yet to apply an intensive program of technological development in HESs and consolidate research groups.

Besides, the number of PhD graduates in Humanities and Social Sciences, both fields of knowledge less related to applied research, represents very high percentages of the total number of PhD graduates: over 50% in Mexico, Costa Rica and Cuba, around 40% in Brazil, Spain and Portugal, and over 30% in Argentina. The complete opposite can be appreciated in the field of Engineering and Technology, where it is easier to use applied research in commercial products. Thus, with the exception of Portugal, where the number of PhD graduates in this area represented 21% of the total PhD graduates in 2010, they are around 15% or less in the rest of the countries for which data are available.

These figures show that research in Ibero-American HESs still suffers from a low specialization in "horizontal" scientific areas, i.e., with a transversal impact in various industries, such as Engineering, Sciences related to materials and Computer Technology and Interdisciplinary Research. It is essential to acquire scientific abilities in these "horizontal" sciences, as they generate spillovers on other scientific areas (BID, 2010).

4.2. BIBLIOMETRIC INDICATORS

Bibliometric indicators also show some of the earlier-mentioned patterns, which could be considered systemic in the region's HESs. Thus, five HESs (Spain, Brazil, Mexico, Portugal and Chile) concentrate 90%

of the region's publications in *Science Citation Index* (SCI). To a great extent, this concentration is due to the differences in the size of the HESs. However, in some cases the "size effect" has been compensated by the efficiency of researchers. For instance, when considering the number of publication per million inhabitants, Chile, whose HES is lower than those of Argentina, Brazil or Mexico, occupies the third place with almost 500 publications per million inhabitants in 2010. These figures are only surpassed by Spain and Portugal, with nearly 900 publications in the *SCI* per million inhabitants. The rest of HES are far behind.

In general, the region's HESs have experienced two opposing trends over the decade. On one hand, there is an outstanding growth in the number of publications in the *SCI*. Thus, countries such as Spain and Mexico have doubled their number of publications, while Chile and Portugal have tripled theirs. In fact, the average annual growth rates registered throughout the decade are over 6% for all HESs shown in Figure 6, as well as countries in groups 1 and 2, except Cuba and Venezuela (Figure 7). On the other hand, there has been a fall in the number of citations. Both trends have also been reflected in a recent publication in *Nature* (Van Noorden, 2014) for the South American SISs.

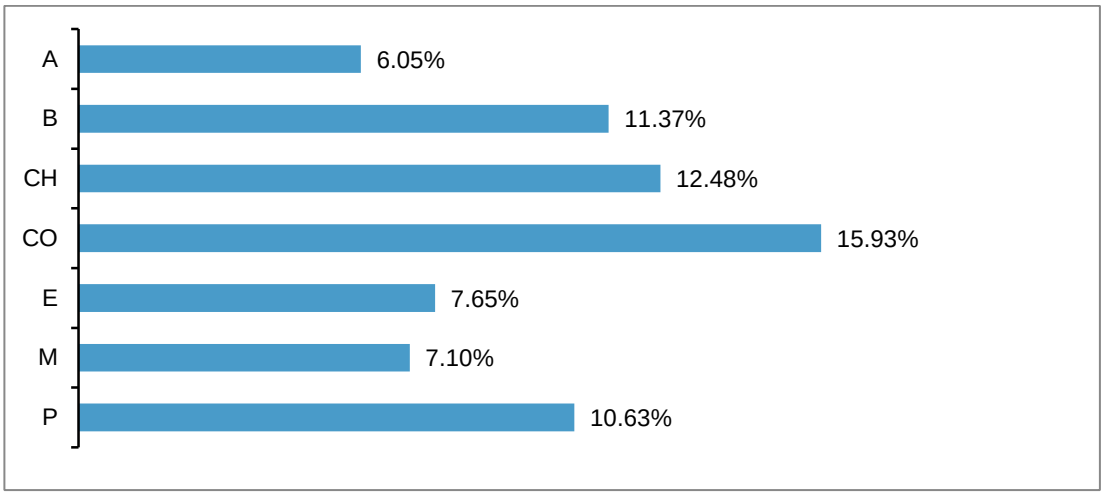


Figure 6. Average annual growth rates of the publications in *SCI*: Argentina, Brazil, Chile, Colombia, Spain, Mexico and Portugal (2000-2010).

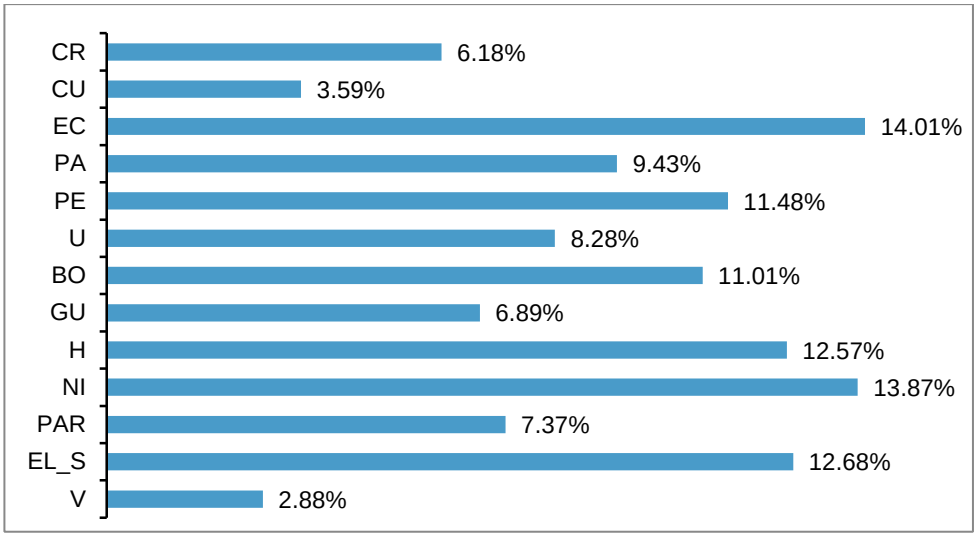


Figure 7. Average annual growth rates of publications in *SCI*: Costa Rica, Cuba, Ecuador, Panama, Peru, Uruguay, Bolivia, Guatemala, Honduras, Nicaragua, Paraguay, El Salvador and Venezuela (2001-2010).

Finally, the percentage of international collaborative publications is not very high. While in Colombia, Chile and Portugal, it represents 50-60% of all their publications in the SCI, it is around 35 to 42% in the

rest of the countries. As a general rule, the number of international collaborative publications has increased in all HESs, except Brazil, where they have fallen. Moreover, as noted by Santelices (2010) and Van Noorden (2014), this indicator used to be negatively related to the size of SIS, i.e., universities in the region's less developed countries are more likely to collaborate beyond the region, which increases the number of citations.

In LAC, the number of PhD graduates and publications in SCI are usually concentrated in just a few HEIs with more R&D resources available. In order to minimize the effects of this vicious cycle, some countries have developed national policies aiming at decentralizing the geographical concentration of research (that is the case of Argentina, for instance), but until now results have not been significant.

The importance of the universities' research in the countries' bibliometric indicators confirms their role as key agents in the national SIS. In Brazil, Chile, Colombia, Mexico, Costa Rica and Venezuela, HEIs produce over 90% of the country's publications in the SCI. In Spain, Portugal, Ecuador, Peru, Uruguay, Bolivia, Guatemala and Honduras, this percentage is over 80%. These figures are far higher than the percentage of the country's human and financial R&D resources concentrated by the HES. This may be explained by the fact that university researchers, compared to those in the industry and government agencies, tend to focus their work on publications to a greater extent.

5. RESULTS FROM UNIVERSITY KNOWLEDGE AND TECHNOLOGY TRANSFER

This section aims to study the university patenting and licensing activities, as well as the scientific, technical or artistic activities hired or commissioned to third parties.

5.1. PATENTING AND LICENSING ACTIVITIES

With the exception of Argentina, Brazil, Spain, Mexico and Portugal, it has not been possible to obtain consistent data regarding the university patenting activities.

Patents are the most common legal means of protecting university knowledge. However, there are huge differences in the patent applications at the national patent offices among the HESs. While the number of patent applications annually filed by the Brazilian HES has been around 1,500 in the past few years, in Spain and Mexico, it has been of over 500 and in Portugal over 100. Argentina is far behind with around 30 patents in 2010. When considering the number of patent applications per million inhabitants, the Spanish and Portuguese HES reached 10 in 2010, while in Brazil this figure was over eight, in Mexico over two and in Argentina less than one.

In the HESs for which data are available, there is evidence of a considerable effort to apply for patents at the national office, as all of them display significant average annual growth rates over the period 2000-2010: Argentina (11.35%), Spain (9.4%), Mexico (18.3%) and Portugal (26.4%). This boost of patenting activities has been accompanied by an increase in human and financial R&D resources, as well as the birth and professionalization of interface structures, namely TTOs, as pointed out earlier.

The Brazilian HES has filed more Patent Cooperation Treaty (PCT) applications than those at the national office, while in Spain the number of filed PCT applications represents around 40% of those filed at the national level. In both countries, the number of filed PCT applications has not experienced significant growth rates throughout the decade. Meanwhile, the Portuguese HES shows an important growth, partly due to the fact that its starting point was very low, so in 2010 the number of filed PCT applications represents around 30% of those filed at a national level.

The "success rates" (patents granted/patent applications) have shown significant differences. We must clarify that the success rates we comment thereof are just an approximation, as sometimes years can go by between the application being filed and finally granted[1]. Thus, while in Argentina, Brazil and Mexico there has been a slight fall, as in Argentina and Brazil granted patents are around 10-13% of patent applications, and 30% in Mexico, in Portugal figures are far more optimistic with over 50% of patent

[1] As an alternative, we have estimated a "delayed success rate" (patents granted/patent applications five years earlier). The results are similar.

applications granted. Spain has also experienced a fall; however, its HES has a higher "success rate" (with over 60% of patent applications granted).

Meanwhile, De Moya-Anegón (2012) presents a detailed analysis of patents granted by the USPTO to Ibero-American applicants, including universities and public research institutions, for the period 2003-2009. Out of the 900 Ibero-American applicants, 6% are universities (54 institutions in total) which own 171 patents. Thus, the HESs have a relevant presence in the patents granted by the USPTO. As can be seen in Figure 8, out of these 54 universities, 24 are Spanish and own 109 patents. They are followed by Chilean universities (nine) with 18 patents, Portuguese universities (five) with nine patents, Argentinian universities (four) with five patents and Brazilian universities (three) with 15. The rest of the HESs represented in the Figure have two or fewer universities with patents. These figures show again a high concentration of R&D activities in only a few universities, which are particularly active in this area[2].

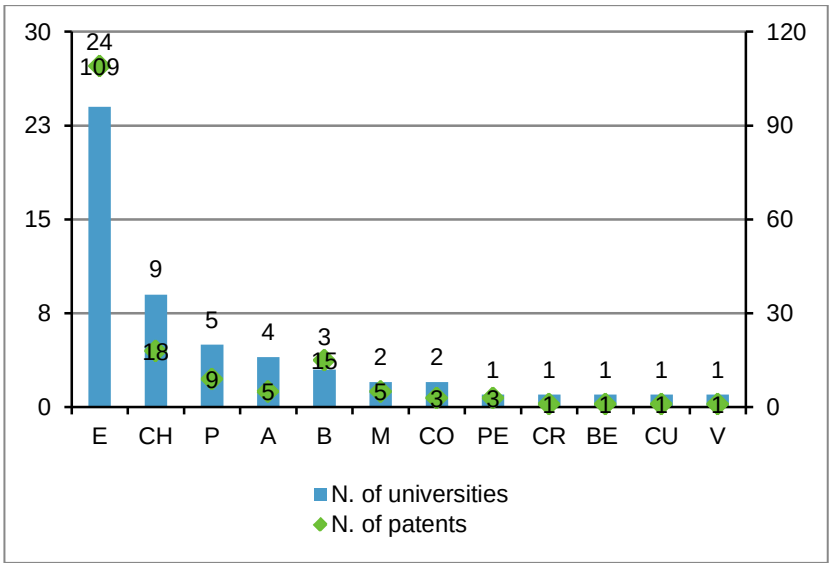


Figure 8. Number of Ibero-American universities with patents granted by UPSTO and number of patents granted by HES (2003-2009).

Notes: HESs are ordered by the number of universities. BE means Belize.

Source: De Moya-Anegón (2012, p. 403)

There are no patent applications or patents granted for the HESs in group 2 (Bolivia, Guatemala, Honduras, Nicaragua, the Dominican Republic, Paraguay and El Salvador), except Venezuela where, according to experts, less than 25% of HEIs would be active in this area. This percentage mainly represents the activity of the HEIs in countries belonging to group 1 (Costa Rica, Cuba, Ecuador, Panama and Peru), with the exception of Uruguay, where experts claim there are 25-50% of HEIs with patents.

The data show that HESs' patenting activity at a national level is fairly low in Argentina and Mexico, but significant in Brazil, Chile, Spain and Portugal, where over 15% of all patents in these countries are granted to HESs. Therefore, we can partially confirm the earlier-mentioned trend to concentrate the university research activities in publication while patenting activity is more reduced.

This lower level of patenting activity is due to several reasons shared by some of the countries. Among others, these are the main reasons:

1. A limited relationship between universities and industry (Argentina, Chile, Spain and Mexico).
2. An economy mainly based on natural resources and dependent on imported technology.

[2] The Universidad Politécnica de Valencia (37 patents), the Universidad de Sevilla (11), the Universidad de Salamanca (nine) and the Universidade Federal de Río de Janeiro (eight) gather almost 40% of all patents granted in the period 2003-2009.

3. A business tissue formed primarily by SMEs with hardly any inclination towards innovation (Lederman, Messina, Pienknagura, & Rigolini, 2014).
4. HESs with academic careers heavily focused on publications, and reluctant to regulations aiming at encouraging the transfer of technology to society.
5. The weakness of intellectual property protection both at a national and institutional level.

However pessimistic the situation might seem based on the previous data, there are two positive issues concerning university patenting activity. First of all, in all countries for which data are available, patents granted to HESs at a national level have increased over the decade. Secondly, the percentage of HESs' patenting activity at a national level could be underestimating the university patenting output. On one hand, patents developed by academic researchers are sometimes owned by private companies. This is the case of Spain, where only 29% of all European patent applications from university researchers belong to universities, as opposed to 69% belonging to private companies (Fundación CYD, 2013). On the other hand, when the patents granted to universities are compared to patents granted to residents, the percentage of HESs patents increases up to 11% in Brazil, 60% in Chile, 25% in Colombia or 40% in Mexico.

As with publications, only a few HEIs concentrate most of the patents granted.

Finally, once again there is a lack of patent licensing data in many HESs, which could imply that not much is being done in this aspect. With the exception of the Brazilian HES, where patent licensing produces considerable income, with over 146 million dollars in 2012, in Spain income reached only over 2 million euros and 600,000 euros in Portugal in 2010. Meanwhile, although no data are available for Colombia and Mexico, in a study by Cruz (2014) regarding the universities in RedEmprendia, there is evidence that the Universidad de Antioquía (Colombia) and two Mexican institutions (Instituto Tecnológico de Estudios Superiores de Monterrey and the Instituto Politécnico Nacional) obtained an income of around 20,000 euros from patents in 2010.

These figures suggest that, although HESs have made huge efforts to encourage technology patents, they are very far from commercializing their results.

5.2. SCIENTIFIC, TECHNICAL OR ARTISTIC ACTIVITIES COMMISSIONED OR HIRED TO THIRD PARTIES

These activities include technical and professional tasks, including management, consultancy, design and specific training, provided in exchange for a fee via research contract. These research contracts allow for R&D knowledge transfer, though they do not necessarily generate new scientific or technological knowledge. This reveals to which extent third parties are involved in R&D activities and technical support.

Although these activities are hardly mentioned in most countries, research contracts have become a strategic aspect in knowledge transfer to industry in the Spanish case. In 2011, research contracts accounted for 95 million euros, falling from 103 million in 2010 partly due to the economic crisis in the country, which produced a negative impact both in the number of companies involved and their overall budgets.

Research contracts also generate significant incomes in other countries, such as Mexico, where the number of industry contracts has been multiplied by 16 throughout the past decade and the average sum for each contract was around 2 million pesos in 2012.

Likewise, in Brazil, for which no data are available, a good example is the relationship between Petrobras and the Universidade Federal do Rio de Janeiro, with over 1,000 contracts to date. In Colombia, universities have signed 972 contracts with external companies and institutions.

Overall, research contracts are increasingly being used by most HESs. Nevertheless, the lack of data regarding this issue is partly due to the universities' fear that income from research contracts may foster a drop of public funding they receive.

6. RESULTS FROM ENTREPRENEURSHIP

The results included in this section refer to academic spin-offs. The information available is so scarce and different in nature that it is virtually impossible to establish comparisons. Even if data are available, the main difficulty stems from the lack of a clear differentiation between the concepts of academic spin-offs and start-ups. While the former are firms created by members of the university community and based on research results, the latter are firms created by entrepreneurs with a university background.

Figure 9 reflects the approximate number of the spin-offs created in some HESs. Thus, in Brazil, the Universidade de Campinas alone created 256 academic spin-offs. Three Chilean universities (Pontificia Universidad Católica de Chile, Universidad de Antofagasta and Universidad de Chile) created 91 spin-offs. Figures for Colombia and Mexico are based on national surveys. In Portugal, three universities (Universidade do Minho, Universidade de Lisboa and Universidade de Coimbra) created 105 spin-offs. Until 2010 the Spanish HESs gathered 1,000 spin-offs, although we chose not to include them in the figure so as not to distort the scale.

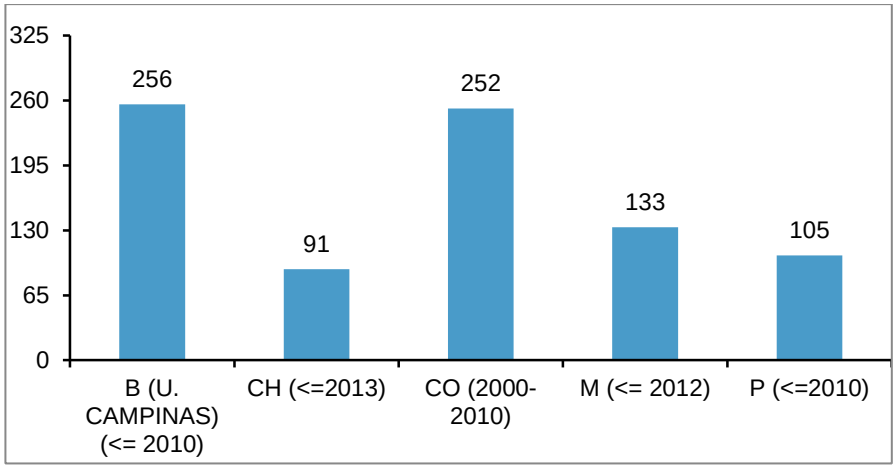


Figure 9. Number of university spin-offs created in some countries of the region.

There is no evidence of spin-offs from most HESs in group 2 (Bolivia, Honduras, Nicaragua, the Dominican Republic, Paraguay and El Salvador), except for Guatemala and Venezuela, where, according to experts, less than 25% of their HEIs would show some activity in this area. This percentage mainly reflects the activity of the HEIs from countries in group 1 (Costa Rica, Cuba, Ecuador and Peru[3]), together with the Argentinian HES, where 15% of universities have been involved in the creation of spin-offs.

From the previous data, we can infer some aspects explaining university entrepreneurship in the region. First of all, it is a relatively recent phenomenon, with little tradition in the majority of HEIs. This is evident as no data are available in this respect. Thus, in some HESs, incubated firms are considered start-ups; for others, there are data for start-ups but not for spin-offs (Portugal) and vice-versa (Spain), therefore the actual nature of the firms would distort the figures of all other countries.

Secondly, the creation of firms is concentrated in a few universities. This is especially evident in the HESs from LAC; however, to a certain extent, they are also present in the Spanish HES, where five to six universities are far more active than the rest, although half of all Spanish universities have created at least one spin-off.

Thirdly, considerable efforts have been made to encourage the creation of firms in recent times. This trend is supported by the fact that entrepreneurship centers are considered some of the main interface structures as earlier mentioned. However, it seems that, although they are consolidated in large universities with a long history of knowledge transfer, other institutions follow their steps without a solid plan. As we have already pointed, this becomes evident due to a lack of laws regulating this activity, even in the largest HESs.

[3] There is no evidence of spin-offs in Panama.

7. CONSIDERATIONS AND RECOMMENDATIONS FOR THE DESIGN OF POLICIES IN R&D&I&E

The HESs of the region present huge differences in their dimension and results, which, together with a systematic lack of information, make it enormously difficult to draw conclusions that could summarize the knowledge transfer activities in Ibero-American HEIs. Thus, we find HESs in countries such as Spain and Portugal, with plenty of information and indicators, which are close to those of developed countries. In turn, within LAC there is a need to detach Brazil, Argentina, Mexico or Chile from the rest of the countries, because, depending on the indicator, their HESs gather around 90% of all activity in LAC.

Throughout the study, it is evident that the Ibero-American HESs play a crucial role in the national SIS. This becomes evident due to the following:

1. They perform around 30% of the R&D expenditure and concentrate most researchers (FTE) in the country.
2. Their role goes beyond capturing most resources and includes intangible relevant values, such as being responsible for qualifying PhD graduates and researchers who will eventually work in the rest of the industries, as well as providing support to innovation in the private sector more so than HESs in more developed countries.
3. They produce around 80% of all publications in the Science Citation Index.
4. Despite the limited amount of patents granted, when considering patents granted to residents at national offices, HESs play a significant role.
5. The private sector interacts less with the Ibero-American SIS compared to the rest of developed countries or even emerging countries, therefore more of the responsibility for the advances in science and technology are placed on the HESs of the region.

The importance of HESs in the region's R&D makes it so urgent to promote a good number of improvement actions; otherwise, the gap among regions will inevitably increase.

The following considerations and recommendations have been formulated so that they apply to all Ibero-American HESs. When providing general recommendations, we are exposed to two fundamental risks. On the one hand, since there were more information and institutional strategies encouraging university R&D activities in some of the countries, we are giving up establishing more suitable recommendations to this group of HESs. On the other hand, the measures herewith proposed may not be applicable in some countries due to legal constraints or their scientific-technological development.

Bearing these points in mind, we present the main considerations stemming from the analysis of the universities' knowledge transfer processes in Ibero-America for the period studied. Our recommendations apply to policies related to R&D, knowledge and technology transfer, innovation and entrepreneurship (R&D&I&E).

INFORMATION AVAILABILITY

One of the difficulties we encountered when elaborating this study was the lack of information on many of the knowledge transfer processes at universities, in particular, those related to interface structures, regulations and patenting activity, and, more specifically, academic entrepreneurship.

The lack of information makes it difficult to adopt decisions and design national and institutional policies that would otherwise help improve the efficiency of HEIs. That is why it is absolutely necessary to gather enough reliable information in order to establish comparisons. **Universities and governments must have data reflecting the activities and impact of academic R&D**. It would be desirable to identify and standardize indicators for each HES. These indicators could be based on those used by institutions with a recognized background experience in the field (AUTM or OTRI Network, among others). In this sense, organizations such as the RICYT (Network for Science and Technology Indicators) are in a privileged position to perform this task. Moreover, the universities who are members of CINDA and RedEmprendia could propose a plan to promote and establish internal systems to collect this information according to international requirements.

FINANCIAL R&D RESOURCES

Between 2000 and 2010, there has been a significant growth in the financial R&D resources of Ibero-American HESs. The economic development of the region's countries foster an overall increase in R&D spending, rather than a greater ratio of R&D expenditure to GDP.

This strong relationship between the financial R&D resources and the countries' economic development will put universities' R&D activities seriously at risk in the coming years. Some of the region's countries are immersed in extremely harsh recessions (Spain and Portugal) and others are likely to experience only moderate economic growth in the near future (Brazil, Chile or Mexico, among others).

Under a climate of macroeconomic volatility, it is essential to **guarantee a minimum level of financial R&D resources which enable HEIs to develop quality R&D and transfer their results to industry and society**, keeping qualified researchers and providing the necessary resources to make R&D feasible. The universities' financial R&D resources, rather than a percentage of the GDP, ought to be established as the amount of resources that guarantee an acceptable level considering the dimension and competitiveness of the HESs, especially regarding their R&D&I&E activities.

HUMAN R&D RESOURCES

Despite the improvement both in the quantity and quality of researchers, we detected some aspects that could put this improvement at risk, such as unstable and varying work conditions with a negative impact on the scientific career. For this reason, it is necessary to **design clear scientific careers, with incentives attached to productivity, R&D and knowledge transfer activities, which guarantee stability for researchers who reach clearly defined goals**.

Although there are not enough data to draw definite conclusions, we have detected a lack of R&D support staff. In this sense, first we need to **distinguish between the administrative and technical workload attached to R&D and knowledge transfer processes**. Once this is clear, we need to **professionalize these tasks by hiring personnel with specialized profiles**.

INTERFACE STRUCTURES

Over the decade, there has been a huge growth and diversification of interface structures allowing technology transfer from universities to society. The most important structure is the Technology Transfer Office, followed by incubators and entrepreneurship centers, and last, science/technology parks. This distribution of interface structures reflects the current trend in the HESs of LAC towards a model of entrepreneurship-driven universities instead of the classical model of research and education-driven universities.

At times, interface structures are created to fulfil the universities' internal needs or interests rather than as the result of a strategical plan shared by external stakeholders (namely, industry and government). In order to avoid duplicating functions, **universities and governments ought to perform appraisals before working with new structures supporting R&D transfer**. In particular, it would be desirable that public governments encourage HEIs to develop coherent plans. The strong and weak points of the universities' knowledge transfer processes need to be analyzed in order to determine which kind of infrastructure is most appropriate to their needs and interests.

In addition, many interface structures have been created recently and, as a consequence, are less experienced. In order to overcome their lack of experience and accelerate their abilities to generate synergies, it is necessary **to create a network of infrastructures and associated services**, following the example of some of the HESs. These networks should share their resources and experience so as to encourage the role of universities in the design of national innovation policies.

The lack of professional staff is one of the weaker aspects of interface structures, notably in the commercialization of technology. It is necessary to **hire staff with specific profiles trained to perform knowledge transfer processes**. Failing this, interface structures could qualify their staff through mobility programs, so that structures could overcome the inertias of parent institutions. It is especially relevant

to employ staff members with a profile specialized in the commercialization of technology, which requires very specific competences.

Moreover, since personnel funding frequently depends on public contracts, there is a high staff turnover, so workers who have already received a specific training at interface centers are often lost once the project concludes. Thus, **having enough budgets to hire and maintain a professional and diverse staff is required.**

THE INSTITUTIONALIZATION OF KNOWLEDGE TRANSFER ACTIVITIES

Though with a slight delay, formal technology transfer regulations have appeared side by side with R&D activities. While protocols regarding intellectual and industrial property are common in HESs, the creation of spin-offs and patenting are hardly regulated. This situation reflects the HESs' stage in R&D processes, as most of them are being initiated only in knowledge protection without considering the commercial value of the research results.

Unfortunately, in Ibero-America, university regulations usually clash with their national legal frameworks, because either they do not exist or they are too restrictive, so universities are unable to apply incentives such as royalty payments to their researchers if the country's law does not allow it to do so.

Despite this, it is important **to develop a framework to regulate knowledge transfer activities within universities, trying to avoid the paralysis due to the lack of regulations.** At the same time, regulations ought to be sufficiently flexible to foresee special cases, which are very different in nature, so as to avoid discouragement, both for researchers and potential beneficiaries of knowledge transfer alike. Finally, **these regulations need to be disclosed to researchers and members of the university community**, as well as external agents working for the university.

ADVANCED HUMAN CAPITAL

Throughout the decade there has been an important focus on qualifying PhD students in Ibero-America. In virtually all HESs, annual growth rates have been over 8%. Nevertheless, we have identified three weak fundamental points, which could be considered systemic and need to be addressed at the earliest convenience in order to avoid even further delays.

Firstly, in most of the region's countries the amount of PhD graduates is still insufficient for setting up and development of R&D activities. Besides, there is a high concentration of PhD graduates in a reduced number of universities from a few countries. Therefore, there is a need to **increase advanced human capital in order to achieve a critical mass of researchers who are able to contribute to the development of science and technology**. Moreover, it is necessary to encourage the design of high quality PhD programs in universities. At the PhD level -more than any other education stage- **programs need to aim for excellence, following the standards of countries that are more advanced in R&D**.

Secondly, the number of PhD graduates in the fields of Experimental Sciences and Engineering, which are considered "horizontal" fields and whose results are more easily transferable to industry, seems to fall behind those in Social Sciences and Humanities. Due to the consolidation and organization of PhD programs, LACs do not offer many programs on emerging subjects (for instance, Genomics, Nanotechnology, Advanced Computer Science, among others). In line with this, first we need **to train PhD tutors and then encourage PhD students to choose emerging areas and more "horizontal" subjects. This can produce a cascading effect in research in other fields, as well as a more significant impact on the industry**. This change in strategy involves that HESs ought to adopt a more interdisciplinary approach.

Thirdly, the research developed by PhD graduates tends not to be connected to the industry. In this sense, it is important to bring them together, so there would be a twofold positive impact. Research would accommodate the firms' needs; therefore, university applied research and innovation would be easier to transfer; and this approach **would create routes so PhD graduates are better equipped to join the industry**, i.e. they would be more employable in areas other than the academia.

BIBLIOMETRIC INDICATORS

Over the decade, although the number of publications in the *SCI* has increased, their quality, measured as the number of citations, has dropped. It is entirely possible that the scientific output in Spanish and Portuguese languages, though rich in quality, does not match the number of relevant citations in English language, thus lowering their impact.

Likewise, international collaborative publications represent a percentage of around 50-60% for most HESs, although it is negatively related to the size of the HES. These figures would also explain why there is less interest in the research carried out in the region and, consequently, publications are cited less frequently.

Nevertheless, there are additional factors that could explain the fall in the number of citations; for instance, the subject-matter of the publications, the relevance, the originality and the journal's reputation, among others.

In any case, without devaluating publications in the region's languages, HESs ought to **foster the quality of research, which usually involves publication outputs with a high impact**. In this sense, clear and strong incentives for publication need to be established. It also becomes strategic to encourage the collaboration with prestigious researchers at a national and international level and fund headhunting programs while retaining the staff.

PATENTING AND LICENSING ACTIVITIES

There are many reasons explaining the low number of patents granted in the region. Among them, there is a low density of links between the university and the industry, whose business tissue is predominantly made by SMEs without much interest in innovation. In addition, an economy mainly based on natural resources limits firms' capacities to absorb R&D results.

Although changing these trends obviously exceeds the universities' missions, universities must find ways to reach the industry. Thus, they need to **adopt a market pull approach on the R&D activities**; in other words, to sound out firms so as to assess their scientific-technological problems and base part of their research on providing solutions to these problems.

Despite that universities are starting to make considerable efforts to protect their R&D results, the "success rates" in patent grants are still low and need attention. In order to correct this imbalance, thorough action is needed from the initial stage when the idea is born to the final stage when knowledge is protected.

Thus, **researchers ought to be encouraged to explore which research results could be patented**. Incentives could include sharing royalties with the researcher and recognizing the results patented or protected in any other way.

Besides, **researchers need to be supported by the TTOs**. Thus, an expert team able to deal with the time-consuming and expensive process of patenting and the commercialization of R&D results is necessary. When unavailable, **HESs ought to engage with public or private agents with experience in this field**.

There is also a need to **go beyond patent grants and exploit them economically**. In this sense, prior to filing a patent application, the expert team must estimate its economic value in order to prioritize applications most likely to be successfully exploited.

Finally, when possible, HESs need to **compel legal changes so as to make the patenting process easier** because, in general, the national regulation frameworks in the region's countries tend to be fairly restrictive.

The lack of information available suggests not much activity in licensing and research contracts between HESs and third parties (firms, public institutions and so on). Moreover, universities are also unwilling to make this information public as they fear it would negatively affect public funding. In this sense,

universities ought to reinforce social awareness on the positive aspects of R&D externalities and explain that benefits can be re-invested in further research. Therefore, **far from reducing public financial resources, resource allocation should positively relate to research results**.

ACADEMIC ENTREPRENEURSHIP

Academic entrepreneurship (academic spin-offs and start-ups) is a relatively recent phenomenon, with hardly no tradition in most Ibero-American HESs. In any case, interest in university entrepreneurship is rapidly increasing as, at the moment, governments and other public and private agents visibly support entrepreneurship in a broad sense.

Universities need to promote an entrepreneurial culture among their members. In order to do so, it is essential to rely on the commitment and leadership of university managers, who ought to promote a complete plan, from cross-training their students in entrepreneurship abilities to the application of incentives for encouraging the staff to set up firms, in particular technology-based firms (TBFs). Some countries, such as Colombia since 2008, take into account the spin-offs set up by researchers in their academic careers.

At the same time, interface structures supporting entrepreneurship need to be professionalized and **there must be a clear incentive-based framework regulating the creation of firms**, especially for researchers involved in the creation of spin-offs.

INSTITUTIONAL CONCENTRATION OF RESOURCES AND RESULTS

Lastly, with the exception of the Spanish and Portuguese HESs, R&D activities tend to concentrate around a few Latin American universities, which benefit from more financial resources because their research teams are larger, creating a vicious circle or a "Matthew effect" (Merton, 1968). A higher resource endowment involves better performance indicators, which in turn attract potential researchers and competitive research contracts. These institutions are typically identified as public universities located in the larger cities of LAC.

To break this circle, several actions are possible; however, we advise against the demagogic approach of dividing resources. On one hand, differences between universities must be considered in order to encourage them to **specialize in knowledge fields related to strategic national industries and somehow close to the university**, or at least potentially so in a short to medium term.

On the other hand, it is necessary to **encourage the co-operation among universities**, especially between those with a long background in knowledge transfer processes and those with less experience in these tasks. This is possible if they promote expert mobility and share best practices and experiences, among other options.

REFERENCES

BID (2010). *Science, technology, and innovation in Latin America and the Caribbean. A statistical compendium of indicators.* Washington.

Branscomb, L. M., Kodama, F., & Florida, R. (1999). *Industrializing knowledge. University-industry linkages in Japan and the United States*. The MIT Press, Massachusetts.

Cruz, A. (2014). *Análisis de las actividades de investigación + desarrollo + innovación + emprendimiento en universidades de Iberoamérica.* Colección Estudios RedEmprendia.

De Moya-Anegón, F. (ed.) (2012). *Estudio de la producción científica y tecnológica en colaboración Universidad-Empresa en Iberoamérica.* Colección Estudios RedEmprendia.

Etzkowitz, H., Andrew, W., Christiane, G., & Cantisano, B. (2000). The future of the university and the university of the future: Evolution of ivory tower to entrepreneurial paradigm. *Research Policy*, *29*(2), 313-330.

Fundación CYD (2013). *Informe CYD 2012. La contribución de las universidades españolas al desarrollo*. Barcelona.

Lederman, D., Messina, J., Pienknagura, S., & Rigolini, J. (2014). *El emprendimiento en América Latina: muchas empresas y poca innovación—Resumen*. Washington, DC: Banco Mundial. License: Creative Commons Attribution CC BY 3.0.

Merton, R. K. (1968). The Matthew effect in science. *Science*, *159*(3810): 56-63.

Roberts, E. B., & Malone, D. E. (1996). Policies and structures for spinning off new companies from research and development organizations. *R & D Management*, 26:17-48.

Rodeiro, D., Fernández, S., Otero, L., Rodríguez, A. (2010). Factores determinantes de la creación de spin-offs universitarias. *Revista Europea de Dirección y Economía de la Empresa*, *19*(1):47-68.

Santelices, B. (ed.) (2010). *Educación superior en Iberoamérica. Informe 2011. El rol de las universidades en el desarrollo científico-tecnológico.* Chile: CINDA-Universia.

Siegel, D. S., Waldman, D., Atwater, L., & Link, A. N. (2003). Commercial knowledge transfers from universities to firms: Improving the effectiveness of university-industry collaboration. *Journal of High Technology Management Research,* 14:111-133.

Van Noorden, R. (2014). The impact gap: South America by the numbers. *Nature*, 510:202-203.

ANNEX 1: CONTRIBUTING AUTHORS

Chapters	Contributing authors
Argentina	Gustavo Eduardo Lugones, Darío Gabriel Codner, Fabián Andrés Britto
Brazil	Guilherme Ary Plonski
Chile	Bernabé Santelices, Marcelo Bobadilla
Colombia	Jose Luis Villaveces, Luis Antonio Orozco
Spain	Marti Parellada, Angela Mediavilla
Mexico	Enrique Villa Rivera, María Antonieta Saldívar Chávez, María Dolores Sánchez Soler
Portugal	Carlos Brito, José António Sarsfield Cabral, María Oliveira, Catarina Roseira
Group 1: Costa Rica, Cuba, Ecuador, Panama, Peru and Uruguay	Gabriel Macaya, Rafael Guerrera
Group 2: Bolivia, Guatemala, Honduras, Nicaragua, Paraguay, Dominican Republic, El Salvador and Venezuela	Rocio Robledo, Norma Morales
General chapters	Senén Barro, Sara Fernández, Claudio Rama, Bernabé Santelices

ANNEX 2: ACRONYMS OF COUNTRIES IN FIGURES

ACRONYM	⇒	COUNTRY	ACRONYM	⇒	COUNTRY
A	⇒	Argentina	**GU**	⇒	Guatemala
B	⇒	Brazil	**M**	⇒	Mexico
BO	⇒	Bolivia	**PA**	⇒	Panama
CH	⇒	Chile	**P**	⇒	Portugal
CO	⇒	Colombia	**U**	⇒	Uruguay
CR	⇒	Costa Rica	**V**	⇒	Venezuela
EL_S	⇒	El Salvador	**LAC**	⇒	Latin America and the Caribbean
E	⇒	Spain	**I**	⇒	Ibero-America

Knowledge transfer and fostering innovation and entrepreneurship are undeniable responsibilities under the universities' third mission of contributing to the social and economic development of regions.

The goal of this document is to analyze the transfer of knowledge, the innovation and the entrepreneurship of the Ibero-American Higher Education Systems during the first decade of the 21st century. This is the fifth in a series of reports on Higher Education in Ibero-America published by CINDA since 2007. These reports reflect the involvement of CINDA with higher education, as well as its efforts to contribute to the region's economic development by putting universities at the service of society.

CONICYT
COMISIÓN NACIONAL DE INVESTIGACIÓN CIENTÍFICA Y TECNOLÓGICA

Fundación C Y D