PUBLIC RESEARCH UNIVERSITIES IN LATIN AMERICA AND THEIR RELATION TO ECONOMIC DEVELOPMENT*

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1. INTRODUCTION

In 1990, the average incidence of poverty and extreme poverty in Latin America was 48.3 per cent and 22.5 per cent respectively. The slow economic expansion experienced since then plus the reorientation of public spending towards social needs managed to only partially alleviate this situation, but was far from sufficient. Indeed, in 2005 38.5 per cent of Latin America's total population of 556 million was still poor (ECLAC, 2006). This percentage is similar to the one recorded in 1980, thus implying that the absolute number of poor people in our region is much higher today than twenty five years ago. This impoverishment has been accompanied by the deterioration of labor market conditions, with informality and open unemployment reaching historical peaks.

In such pressing social context, Latin America faces the urgent challenge of achieving high and sustained rates of economic expansion capable of generating the quantity of jobs necessary to meet employment needs and alleviate poverty. To meet this challenge, the region will have to modernize its productive structure to be able to successfully compete in world markets on the basis, not of low wages, but of increased value added and technological sophistication. Such transformation requires an increasingly qualified labor force combined with a dynamic entrepreneurial sector with a strong capacity for innovation and research. Such combination is indispensable to reduce the gap in the region's pace of technological and scientific progress relative to that of the developed world.

The challenge is daunting given Latin America's laggard economic performance, and the constraints imposed on the region policy options –and for that matter on all open, less developed economies- by global markets and their increased dependence on world capital flows. The panorama has been further complicated by the Washington-Consensus based reforms implemented in Latin America that brought about a retreat of the State's intervention in the economy in favor of market forces as the main mechanism to allocate resources.

But, as we here argue, strengthening Latin Americas´ public universities, and in general institutions of higher learning and research, is a key requirement to build the competitive productive structure that may trigger and sustain a long-term economic expansion. Without it Latin America will not keep pace with advances in science and technology, and have the capacity to adapt them to finally succeed in its yet quest for economic development. What are the channels through which public research universities favor economic growth in Latin America? How can these be widened, made more efficient and effective to promote economic development? How much do they matter for economic growth? What are the shortcomings and limitations such universities must soon overcome? These are central issues addressed in the present paper.

However, before moving on, two caveats are necessary. The first is that assessing the economic impact of universities is far from being an exercise in precision. Only a few months ago was the first ever attempt to quantify such impact of Cambridge University completed. It threw an estimated impact on the British economy of 58 billion

pounds (plus 154,500 jobs) over a ten year period (CAM 2007).[1] For any Latin American university such attempt is if at all still a blueprint. And, the second one is that in our view, the contribution of public universities to Latin America's overall development can not and should not be bounded to the measurement of their impact on economic matters growth, no matter how significant -potentially or actually- it may be. Such universities in our region play and have played a critical role in the advancement of arts and sciences, diffusion of knowledge, and professional training of human capital. But also and equally important is their role in building citizenship and preserving democratic values. The social and political value of such merits is way above that of their impact on the economy.

2. HUMAN CAPITAL FORMATION, ECONOMIC GROWTH AND ECONOMIC THEORY

A fundamental tenet of our analysis is that, to achieve high and persistent economic expansion it is indispensable to carry out technological and scientific development in less developed countries, and apply it to production processes. This requires high quality public universities, particularly in their graduate and research programs and departments. Most important, for this research and training effort to translate into more and better capital accumulation and higher labor productivity, a substantive collaborative effort between academic institutions, private firms and governments is needed.

From kindergarten to graduate and post-graduate schooling, widespread access to quality education has an intrinsically high social value, reflected in a better educated population, a richer material well-being, and stronger social cohesion. In fact, average educational achievement is typically considered a key indicator of a country's human development. In countries that have or are successfully moving on the road to development, education plays an important role in improving the skills and productive capacities as well as in promoting social integration and upward mobility. Technological progress is directly linked to scientific research and, thus, to the training of scientists and engineers. In general it is mainly in universities and technological institutes where such training is provided. But, in developing countries, public universities and academic centers are the origin of the vast proportion of research actually done in them. In Latin America the vast majority of research and development projects is financed or carried out by State institutions; with more then 75 per cent of all graduate students enrolled in public universities, and on average approximately 80 per cent of the total population of researchers working in such public entities (Tunnerman, 2003).

Besides this direct impact that education has had on economic development through the advance in science and technology, education is generally associated with the level of income in a more or less direct fashion, so that the more educated a person is, the higher his, or her, level of income he, or she, can get in the labor market. This has a direct impact on economic equality in almost any society, developed or underdeveloped. It is no surprising to find in the medium run that the less educated people are, in average, the more unequal the society is in terms of income distribution.

[1] As quoted in CAM (2007), this pioneering research by the East Development Agency in addition indicates that the University "contributes 961 million pounds to the economy in direct expenditure. It employs 11,700 people, and in total supports more than 77,000 jobs".

Paradoxically, the undeniable and conspicuous relationship between, on the one hand education –particularly tertiary and graduate– and on the other hand technological change and economic growth had not been well captured by the standard theoretical models within the mainstream economics profession until a few decades ago. In fact not so long ago, such literature saw technological change merely as a residual in growth accounting exercises, exogenously and independently determined of the pace of investment. A notable exception –and actually quite critical of the conventional literature- was Nicholas Kaldor in his model of economic growth (Kaldor, 1957). In this model he captures technology changes as endogenously incorporated in new investments. Thus, research universities have a direct effect on economic growth associated to technology changes, besides their influence on human capital education.

It was not until the advent of the so-called New Growth Theory that such shortcoming of mainstream economics was corrected, and technological change was recognized as endogenously determined influence on structural change and economic growth at the micro and the macroeconomic level.

Today most literature on growth economics recognizes the relevance of human capital formation and technological advancement for economic development. Among the main contributions, within the neo-classical school stand out Romer (1986, 1990) and Lucas (1988) and within a neo-Schumpeterian view Aghion and Howit (1992), as well as Dosi (1984) and Metcalfe (1995) from a structuralist/evolutionist school. Whether through their effects on the surge of new products or processes, on the increased competitiveness of firms or the expansion of their markets, *inter alia*, they recognize research and education as essential ingredients of a dynamic and internationally competitive economy.[2]

3. Technological Progress and Latin America's Current Quest for Growth in the Global Economy

Parallel to these developments in economic growth theory, the world's economic structure and political scene changed dramatically, in an overall context marked by the swift pace of technological change. Indeed, the intense and rapid progress of science and technology has been another outstanding aspect of this era. Areas like computers, micro-electronics, robotics and biotechnology and their applications in communications, production and services have flourished. This has translated into changes in the demand and consumption patterns in most countries, as well as a modification of industrial processes that are re-mapping the world matrix of international production and trade.

Developing as well as developed nations are finding that their international competitiveness -and economic growth potential- is based more and more on their technological prowess. Successfully consolidating institutions to build up and adapt technological knowledge and innovation -in niches or across the board in different industries- new competitors, like China and India, have abruptly appeared in the international trade scene, putting pressure on Latin America to transform and modernize its productive structure. To achieve such transformation, Latin America will have to do

[2] For the purposes of this paper it is important to underline the interesting strand of research produced in Latin America in, say, the last ten years focusing on the links between universities, science/technology and human capital formation and their impact on economic growth (see *inter alia*; Cimoli, *et al.* 2005, 2006; Tunnerman 2003, Malo 2005 and, for a more global perspective see Shahid and Nabeshima, 2007).

a qualitative jump in its teaching, training and research capacity to innovate. Without it a sustained and robust long-term economic expansion, simply, will not happen.

To better gauge the relevance of public research universities to promote Latin America's economic development today, at the brink of the XXI Century, it is useful to start with a brief overview of its recent growth performance and economic outlook; paying attention to the relevance of research and technical progress. This overview will help to identify the key constraints that bind the region's long-run economic expansion and, in this regard, the ways in which public universities contribute to remove them.

3.1 Economic Liberalization and Growth in Latin America: 1980-2006.

In the 1990s, in the aftermath of the debt crisis, Latin American governments launched radical reforms to eliminate trade protection, liberalize financial markets and cut down the State's intervention in the economy. This new, neo-liberal, strategy was drastically implemented in the region. The public sector was downsized and state enterprises either shut down or privatized. Most subsidies and industrial policies were cancelled. Development banks and other public institution aimed at fostering planning and development were weakened. Trade protectionism was eliminated, and financial and other markets were deregulated and opened to international competition, increasing the role of private capital -particularly foreign capital- on the allocation of investment.

The reforms however had frustrating results on the region's development. They did reduce inflation and fiscal deficit, and brought about an export boom in Latin America. However, they were unable to trigger high and sustained economic growth or job creation. Indeed, for the vast majority of countries in the region, investment has been laggard, and the pace of economic expansion far from dynamic. In fact, the average rate of growth of real GDP per capita -as well as of labor productivity- has since then been much lower than what it used to be in 1950-1980, *i.e.*, before the neo-liberal, macroeconomic reforms were launched. Poverty, as mentioned above, still afflicts a vast proportion of our populations, the region is not catching-up with the develop world, and the gap between the have and the have-nots is widening.

Why did the reforms fail? First of all, private investment did not compensate for the decline in public investment. The lack of dynamism of investment, after years of decline during the debt crisis, impeded the modernization of domestic machinery and equipment. In this way, it sharply bounded the rise in productivity and international competitiveness. Second, exports, though they have certainly boomed, have been insufficiently linked to the domestic economy and tended to be either based on low-tech assembling activities (*maquiladoras*) or on natural-resource based manufactures with rather low or intermediate technological content. Thus they have failed to act as a dynamic engine of growth for the region. In fact, in the last four years (2003-06) the region has experienced a substantial economic recovery boosted by foreign demand -mainly for mineral inputs and natural resource based products-, the improvements in its terms of trade and a massive flow of family remittances from abroad. However, for most countries in the region, this recovery has not been accompanied by a surge in investment to guarantee persistent annual rates of economic expansion over and above the 6 per cent needed to generate sufficient jobs and soon alleviate poverty.

There is consensus that Latin America is at a crossroads. On the one hand, the region can not keep competing internationally on the basis of low wages, given that China and other East Asian economies have substantially lower unit labor costs. On the other hand, with few exceptions, Latin American economies do not yet have the technological capacity or specialized human capital to successfully compete internationally at a large scale on high-tech products. In order for Latin American nations to launch their much needed high economic growth based on international trade in knowledge intensive goods and services, they must significantly strengthen their research and development activities, their national innovation systems in which, certainly, public research universities are a pillar. Their ability to train human resources and carry out research determine the successful adaptation of the economy and society to the new global market and, ultimately, to join the ranks of developed nations.

One important function of universities is to create a critical mass of scientists and engineers to work directly in industry, business and government. The developed countries' universities and technological institutes have been fulfilling this function completely for a long time. In these countries, large corporations have R&D departments that hire university graduates. These companies, together with government agencies, finance scientific and technological research projects in universities and research institutes. In addition, the private sector supplies funds for higher education and research through different mechanisms (see Tables 1 and 2). Lastly, it is noteworthy that in such countries, corporations tend to preferentially use technology produced by their own national system of innovation, allowing them to "own" knowledge generated both in-country as well as elsewhere and apply it to local production.

4. Obstacles to the development of science and technology in Latin America

Generally speaking Latin American countries achievements -and perhaps capabilities- in developing innovative technology are found wanting (Martín del Campo, 1998; Cimoli, *et al.*, 2006). The region contributes less than 1.5 per cent of the world's scientific output (Tunnerman 2003), but accounts for 8.5 per cent of the world's total population. This is explained, partly, because in Latin America the conditions to put in place an efficient system of science, technology and innovation have been difficult, facing major obstacles. An important one is the feebleness or lack of private businesses funding and collaboration with universities and institutes for research and development. The situation is worsened by the fact that in Latin America, as in many semi-industrialized, developing economies, private firms have no R&D departments and tend to spend rather little overall on it. In general, they acquire their technology directly from abroad and devote scant resources to technical innovation beyond d that concerning administrative or marketing processes. Moreover, local scientists, technological experts and researchers tend not be fully recognized as relevant factors of production in national industries nor as pecuniary interesting career options for the young.

Recent data available for Latin America estimates the number of researchers at around 150,000 including personnel working in the productive sector and in education. The ratio of researchers to total population is between 50 researchers per million inhabitants in Ecuador and 720 in Brazil. While Japan has 5,300 researchers per million of inhabitants and the US 4,600, Spain for example has 2,200 (see Table 1). Such performance is low by international standards (see Tables 3 and 4).

Indeed, Latin America has an estimated 2,500 research institutions, (mostly linked to higher education in public universities).[3] Nevertheless, almost 80 percent of them are concentrated in only six countries and at the most an estimated 15 percent of the institutions have the effective capability to carry out research and development at internationally competitive standards (Martín del Campo, 1998). There is no reason to believe that this situation has improved significantly in the last decade. Science and technology spending is less than 0.5 percent of the gross domestic product (GDP) in the great majority of Latin American countries, and in none of them exceeds 1 percent of GDP, the percentage recommended by a number of international organizations. In the case of Mexico, for example, such expenditure averaged 0.4 percent of GDP over the last ten years. In 2003, Japan, the US, Korea, Germany, France and Canada spent between two and three percent of GDP into science and technology (see Table 3). Having said so, it is important to stress that in Latin America, most science and technology expenditures are made by the state (between 60 and 90 percent) either directly or through public institutions. The rest of the funding private sector comes either from the private sector or from funds of external sources. In contrast, in most developed countries, the government R&D financing makes up less than 50 percent of the total.

One additional element that in our region weakens the capacity to innovate as well as the capacity of universities to promote economic growth is that, in general, the distribution of science and technology expenditures does not favor engineering. This discipline receives only 10 percent of the total, thus greatly limiting the region's technological capability (Martín del Campo, 1998). Moreover, science and engineering careers average respectively no more than 28 per cent of graduates (see Table 5).

Another obstacle that the region and its research universities face is the lack of interaction and collaboration among Latin American scientists (Aréchiga, 1998) and between them and the local industry (Zubieta, *et al*., 1999, Puchet-Anyul and Ruiz-Nápoles, 2005). As the data show, Latin American industries prefer to base their technological advancement on buying imported machinery, equipment and know-how from developed countries. Such reliance on imported capital goods and know-how is evidenced by the sharp deterioration of the trade balance in the upward phase if the business cycles when new investments are put in place.

5. Higher Education and Graduate Programs in Latin America

For a number of reasons, in Latin America, public universities are responsible for the vast majority of postgraduate training, including science and technology. The bulk of qualified researchers working in these fields in our region has been trained and/or is at work in public universities. And, to the extent that a critical mass for research in science and technology there has been established in different countries in our region, it gravitates in public universities, and fundamentally funded supported by government funds.

[3] In Latin America, most public universities have three functions: teaching, doing research, and promoting social integration. Thus, the distinction between public research universities and othe public universities –so relevant in the United States- is not relevant. Such differentiation may be, however, useful for the case of private universities in Latin America given that a majority carry out very little or none research.

In most countries of Latin America, higher education is in the hands of public institutions (see Table 5). Despite the fact that, for different reasons, over the last two decades the number of private institutions which compete in some fields with the public ones has significantly increased. Surprisingly enough, two thirds of higher education is run by public institutions also in the developed countries selected for comparison purposes (see Table 5). Here is where the highly qualified human resources are trained - and employed- and the main research laboratories and facilities have been built. Without public research universities the region would have dramatically few of its so much needed: professionals with solid education in specific branches of knowledge and the ability to constantly adapt and stay up to date in their fields. This includes the high-level scientists or engineers who can either go into production or dedicate themselves to research and to teaching.

According to UNESCO estimates, a little over 13 million students are enrolled in Latin America in what is defined as *tertiary* education (see Table 6). As with other indicators, 86 percent of such enrollment is concentrated in only seven countries in the region (Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela). It should be emphasized that in almost every country, one single major –business administration– concentrates 33 per cent of total enrollment, a percentage close to that of science, engineering and health combined. Note too that the average gross enrollment ratio[4] in most Latin American countries -except Argentina- (20-40 per cent) less that half of that in most developed countries (50-90), (see Table 5). The graduation ratio is also less than half in Latin America (12.4 per cent) than in the developed countries (35.4 per cent) even though the teaching staff per student ratio is similar, reflecting somehow a lower level of efficiency in our region. U.S. and European universities are preferred by master or doctoral candidates from several countries over the institutions in their own countries or regions. Latin American demand for studying in the United States is about 10 percent of the total, including undergraduate studies (UNESCO).

For different reasons, the demand for graduate studies increased significantly in the 1990s in some Latin American countries. The biggest increase was for master's programs, which concentrate 65 percent of all graduate students. By fields, the increase is mainly in the social and administrative sciences, the largest area of all (UDUAL, 1995). These trends appear to have continued in the last ten years and thus our graduate systems tend be favor master's programs, concentrated in the social and administrative sciences, mainly business administration, law, psychology, economics and social sciences.

Globalization and the stabilization plus structural adjustment programs have s imposed new demands on our public universities. In addition, the urgent need to transform and modernize our industrial apparatus and gear it to more knowledge intensive activities put additional pressure on them and, in general, on our national or regional innovation systems.

More specifically globalization, and the increased international competition that has it brought about, challenges public universities to increase their overall quality standards to meet world class standards. As students, professors, researchers and funds acquire greater international mobility, public universities –and for that matter private

[4] Number of students currently enrolled, independent of their ages, divided by the age group population they should belong.

ones too- must modernize and be competitive to keep blinking in the national monitor of education. For some universities the only effective response may be to specialize their research and teaching in some fields, closing down or trimming their curricula, departments and campuses. This option runs the risk of eliminating or weakening the capacity for interdisciplinary or multidisciplinary studies; a much valued trait that is at the essence of a university as originally conceived. For others, the way out may be to form alliances with top level universities and research centers in developed economies.

Pairing up our universities to meet international standards has many advantages, no doubt. But it has risks and costs. One of the risks is that our public universities research agenda may echo more and more the international one, with national problems taking the back seat in favor of more global concerns. In other words, our public universities have to meet the challenge of becoming more internationally competitive while at the same time preserving their national and regional relevance for economic and social issues.

The financial costs are evident too, as modernizing and improving research equipment and human capital will certainly requires additional funds. In this regard it is important to recall the impact of the intellectual climate that flourished in many Latin American countries against public institutions –including universities-. Indeed the wave -begun since the mid 1980s and until rather recently- against the public sector interventions combined with the structural fiscal weakness in the region led many governments to dwarf the funds to public universities. Such cuts, having more an ideological than a rational basis, were rationalized on two main grounds. The first one was that the subsidies to graduate education were seen as regressive, as they tend to benefit the middle class. The second was that, following the neo-liberal mantra, public universities as any other public entities are inefficient and thus need to be disciplined by market forces. In any case, funds for public universities suffered a reduction in real terms. This reduction coupled with a trend to put in place performance-linked criteria and incentives for wages and salaries settlements has changed the working environment and capabilities in many public research universities. Whether such changes will strengthen or weaken the research capabilities of public research universities in Latin America must be assessed case by case.

Another key challenge that public research universities face is the need to absorb the increased demand for graduate and postgraduate education, inherent to our rapidly growing population. This challenge however can be adequately met only if the quality standards are maintained or raised. Finally, there is the issue of finding ways to strengthen the relation between public universities and the business community in order to enhance the nexus between training research innovation and national economic performance and competitiveness. This issue is examined in somewhat more detail in the following section, But, in any case, the way that public universities in Latin America -being at its center of research, development and training of highly qualified human capital- meet these challenges will likely determine the future development path of our region.

6. THE TECHNOLOGICAL MISSING LINK IN LATIN AMERICA: UNIVERSITY-INDUSTRY LINK

Despite the wave of privatization oriented policies followed in Latin America, in the last twenty years, higher education institutions and research centers are still mostly public

institutions funded by the State. These institutions carry out most of the highest levels of training of human resources in science and technology and almost all of the scientific and technological research produced in them. A particular and to some extent representative case is the one of the National Autonomous University of Mexico (UNAM), currently ranked worldwide by the Times Higher Education Supplement as number 74. It is precisely public universities the ones that in Latin America carry out research and training in the fields that are currently crucial for innovation led growth.

However, in general in our region the links between university research and industrial activities and performance are weak. To broaden them and make them more conducive to growth an effective national innovation system is required. This system, comprehends three key factors:

i) Human resources (research and technical personnel);
ii) Adequate infrastructure (laboratories, workshops, computers, libraries)
iii) Institutions that link the academic research groups in the universities with the firms producing goods and services for the market. These are particularly important in developing countries given that its firms typically do not have R&D departments. Such institutional framework includes a wide variety of possible alliances between government agencies, firms, and academic institutions that create an "innovation environment" (Shaihd, 2007).

A quick assessment of resources from the Tables regarding existing researchers, graduate enrollment, and public expenditure in research and development activities, directly or through higher education institutions, in Latin America, shows that Latin America has a very weak basis for establishing an innovation system in anyone of its countries. However, its most striking weakness –*viz a viz* its likely impact on economic growth- is the lack of university-firm links. In fact, except for some policy efforts in Argentina, Brazil, Chile, Mexico and Venezuela -not necessarily coordinated with corresponding industrial policies- there are no deliberate and serious state policies oriented for linking public universities' -or for that matter private ones- research work with local firms innovation needs. In addition, institutions like intellectual property rights, systems management and regulation rules, funding sources are also weak in most cases in the region.

7. CONCLUSIONS

Latin America's economic development urgently needs top level institutions capable of teaching and carrying out relevant and high quality research in science and technology. The innovation system now in place –in which public universities play a key and dynamic role-is simply insufficient and ineffective to meet this challenge. In fact the institutional, financial and in terms of human resources bases for such systems are wanting. The number of active and in-training researchers in the different areas is still low, both in absolute and relative terms. As important as they are in our region, in general, public universities do not have a sufficiently adequate up-to-par existing infrastructure, human resources as well as functional links with the industrial or service sector to promote a dynamic local innovation and technological progress. Thus there is very little real collaboration among the research community -including public universities- and the industrial or service producers.

These weaknesses can perhaps be seen more starkly in graduate programs, the basis for training high-level scientists and technicians. Absolute and relative enrollment size is low. The structure of graduate programs and higher education in general is uneven, to the detriment of the sciences and engineering. This forces Latin Americans to continue to get their graduate training in other countries. While in some Latin American countries there is what we could call the minimal basis for carrying out scientific-technological activities (infrastructure, researchers, basic and applied scientific production and graduate programs), it is not sufficient neither in quantity nor quality.[5]

Substantial political efforts and investments are needed, particularly in the short term, to train *human resources* better and in the additional volumes required by the demand. These efforts must not be isolated. The costs for public universities of training a scientist or high-level technician and of creating the conditions so that he/she can carry out cutting-edge research are high and growing. This makes cooperation to create, maintain and develop science and technology systems a regional and national necessity, urging the coordinated work between the scientific communities and institutions of different Latin American countries, and among the governments, scientific communities and industrial representatives and groups in each country. Although mechanisms for inter-American collaboration undeniably exist, up until now, scientific collaboration has not been used very much to strengthen national innovation systems (Ortega, 1998).

On the other hand, these investments' profitability is not immediately visible and in any case its benefit is higher in a social basis than on an individual perspective. When solely left to market criteria, there is the risk that these efforts and investments will not be made. Such positive externalities of research and development amply justify the activity of public research universities in our region. Public universities and other institutions of higher learning have the capacity to meet the society's demand to provide educational services as well the demand by local corporations, governments and academic institutions for qualified human resources. If institutions of higher learning operated exclusively on a profitability criterion, they would offer majors in professions in great market demand, to generate short term profits. Public universities guarantee that research and teaching in disciplines that, although not currently in demand by the private sector, they are crucial for long-term economic growth and development.

Scientific disciplines are precisely the most expensive and the ones that are seemingly least in demand today. That is why public universities must implement policies and operating criteria with an emphasis to boost them. It is indispensable that higher education be bolstered with resources from different sources as well as the State. Under current conditions, it would be very desirable for the private sector to also contribute without endangering educational institutions' indispensable autonomy. They must have the mandate –and hopefully the capacity- to plan for, finance and provide high quality training and research in disciplines that might not seem very profitable right now but that will be in demand and play an important role in the near future.

[5] The approximately 150,000 working researchers in Latin America produce only 1.5 percent of the articles published in internationally circulating peer-reviewed journals (see Martín Del Campo, 1998).

Economic growth requires specific quantities of technicians, professionals and scientists in different areas of the economy and society in order to achieve balanced development. Public research universities in Latin American as well as other institutions of higher learning face important challenges today. Perhaps the most crucial ones are to satisfy the demand for research and training high-level human resources in science and technology in sufficiently high numbers to promote economic growth based on comparative advantages rooted in knowledge intensive activities and not on unskilled, poorly paged workers. This must be done successfully complying with the degree of efficiency and quality set by the national and world economy.

To deal successfully with these challenges, public universities the institutions of higher learning and research must have the support of, both, the State and the private sector. Without this support, modernizing their teaching and research activities and stay ahead of labor market demands without abandoning the scientific, technological and humanist fields that allow our countries to develop their capabilities and preserve their culture may be more and more a dream than a concrete reality in our region.

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TABLE 1
HUMAN RESOURCES IN RESEARCH AND DEVELOPMENT

Country	Year	Researchers							
		Researchers				Researchers by sector of employment			
		Full- time equivalent	Researchers per mill. inh.	Head Count	Researchers per mill. inh.	Business enterprise	Government	Higher Education	Private non-profit
Latin America									
Argentina	2003	27,367	720.1	43,609	1,147.4	3,101	10,201	13,485	580
Chile	2003	7,085	444.2	8,658	542.8	985	471	5,225	404
Uruguay	2002	1,242	366.3	3,839	1,132.1	12	166	1,064	n.a.
Cuba	2003	n.a.	n.a.	6,027	537.2	n.a.	n.a.	n.a.	n.a.
Costa Rica	1999	n.a.	n.a.	1,412	367.7	n.a.	n.a.	n.a.	n.a.
Venezuela	2003	n.a.	n.a.	6,100	236.3	n.a.	n.a.	n.a.	n.a.
Brazil	2000	59,838	344.2	n.a.	n.a.	15,989	4,736	38,701	412
Mexico	2002	27,626	268.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Peru	1997	5,576	225.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Bolivia	2002	1,040	120.1	n.a.	n.a.	52	156	728	104
Colombia	2003	4,829	109.2	10,851	245.4	417	500	3,707	206
Ecuador	2003	645	50.2	845	65.7	n.a.	n.a.	n.a.	n.a.
Other Countries									
Japan	2003	675,330	5,286.9	830,545	6,502.0	458,845	33,711	172,396	10,378
United States	2002	1,334,628	4,605.0	n.a.	n.a.	1,066,000	47,822	208,806 *	12,000
Australia	2002	73,344	3,758.9	n.a.	n.a.	20,622	8,036	42,780	1,906
Canada	2002	112,624	3,596.9	n.a.	n.a.	69,634	7,820	34,910	260
Russia	2004	477,647	3,319.3	401,425	2,789.6	257,621	147,896	70,844	1,286
Germany	2004	269,500	3,260.9	n.a.	n.a.	162,000	40,000	67,500	n.a.
France	2003	192,790	3,212.7	240,186	4,002.6	100,646	24,541	64,403	3,200
Korea	2003	151,254	3,186.7	198,171	4,175.2	111,388	11,974	26,419	1,473
United Kingdom	2003	165,460 *	2,712.0 *	n.a.	n.a.	102,684	9,278	49,000 *	4,498
Spain	2003	92,523	2,195.4	158,566	3,762.5	27,581	15,489	49,196	258
Hong Kong	2002	10,639	1,563.8	n.a.	n.a.	3,142	212	7,285	n.a.
Italy	2003	70,332	1,213.5	107,454	1,853.9	26,866	13,976	27,774	1,716
China	2004	926,252	708.1	n.a.	n.a.	484,164	191,957	185,987	n.a.
India	1998	117,528	119.1	n.a.	n.a.	34,973	60,455	22,100	n.a.

*Estimated data
n.a. = not available
Source: UNESCO, IES, Global Education Digest 2006.

TABLE 2
GROSS EXPENDITURE ON RESERACH AND DEVELOPMENT (GERD)

Selected Countries	Year	Gross Expenditure on R&D			GERD by sector (%)				GERD by source (%)				
		PPP Dollars Millions	As percentage of GDP	Per capita PPP Dls	Business enterprise	Govern-ment	Higher Education	Private non-profit	Business enterprise	Govern-ment	Higher Education	Private non-profit	Abroad
Latin America													
Brazil	2003	13,487.0	0.98	74.35	n.a.	n.a.	n.a.	n.a.	41.0	30.4	28.6	n.a.	n.a.
Cuba	2003	n.a.	0.65	n.d.	0.0	0.0	0.0	0.0	35.0	60.0	0.0	0.0	5.0
Chile	2003	980.8	0.61	61.49	37.8	12.7	33.8	15.8	35.2	50.5	0.0	0.5	13.3
Argentina	2003	1,825.7	0.41	48.04	29.0	41.1	27.4	2.5	26.1	44.2	25.9	2.3	1.4
Mexico	2002	3,604.7	0.40	35.02	29.8	41.4	28.6	0.3	30.6	61.0	7.1	0.3	1.0
Costa Rica	2000	131.2	0.39	33.40	23.3	19.5	36.2	21.0	n.a.	n.a.	n.a.	n.a.	n.a.
Uruguay	2002	68.9	0.26	20.33	49.0	19.4	31.6	0.0	46.7	17.1	31.4	0.1	4.7
Venezuela	2003	359.0	0.28	13.91	0.0	0.0	0.0	0.0	1.0	71.6	27.4	0.0	0.0
Bolivia	2002	60.5	0.28	6.99	25.0	21.0	41.0	13.0	16.0	20.0	31.0	19.0	14.0
Peru	2003	149.7	0.10	5.51	9.8	35.4	44.7	10.1	n.a.	n.a.	n.a.	n.a.	n.a.
Ecuador	2003	32.4	0.07	2.52	12.9	34.9	10.8	41.4	n.a.	n.a.	n.a.	n.a.	n.a.
Other Areas													
Japan	2003	112,221.8	3.15	878.54	75.0	9.3	13.7	2.1	74.5	17.7	6.3	1.2	0.3
United States	2003	291,765.1	2.67	997.09	69.8	12.4	13.7	4.1	63.8	30.8	2.8	2.9	0.0
Korea	2003	22,761.5	2.64	479.56	76.1	12.6	10.1	1.2	74.0	23.9	1.7		0.4
Germany	2003	58,683.0	2.56	710.60	69.7	13.4	16.8	0.1	66.3	31.2	0.3	0.0	2.3
France	2003	36,717.4	2.22	611.87	62.6	16.7	19.4	1.3	50.8	39.0	1.9	0.0	8.4
Canada	2003	19,398.9	2.00	613.18	55.8	10.0	33.9	0.3	49.3	24.5	14.9	2.6	8.6
United Kingdom	2003	30,503.6	1.89	514.55	65.7	9.7	21.4	3.2	43.9	31.3	1.0	4.5	19.4
Australia	2002	9,499.2	1.70	486.84	51.2	19.3	26.7	2.8	48.8	42.4	4.7		4.1
China	2003	84,618.3	1.31	65.09	62.4	27.1	10.5	0.0	60.1	29.9	0.0	0.0	2.0
Russia	2003	16,926.4	1.28	117.04	68.4	25.3	6.1	0.2	30.8	59.6	0.5	0.2	9.0
Italy	2003	17,748.0	1.14	306.21	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Spain	2003	10,172.2	1.11	241.37	54.1	15.4	30.3	0.2	48.4	40.1	5.4	0.4	5.7
Hong Kong	2002	1,089.8	0.60	160.19	33.2	3.1	63.6	0.0	35.3	62.8	0.2	0.0	1.7

n.a. not available
Source: UNESCO, IES, Global Education Digest 2006.

TABLE 3
TERTIARY EDUCATION GRADUATES BY FIELD OF EDUCATION 2004

Selected Countries	Total number of graduates	Graduates by field of education as a % of total										
		Science and technology fields			Other fields							Not Known
		Total	Science	Engin. M..& C.	Total	Education	Humanities and Arts	Social Sciences	Agriculture	Health and Welfare	Services	
Latin America												
Brazil	497,598	12.8	7.2	5.6	80.9	27.0	3.2	35.0	1.8	12.1	1.8	6.3
Mexico	339,450	28.7	11.2	17.5	71.3	15.8	1.4	41.2	2.1	10.4	0.4	n.a.
Venezuela	101,112	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Colombia	65,720	24.7	2.3	22.4	75.3	17.3	2.3	46.3	0.7	8.8	n.a.	n.a.
Chile	64,364	26.3	0.9	25.3	73.7	12.5	6.0	40.9	4.3	10.0	n.a.	n.a.
Costa Rica	26,463	11.9	6.0	6.0	88.1	34.5	3.3	38.6	1.3	9.5	1.0	0.0
Bolivia	19,326	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Uruguay	7,476	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Other Areas												
United States	2,473,299	12.4	7.0	5.4	72.1	11.1	13.1	36.5	0.9	6.4	4.0	15.5
China	1,948,080	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Russia	1,706,156	25.6	5.9	19.7	70.7	7.6	5.2	44.9	4.3	6.0	2.7	3.8
Japan	1,051,262	21.5	3.0	18.6	73.1	6.9	15.8	24.9	2.2	12.3	11.0	5.3
United Kingdom	595,641	22.7	14.6	8.1	75.5	9.9	15.3	30.9	1.0	17.8	0.7	1.8
France	584,849	29.3	13.0	16.3	70.6	6.6	12.4	39.7	0.3	7.6	4.1	n.a.
Germany	319,791	26.9	10.1	16.8	72.9	7.5	10.4	23.5	2.4	25.2	3.9	n.a.
Spain	298,448	27.9	11.0	16.9	72.1	11.2	9.3	29.3	2.1	12.9	7.2	n.a.
Italy	248,710	22.7	7.5	15.2	76.7	8.7	13.2	33.6	2.2	16.0	3.0	0.5
Australia	233,488	23.1	14.7	8.4	84.8	10.8	11.6	43.3	1.3	14.4	3.4	0.1
Hong Kong	53,104	28.0	12.4	15.6	47.1	9.4	7.5	26.5	n.a.	3.3	0.4	24.8

Source: UNESCO, IES, Global Education Digest 2006.

TABLE 4
EDUCATION EXPENDITURE, SOURCES 2004
as a percentage of GDP

	All sources		Public sources		Private sources		Inter-
	Total	Tertiary	Total	Tertiary	Total	Tertiary	national
Latin America							
Mexico	6.25	1.39	5.06	0.99	1.18	0.40	n.a.
Colombia	7.84	n.a.	4.90	n.a.	2.93	n.a.	n.a.
Costa Rica	4.78	0.93	4.73	0.93	n.a.	n.a.	0.05
Chile	7.23	2.20	3.97	0.38	3.26	1.83	n.a.
Argentina	4.74	1.09	3.94	0.70	0.80	0.39	n.a.
Peru	n.a.	n.a.	2.99	n.a.	n.a.	n.a.	n.a.
Uruguay	2.84	0.58	2.57	0.55	0.21	n.a.	0.06
Other Areas							
United States	7.44	2.70	5.49	1.22	1.95	1.48	n.a.
France	5.88	1.06	5.41	0.91	0.46	0.15	n.a.
United Kingdom	5.98	1.16	5.05	0.83	0.93	0.33	n.a.
Germany	5.30	1.08	4.42	0.98	0.87	0.09	0.01
Hong Kong	n.a.	n.a.	4.36	n.a.	n.a.	n.a.	n.a.
Spain	n.a.	n.a.	4.33	0.94	n.a.	n.a.	n.a.
Australia	5.83	1.57	4.33	0.76	1.51	0.81	n.a.
Korea	7.06	n.a.	4.12	n.a.	2.95	1.88	n.a.
Russia	n.a.	n.a.	3.84	0.65	n.a.	n.a.	n.a.
Japan	4.67	n.a.	3.48	n.a.	1.19	0.63	n.a.

n.a. = nota available
Source: UNESCO, IES, Global Education Digest 2006.

TABLE 5
TERTIARY EDUCATION ENROLMENT AND TEACHING STAFF 2004

Selected Countries	Total enrolment			Gross enrolment ratio	Distribution of students by ISCED level (%)			Gross graduation ratio 5A	Teaching Staff	Student/ teacher ratio
		Public	Private		5A	5B	6			
World	**131,999,450**			**23.7**	**79.0**	**19.2**	**1.7**		**8,475,673**	**15.6**
Latin America	**12,099,953**	62.7	37.3	**34.1**	79.1	22.7		**12.4**		**13.2**
Argentina	2,026,735	78.9	21.1	61.1	74.0	25.7	n.a.	7.7	127,077	15.9
Chile	567,114	25.8	74.2	43.2	83.0	16.7	n.a.	15.8	n.a.	n.a.
Bolivia	346,056	n.a.	n.a.	40.6	n.a.	n.a.	n.a.	n.a.	17,759	19.5
Venezuela	983,217	72.9	27.1	39.3	61.6	34.3	4.1	11.5	n.a.	n.a.
Uruguay	98,520	89.8	10.2	37.8	76.3	23.6	n.a.	9.0	11,989	8.2
Cuba	235,997	100.0	0.0	33.0	98.9	n.a.	1.1	13.6	44,669	5.3
Peru	831,345	53.1	46.9	31.5	54.1	45.8	n.a.	n.a.	56,070	14.8
Colombia	1,112,574	45.0	55.0	26.9	81.8	18.1	n.a.	5.9	87,544	12.7
Mexico	2,236,791	66.8	33.2	22.5	96.6	2.9	n.a.	14.4	231,558	9.7
Brazil	3,582,105	31.7	68.3	20.1	n.a.	n.a.	n.a.	13.2	242,475	14.8
Costa Rica	79,499	n.a.	n.a.	19.0	85.2	14.6	n.a.	20.8	4,494	17.7
Other Areas	**62,780,117**	66.7	33.3	**59.9**	72.2	25.2		**35.4**		**15.8**
Korea	3,223,431	19.4	80.6	88.5	58.8	40.0	1.1	34.4	172,572	18.7
United States	16,900,471	76.1	23.9	82.4	76.6	21.1	2.2	34.5	1,174,831	14.4
Australia	1,002,998	99.2	0.8	72.2	79.9	16.4	3.7	46.9	n.a.	n.a.
Russia	8,622,097	88.8	11.2	68.2	74.9	23.3	n.a.	37.1	601,354	14.3
Spain	1,839,903	86.4	13.6	65.7	81.9	13.9	4.2	36.1	140,740	13.1
Italy	1,986,497	93.6	6.4	63.1	97.0	1.1	1.9	31.3	91,978	21.6
United Kingdom	2,247,441	0.0	100.0	60.1	73.2	22.8	4.0	39.1	111,830	20.1
Canada	1,192,570	n.a.	n.a.	57.2	72.5	25.4	2.2	32.9	131,320	9.1
France	2,160,300	83.6	16.4	56.0	71.5	23.8	4.7	42.7	135,783	15.9
Japan	4,031,604	23.0	77.0	54.0	73.8	24.4	1.8	36.8	496,370	8.1
Hong Kong	155,761	96.6	3.4	32.1	54.4	42.3	3.4	17.8	n.a.	n.a.
China	19,417,044	n.a.	n.a.	19.1	51.6	47.7	0.7	n.a.	850,227	22.8

ISCED International Standard Classification of Education.
5A= B.A. and M.A. programs; 5B = technical education ; 6 = Dotorate
n.a. = not available
Source: UNESCO, IES, Global Education Digest 2006.

TABLE 6 EDUCATION EXPENDITURE, SPENDING AS A % OF GDP 2004							
Selected Countries	Total public expend. on education		Public expend. per Tertiary student as a % of GDP per cap.	Educational expenditure in Tertiary as a % of total educational expenditure in public inst.			
	as a % of GDP	as a % of total g.exp.		Salaries all Staff	Other Current	Total Current	Capital
Latin America							
Bolivia	6.4	18.1	35.9	n.a.	n.a.	100.0	n.a.
Mexico	5.3	n.a.	49.8	75.2	22.1	97.3	2.7
Costa Rica	4.9	18.5	n.a.	n.a.	n.a.	n.a.	n.a.
Colombia	4.9	11.7	26.3	49.7	37.5	87.2	12.8
Chile	4.1	19.1	15.3	61.7	31.4	93.2	6.8
Argentina	4.0	13.8	13.1	88.4	10.6	99.1	0.9
Peru	3.0	17.1	14.0	61.3	35.3	96.6	3.4
Uruguay	2.6	9.6	19.0	77.0	17.2	94.3	5.7
Cuba	n.a	19.4	n.a.	37.7	43.7	81.4	18.6
Other Areas							
United States	5.7	n.a.	25.9	53.5	37.2	90.7	9.3
France	5.6	n.a.	29.3	65.7	23.6	89.3	10.7
United Kingdom	5.3	11.5	28.8	n.a.	n.a.	n.a.	n.a.
Australia	4.9	n.a.	22.6	53.9	36.5	90.4	9.6
Germany	4.8	n.a.	n.a.	65.0	25.4	90.3	9.7
Italy	4.7	n.a.	27.4	52.7	30.7	83.4	16.6
Hong Kong	4.7	23.3	67.1	74.6	21.4	95.9	4.1
Spain	4.5	n.a.	23.1	64.4	16.1	80.5	19.5
Korea	4.2	15.5	n.a.	n.a.	n.a.	n.a.	n.a.
Russia	3.8	10.7	n.a.	n.a.	n.a.	n.a.	n.a.
Japan	3.6	n.a	17.1	56.5	27.9	84.4	15.6

n.a. = not available
Source: UNESCO, IES, Global Education Digest 2006.