Higher Education and Research and Development (R&D) in East Asia and Latin America: Different Perspectives?[1]

Guillermo Cardoza

Abstract

In addition to increased rates of enrollment in Institutions of Higher Education (IHE) and chronic financial limitations, the over reliance on low-qualified lecturers and the lack of appropriate incentive systems have had a negative impact on the quality of higher education in Latin America. These countries can extract valuable lessons from the East Asian experiences to design better instruments for allocating resources among different educational levels and evaluate the impact of educational policies on social and economic development. To this end, this article compares some data about higher education and research and development (R&D) activities in East Asia and Latin America that have relevance for current policy-making efforts. The argument put forth here is that, in order to be effective and sustainable over time, higher education reforms designed to raise academic quality should be based on organizational structures promoting quality assessment linking rewards to academic performance, providing access to up-to-date information, offering continuing faculty training about new advances in their fields and, wherever possible, promoting the participation of teachers and students in research. Current higher education reforms in Latin America should not only pursue more autonomy, effective regulation, and funding diversification but also must place research-based teaching at the center of quality-enhancing initiatives in higher education.

Introduction

The new conditions of competition that predominate in international trade have dramatically altered the context for the incorporation of Latin American countries into the world economy. The rapid pace of technological change has caused an erosion of the competitive advantages of these economies, advantages based on an abundance of natural resources and low labor costs. In the
coming years, Latin American countries will face major challenges in the process of creating a more equitable and sustainable development model. Current economic reforms are expected to create the conditions for the progressive incorporation of the majority of the population into economic activities, to raise productivity and to enhance international competitiveness.

These structural transformations demand not only huge investments but more importantly, the participation of skilled and creative workers. Indeed, human capital has become the determining factor in building competitive economies. As economies move from traditional labor-intensive industries to technology-intensive industries, where products and processes become more complex in terms of knowledge and expertise, economies progressively face new educational and technological requirements. Thus, the adoption of a knowledge-based development strategy increasingly demands highly trained professionals, particularly engineers and scientists, to lead research and development activities.

Still, given the weak learning and innovation capabilities of the private sector in Latin America, institutions of higher education (IHE)[2] are called upon to play a crucial role in creating and disseminating new knowledge, offering technical assistance and, providing the engineers and scientists required by

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[2] The concept of IHE used in this paper refers to private and public universities and other institutions providing post-secondary education training. It should be mentioned that, with the exception of Brazil, Chile, Colombia and El Salvador, where provate education accounts for more than 50% of current enrolments, public institutions of higher education, mostly universities, are the main providers of higher education in the rest of Latin American countries.

companies to improve their learning and innovation capabilities. In particular, universities and public research institutions in Latin America are responsible for generating and disseminating new scientific and technological knowledge through research and teaching since they concentrate between 70 and 90 percent of the total research undertaken in the region. However, serious doubts remain about the ability of IHE to meet these challenges given their organizational constraints and limited capacity for self-transformation when faced with rapidly changing conditions.

Considering their prominent role in the implementation of skill-intensive industrial development strategies and their current structural weaknesses, several questions have arisen in the last few years: What kinds of organizational structures do IHE need in order to assure the continuation of their traditional roles of training human resources and generating and disseminate new knowledge while assuming a more proactive role in the construction of knowledge-based economies? Do THE have the mechanisms required to continuously update curricula and teaching methodologies? How can IHE aid in alleviating the heavy burden inherited from the import substitution period and generate a new entrepreneurial mentality fostering creativity and innovation? In short, how can IHE provide the best possible education to their students and at the same time address the training needs of the public and private sectors? In great part, the success of the ongoing modernization efforts taking place throughout the region will depend on the answers to these crucial questions.

Rather than offering normative solutions to the problems mentioned above, this paper intends to highlight some important points to correctly assess and address these issues. I argue that besides the lack of financial support for teaching and research activities, the weak links between the productive sector and IHE, the lack of effective updating and training systems for faculty, and the scarce involvement of teachers in good quality research activities prevent THE from disseminating new scientific and technological knowledge, lead to a mismatch between the qualifications of IHE graduates and the demands of labor markets, and lower the quality of scientific, professional and, technical training. The paper emphasizes the need to adopt performance criteria and self-assessment mechanisms to improve the quality of teaching and services.

This article is organized in four sections. In the first part, a rapid review of patterns of allocation of public resources to education is presented. Also, the role played by private financing in higher education in East Asian countries is examined. In the second part, a brief analysis of research and development (R&D) is presented for both groups of countries focusing on the public expenditures and the participation of the private sector in these activities. This section, emphasizes the results of R&D policies adopted in East Asia, the outcome of R&D investments and their contribution to industrial development. The third section analyses the role that THE play in R&D activities in Latin America and the nature of scientific production. I argue that the scarce participation of faculty in research activities lower the quality of THE output in these countries. In the last part, I emphasize the role that management and quality assessments play in the sustainability of higher education reforms and present some conclusions of relevance to policy makers aimed at improving the contribution of IHE to the economic and social development of Latin America.

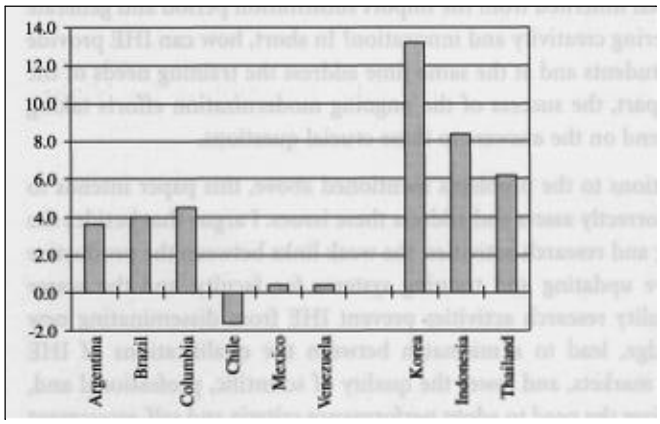
Higher Education in East Asia and Latin America

Cross-country analyses based on growth accounting techniques have shown that education attainment, mainly in primary education, has a positive impact on growth (Barro, 1991; Barro and Lee, 1994; Easterly Levine, 1996), has high rates of return (Psacharapoulos, 1994), and contributes to reducing inequality in East Asia[3] (Birdsall, 1995; Birdsall *et al* 1998). Similarly, other authors have argued that the availability of a highly skilled labor force allows for increasing global productivity and enhancing the profitability of investments in the East Asian economies (Perkins, 1986; Mingat and Tan 1988; Hou and Gee, 1993; Page, 1994; Rodrik, 1995). Unfortunately, as observed in Figure 1, Latin American countries exhibit lower average growth rate of public expenditure in education for the period 1980-1992 in comparison to

[3] Based on recent studies on the relationship between education and inequality in Latin America, Birdsall (1998) argues that “there is a vicious circle: the region’s weak record in education is not only a cause of current poverty and income inequality, which has itself affected the demand for and supply of education to the poor”.

countries such as Korea, Indonesia and Thailand. These modest growth rates in education in Latin America can be explained by the severe economic crisis that affected these countries during the 1980s.[4]

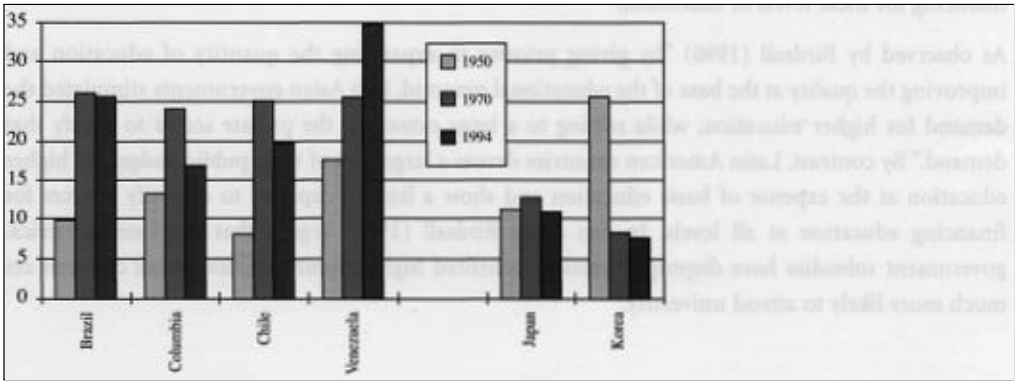
Figure 1: East Asia and Latin America: average growth rate of public expenditure in education (1980-1992)



Source: Unesco, Statistical Yearbook, 1995.

At the same time, due to the growing number of secondary graduates, enrollment in higher education increased notoriously during the 1980-1994 period in Latin America and East Asia (Figure 2). However, according to several studies, rapid educational expansion at the tertiary level in Latin America was not accompanied by a corresponding improvement in quality (Schwartzman, 1988; Brunner, 1992; Levy, 1994; Balán, 1996; Balán and Trombetta, 1996; Puryear, 1996; De Moura Castro and Levy, 1998).

Figure 2: East Asia and Latin America: Third level students per 100,000 inhabitants

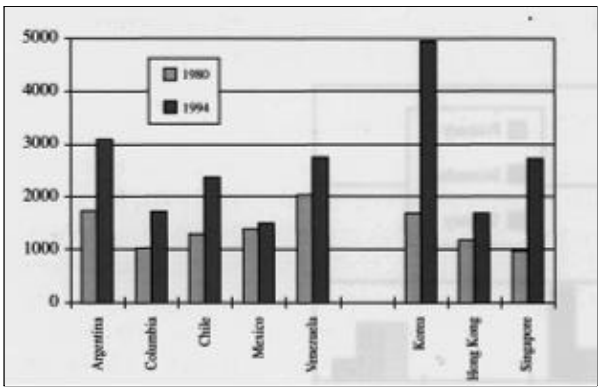


Source: Unesco, World Education Report, 1993, 1998.

Interestingly, as depicted in Figure 3, the shares of public expenditure on education devoted to higher education in 1950, 1970, and 1994 were considerably lower in Korea and Japan compared to Latin American countries. In fact, Asian governments have been highly committed to providing broad based, quality education by allocating a high share of their public expenditure on education to basic education (including pre-primary, primary and secondary school). For instance, in 1993 Korea dedicated 81% of is current public expenditure to basic education.

[4] This crisis, due mainly to the exhaustion of the import substitution strategy and the massive capital outflow associated with foreign debt, was accompanied by high inflation rates and important reductions in per capita income and gross domestic investment (Cardoza, 1997).

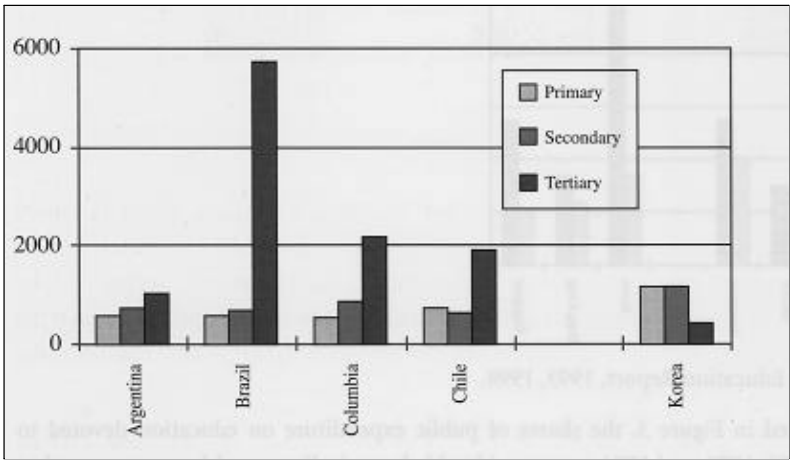
Figure 3: East Asia and Latin America: Share of Public Expenditure for Higher Education (1950, 1970, 1994)



Source: Unesco, World Education Report, 1993, 1998.

As observed in Figure 4, in 1992 the public expenditures in basic education per eligible student, measured in international US$ purchasing power parity (PPP), were considerably higher in Korea than in the Latin American countries. By contrast, Korea's public expenditures per student on higher education are only a fraction of that of Latin American countries. This indicator shows a tendency of Latin American countries to concentrate their investments in higher education to the detriment of basic education. Moreover, as depicted in Figure 5, private financing plays a major role in higher education in East Asian countries such as Japan, Korea and Taiwan.

Figure 4: East Asia and Latin America: Public expenditure per capita by level of education in international US$

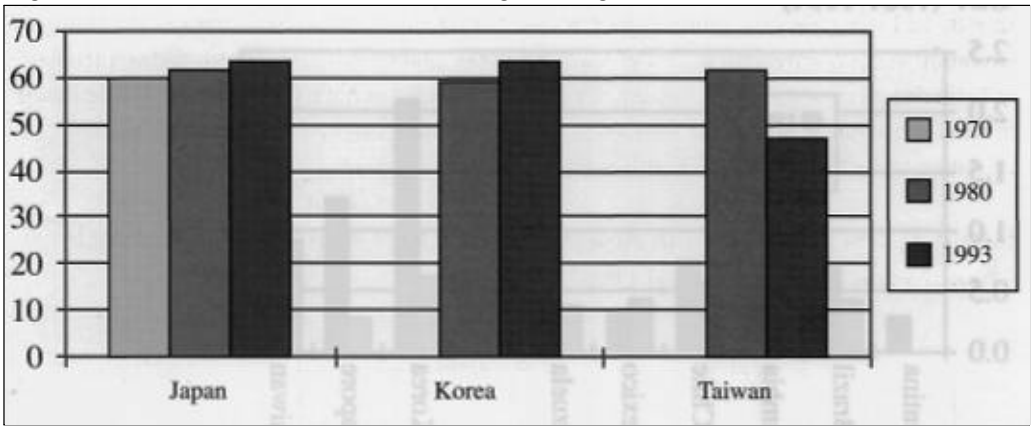


Source: IDB (1996)

The rationale behind these public policies is that due to the increased social equity and efficiency derived from investments in basic education, mainly in primary school, and their important contribution to economic growth, Asian governments tend to consider basic education as a public good and put more emphasis on it. Similarly, as explained by Mingat and Tan (1992) because "most of the benefits of higher education, particularly for undergraduate studies, are privately captured by students", Asian countries consider them as private goods and, therefore, rely mostly on private financing for these levels of education.

As observed by Birdsall (1998) "by giving priority to expanding the quantity of education and improving the quality at the base of the educational pyramid, East Asian governments stimulated the demand for higher education, while relying to a large extent on the private sector to satisfy that demand". By contrast, Latin American countries devote a large part of their public budgets to higher education at the expense of basic education and show a limited capacity to diversify sources for financing education at all levels. In this sense Birdsall (1998) argues that "in Latin America, government subsidies have disproportionately benefited high-income families whose children are much more likely to attend university."

Figure 5: Share of Private Financing in Higher Education in East Asia



Sources: Mingat (1992), Mingat and Tan (1998)

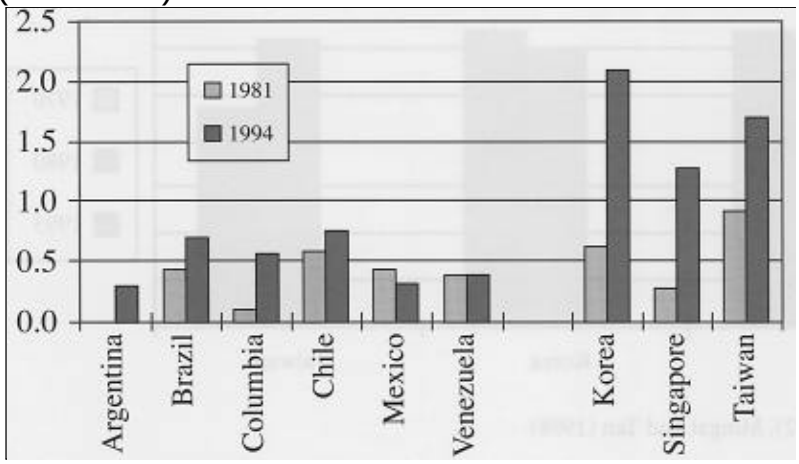
Private financing in East Asia, usually achieved through fee-charging policies, allows for more accountability in public institutions of higher education. As argued by Mingat (1992), it creates "incentives for cost-containment by promoting competition with the private sector and by sharpening cost-consciousness among students and managers [and] has helped not only to keep the production of human capital in line with the demands of the economic sphere, but to maximize the efficiency with which this production is accomplished."

East Asian experiences can offer some guidance in the process of assessment of educational policies at the national level in Latin America. Furthermore, the adoption of new patterns of resource allocation based on social returns and the continuous evaluation of outcomes from educational institutions is recommended in order to optimize scarce financial resources. Similarly, the exploration of private sources of financing, particularly for higher education, may offer the possibility of reallocating higher education budgets in order to properly fund vital areas such as research and development (R&D) to improve the quality and relevance of post-secondary education and to create the knowledge base required to foster economic and social development.

Research and Development (R&D) in East Asia and Latin America

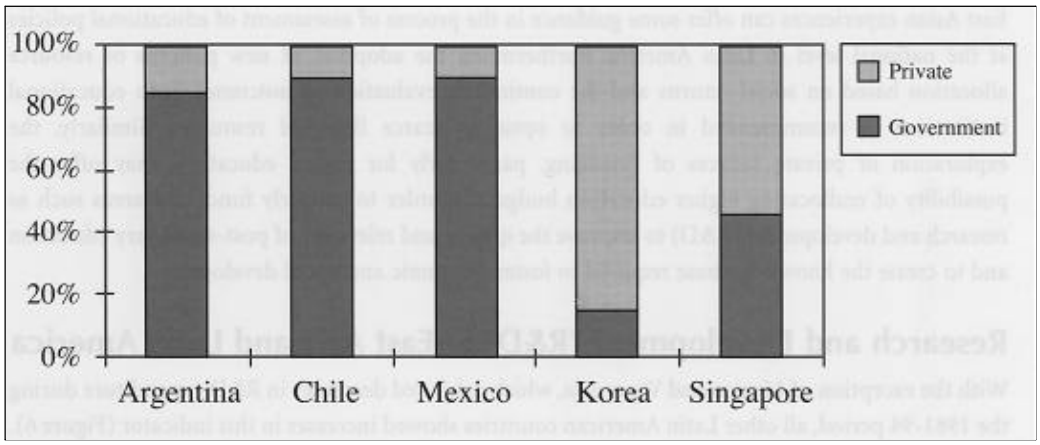
With the exception of Mexico and Venezuela, which exhibited decreases in R&D expenditure during the 198 1-94 period, all other Latin American countries showed increases in this indicator (Figure 6). Yet, it is important to emphasize that no country in Latin America even reached 1% of the GDP in R&D expenditures. East Asian countries, on the contrary, exhibited impressive increases on this indicator approaching the expenditure levels of the industrialized countries in 1993 (Korea, 2.2%; Singapore, 1.3%; Taiwan, 1.65%). Most important, as shown in Figure 7, increases in R&D expenditures by the Asian countries are due almost entirely to large contributions from the private sector, whereas R&D activities in Latin America are mostly government funded (Villegas and Cardoza, 1993).

Figure 6: East Asia and Latin America: R&D expenditures as percentage of GDP (1981-1994)



Source: ACAL (1990-1997), Unesco Statistical Yearbook (1993, 1997)

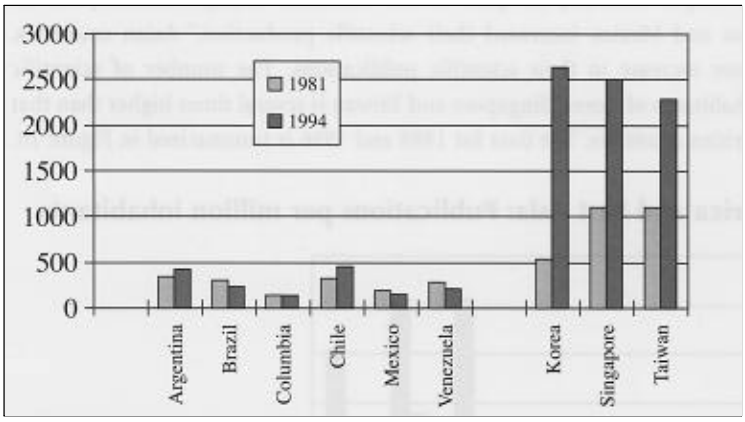
Figure 7: R&D in selected Latin American and Asian countries by source of funds (1990)



Source: ACAL (1990-1997); Science (1993).

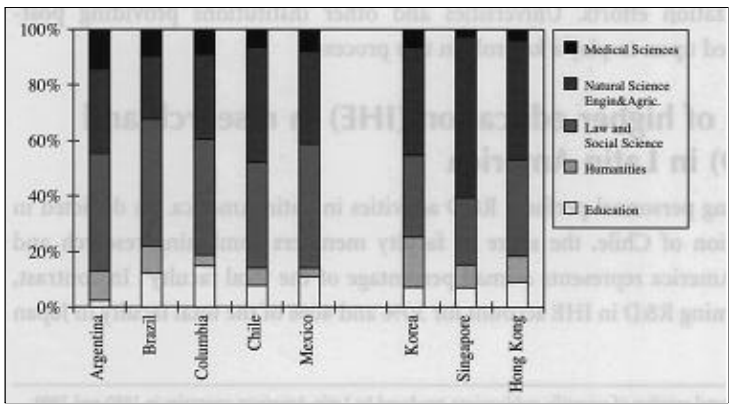
All of the countries show an increase in R&D personnel per million inhabitants during the 198 1-1994 period (Figure 8). Nevertheless, the adoption of policies actively supporting training allowed Asian countries to increase their R&D personnel more significantly than their counterparts in Latin America. Indeed, it can be observed that by 1994, Korea, Singapore and Taiwan exhibited numbers several times higher than Chile and Argentina, the Latin American countries showing the highest figures (Cardoza and Villegas, 1996).

Figure 8: East Asia and Latin America: Number of R&D personnel per million inhabitants



Source: ACAL (1990-1997), Unesco Statistical Yearbook (1993, 1997).

Figure 9: East Asia and Latin America: Third level students by broad field of study (1990)



Source: Unesco, Statistical Yearbook (1997)

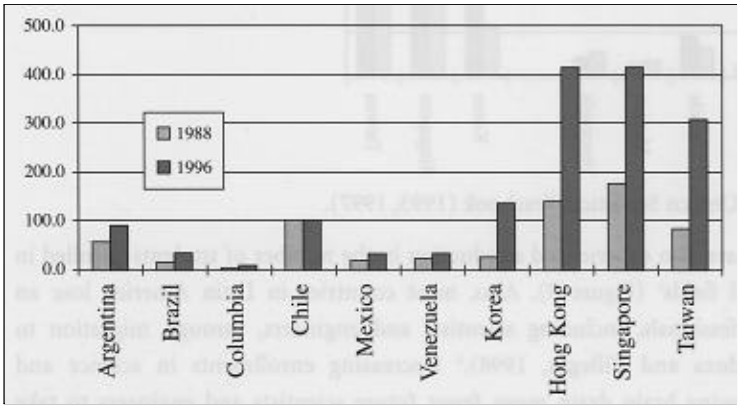
Latin American countries have also experienced a reduction in the number of students enrolled in scientific and technological fields[5] (Figure 9). Also, most countries in Latin America lose an important

[5] Compared with other professions such as business administration, law and medicine, research careers offer lower financial rewards and inferior social status.

number of professionals, including scientists and engineers, through migration to developed countries (Cardoza and Villegas, 1998).[6] Decreasing enrollments in science and technologies fields and growing brain drain mean fewer future scientists and engineers to take charge of research and development projects in universities and industries. This situation places an additional burden on Latin American countries in their modernization efforts.

Furthermore, taking the number of scientific publications per million inhabitants as an indicator of scientific production, we can observe that during the last decade Chile and Venezuela suffered a decrease in their research output whereas, in spite of the economic crisis, countries such as Argentina, Brazil, Colombia and Mexico increased their scientific production.[7] Asian countries, however, registered a greater increase in their scientific publications. The number of scientific publications per million inhabitants of Korea, Singapore and Taiwan is several times higher than that of this group of Latin American countries. The data for 1988 and 1996 is summarized in Figure 10.

Figure 10: Latin America and East Asia: Publications per million inhabitants



Source: IST (1988, 1996)

Compared to East Asia, Latin America is lagging behind in public and private R&D investments. Incentive policies should be adopted to encourage business firms to invest in in-house R&D. Similarly, students should be encouraged to engage in the study of science and technology studies and policies oriented toward training scientists and engineers are urgently required to pursue badly needed industrial modernization efforts. Universities and other institutions providing post-secondary education are called upon to play a key role in this process.

Role of institutions of higher education (IHE) in research and development (R&D) in Latin America

Only a small share of teaching personnel perform R&D activities in Latin America. As depicted in Figure 11, with the exemption of Chile, the share of faculty members combining research and teaching activities in Latin America represents a small percentage of the total faculty.[8] In contrast, the shares of teachers performing R&D in IHE account for 30% and 40% of the total faculty in Japan and Korea, respectively.

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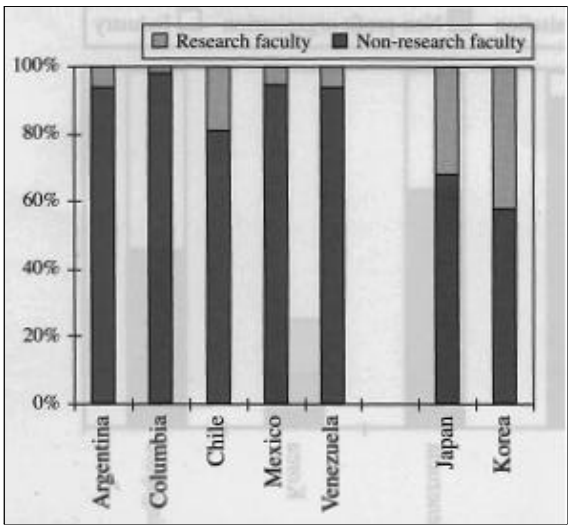
[6] According to Alvarez (1992), Latin American countries registered a considerable outflow of about 500,000 skilled professionals and technicians towards the United States between 1961 and 1990. Considering the factors mentioned above and the difficult circumstances that most universities and R&D institutions are currently facing in Latin America, it is likely that these countries will experience the continuing emigration of highly trained professionals in the coming years.

[7] It is important to note that of the total number of scientific publications produced by Latin American countries in 1980 and 1990, 94.0% and 91.5% respectively were contributed by Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela.

[8] Between 1950 and 1992, as indicated by Unesco-Cresalc (1996), the number of students enrolled in Latin American higher education increased by a factor of 30 (from 270,000 to 8 million). The number of teachers also increased considerably during the same period, however, only 20% of teaching personnel of IHE have graduate training and only 10% of them conduct research activities on a regular basis (Ibid). For example, in 1990 Venezuela had a teaching staff of about 46,000 in its higher education system. According to Unesco, of the 5,457 researchers in the country, only some 3500 were working at the universities (Unesco Statistical Yearbook, 1994). The same year only 800 university

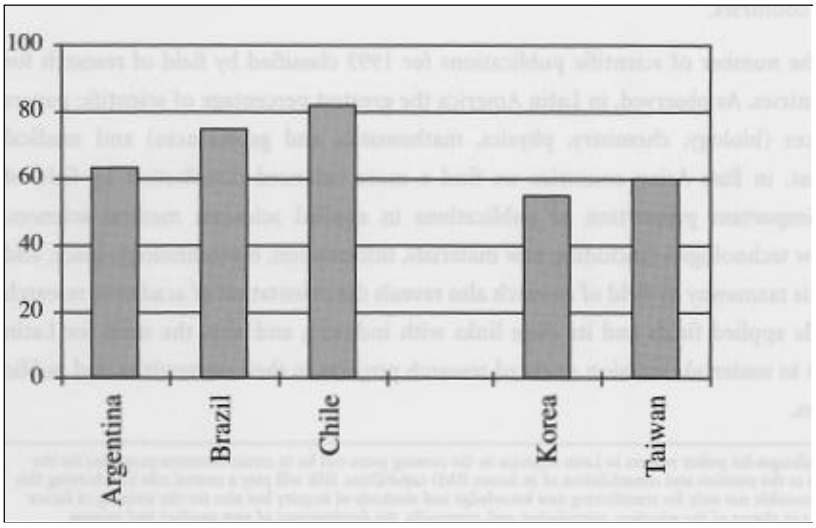
Figure 11: East Asia and Latin America: Shares of non-research faculty and research faculty in 1990



Source: Unesco, Statistical Yearbook (1995).

In spite of the scarce participation of teachers of higher education in R&D activities, IHE, mainly universities, are currently playing an important role in research and development (R&D) activities in Latin American countries (Villegas and Cardoza, 1992). Figure 12 shows the percentage of scientific publications registered in the Science Citation Index (SCI) for 1993 in which at least one of the authors was a university researcher. As can be seen, the majority of scientific papers published by Argentina, Brazil and Chile during that year came from university-based researchers.

Figure 12: East Asia and Latin America: Scientific publications by university faculty members (1993)



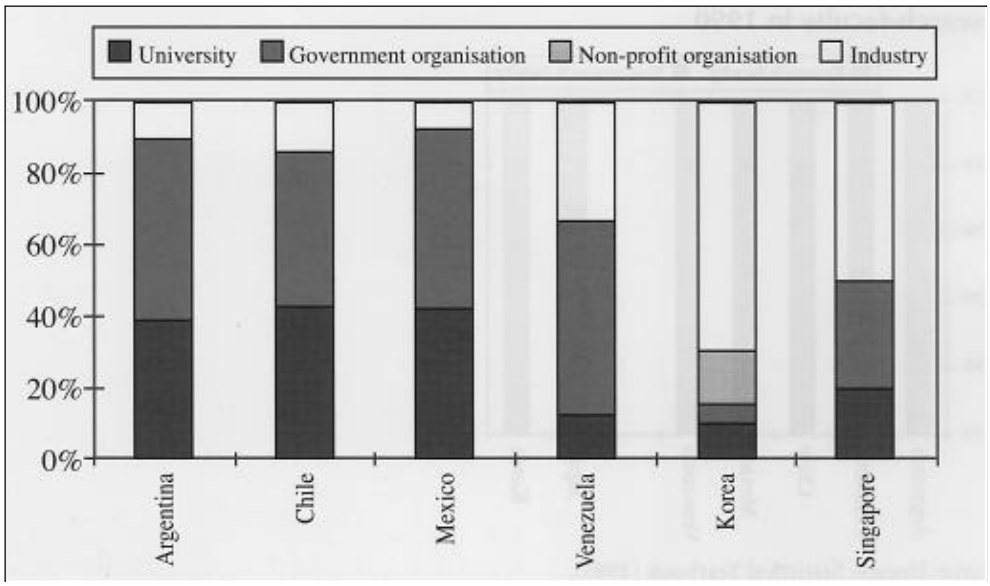
Source: ISI (1993)

However, when considering the distribution of the total scientific and technological research by performer a different picture for East Asian countries emerges. Figure 13 shows the percentages of R&D expenditures performed by universities, industries, and governmental and private nonprofit research organizations for selected countries of East Asia and Latin America. Again we observe that the majority of R&D activities in Latin America are concentrated in universities and public research institutions, while in Asian countries the greatest part of research is funded and performed by industry. It is striking to note the scarce participation of industry in R&D in Latin America when compared to Asian countries.[9]

reseachers in all fields were participating in the System for the Promotion of Researchers (PPI) mechanism implemented by the National Council of Science and Technology (CONICIT) as a compensation and reward mechanism for researchers (CONICIT, 1995).

[9] One of the greatest challenges for policy makers in Latin America in the coming years will be to create incentive

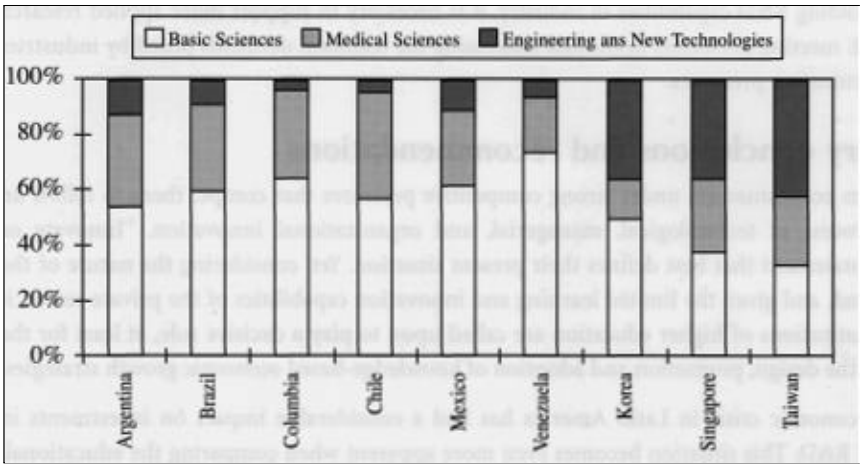
Figure 13: East Asia and Latin America: R&D by performer (around 1990)



Source: ACAL (1996); Science (1993).

Figure 14 depicts the number of scientific publications for 1993 classified by field of research for both groups of countries. As observed, in Latin America the greatest percentage of scientific papers are in basic sciences (biology, chemistry, physics, mathematics and geosciences) and medical sciences. By contrast, in East Asian countries we find a more balanced distribution by field of research with an important proportion of publications in applied sciences: medical sciences, engineering and new technologies (including new materials, information, biotechnology, space, and nuclear energy). This taxonomy by field of research also reveals the orientation of academic research in East Asia towards applied fields and its close links with industry, and also, the need for Latin American countries to undertake mission oriented research projects in their universities and public research laboratories.

Figure 14: East Asia and Latin America: Distribution of scientific publications by field (1993)



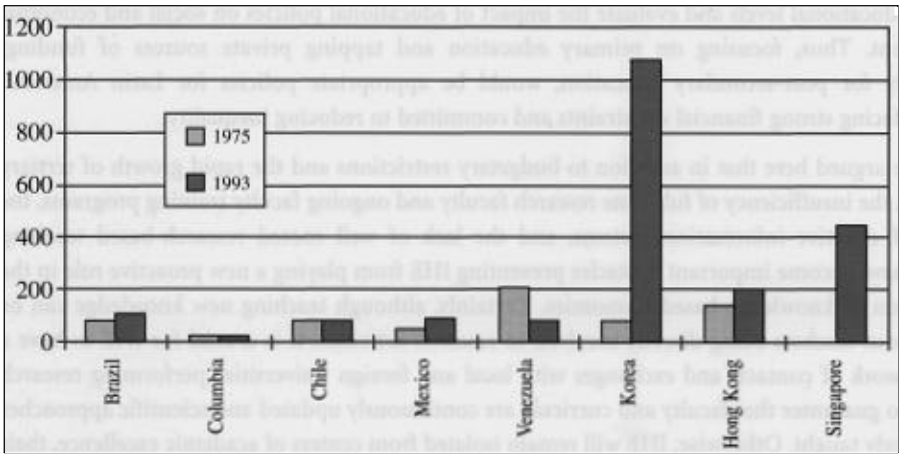
Source: ACAL (1996), ISI (1993)

As we can observe in Figure 15, East Asian countries exhibited a rapid growth of industrial research measured as the number of patents per million inhabitants, indicating the clear orientation of East Asian R&D towards economic activities. Certainly, a significant proportion of research in engineering and new technologies in East Asia can be attributed to the support offered by research facilities to technology-based

programs for the private sector that lead to the creation and consolidation of in-house R&D capabilities. IHE will play a central role in achieving this goal since they are responsible not only for transferring new knowledge and methods of enquiry but also for the training of future scientists and engineers in charge of the selection, assimilation and, eventually, development of new product and process technologies in industry.

industries and indicates to what extent economic priorities are taken into account in the research agenda of these countries.

Figure 15: East Asia and Latin America: Number of patents per million inhabitants



Source: United Nations, Statistical Yearbook (several issues)

The figures presented above have clear policy implications for Latin American countries struggling to close the knowledge gap that separates them from industrialized countries and hampered their development opportunities. First, the private sector urgently needs to invest in industrial R&D if willing to take advantage of rapid technological changes. However, given the current role that universities and public research institutions play in R&D activities in Latin America, and the lapses involved in building R&D capabilities in industry, it is necessary to support more applied research projects in IHE meeting personnel needs and addressing the technical demands posed by industries in their modernization processes.

Preliminary conclusions and recommendations

Latin American economies are under strong competitive pressures that compel them to follow an accelerated process of technological, managerial, and organizational innovation. “Innovate or perish” is the statement that best defines their present situation. Yet, considering the nature of the challenges ahead, and given the limited learning and innovation capabilities of the private sector, it is clear that institutions of higher education are called upon to play a decisive role, at least for the time being, in the design, promotion and adoption of knowledge-based economic growth strategies.

The current economic crisis in Latin America has had a considerable impact on investments in education and R&D. This situation becomes even more apparent when comparing the educational, scientific, and technological performance achieved by the Latin American countries with those of East Asia. It should be noted, however, that despite the limited economic resources devoted to higher education in Latin America, enrollment has increased substantially during the last decades, and universities continue to perform the largest part of R&D activities, mostly in non-applied fields. Unfortunately, the expansion of higher education has not been accompanied by a similar improvement in quality. Quality has become a common concern in most institutions of higher education in the region.

As discussed earlier, East Asian success stories have shed light on the impact that investments in basic education have on social equity and economic growth. Latin American countries can extract valuable lessons from these experiences to design better instruments for allocating resources among different educational levels and evaluate the impact of educational policies on social and economic development. Thus, focusing on primary education and tapping private sources of funding, particularly for post-secondary education, would be appropriate policies for Latin American countries facing strong financial constraints and committed to reducing inequality.

I also have argued here that in addition to budgetary restrictions and the rapid growth of tertiary education, the insufficiency of full-time research faculty and ongoing faculty training programs, the

scarcity of effective information systems, and the lack of well rooted research-based teaching practices have become important obstacles preventing IHE from playing a new proactive role in the construction of knowledge-based economies. Certainly, although teaching new knowledge can be done without teachers being directly involved in research activities, it is crucial for IHE to have a broad network of contacts and exchanges with local and foreign universities performing research activities to guarantee that faculty and curricula are continuously updated and scientific approaches are effectively taught. Otherwise, IHE will remain isolated from centers of academic excellence, their undergraduate and graduate studies will be outdated and students will not develop the skills to inquire and think creatively needed to carry out highly demanding professional responsibilities in the emerging knowledge-intensive industries.

Similarly, the establishment of research groups actively contributing to the generation of knowledge and the development of up-to-date courses in various disciplines are the sine qua non for a country interested in forging a scientific tradition, increasing its productivity and enhancing its international competitiveness. Indeed, to be effective and sustainable over time, higher education reforms must take into account the need to create and preserve organizational structures guaranteeing the continuous linking of research and teaching activities at all IHE levels.

Moreover, several specific actions should be undertaken by THE to assure the effective transfer of knowledge: reorientation of research to match specific needs of industries; strengthening of transfer sciences (engineering, information technologies, material sciences, biotechnology, etc.) in order to bridge the gap between research and industrial needs; simplification of regulations and procedures to facilitate the transfer of research results to the productive sector; establishment of training programs for company employees including conferences and seminars; promotion of faculty and student internships in industries to carry out specific projects; offering of consulting services by faculty and their participation in national and international collaborative innovation networks.

Also, the sustainability of reforms depends increasingly on the quality of management of IHE. Improving managerial practices and decision-making processes at IHE require highly trained administrative personnel with a clearly defined mission, a common set of performance criteria, an explicit strategic plan, and a good information management system to guarantee that effective self-evaluation mechanisms are introduced and applied. In fact, in order to maintain high quality standards and assure the dissemination of relevant knowledge, IHE should engage in the design and adoption of incentive structures to guarantee that rewards are linked to academic performance. Parameters of performance, such as the quality of teaching programs, academic output (scientific publications, patents, extension services), and efficiency in the use of resources should be tied to the allocation of public resources.

Summing up, to satisfactorily fulfil their new mission in the so-called knowledge-based economies, IHE need to review their organizational structures as well as funding sources and mechanisms. Establishing quality parameters and appropriate evaluation instruments are needed to adopt incentive systems linking rewards to academic and institutional performance. Also, producing and disseminating new knowledge and providing high quality training can be achieved only if IHE unambiguously address the importance that research-teaching-learning linkages represent for achieving academic excellence. Indeed, current higher education reforms should not only pursue more autonomy, effective regulation, and funding diversification but also must place research-based teaching at the center of quality-enhancing initiatives in higher education.

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