Research for Development in the South
Regional Report for
Latin America and the Caribbean – LAC

by
Léa Velho
DPCT/IG/UNICAMP- Brasil
UNU/INTECH

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Contents

Acronyms

CAPES	Brazilian Graduate Agency
CEPAL	Economic Commission for Latin America and the Caribbean
CGIAR	Consultative Group on International Agricultural Research
CONACYT	National Council of Science and Technology
CONICET	Council of Scientific and Technical Research (Argentina)
CONICYT	National Commission of Science and Technical Research (Chile)
CSIC	Commission for Scientific Research
EMBRAPA	Brazilian Agricultural Research Corporation
EU	European Union
FDI	Foreign Direct Investment
FUNDACYT-BID	Foundation for Science and Technology – Inter-American Development Bank
GDP	gross domestic product
ICT	information communications technologies
IDB	Inter-American Development Bank
INCO-DEV	International Cooperation in Development Programme
ISI	Institute for Scientific Information
LAC	Latin America and the Caribbean
NGOs	nongovernmental organizations
NICs	Newly Industrialized Countries
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
PEDECIBA	Program for the Development of Basic Sciences
PPP	Purchasing Power Parity
R&D	Research and Development
RICYT	Red Iberoamericana de Indicadores de Ciencia y Technologia (Science & Technology Ibero-American Indicators Network
S&T	Science and Technology
SCI	Science Citation Index
SMEs	small and medium enterprises
SOEs	state-owned enterprises
STAs	Science and Technology Activities
STI	Technology Capacity Index
TAI	Technological Achievement Index
TNCs	Transnational corporations
UNAM	Autonomous University of Mexico
UNDP	United Nations Development Programme
Unesco	United Nations Educational Scientific and Cultural Organization

Executive Summary

The gap between developed and countries of Latin America and the Caribbean (LAC) in income and quality of life is well documented. This inequality in income is exceeded by inequalities in research and development (R&D) expenditures. Not only do LAC countries spend less in R&D than the advanced countries in absolute terms, but also in proportion to their gross domestic product (GDP); the average for LAC countries was 0.57 percent of GDP in 2000 and it has remained relatively stable through the past decade. The comparable expenditure rate for advanced countries and the Asian newly industrialized countries (NICs), such as Korea, varied from 2.5 to 3 percent of GDP in the same year.

About two-thirds of R&D funding in LAC was provided by the public sector in 2000 and the remaining one-third from private enterprises. This is in contrast to the strong presence of the business sector in R&D funding in Korea and Japan (over 70%), the USA (69%), and the European Union (54%). The uneven relationship in R&D expenditure between the public and private sectors seems to impede LAC countries from moving to more advanced stages of technological development.

In terms of socioeconomic objectives, in most LAC countries R&D's highest share goes to agriculture, forestry, and fishing. This is particularly true for the least industrialized countries in the region such as Paraguay, Ecuador, and Trinidad and Tobago. It is noteworthy that, with the exception of Cuba, R&D expenditure in health is only around 10 percent (the equivalent share for health in the US is over 45%). The low proportion of funding going to industrial development technology (with the exception of Argentina) resembles the already mentioned low R&D expenditure by the business sector.

LAC countries lack researchers capable of conducting high quality research. In 2000, LAC recorded around 240,000 researchers, the equivalent of 0.89 researchers for every 1,000 economically active people. Equivalent rates for Organisation for Economic Co-operation Development (OECD) countries are 10 (Spain) to 15 times (US) higher. In LAC, few scientists and engineers are employed in the business enterprise sector. Two out of three researchers are located in universities and only 11 percent work for companies (some of which are state-owned); this has not changed since 1995. This compares with almost 40 percent in leading OECD countries.

The participation of female researchers in science and technology (S&T) systems in most LAC countries ranges from one-third to one-half of staff employed in the sector in 2000. This is well above the numbers for more developed countries, such as those in the European Union (EU), where on average more than two-thirds of the researchers employed in government institutions and three-quarters of those in higher education are males; in the US, only one researcher in five is female. However, in terms of hierarchy and career progress, women researchers in LAC face the same constraints and barriers as their female colleagues elsewhere.

The LAC region as a whole makes only modest contributions to the scientific mainstream. Of the nearly 528,000 publications registered in the Science Citation Index (SCI) in 2000, only 12,000 (2.3%) originated in LAC countries. On a population basis, the LAC region produces 5.6 articles per 100,000 inhabitants, while the equivalent figure for the US is 116, 64 for Spain, and for 30 for Portugal per 100,000 people.

LAC received less than 1 percent of worldwide citations, less than half of LAC's contribution (2.3%) to world publications. This confirms the low impact of papers published by the LAC region and, in this specific indicator, no LAC country performs well. In terms of patents per 1,000 inhabitants, most LAC countries, in comparison to others, are further and furthest from the technological frontier.

Most LAC countries have an institution responsible for S&T policy at a high government level — either a Ministry of Science & Technology or an organization linked directly to the Presidency of the Republic. The same applies to research funding agencies which traditionally allocate funds on the basis of scientific criteria. Recently, policy schemes have been initiated to foster linkages between public sector research and businesses. Evaluation studies of such schemes show that their objectives have not been reached, although there are isolated success stories.

Public universities are the main source of knowledge production throughout the region. They performed around 41 percent of R&D activities in 1995, declining to around 38 percent in 2000. This downward trend is confirmed by the drop in the share of researchers in higher education, from 62 percent in 1995 to 59 percent in 2000. Universities' links with the industrial sector are quite limited; human capital in universities is regarded as a poor match with the needs of the private sector.

The picture for public research institutes is similar. Performance assessments of such institutes are mixed, but there is a tendency to accept that they enjoy a disproportionate share of national research budgets (performing 24% of R&D) and deliver proportionately little to the productive sector.

Business enterprises in LAC contribute 33 percent to R&D expenditures and perform about the same share, 36 percent. This has been an increasing trend from past decades, but seems to have reached a plateau since 1995. Yet, businesses hire only 11 percent of the researchers in LAC, perhaps an indication that their R&D activities do not necessarily require highly qualified personnel.

R&D funding and performance by nongovernmental organization (NGOs) in LAC decreased during the 1990s, while the number of researchers in NGOs more than doubled, climbing to almost 10 percent in 2000. NGOs are almost totally financed by external donors and play a very important role in carrying out relevant research for social movements and underprivileged groups, and in preserving indigenous knowledge.

In the last decade, LAC countries have not increased their international collaboration in research as a whole. However, they have strengthened scientific links among themselves.

The evidence presented here suggests that LAC countries have not been able to build links among the various relevant social actors involved in S&T production and use. Problems exist both in supply and demand. Concerning supply, universities and public research institutes, which together account for almost 70 percent of R&D activities, have not created mechanisms to identify user needs and set their research agenda on the basis of scientific criteria dictated by international mainstream science. On the demand side, there is not much demand on local R&D since transnational corporations (TNCs) act on the basis of R&D conducted in the developed countries. Local private firms, in order to be competitive, also prefer to import foreign technology. Some governments have implemented a few schemes designed to bring together supply and demand but, with only a few exceptions, they have not been successful. Macroeconomic policies geared to open up a country to foreign competition and the privatization of state enterprises without the necessary measures and incentives to guarantee investments and diminish the risks involved in R&D, help to explain this state of affairs.

Firm and focused government intervention is necessary if such trends are to be reversed. The most obvious sphere for intervention is creating a more just society in the region, and thus granting access to education to social groups currently excluded. Other policies have more direct bearing on R&D and include incentives for private sector investment in R&D and hiring of researchers. Most of all, measures must be implemented by all relevant S&T actors in terms of strengthening links among themselves.

The State of Research in Latin America and the Caribbean

Basic data

Expenditure in science and technology

Intensity of expenditure

The depth of any country's commitment to become a "knowledge society" is partly reflected in the financial resources it devotes to Scientific and Technological Activities (STAs) and, particularly to research and development (R&D). Although all LAC countries fund some kind of STAs, not all of them have a specific budget line for this and some do not keep statistics on these expenditures. Among those that do, some countries collect information for STAs only, others for R&D only. From 1995 onwards, thanks to the efforts of RICYT,[1] there is a tendency to present data for both categories.

STA investment (including R&D) by the LAC countries amounted to more than US$15 billion in 2000 (see Appendix Table 2). While still low when compared to the industrialized countries and to the Asian newly industrialized countries (NICs) like Korea,[2] the region's investment experienced 70 percent growth during the last decade, twice the pace of S&T investment in the European Union (EU) during the same period[3] (Urzúa 2002). Notwithstanding overall increases, some countries (Brazil, Chile, Cuba, and Ecuador) have experienced a number of kinks in their spending during the 1990s. Such fluctuations, generally provoked by difficult economic and political situations, question the commitment of LAC governments to S&T and have detrimental consequences for the overall performance of the system. In Brazil, for example, resources for the so-called Centres of Excellence in research were drastically cut in 2000, affecting most notably the hiring of young researchers, the purchase and maintenance of equipment, and institutional collaboration, areas that are decisive for a S&T system's competitiveness (Hansen et al. 2002).

The absolute volume of expenditures in S&T also differs enormously among LAC countries: Brazil is by far the frontrunner, accounting for 50 percent of total LAC expenditure in 2000, followed at a considerable distance by Mexico (15%) and Argentina (9.5%). Costa Rica, Chile, and Argentina, however, together with Brazil, perform comparatively well in the region in terms of S&T spending per resident (about 43.3; 26.0, and 38.6, respectively in 2000; see Appendix Table 2).

Considering the more usual and relative indicators of R&D expenditures to GDP, the average for LAC countries was 0.57 in 2000, remaining relatively stable through the past decade (RICYT 2002 and Appendix Table 2). This expenditure rate compares unfavourably with the industrialized countries and Asian NICs like Korea, which invest from 2.5 to 3 percent of GDP on R&D (NSB 2002). A country-by-country analysis shows that only Brazil had consistent investment rates higher than the regional R&D/GDP average since 1990 (from 0.76% in 1990 to 1.05% in 2000), while Chile fluctuated from above the average in 1995 to the average in 2000. Cuba is an interesting case in point; its R&D/GDP expenditure rate in 1990 was quite high for regional standards (well above the LAC average and comparable to Brazil at 0.70%) and explains the research gains the country was able to achieve,

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[1] RICYT is the Red Iberoamericana de Inicadores de Cienia y Technologia (Science and Technology Ibero-American Indicators Network) coordinated from Argentina and funded by the Organisation of American States (OAS) and the Spanish Development Co-operation Agency (CYTED). Although RICYT puts an enormous effort into the conceptualization and analysis of data, collection, it does not collect data itself, but relies on information sent by the countries. See: www.ricyt.org

[2] Korea alone invests more than all LAC combined and the USA spent around 20 times as much as all LAC expenditures in 2000 (NSB 2002).

[3] Although this magnitude of increase in S&T spending is generally accepted (see Hill 2000; Hansen et al. 2002; and Urzúa 2002), a word of caution is necessary: more countries collected information in 2000 than in 1990, an increase which may be attributed, at least in part, to the aggregation of newcomers to statistics collection.

particularly in the medical sciences and in biotechnology (Thorsteinsdóttir et al. 2003). This rate dropped consistently during the 1990s due to the loss of political and economic support from the vanished communist bloc. None of the other countries reached the regional average for R&D/GDP during the 1990s up to 2000.

Expenditure by financing sector

The most noteworthy characteristic of R&D expenditures in LAC is the crucial role played by the public sector: some two-thirds of R&D funding was provided by the public sector in 2000, with the remaining one-third from private enterprises (Appendix Table 3). This is in contrast to the strong presence of the business sector in R&D funding in Korea and Japan (over 70%), the US (69%), and the European Union (54%) (NSB 2002). In fact, public spending in LAC may even be underestimated because "public expenditures" for some countries do not include R&D expenditures of state-owned enterprises but are recorded under "enterprise expenditure." This is the case for Brazil, where public enterprises provided one-third of industrial R&D funding in 1998 (Hansen et al. 2002). Cuba also includes public firm expenditures under the "enterprise" category. The participation of private enterprises in R&D expenditure is probably smaller in LAC than the figures in Appendix Table 3 lead us to believe.

The share of private sector R&D funding has slowly increased during the 1990s in LAC, from 26.1 percent in 1990 to 32.6 percent in 2000 (see Appendix Table 3). This trend applies to most of the countries in the region, although in only a few of them (Brazil, Colombia, Uruguay, and Venezuela) does the business sector seem to play a significant role in R&D funding with a 40 percent share of total R&D expenses. In El Salvador, Panama, and Paraguay, the enterprise sector funds less than 5 percent of total R&D activities.

This uneven relationship in R&D expenditure between the public and private sectors impedes LAC countries moving to more advanced stages of technological development. No country has ever secured advanced technological capabilities without significant private R&D expenditures.[4] As a matter of fact, countries that made the transition to knowledge economies showed a consistent and marked increase in private sector participation in R&D investment over time (e.g., Korea and Ireland).[5]

Another source of R&D funding in LAC are institutions of higher education. Their share has increased consistently, albeit slowly, from 5.7 percent in 1990 to 8.3 percent in 2000. The nature of R&D expenses that are considered in this category by each country varies, but there is a tendency to include the R&D funding provided by private universities (since public universities are accounted for in government spending). In light of the considerable increase in the number of private universities in LAC in the last decade, and given that some countries (Brazil, Colombia, Mexico) only allow the creation of new universities if they invest in R&D, it is reasonable to assume that the increase in R&D expenditures by this sector is due to the entry of new institutions to the system. This explanation, however, does not fit the case of Uruguay which shows a comparatively high share of R&D expenditure by the higher education sector (50.3% in 1995, decreasing to about 35.7% in 2000). The explanation for Uruguay's numbers lie with the Universidad de la Republica, the only public university, and its internal research council (the Commission for Scientific Research – CSIC) with a specific budget which is the most important source of funding for academic research in the country (Davyt and Velho 1999).

Other sponsors of R&D activities in LAC include nonprofit organiszations and foreign sources. Together, these sources represented less than 5 percent of R&D expenditures for LAC as a whole during the 1990s. However, both are quite significant for poorer LAC countries, such as Bolivia, Ecuador, and El Salvador

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[4] Even to be technology followers, countries need to have business enterprises willing to invest in R&D. The reasons are that R&D units located in firms allow "better and faster diffusion within the economy of new technologies, lower the cost of technology transfer and capture more of the spillover benefits created by the operation of foreign firms" (Lall 2002, p. 3).

[5] The evolution of the ratio of private to public R&D expenditures, from 1980 to 1995 in Korea and Ireland was, 1.62 to 4.80 and 0.80 to 2.60, respectively (Ferranti et al. 2002).

and even for a few middle-income countries like Panama and Uruguay (Appendix Table 3), for reasons worth exploring. First, the distinction between R&D funding from nonprofit organizations and foreign sources is somewhat blurred. Nonprofit organizations dedicated to R&D face great difficulty in raising funds domestically and are dependent on foreign resources. When foreign money is granted directly to nongovernmental organizations (NGOs) without local government mediation, it is classified as "nonprofit organization's R&D expenditure." This means that a country with a high share of nonprofit organization expenditure, is actually receiving considerable foreign support for research. This is the case in Bolivia, where NGOs play a vital part in R&D expenditure but receive all their support from foreign sources. Nicaragua (which is not featured in Appendix Table 3), shows a similar picture. Nicaragua and Bolivia are the largest development assistance recipients in LAC (WDI 2002). Although, as a norm, only a fraction of official development assistance (ODA) (from 5 to 10%) is spent on R&D activities,[6] studies carried out in Nicaragua and Bolivia revealed that not only NGOs but universities are also heavily dependent on international cooperation and foreign aid to carry out R&D activities (Velho 2000). There is, however, a decreasing trend in the share of nonprofit and foreign expenditure, even for the poorer countries (Appendix Table 3, see especially Bolivia).

Foreign funding for R&D in LAC comes from different sources, most commonly from multi- and bilateral development agencies and philanthropic organizations. In particular, the World Bank and the Inter-American Development Bank (IDB) provided substantial resources to support S&T activities in the region, such as multiyear loans amounting to about US$600 million for Argentina, Brazil, and Mexico during the 1990s (Hansen et al. 2002). Since public government spending in R&D is considerably different in these countries, the impact of such loans varies accordingly, being practically negligible in R&D total expenditures in Brazil but totalling almost 7 percent in Mexico (Appendix Table 3). In Uruguay, the share of foreign funding was 12.5 percent in 1995 and dropped to about 5 percent in 2000. This reflects the support granted to the Program for the Development of Basic Sciences (PEDECIBA) by various international agencies, and the special role of the United Nations Development Programme (UNDP) (Barreiro 1997).[7] In Panama, foreign funding for R&D from the Smithsonian Institute of Tropical Research amounted to over US$18 million in 2000 (RICYT 2002).

Expenditure by socioeconomic objective

Appendix Table 4 shows that for most LAC countries, R&D funding flows mostly to the agriculture, forestry, and fishing sectors. This is particularly true for the least industrialized countries in the region such as Paraguay, Ecuador, and Trinidad and Tobago. With the exception of Cuba, R&D expenditure in health is only around 10 percent (the equivalent share for health in the USA is over 45%) (NSB 2002). The low proportion of funding to industrial development technology (with the exception of Argentina) mirrors the low R&D expenditure by the business enterprise sector outlined earlier. Brazil's high share of funding to "general promotion of knowledge," reflects the existence of traditional research councils and funds operating on a competitive basis since the 1950s.

[6] In terms of GNP, ODA fell everywhere from 1989 to 1996, but still represents from 1.03% (Denmark) to 0.12% (USA), approximately US$7 to US$8 billion (Japan, US, Germany, and France) to US$2 to US$3 billion (UK, Denmark, the Netherlands), according to Gaillard (1999, p. 298-301). Although accepting that data on ODA is quite unreliable, by examining various sources, the author estimates that between 5 and 10% is spent on research (see also Wagner et al. 2001, p.21-22).

[7] PEDECIBA was established in October 1986 by agreement between the Ministry of Education and Culture, on behalf of the Government of Uruguay, and the University of the Republic, with strong support from the UNDP. From 1993 to 1997, research projects and fellowships were partially administered by CONICYT. Since 1995 PEDECIBA has been incorporated into the national budget on a permanent basis. Among its objectives was reversing the huge brain drain of natural scientists provoked by the military dictatorship from 1973 to the mid-1980s (http://www.rau.edu.uy/pedeciba/)

Personnel

There is wide agreement among analysts that LAC countries lack the researchers capable of conducting high quality research. In 2000, LAC recorded around 240,000 researchers, the equivalent to 0.89 researchers for every 1,000 economically active people. Equivalent rates for Organisation for Economic Co-operation and Development (OECD) countries are 10 (Spain) to 15 times (US) higher. There are, however, significant differences among LAC countries. Argentina, Costa Rica, and Chile are the best performers in this respect (with 2.5; 1.5, and 1.2 researchers per 1,000 residents, respectively), while Mexico and Brazil fare much worse than expected (ranging around the LAC average. See Appendix Table 5), given their level of R&D expenditure and their emphasis (particularly Brazil's) on postgraduate training programs.

In LAC few scientists and engineers are employed in the business enterprise sector (Appendix Table 3). Two out of three researchers are located in universities and only 11 percent work in companies (some of which are state-owned); this has not changed since 1995. This compares with almost 40 percent in leading OECD countries with a tradition of close business-university collaboration in research. Brazil is the only LAC country that shows a considerable proportion of researchers in business in 2000, but the amazing increase since 1995 (7.8%) suggests that there are problems with the data (Velho and Saenz 2002).[8] Costa Rica also merits attention, reporting one-fourth of researchers active in this sector. For all other LAC countries, the figure never rises above 12 percent and is often zero percent. As a result of the low share of business spending on R&D and of researchers employed in the business sector, LAC puts much less effort into development research (which is generally underwritten by the private sector). The share of basic research (as defined in the Frascati Manual) in LAC countries is 53 percent and only 18 percent in development research, while equivalent figures for the OECD and Asian tigers are 17 percent and 63 percent, respectively (Guasch 2002).

In short, the majority of LAC researchers work in the public sector, most notably in universities. Further examination reveals that some 60 percent of faculty members work part-time and their lack of formal qualifications: less than 6 percent hold a PhD degree; fewer than 26 percent had a Masters degree (García Guadilla 1998). Once again, LAC averages hide considerable differences in the region: over 50 percent of researchers in Brazil and in Trinidad and Tobago, and about one-fourth in Argentina hold a PhD. Surprisingly, in Mexico, 64 percent of researchers have not undertaken any postgraduate training and only 6 percent are PhD holders. Masters are much more generalized, as in the case of El Salvador (Appendix Table 6). Despite these figures, estimates cite a 70 percent increase in Master graduates in the LAC region over the past decade. An even faster growth was experienced in the number of doctorates, which practically doubled in the same period (Urzúa 2002).

One important aspect of research personnel has to do with its distribution in the various knowledge fields. Appendix Table 6 shows that more than 30 percent of researchers in LAC work in the social sciences and humanities. It has been forcefully argued that an additional problem with the research workforce in LAC is that there are too many social scientists as compared to natural scientists and engineers (Schwartzman 2001). Since there is no established guide as to what that proportion should be, one practice is to compare LAC to the advanced countries. The proportion of researchers in the social sciences in academic institutions in the USA is about 20 percent, but as part of the entire science and engineering workforce, it is 28 percent (NSB 2002, Table 5-30). This is very similar to the LAC share of social scientists. On a country-by-country basis, however, it is striking that about 60 percent of the researchers in Mexico and El

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[8] Data on R&D expenditures by researchers in Brazil's enterprise sector was collected in a survey based on a very limited sample of firms. There is serious controversy in the country on the representativeness of the sample and the methodology used. Most analysts believe that the participation of the business sector as it appears in the indicators of S&T produced by the Ministry of Science and Technology has been grossly overestimated.

Salvador are concentrated in the social sciences and humanities. Of the LAC countries featured in Appendix Table 5, Bolivia and Ecuador have the lowest share of social scientists (about 10%). This data is confirmed by case studies in Bolivia as well as in Nicaragua (for which there is no available quantitative data). Research in the social sciences in Bolivia is believed to be "poor, personalised, isolated, discursive and lacking of systematic approach and empirical basis" (Souza Paula et al. 2000). For this reason, and assuming that a critical mass of social scientists is essential for development, some bilateral programs have decided to support initiatives in this direction in Bolivia. In the same vein, university officials and researchers in Nicaragua have insisted in negotiations with donors that they need support to strengthen their research capacity in the social sciences, but have not succeeded so far.[9]

Uruguay and Chile show a strong representation of natural scientists among researchers (around 30%, see Appendix Table 5). For Uruguay this is probably the outcome of the strong support granted to the natural sciences within the framework of PEDECIBA (see note 7). Chile has a strong tradition in the natural sciences and mathematics, fields that host the best graduate programs in that country (Krauskopf 2000). Brazil's pattern of distribution of researchers in scientific fields is similar to that of the US, with the exception of the medical sciences where the US has a significantly higher share (20% in Brazil and 34% in the US). However, a recent estimate of researchers in medical-related fields in Brazil argues that their share in the R&D workforce varies from 25 to 33 percent, depending on the definition used (Guimarães 2003)). Finally, the share of researchers in engineering in LAC is also comparable to that of the US — 17 percent and 18 percent, respectively.

Gender participation in the S&T system

Participation of female researchers in S&T in most LAC countries ranges from one-third to one-half of total staff in 2000 (see Appendix Table 7). This is well above the norm in more developed countries such as the EU, where on average more than two-thirds of the researchers in government institutions and three-quarters in higher education are males,[10] or the US, where only one researcher in five is female. One possible explanation for women's higher participation in research activities in LAC could be the existence of family and social support networks that enable women to balance career and family responsibilities. Another explanation could be the differences in pay and working conditions between the public and private sectors, since most research is carried out at universities or public institutions. The relatively low pay in the public sector may be a disincentive for males, who are culturally the income providers for the family. On the other hand, the flexibility in working conditions in public institutions may act as an extra incentive for women, who culturally have to balance their reproductive and productive roles.[11]

At the undergraduate level, gender participation is relatively balanced on the whole, leaning perhaps more favourable to women in countries such as Argentina, Uruguay, and Brazil. Although men are the majority in some technical and scientific disciplines, such as the agricultural sciences or engineering, women make up the majority in chemistry and the biological sciences. The ratio in social sciences is about 50 percent, and in humanities it exceeds 60 percent. This gender ratio is maintained through the Master (50% in the case of Brazil, 41% in Mexico) and doctoral degrees (46% in Brazil, about 50% in Argentina). However, when scholarships systems are taken into account, the differences are wider: in Mexico, only three out of 10 scholarships are awarded to women.[12] In Uruguay, women account for only

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[9] Bilateral development agencies supporting social sciences research in Bolivia are the Swedish SIDA/SAREC and the Dutch Directorate for Development Co-operation (DGIS). Paradoxically, the SIDA/SAREC has not agreed to support social sciences in Nicaragua, despite urging from local universities (for Bolivia see Souza Paula et al. 2000; for Nicaragua, personal information).

[10] Eurostat. 2001. Women in public research and higher education in Europe. Statistics in focus. Science and Technology, Theme 9 – 7/2001.

[11] Participación de la mujer en el sistema de Investigación y Desarrollo en Argentina www.secebyt.org.uy.

[12] El factor género en las estadísticas del CONACYT México www.segecyt.org.uy

35 percent of postgraduate scholarships.[13] In Ecuador the ratio is 27 percent.[14] In Brazil only 38 percent of Fulbright award winners are female.

Joining a research institution does not seem to be any different for men or women, except in the case of Mexico, where some de facto entry barriers seem to exist. However, in terms of hierarchy and career progress, women researchers in Latin America face the same constraints and barriers as their female colleagues elsewhere. Hierarchy implies decision-making power, which is crucial in selecting research topics and allocating resources, and it is here where women encounter difficulties. In Argentina, of the women researchers at CONICET (Council of Scientific and Technical Research), 72 percent are concentrated in the lower levels, compared with 51 percent of the men. Only 0.4 percent of women researchers reach the highest level, compared with 4.5 percent of men, which leaves a ratio of nearly 10:1 at the top. The same occurs in Uruguay, where men occupy 80 percent of the director positions in CONACYT (National Council of Science And Technology) and a negative relationship has been found between project size and female directors (33% when projects are below US$30,000, 19% when above US$150,000). In Brazil, there is gender balance only in the early stages of a research career (50% of staff below 24 years of age is female), thereafter it slips to around 40 percent (only 28% of 60+ is female).[15] In Ecuador, women have led only 13 percent of the university research projects (1983-96) and 9 percent of FUNDACYT-IDB (Foundation for Science and Technology) research projects (1994-96). One exception seems to be Cuba, where women account for 58 percent of researchers and 45 percent of research directors at the university.[16]

In terms of the scientific disciplines, the distribution of researchers is similar to that observed in tertiary education. Women are the majority in most humanities, are equally represented in the social sciences and in some hard sciences such as biology, chemistry, and medicine. Researchers in the exact, agricultural, or engineering sciences are mostly men. Women's groups and agencies dealing with women's development in Latin America are currently focusing on promoting and securing women's rights in the following areas: social and economic rights; civil and political rights; and health and reproductive rights.[17]

Research output

Research output can take many forms: from the publication of articles in specialized, peer-reviewed "international" journals (the so-called mainstream publication channels) to research reports in local languages contracted out by governments and donors, to presentations in meetings (the "gray" literature). How to collect systematic information on such output and how to ascertain its "scientific quality" or "social relevance" has always been a matter for discussion and debate. To date, there is no publication database that is reliable or systematically updated, which covers all fields and the LAC countries. The existing databases suffer from conceptual or methodological limitations: some cover only publications related to specific fields (such as Medline for medical-related fields and Chemical Abstracts for research using chemistry-based methodology; both include the mainstream and grey literatures). Others are intended to cover only specific countries and institutions (such as the one maintained by the Brazilian

[13] Mujeres, Ciencia y Tecnología en el Uruguay: Situación del CONICYT www.conicyt.gub.uy

[14] See León 2001.

[15] Kochen et al. 2001.

[16] Fernández (2001).

[17] In the area of social and economic rights, there are projects aimed at eradicating illiteracy, enhancing women's participation in economic decision-making, building women's entrepreneurial capabilities, creating employment opportunities for women, especially in the rural areas, and improving rural women's access to land and resources. In the area of civil and political rights, the main focus is eliminating domestic violence and promoting gender justice by engaging women in the political process at all levels and changing sociocultural attitudes regarding violence and gender inequality. In the area of health and reproductive rights, the focus is twofold. Top priority is the reduction of maternal mortality, the most serious health-related problem for LAC women. Depending on the country, the focus is on extending prenatal services, improving health care quality, reducing unwanted pregnancies and/or involving men in reproductive health programs. The other priority is reducing the spread and impact of HIV/AIDS in the region, by protecting and promoting the rights of women.

Graduate Agency — CAPES or by the Chilean CONICYT — National Commission of Science and Technical Research). Others attempt to provide comprehensive LAC coverage but lack the financial and human resources to accomplish the project. For example, Periodica, maintained by the Autonomous University of Mexico (UNAM), which is admittedly biased in its coverage of Mexican publications, neglects a large part of South American output and does not provide information about countries outside LAC, making comparability across regions unfeasible (Narvaéz-Berthelemot et al. 1999). Finally, the most commonly used databases produced by the Institute for Scientific Information (ISI), of which the Science Citation Index (SCI) is the best known, have long been judged as discriminatory against non-English publications from developing countries which highlight more applied, locally relevant, and interdisciplinary research.[18]

To address these issues, RICYT moved to publish output indicators for LAC. It organized a number of meetings with experts and policymakers and a decision was made to present research output according to various databases. The rationale was that each database would be appropriate for a specific purpose and researchers could choose according to their particular objective. Ten different databases report LAC research output in the Science and Technology Indicators series produced by RICYT. Only three (SCI, INSPEC, and Pascal) cover all scientific fields and all countries, thus allowing us to estimate LAC contributions to world science, which varies from 2.3 percent of the total output of nearly 528,000 publications registered in the SCI in 2000, to 2.1 percent of 335,089 publications compiled by INSPEC in the same year, to 2.6 percent of 511,617 items registered by Pascal, also in 2000. Moreover, in all three databases, Brazil is responsible for about 50 percent of the publications from LAC. What these figures show is that, by whatever means publication data for different countries is obtained (the three databases use different collection criteria), the aggregated contribution of LAC to world science is modest, just above 2 percent.[19] Moreover, given the convergence of the three databases, it seems reasonable to use the SCI for gross comparative analysis, as presented in Appendix Table 8.

The LAC region produces 5.6 articles per 100,000 inhabitants, while the equivalent figure for the USA is 116, 64 for Spain, and 30 Portugal per 100,000 (RICYT 2002). Brazil is LAC's biggest producer, with a ratio of only 7.6 publications per 100,000 people. Although this is a considerable improvement from the beginning of the 1990s when the ratio of publications per 100,000 people in Brazil was 2.5, countries like Argentina, Chile, and Costa Rica perform better than Brazil when ratios of publication/population are considered.

Even more controversial than estimating scientific output is to make statements about scientific quality and social relevance. It is widely accepted that social relevance can only be assessed through case studies and with the use of qualitative information. As far as measuring scientific quality is concerned, the conventional approach is to use the proxy measure known as the "impact of publication." This measure is

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[18] In 1984 I published a pioneering article, which had a considerable impact, criticizing the use of the ISI database to analyze the scientific output of LAC (Velho 1984). On that occasion, as in many others that followed, I pointed out that the majority of the publications of any LAC country appeared in local journals in Spanish and in Portuguese and that there was no reason to believe that such publications were of lower quality than the ones published in journals indexed by the SCI. Therefore, my main argument has been that assessing scientific output of a specific LAC country must be based on local data collection. However, I also pointed out that for comparative studies among different countries, there is no other way but to use international databases.

[19] If specific research fields are considered separately, the contribution of LAC to global scientific output can vary considerably. In the medical field, for example, LAC's contribution to world science, according to Medline is 1.8% of 479,731 publications indexed in 2000; in biology, on the basis of 572,218 items compiled by Biosis, LAC contributed 2.8%. In agriculture, however, LAC's contribution to world output in 2000 was considerably higher: of a total 162,507 titles compiled by the Comprehensive Agricultural Database (CAB), almost 7% originated in LAC countries (www.ricyt.org). The scientific output in the social sciences is particularly difficult to estimate given the absence of reliable databases and this is a universal problem and not one restricted to LAC. The existing Social Sciences Citation Index is too narrow and has too many methodological problems to be used even for comparative purposes only. In LAC social scientists are the most likely to publish in the local languages and in domestic journals.

derived from the SCI database and relates to the number of times an article has been cited. Appendix Table 9 shows how many times LAC publications were cited in 1990 and 1999 and what this represents in terms of the distribution of total citations indexed in the ISI database. The figures reveal that LAC received less than 1 percent of worldwide citations, which is less than half of LAC's contribution (2.3) to world publication. This illustrates the low impact of papers published by LAC and, in this specific indicator, no LAC country performs well.

Another important output of R&D is patents, one of the few indicators measuring successful innovation. Patents registered in the United States are readily available. A high patent counts indicates a nation's presence close to or at the technological frontier; and low patent counts signal a significant distance from the technological frontier. Appendix Table 10 presents patents per 1,000 inhabitants and classifies countries into four broad categories. Most LAC countries fall into those groups which are further and furthest from the technological frontier, including Costa Rica and Brazil. The country closest to the technological frontier, as per this indicator, is Venezuela. Finally, countries farthest from the frontier, such as Nicaragua, Paraguay, Peru, and El Salvador, do not yet posses the skills, infrastructure, or the incentive regime to undertake technological initiatives (Ferranti et al. 2003).

Position in the "knowledge divide"

The basic data presented above shows that LAC countries are lagging considerably behind OECD countries, as well as the Asian tigers, in terms of their capacity to produce and utilize knowledge. But the data also confirms that there is much diversity among LAC countries. This diversity, added to the fact that each indicator focuses on only one aspect of a very complex picture, has led to a tendency to construct indexes that take into consideration a group of indicators. From a policy viewpoint, such exercises are extremely important because they call attention to important differences among countries and highlight the lack of blueprints and general prescriptions.

Attempts in this direction began with Unesco in 1990. A number of others have since followed, including the Rand Index and the Technological Achievement Index (TAI) constructed for the UNDP's 2001 *Human Development Report*. More recently, a Science and Technology Capacity Index was developed by Sagasti (2003) which, for the first time, was based on a clear conceptual framework and is policy-oriented. Although some of the variables used in the construction of these indexes are common to all, each has specificities. Table 11 illustrates the results of the application of two of such indexes to LAC countries.

Each of the indexes is composed of four categories ranking the countries in descending order of capacity, intensity, or proficiency. Appendix Table 11 reveals that no LAC country appears in the first category in any of the two indexes. It also shows significant consistency in how the indexes group LAC countries (the highlighted cells in Appendix Table 11). However, a few divergencies do occur. Appendix Table 11 shows an uncomfortable position for Brazil in the TAI group of dynamic adopters. In the Science and Technology Capacity Index (STCI), Brazil falls into group 2. Costa Rica is exactly the opposite: it is in the group of potential leaders for TAI and in group 3 for STI. The reason lies in the fact that the TAI takes into account certain social indicators (mean years of schooling, enrolment at tertiary level, etc.) which reflect the high level of social inequality in Brazil and the much more equalitarian society in Costa Rica. The choice of indicators and indexes to inform policy-making is not neutral. The combination of two or more indexes allows the perception of subtleties not revealed by one. For example, in using only the TAI, one would end up with a large group of LAC countries in the dynamic adopter group; combining the TAI with the STI would further differentiate this group.

The research sector

It is now generally accepted that countries that became knowledge societies are those with a well functioning system of innovation. This system consists of a network of social actors — firms, public and private laboratories, universities, professional associations, trade unions, grass-roots organizations, etc., — together with the institutions[20] and policies that influence innovative behaviour and performance (Freeman 1987; Lundvall 1992; Nelson 1993). The most important element in the system is not so much the strength of the individual actors as the links between them. When actors are not particularly strong, but the links between them are well developed, the system of innovation may operate more effectively (in terms of learning and in generating innovations) than others where one actor is strong but the links are weak. It is thus important to identify not only the relevant social actors which are present in LAC countries, but also the links among them and the public policies targeting them, so as to determine whether a system of innovation is in place or, perhaps, being built. Annex Table 12 provides an overview of such S&T actors in a number of LAC countries.

S&T policy-making and funding government institutions

The LAC countries featured in Annex Table 12 have established a body responsible for S&T policy at a high government level — either a Ministry of S&T or an organization linked directly to the Presidency of the Republic. The same applies to research funding agencies, as all countries have also created so-called research councils. The division of labour between these two types of organizations is that the former articulates S&T policy, normally in negotiation with ministries of other sectors, while the research councils are responsible for implementing the policy through funding and incentive mechanisms.[21] The mere creation of such institutions, however, does not make them operational or dynamic. In a few countries, S&T plans as well as the so-called *Fondos de C&T* (S&T funds), only exist nominally, on paper. This is the case of Bolivia (where at least three attempts were made to actually institutionalize the research council), Paraguay, and Nicaragua.[22] In those countries where the policy and funding mechanisms do work (Brazil, Uruguay, Argentina, Chile, Colombia, Venezuela, Costa Rica, and Mexico), they are usually under the control of the local scientific community. Assuming a linear model of innovation, efforts were concentrated in the scientific end, the rationale being that a critical mass of qualified researchers, well-equipped labs, and strong universities would result in “good science” which, sooner or later, would find its application in technological development.[23]

In LAC, identifying research priorities for resource allocation has, traditionally, been left to the research community and not negotiated with potential users. As such, research themes tend to be selected more on the basis of their scientific importance, taking the lead from international science, than on the basis of local needs. More recently, and very much in line with international trends, a number of policy schemes have been devised by research councils in many countries to foster linkages between public sector research (particularly universities) and business. Such schemes include cooperative projects between the public and private sectors, support to incubators and science parks, and support to research training in business. However, evaluation studies of these schemes in a number of LAC countries show that their objectives have not been met, at least not in a way that makes any difference in the aggregate (although there are isolated success stories).[24]

Institutions of higher education

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[20] Institutions are understood here as the combined environment of physical organizations and the practiced routines, norms, shared expectations, morals, etc. (Edquist and Johnson 1997).

[21] Research councils as both policy and funding organizations for S&T were established in LAC mostly through the 1960s and 1970s, with the advice and support of Unesco and the OAS. A number of authors have analyzed the consequences and impacts of this “blueprint” (see, among others, Amadeo 1978; Oteiza 1992; Bastos and Cooper 1995).

[22] For an analysis of the case of Bolivia, see Escobar (2002); for Paraguay, see Davyt (1997); and for Nicaragua, Velho (2003).

[23] This is what has been called by Latin American authors as an *ofertista* S&T policy, meaning a policy which takes care of the supply side only (Sagasti 1980; Avalos 1991). According to this logic, by supporting scientific research and strengthening research training capabilities in universities, the government was, indirectly, contributing to technological development.

[24] Case studies about these failures have been done in Mexico (Casas 1997); Argentina (Chudnovsky and López 1996); Brazil (Velho and Saenz, 2002); and the region (Arocena and Sutz 2001), among others.

LAC universities are traditionally public and were created after the classic Humboldt model and the contemporary research universities in the US and Europe. In the past 15 years, many countries in the region have experienced an impressive growth of private tertiary education institutions. In the Dominican Republic and El Salvador, the share of student enrolment in private tertiary education rose from about 25 percent in 1970 to about 70 percent in 1996; for the region as a whole, the figure is 40 percent (García Guadilla 1998). Some countries also have a significant nonuniversity tertiary sector (79% of total enrolment in Cuba, 43% in Peru, 38% in Brazil, and 35% in Chile); in others, among them El Salvador, Guatemala, Honduras, Nicaragua, and Panama, the nonuniversity sector accounts for less than 5 percent (World Bank 2002).

Most of the new private universities and nonuniversity education institutions concentrate in "chalk and blackboard" disciplines (law, business, accounting, social work, etc.) and do not carry out research. There is no dispute among analysts and policymakers that public universities are the main *locus* of knowledge production across the region. A look at the figures in Appendix Table 3 reveals that higher education institutions performed approximately 41 percent of R&D activities in 1995, with a slight decline to around 38 percent in 2000. This decline seems to be confirmed by the drop in the share of researchers in higher education from 62 percent in 1995 to 59 percent in 2000 (Appendix Table 3).

University researchers in LAC tend to be academically oriented, for a number of reasons. The most obvious is that, in many countries, they are evaluated and promoted on the basis of their formal qualification and publication record, which traditionally values more publications in mainstream journals.[25] Another important reason is that university researchers tend to have weak links with other segments of society, be it government, the productive sector, or civil society organizations. In these circumstances, research agendas are more likely to be influenced by the international mainstream. There is nothing intrinsically wrong in academic research. Many argue that basic research is a true function of universities. Problems arise when research is totally disconnected from local problems. Research benefits from contact with links to its outer environment where problems are identified and relevant solutions are designed. Thus, socially relevant basic research is born. The general academic orientation of university research in LAC has been remarked on since the late 1960s (Varsavsky 1969; Herrera 1975) and confirmed by several empirical studies in different countries (Velho 1995; Casas 1997; Arocena and Sutz 2001). There are however, some notable differences among scientific fields. In agriculture, for example, LAC universities have traditionally held strong links with applications in plant breeding and pest and disease control. However, even in such an applied field, empirical research has found that university researchers in agriculture tend to choose their research topics from their own assessment of production needs, not through contact and discussion with farmers and extension agents (Velho 1990). There is some connection between university research in tropical diseases and knowledge demands, but the channels connecting knowledge producers and users are far from satisfactory (see, for example, the case of the Medical School in León, Nicaragua, in Velho 2003). In addition, the links between LAC universities and the industrial sector are quite limited and do not normally involve research activities, but are generally short-term contracts for consultancy, trouble-shooting, and routine analysis.[26] One report compiling results for various case studies of university-industry links in LAC countries concluded that "human capital in universities appears to be poorly matched to the needs of the private sector," and that "LAC business leaders do not generally consider higher education to meet the needs of the economy" (Ferranti et al. 2003, p. 228). Finally, in the social sciences, there is a tendency to focus only on aspects of the local reality, not the wider picture. Again, the issues to be studied are determined by the researchers themselves

[25] In some poorer LAC countries such as Nicaragua, Bolivia, and the Dominican Republic, public universities have no research tradition, although most faculty members are hired on a full-time basis. An academic career does not rest on degrees or research publications, but is based on seniority. Faculty members earn extra pay when they take on administrative positions. See Velho (2003) for Nicaragua, Souza Paula et al. (2000) for Bolivia, and Pimentel (2002) for Dominican Republic.

[26] A number of studies present convergent findings in this respect. For a review, see Velho and Saenz (2002) and Sutz (2001).

and not from identified social demands. The exceptions are the work carried out by the elite social scientists, attached to the best universities who are often contracted out by government to carry out studies to inform policy decisions.

One fundamental contribution of universities to knowledge production is in the training of new researchers. Expansion of postgraduate education in LAC has been extremely slow. Students enrolled in postgraduate programs represented, on average, only 2.4 percent of overall tertiary education enrolment in 1997, compared with 13 percent in the USA. Moreover, most of such students tend to be either in nondegree, specialization courses or in Master programs, mainly in the social professions like law and business (Schwartzman 2001). As for doctoral training, whereas OECD countries produce, on average, one new PhD per year per 5,000 population, the ratio is one PhD per 28,000 population in Brazil (Appendix Table 13), one per 140,000 in Chile, and one per 700,000 in Colombia. More than two-thirds of all Latin American postgraduate students are concentrated in just two countries: Brazil and Mexico (World Bank 2002). Brazilian universities, however, graduate almost six times as many PhDs as their Mexican counterparts (Appendix Table 13). In addition, the Brazilian government also provides scholarships to an approximately 1,500 doctoral candidates abroad per year. Another important feature of the Brazilian postgraduate training programs is that they provide free tuition and offer maintenance stipends to a high proportion of the students (over 60%) and extend this access to foreign students. As a result, a large number of students from other LAC countries are enrolled in graduate programs in Brazil.[27]

Public research institutes

Research activities in most LAC countries started in the 19th century with the creation of government research institutes in specific fields, and aimed to produce relevant knowledge to solve practical problems. It is not surprising that these institutes concentrate in fields related to natural resources (botanical gardens, agriculture, forestry, geology) and health which cannot rely solely on knowledge from the North. Appendix Table 12 reveals that all LAC countries have established research institutes in such fields — agriculture, for obvious reasons, is the most common, as confirmed by Appendix Table 4 which shows that agriculture receives the highest share of R&D expenditures. The significance of natural resources for the region has also led to the establishment of some regional and international research institutes, such as the Inter-American Institute for Co-operation on Agriculture and three centres of the Consultative Group on International Agricultural Research (CGIAR) system (for maize in Mexico; for potatoes in Peru; and tropical agriculture in Colombia). Despite the importance of such international institutes in terms of knowledge generation, the general feeling is that they are not part of the R&D structure of LAC countries. Such international research centres are perceived to be too science-oriented and far removed from the practical needs of the countries where they are physically located.

LAC countries also established industrial technology research institutes to support the industrialization process that was taking place. In addition, some countries created state enterprises in strategic sectors, such as oil, telecommunications, electricity and space, as well as dedicated R&D institutes. The performance of such institutes is mixed, but there is a perception that they enjoy a disproportionate share of national research budgets (see Appendix Table 3) but deliver proportionately little to the productive sector, for two reasons. First, government researchers have relatively little understanding of the specific needs of industry and hence the necessary feedback is absent. Second, it is difficult to provide researchers working in public institutes with strong incentives to be responsive to industrial needs (Ferranti et al. 2003, p. 224).

In light of this, public research institutes were urged to modernize and to seek funding from the marketplace and to establish partnerships with the productive sector. This required a reorganization of the

[27] The exact number of foreign graduate students in Brazil is difficult to estimate since there is no centralized system gathering this data for all universities. The Brazilian government provides a special scholarship for foreign students from some poorer LAC and African countries (see www.capes.gov.br)

institutes in terms of setting research agendas, stimulating interdisciplinarity, and acquiring skills in planning, management, monitoring, and evaluation. One negative outcome is that institutes now tend to undertake work for paying clients who can pay to the neglect of others like small farmers and small and medium enterprises (SMEs). Budget cuts have eliminated what little independent long-term research and development projects the institutes had and, in the poorer countries, the institutes are increasingly dependent on foreign financial assistance (Alcorta and Peres 1998). Some institutes have adjusted better than others. Agricultural institutes in LAC have reinvented themselves and are often cited as examples of success (for example, Brazil's EMBRAPA cited in OECD 2001). Success stories also exist in the industrial sector, where Colombia's Institute for Rubber and Plastic is an important source of technology transfer to the revived Colombian plastic industry (Ferranti et al. 2003). It appears that when institutes have strong links with the private sector, they are able to undertake relevant R&D. Questions remain about the unmet demands and needs of users who cannot pay.

Business enterprises

Businesses in the LAC countries contribute 33 percent to R&D expenditures and perform about the same share, 36 percent (Appendix Table 3). Despite steady increases in past decades, spending seems to have reached a plateau since 1995. Yet, businesses hire only 11 percent of the researchers in LAC, perhaps an indication that their R&D activities do not necessarily require highly qualified personnel.

The composition of business enterprises in LAC includes state-owned enterprises (SOEs) and the private sector, which can be grouped into three categories: local subsidiaries of transnational corporations (TNCs); small and medium-sized enterprises, most of which are family-owned firms; and large domestic conglomerates.

SOEs were created in LAC after WW II, as the state produced goods and services in energy, transport, and telecommunications, as well as some industries related to the defence sector, such as oil and petrochemicals, iron, and steel. It was deemed that these SOEs required their own R&D and engineering departments, which grew to have strong links with some universities as well as with SMEs in the private sector (Dagnino and Velho 1998). A number of studies have documented the success of such arrangements, but have also recognized that "the innovation system developed was fragmented … and failed to serve as a true engine for growth in the domestic environment" (Katz 2001, p. 6). With the privatization of state-owned enterprises during the 1990s, a significant reduction in enterprise investment in R&D also occurred (Amann and Baer 1999). As such enterprises are now foreign-owned, they operate on the basis of imported capital equipment and engineering know-how from their respective headquarters (Katz 2001). Firms that possess technological assets developed elsewhere do not replicate such investment under conditions where there are less economies of scale and scope (Erber 2000). In short, privatization of SOEs has diminished the technological gap between LAC and the advanced countries, but has had a negative impact on the region's R&D institutions by excluding them from the technological development process.

TNCs have been rapidly moving into LAC countries with the opening of national markets. Not only have TNCs moved into the sphere of SOE activities, they are also encroaching on SMEs and locally owned conglomerates. LAC countries compare very favourably to newly industrialized countries in securing foreign direct investment (FDI). FDI flows to LAC increased from 0.5 percent of purchasing power parity (PPP)/GDP in 1989 to 3.2 percent PPP/GDP (Chile is the largest recipient with 10.3 percent PPP/GDP in 1999. Ferranti et al. 2003.) Given this trend toward an increasing TNC participation in LAC countries, one questions whether *FDI encourages or discourages local research activities*. Most studies on the impact of FDI on the domestic economy agree that *recipient firms* benefit from foreign investment. However, the impacts on intra-industry spillovers are more ambiguous. The composition of FDI matters. In a number of countries, a large component of FDI is found in the service sector and retail distribution, sectors with low R&D intensity (for example, Brazil and Mexico). The level of technology and knowledge transfer is reasonably small. Studies in the manufacturing sector, such as in auto assembly and pharmaceuticals in Brazil and Argentina, found that, despite differences in company strategy, the tendency is to downsize R&D personnel and infrastructure in Latin America (Quadros and Queiroz 2000). In pharmaceuticals, not only was R&D excluded from subsidiaries in Brazil, but local production was regarded as simpler and of lower aggregated value, compared to products made in developed countries (Queiroz 2001). In Mexico, most high-tech products are produced in the export processing zones. Linkages to the domestic economy are weak and even in the case of the automotive industry, which is based in mainland Mexico, the previous strong linkages with local specialized suppliers seem to be waning (Alcorta and Peres 1998, p. 876). In short, relatively little FDI in LAC is in R&D-intensive activities; and when it is so, most R&D is carried out at the parent firm. There seems to be little demand from TNCs on local R&D institutions in LAC countries.

Nongovernmental organizations

In most developing countries nongovernmental organizations (NGOs) have mushroomed over the last 10 years. In Nicaragua, for example, during the 1980s, the government registered 114 NGOs. From 1990 to 1997, the number of NGOs increased to 1,615. Between 1990 and 1995, these NGOs channeled US$316 million in development aid into Nicaragua (Toni and Velho 2000). Only a small number of these NGOs carry out some form of R&D and when they do, it is mostly diagnostic and action-oriented. Appendix Table 3 shows a somewhat conflicting picture of the share of NGOs in R&D activities in LAC. On the one hand, data on R&D financing and performance by NGOs has decreased during the 1990s; on the other hand, the number of researchers in NGOs has more than doubled, representing in 2000 almost 10 percent, a quite significant share, similar to that of researchers in enterprises. Interpreting these numbers is not straightforward. It may be a problem with data collection, but it may also be an indication of the increasing numbers of young researchers who are joining NGOs, either because of a lack of jobs in the formal R&D sector or simply by choice. There is evidence, though, that the R&D conducted in NGOs is gaining recognition and is being published in mainstream journals together with that of their university-based colleagues. This has only been possible because external donors have elected NGOs as privileged receivers of funds, and as entry points to the communities or societies donors want to reach, thus bypassing local governments and universities regarded as either corrupt or inefficient (Stiles 1998). In these circumstances, the research conducted by NGOs is much more in tune with the donors' agenda. Donors tend to have a strong commitment to environmental issues (including biodiversity conservation), poverty alleviation (which is easily associated with education and support to poor farmers), social justice (including gender and minority rights), as well as to the maintenance of cultural diversity (bilingual education and indigenous knowledge), themes which are often marginal in the research agenda of universities and research institutes. Appendix Table 12 presents the areas of interest of research-oriented NGOs in some LAC countries.

The cases found in the literature of the recollection, preservation, transmission, and use of indigenous knowledge in LAC were all led by NGOs. A number attempt to record local peoples' knowledge of plants and their medicinal uses, in efforts to decrease dependency on external medicines.[28] Others report traditional knowledge which is more environmentally friendly being adapted to local conditions. One of the most fascinating cases tells of the communities inhabiting the Pacific region of Colombia where a network of 140 local organizations developed an alternative political ecology framework that includes conceptualizations of development, conservation, and sustainability (Escobar 2001). This and other examples show how transnational development, environmental and cultural rights networks — involving the linkage of indigenous organizations, the state, universities, and international actors — have helped

[28] Examples of this kind of program are the Royal Botanical Gardens, Kew study about the Yanomami Indians of the northern Brazilian Amazon (Milliken 2002), and Project Tramil in the Caribbean (www.funredes.org/endacaribe/tramil)

reconfigure traditional power relations and increased indigenous peoples' access to land, resources, and state institutions, thus, preserving their culture and strengthening their knowledge.

North-South, South-South collaboration

It is well known that knowledge production is increasingly internationalized and involves partnerships between researchers in different countries.[29] The standard indicator of international collaboration is the number of co-authored articles involving researchers with institutional affiliations in at least two different countries, identified in the ISI database. An empirical exercise using this technique was performed specifically for this report, for the years 1993 to 1999; the results are found in Appendix Table 14. For LAC as a whole, about 30 percent of the articles in the ISI database are internationally co-authored and this share has not changed during the period analyzed (although this is a 10-point decrease from 1990, according to Narvaez-Berthelemot et al. 1999). For most LAC countries, with the exception of Cuba, the USA and Canada are the main international partners. However, for larger countries like Brazil, Mexico, Chile, and Argentina, collaboration with the USA is much less important (around 15% in the four years covered by this study) than for the smaller countries of Central America, like Guatemala (42%), Honduras (53%), and Nicaragua (44%). A group of countries — Costa Rica, Cuba, Bolivia, and Colombia — has markedly increased their collaboration with Europe, a probable outcome of the support granted by the EU to the region via the framework of the INCO-DEV program and bilateral cooperation.

The most significant result of the exercise, however, is the increase in LAC intraregional collaboration. Brazil, for example, has maintained the same level of collaboration with its US and European partners, but has doubled its collaboration with other LAC countries. This may be a reflection of the links researchers established during graduate training in Brazil. Uruguay and Argentina show similar trends concerning intraregional collaboration, an offshoot of the policies implemented following the creation of Mercosur (Narvaez-Berthelemot et al. 1999). In sum, the exercise revealed that LAC countries are not part of the rocketing increase in international collaboration experienced by the USA and Europe. The improvement in South-South collaboration intra-LAC is a positive sign, but it certainly does not compensate for the stagnation in North-South cooperation.

Research dissemination

LAC scientific journals are largely unknown and poorly distributed beyond the region; they rarely reach libraries outside the region and, since many of them are published in Spanish or Portuguese, have a limited readership. There is, however, in place an initiative to enhance the visibility of the region's journals — LATINDEX, a regional information system based on a coordinated network of national resource centres, each taking responsibility for the collection of bibliographical information in all knowledge areas from their respective countries (Cetto and Gamboa 1998). Electronic publishing is at different stages throughout the region: Brazil, Cuba, and Mexico offer a number of online titles, while Argentina and Colombia offer limited online information about their journals. Most countries in LAC, however, especially the smaller ones, do not have the communication infrastructure to support these online services. This affects researchers' access to journals (they are the local actors most likely to have access to ICTs) and also dissemination of results to other potential users in the wider society. The number of Internet hosts (per 10,000 population) and personal computers (per 1,000 people) in industrial countries is 811 and 353, respectively. In LAC, the corresponding numbers are 23 and 44, but vary across the region. Costa Rica has the highest penetration of computers in the region (100 per 1,000 people), while in Cuba and Bolivia the penetration is only 10 per 1,000 people. Argentina, Chile, and Mexico

[29] From 1985 to 1995, European countries doubled their production of scientific articles but have tripled the number of articles coauthored with partners in industrialized countries in other continents (Georghiou 1998). From 1986-88 to 1995-97, the total number of articles in the ISI databases increased by 12%; internationally co-authored articles increased by almost 115% in the same period (NSB 2000, pp. 6-48).

feature between 40 and 50 hosts per 10,000 people; Cuba and Bolivia have the lowest numbers (1 per 10,000 people) (Hansen et al. 2002).

The evidence presented above suggests that LAC countries have not been able to build links among the various relevant social actors involved in S&T production and use. Problems exist both on the supply and demand sides. Concerning the former, universities and public research institutes, which together perform almost 70 percent of R&D, have not created mechanisms to identify user needs and set their research agenda more on the basis of scientific criteria dictated by international mainstream science. On the demand side, there is not much demand on local R&D since TNCs operate on the basis of R&D conducted in the advanced economies. Local private firms, in order to be competitive, also prefer to import foreign technology. Of course, this supply/demand framework is grossly oversimplified: universities and research institutes also demand knowledge (codified and tacit) from other sectors and enterprises and social organizations are important suppliers of knowledge. What is important to note is the lack of connection between the various agents. Governments in some countries have implemented a few schemes primed to bring together supply and demand but, with only a few exceptions, they have not been successful. The broader context — the social, political, and macroeconomic environment — can certainly help us to understand why this is so.

The Environment for Research in Latin America and the Caribbean

The social, cultural, and political, environment for research

During the 1990s and up to 2002, the annual per capita growth rate of LAC was below 2 percent, with an amazing degree of homogeneity across countries. Economic stagnation has been accompanied by the most inequitable income and wealth distributions in the world. In 14 of the largest countries in LAC, all but five have income Gini coefficients[30] above 0.53, including Brazil, Paraguay, Ecuador, and Chile with Gini coefficients above 0.57. This is a degree of income concentration surpassed by very few countries (Lopez 2003) This inequality reflects deep and persistent differences across individuals or groups in access to assets that generate income, including land (which is extremely unequally distributed in LAC) and, of particular importance in today's knowledge societies, education. The composition of education in the LAC countries is still skewed toward primary education. Thus, 40-50 percent of the population reach the primary school level but never surpass it, with only 20 percent moving on to the secondary level[31] (Hansen et al. 2002, p. 33). There is no need to rationalize what these figures represent in terms of social injustice. Consider the deleterious effect they have on R&D capacity: a less educated workforce, knowingly, makes the process of technological innovation at the company level even more difficult. But most important of all, social inequalities in LAC restrict the pool from where researchers are recruited; the result is the automatic exclusion of people with a potential vocation for research and the creation of a

[30] The Gini coefficient is a number between zero and one that measures the degree of inequality in income distribution in a given society. The coefficient would register zero inequality (0.0 = minimum inequality) for a society in which each member received exactly the same income and it would register a coefficient of one (1.0 = maximum inequality) if one member received all the income and the rest got nothing. In practice, coefficient values range from around 0.2 for historically equalitarian countries like Bulgaria, Hungary, the Slovak and Czech republics, and Poland, to around 0.6 for places like Mexico, Guatemala, Honduras, and Panama where powerful elites dominate the economy. The coefficient is particularly useful to show trends. It reveals the change toward greater equality in Cuba from 1953 to 1986 (0.55 to 0.22) and the growth of inequality in the USA in the last three decades when the Gini went from 0.35 in the 1970s to 0.40 in the 1990s (and still rising!). Most European countries and Canada rate around 0.30, Japan and some Asian countries around 0.35, some reach 0.40, while most African and South American countries exceed 0.45 (http://www.berclo.net/page01/01en-gini-coef.html)

[31] "[This] trend is broken in Chile and Mexico where the proportion of the population that attained secondary education as the highest level increased to 30-40%. Finally, only 10% of Latin Americans attain some extent of tertiary education. Costa Rica and Argentina are among the regional leaders, where approximately 20% of the population reach the level of tertiary education" (Hansen et al. 2002, p. 33).

socially uniform “class” of researchers. The poorer populations in LAC include the majority of blacks[32] and native groups; their cultural perspectives and indigenous knowledge have no channel to reach universities and other forums where formal R&D occurs. The diversity of perspectives, cosmologies, and knowledge of these populations could substantially enrich formal R&D methodologies in LAC and the search for solutions to local problems.

On the political front, R&D has suffered considerable setbacks in LAC. The military dictatorships which ruled one country after the other from the mid-1960s to the end of the 1980s — from Brazil to Argentina, Uruguay, Paraguay, and Bolivia, the Dominican Republic, and El Salvador — hit universities particularly hard, as they were the main focus of intellectual resistance to the regimes. For some countries, of which Uruguay is perhaps the best example, this meant the almost complete dismantling of the research infrastructure. Since the return to democracy, there is political freedom, but there is no denying that in many respects, we are still paying the price for this “black political period.” One of the legacies of this period is the absence of a “negotiating culture” among social groups with differing political interests, not only in government, but also within the public universities and research institutes, and the subsequent lack of continuity and coherence in planning and projects. It is a common feature of LAC countries that changes in government mean a halt to ongoing projects and starting over. The same stop-and-go climate exists in LAC universities, which are extremely politicized with their higher administrative posts (rectors, deans, directors, and department heads) subject to election by the university community. The external political environment is often reproduced within the universities. LAC countries face a huge challenge ahead in consolidating their democratic political institutions at all levels. Globalization has added more variables to an already complex situation.

A gender perspective on the environment for research

[32] A recent survey in Brazil found out that only 2.3% of the black and mulatto populations in the age group of 18 to 25 years were enrolled in tertiary education, The equivalent figure for the white population of the same age is 12% (JC e-mail 2305, 24 junho de 2003, www.jornaldaciencia.org.br)

Health. The maternal mortality ratio is the most pressing health problem affecting women in LAC countries. Only Chile, Costa Rica, and Uruguay report ratios below 30 deaths per 100,000 live births; Argentina, Colombia, Mexico, Panama, and Venezuela report ratios below 100. The remaining countries all register ratios above 100, with the Dominican Republic, Bolivia, and Peru exceeding 200 deaths per 100,000 live births (CEPAL website).

Education. In the last 20 years, gender disparities in education have almost disappeared in all the countries, and in some cases women's educational achievements are higher than men's. Primary education has similar enrolment ratios for girls and boys, except for those countries with a significant indigenous population, such as Bolivia, Ecuador, and Guatemala, where the ratio is 90 percent or lower. Although there is an overall decrease in the enrolment ratio in secondary education, on average girls continue their education further than boys, as the latter tend to drop out of school more often to work.

Employment and incomes. Women's participation in the labour force has increased in LAC countries to 40 percent of the economically active population. However, the unemployment gap has widened. Female unemployment is 30 percent higher than male unemployment, compared to 20 percent higher 10 years ago. Income gaps have narrowed slightly but remain one of the main indicators of gender inequality in LAC countries.[33] Higher education does not necessarily guarantee women better employment opportunities relative to men and the quality of female employment is lower.[34]

Decision-making power. Women remain underrepresented in positions of power. This includes executive and legislative positions, as well as participation in social organizations such as trade unions and professional associations. Women are virtually absent from decision-making or executive positions in the business world.

Progress since the 1995 Beijing Conference on Women. In the last decade, LAC countries have implemented polices to provide women with equal access and opportunities, especially to education; positive action or antidiscriminatory policies to redress existing gender inequalities, such as antiviolence and sexual harassment laws and political participation quota laws; and specific programs aimed at tackling female poverty and vulnerability by offering health and literacy services and access to microcredits. More than 100 women's programs and courses, mostly in the humanities, law, and social sciences, have been started at the undergraduate and postgraduate levels in a total of 14 LAC countries, a sign of progress in the development of human resources sensitivity to gender equity.

Macroeconomic policies and the development of STAs

The first important macroeconomic policy adopted by the LAC countries during the 1990s related to the *liberalization* of markets. An important argument against the market protectionist measures adopted by LAC during the import substitution industrialization (ISI) process is that the incentive for firms and governments to develop new technologies is often stirred by exporters and by competitive market pressures, both domestic and external. Therefore, opening up the economy to external competition, as LAC countries increasingly did in the 1990s, should have had a beneficial effect on technological innovation. In reality, case studies have shown that the recently created unprotected market was responsible for the development of new sources of foreign know-how for domestic firms and consumers and a rapid diffusion of information technologies. As a result, the pattern of accumulation of technological capabilities changed in structure and performance, and the "relative technological gap with the world's 'best practice' frontiers has become smaller only in some selected enclaves" (Cimoli and Correa 2002, p. 2). Two separate patterns emerged: one in Mexico and the Central American nations

[33] Abramo and Valenzuela, "América Latina: Brechas de equidad y progreso laboral de las mujeres en los 90," OIT/Regional Office for the Americas, Lima 2001.

[34] The proportion of women working in the informal sector compared to the total number of working women is higher than the corresponding men's ratio, and the percentage of women without social protection is also higher. Both ratios have worsened during the 1990s.

which featured manufacturing and assembly activities based on cheap labour (*maquiladoras*); the other, at the Southern Cone (Argentina, Brazil, Chile, and Uruguay), intensified specialization in natural resources and standardized commodities, using highly capital-intensive industries to produce low domestic value-added products. These two patterns were the result of a "shock of unilateral and non-selective policies that have radically modified the pattern of technological learning and knowledge diffusion across firms and sectors. Such changes are inducing a complex process of 'destruction' of deeply rooted forms of production organisation and institutions, and gradually (and painfully) forcing the establishment of a new, more competitive, outward-oriented and de-regulated incentive regime, whose basic structural features are still in the making" (Cimoli and Correa 2002). So far, both patterns have made very little use of local R&D structures: there is a trend toward less absolute demand for national technological innovation, and relatively more demand for short-term technoscientific advice.

Moreover, trade liberalization is a potent source of asymmetry in market power, and in this sense facilitates oligopolies by large firms that survive the economic transition. A clear example is provided by Uruguay's food industry which, under harsh competition from foreign companies, was left with only a few large companies that survived by importing foreign technology. The obvious conclusion is that increased competition from imports is a disincentive to carry out R&D (Peluffo n.d.). This process of fierce competition in LAC was reinforced by merger and acquisitions, with transnational corporations buying out small, medium, as well as large domestic companies. Since TNCs concentrate technological activities in their home countries, the liberalization process in LAC resulted more in the globalization of production rather than the globalization of STAs (Katz 2002).

Analysts tend to agree that *privatization* had negative affects on STAs in LAC countries, since the SOEs that used to develop research activities, no longer did so once they were taken over by the multinationals. "These and similar developments involve the 'destruction' of human capital and domestic technological capabilities and their substitution by capital 'embodied' new technology, as in the case of imported capital goods, or by foreign-produced R&D and engineering services, as in the case of the telecom and energy companies now operating in the region" (Cimoli and Katz, 2001, p. 16).[35] One instance where privatization seems to have upgraded industry technology and fostered local R&D is the in Brazil's steel industry (Tigre et al. 2001).

Fiscal incentives in LAC countries are considered one of the most important factors in attracting FDI. However, it is also argued that when firms which receive FDI are not well connected to the domestic industry, improvements in technological activities remain poor. In addition, the literature points out that both FDI and merger and acquisitions (both attracted by fiscal incentives) have caused disruptions in domestic engineering activities, and have had a negative impact on STAs in the region. Costa Rica is an example of FDI's positive impact. The decision of Intel to set up a plant in the country encouraged other firms to follow suit. Today Costa Rica possesses a highly competitive microchip sector (Hansen et al. 2002).

The only LAC countries that offer R&D fiscal incentives are Brazil and Mexico, and even this support has been marginal (the B-Index is 1.030 and 1.015, respectively and for the USA and Korea, it is 0.893 — the smaller the index, the more generous the tax support system). No LAC country has used matching grants to stimulate private R&D. The lack of fiscal incentives and concerns about the sustainability of such assistance are the main reasons for the low level of private R&D in LAC countries. However, it is important to note that fiscal incentives have a low impact in promoting R&D in SMEs, a characteristic of the domestic private sector in Latin American countries.

The public sector (government and institutions of higher learning) is not only the primary sponsor of R&D in LAC, but also the dominant conductor of R&D, carrying out almost 70 percent of research activities. This suggests that *any reduction in government expenditures in STAs would have a profound negative effect*, since the increase of private R&D in the region did not increase proportionally, from 20.9 percent in 1990 to 36.5 percent in 2000 (Ferranti et al. 2003). Many countries in LAC that have suffered budgetary constraints in recent years have seen the virtual disappearance of research centres and departments, as was the case in the Dominican universities (Pimentel 2002). This also led to a gradual exodus of talented faculty members. Generally, salaries are considered low, fostering the practice of assigning honoraria for researchers in project budgets. In the cases of the social sciences and of more technical disciplines, like engineering or economics, consultancies to private firms or the government and international organizations help boost researchers' remuneration (Urzúa 2002).

[35] For the same argument, see also Alcorta and Peres (1998); Katz (2002); Cimoli and Correa (2002).

The economic factor, however, is not the only one promoting the brain drain. A study of LAC public research institutes revealed a total absence of wage, recruitment, promotion, and training policies leading to professional frustration and low morale and a desire to leave the country (Alcorta and Peres 1998). Highly skilled researchers prefer to work among their peers. Mexico and Colombia have the highest level of brain drain in the region. The Colombian National Council of S&T established Centres of Excellence in 1995 in order to stop migration, but the brain drain numbers remain alarming. Chile, Brazil, and Costa Rica face fewer problems in terms of brain drain.

Market constraints on the development of STAs

A trade regime rests on a country's external tariff regime (clearly the most important one), nontariff barriers, safeguards, countervailing duties, and antidumping framework. The 1990s have seen a significant lowering in trade barriers in most LAC countries with mean tariff rates falling dramatically. Brazil has the highest rate (13.6%) among the LAC countries and Costa Rica the lowest at 7.2 percent (Korea's rate is 8.7%). There has also been a decrease in nontariff barriers in most LAC countries, although they remain relatively high in Brazil, Mexico, and Venezuela (and lower than for some East Asian countries) Thus it appears "there is little more that most LAC countries can do in the trade area to facilitate technological transfer or the transition to increased technological capabilities" (Ferranti et al. 2003, p.145). The benefits of trade can and will increase as the other pieces of a coherent science and technology platform — a skilled labour force, stronger network linkages, and selected increases in R&D — fall into place. That is where the efforts of LAC should be placed.

Economic evaluation studies consistently identify trade as a significant channel for technology transfer, that is, trade is an important mechanism through which knowledge and technological progress are transmitted across countries. The idea is that importing countries (firms) learn from the knowledge embedded in the inputs that they import. A recent study examined the impact of trade with the OECD countries of nine LAC countries through spillovers of knowledge created by R&D in six R&D-intensive industries (Schiff and Wang 2002). The studies show that foreign R&D has a positive impact on R&D-intensive industries, but this impact is dependent on education levels in the recipient country. In other words, the greater the educational attainment (measured as a share of the population aged 25 years and over that completed secondary education) of the country, the greater the impact of foreign R&D on total factor productivity (TFP) though trade. The correlation between impact on TFP and the secondary school completion ratio is direct: Panama, the country in the study which had the greatest impact of technology transfer by trade, also had the highest ratio of secondary school completion. Thus, the study shows that education (skills) and foreign knowledge (R&D) are mutually reinforcing in knowledge-intensive industries. Education reflects the capacity of LAC countries to absorb knowledge from the North and transform it into higher productivity.

Conclusions

There seems to be a huge knowledge divide between the LAC countries and the advanced countries and the Asian tigers in most of the components of the S&T sector examined in this paper. Although this divide holds for LAC as a whole as well as for any individual country in the region, there are also significant differences among the LAC countries themselves. Countries like Argentina, Brazil, Chile, Costa Rica, and Mexico tend to perform better in a number of indicators than the smaller countries of South and Central America and the Caribbean.

The first group of countries has a significant level of R&D expenditure per population and was able to achieve a critical mass of researchers who have been able to considerably increase their contribution to mainstream science in terms of publications in the past decade. It is encouraging that almost half of those researchers are women (even if most professorships are held by men). The other group of countries is still struggling to reach this level.

The issue here is what is the trend? Will this divide among LAC countries and with the advanced countries grow or are there signs that both gaps are closing?

If current trends continue, the divide will grow. It is clear that the transition of the current advanced countries to a knowledge society took place with an enormous growth in R&D expenditure and performance in the private sector. In the data and analysis presented earlier, it was shown that in LAC it is the public sector which is responsible for about 70 percent of R&D funding and performance. Although there are signs this is changing, movement is very slow.

Other features in the advanced economies is their articulation of a national system of innovation with strong links among its diverse components (firms, universities, research institutes, financing institutions, regulatory agencies, etc.), and the existence of incentives provided by the state, in terms of macroeconomic policies and political climate. Our LAC countries (at least some of them), however, concentrated their efforts (erratically) in creating a strong research system within the public sector (with variable results) but did not foster the links with the business community. In the sectors where such links were established, this took place under a protectionist economic policy which created a research bureaucracy that did not have the incentive to be creative and that faced little competition to survive. With the liberalization and privatization measures adopted in the 1990s, LAC countries found themselves ill-equipped to face fierce competition from foreign firms. If the current trends continue, where local firms (SMEs, large domestic conglomerates, and SOEs) are acquired by TNCs with their own technology, the remaining local firms that wish to be competitive will follow the same technology-import patterns. Under these circumstances, it is unlikely that the LAC countries will be develop their own national innovation systems and local R&D efforts will continue to be disconnected from potential users.

Such a scenario can only be avoided through government intervention in the form of the right macroeconomic policies and incentives that would promote the necessary links to foster and nurture innovation. Clearly, governments cannot do this for the entire economy, but specific industries where countries have particular strengths and interests could be targeted.

Finally, one notable trend of the R&D sector in LAC is its distance (or lack of links) from the needs of the various social groups in civil society. Such needs seem to have been addressed by researchers working in NGOs and funded by external donors. It is extremely important that the connection is made between such NGOs and the groups they assist and formal R&D systems. Both NGOs and the universities have much to gain from tackling problems together. Ultimately, society is the greatest beneficiary. Donors can certainly help in fostering such links.

Appendix : Tables 1-14

Table 1. Population (total and female) and GDP per capita.

Country	Total population in thousands 1990	2000	Population female % of total 1990	2000	GDP per capita PPP in units 1990	2000
Antigua and Barbuda	64	68		56	7,210	10,541
Argentina	32,527	37,032	51	51	7,721	12,377
Belize	189	240	49	50	3,633	5,606
Bolivia	6,573	8,329	50	50	1,826	2,424
Brazil	147,957	170,406	50	51	5,562	7,625
Chile	13,099	15,211	51	50	4,981	9,417
Colombia	34,970	42,299	50	51	7,195	6,248
Costa Rica	3,049	3,811	49	50	5,288	8,650
Cuba	10,625	11,188	50	50		
Dominican Republic	7,061	8,373	49	49	3,361	6,033
Ecuador	10,264	12,646	50	50	2,781	3,203
El Salvador	5,112	6,276	51	51	2,969	4,497
Grenada	94	98		51	4,567	7,580
Guatemala	8,749	11,385	49	50	2,824	3,821
Guyana	731	761	51	52	2,858	3,963
Haiti	6,473	7,959	51	51	1,638	1,467
Honduras	4,870	6,417	50	50	2,074	2,453
Jamaica	2,404	2,633	51	50	3,261	3,639
Mexico	83,226	97,966	50	51	6,383	9,023
Nicaragua	3,824	5,071	50	50	1,721	2,366
Panama	2,398	2,856	49	50	3,871	6,000
Paraguay	4,219	5,496	50	50	3,922	4,426
Peru	21,569	25,661	50	50	3,251	4,799
Puerto Rico	3,537	3,920	52	52		
St. Kitts and Nevis	42	41		51	6,344	12,510
St. Lucia	134	156	52	51	4,360	5,703
St. Vincent and the Grenadines	107	115		52	3,631	5,555
Suriname	402	417	50	50	2,508	3,799
Trinidad and Tobago	1,215	1,301	50	50	6,035	8,964
Uruguay	3,106	3,337	51	51	6,177	9,035
Venezuela	19,502	24,170	50	50	5,050	5,794
Total LAC countries	438,092	515,639	50	50	5,376	7,273

Source: WDI 2002.
Note: PPP = Purchasing Power Parity

Table 2. Expenditure on S&T: volume, percentage of GDP and expenditure per/ 1,000 population.

		1990 millions US$	% GDP	1995 millions US$	% GDP	2000 millions US$	% GDP	Exp/ Pop.
Argentina	STA	647.10	0.33	1 353.00	0.50	1 430.00	0.50	38.6
	R&D			1 136.20	0.42	1 247.20	0.44	33.7
Bolivia	STA					47.00	0.54	5.6
	R&D			24.00	0.37	24.50	0.28	2.9
Brazil	STA	7 457.50	1.59	8 897.71	1.26	7 157.25	1.35	42.0
	R&D	3 544.07	0.76	6 134.54	0.87	4 626.52	1.05	27.1
Chile	R&D	154.93	0.51	401.08	0.62	394.96	0.56	26.0
Colombia	STA			441.91	0.55	303.40	0.36	7.2
	R&D			236.39	0.29	153.72	0.18	10.1
Costa Rica	STA			159.96	1.75	164.94	1.58	43.3
	R&D			35.28	0.39	36.23	0.35	9.5
Cuba	STA	214.20	1.09	188.70	0.87	290.60	1.05	26.0
	R&D	136.60	0.70	101.10	0.47	146.30	0.53	13.1
Ecuador	STA			33.03	0.18	26.30	0.19	2.1
	R&D			14.30	0.08			
El Salvador	STA			28.70	0.30	99.20	0.84	15.8
	R&D					9.65	0.08	1.5
Honduras	STA					3.40	0.06	0.5
	R&D					3.20	0.05	0.5
Mexico	R&D			886.00	0.31	2 283.64	0.40	23.3
Nicaragua	STA					2.80	0.14	0.6
	R&D					2.60	0.13	0.5
Panama	STA	33.45	0.63	60.35	0.76	101.57	0.91	35.6
	R&D	20.22	0.38	29.96	0.38	44.62	0.40	15.6
Paraguay	STA					71.82	1.00	13.1
	R&D					5.69	0.08	1.0
Peru	STA			389.82	0.74	691.21	1.29	27.0
	R&D					58.30	0.11	2.27
Trinidad & Tobago	STA			19.30	0.34			15.9
	R&D			7.60	0.13			6.3
Uruguay	R&D	20.62	0.25	49.65	0.28	47.75	0.24	14.3
Venezuela	STA	176.60	0.37	357.90	0.48	404.86	0.33	16.8
LAC	STA	10 395.11	0.90	13 405.75	0.80	15 037.73	0.76	29.2
	R&D	5 872.93	0.51	9 528.11	0.57	11 137.59	0.57	21.6

Source: RICYT 2002.

Table 3. Expenditure on R&D by funding, performance, and researchers by sector.

		Funding			Performance		Researchers	
	Source	**1990**	**1995**	**2000**	**1995**	**2000**	**1995**	**2000**
Argentina	Government		45.5%	41.9%	40.9%	37.6%	33.8%	31.6%
	Enterprises		27.7%	23.4%	25.9%	25.4%	16.1%	12.1%
	Higher education		21.8%	30.8%	31.5%	34.7%	49.1%	54.6%
	Nonprofit organizations		1.5%	1.9%	1.7%	2.3%	1.5%	1.8%
	Foreign		3.5%	1.8%				
Bolivia	Government		37.0%	22.0%	25.0%	22.0%		17.5%
	Enterprises		17.0%	22.0%	25.0%	26.0%		11.3%
	Higher education		12.0%	32.0%	30.0%	46.0%		67.0%
	Non-profit organizations		22.0%	15.0%	20.0%	6.0%		4.1%
	Foreign		10.0%	9.0%				
Brazil	Government	71.5%	59.1%	60.2%	12.4%	18.4%	17.1%	10.5%
	Enterprises	23.9%	38.2%	38.2%	42.6%	37.4%	7.8%	31.1%
	Higher education	4.7%	2.7%	1.6%	45.1%	43.6%	75.1%	58.0%
	Nonprofit organizations					0.6%		0.3%
	Foreign							
Chile	Government	46.1%	58.4%	70.3%	51.4%	40.4%	20.5%	19.7%
	Enterprises	35.0%	26.5%	23.0%	6.4%	14.9%	5.9%	5.9%
	Higher education				40.9%	43.8%	68.2%	69.4%
	Nonprofit organizations	13.4%	9.0%	1.9%	1.0%	0.9%	5.5%	5.0%
	Foreign	5.5%	6.1%	4.7%				
Colombia	Government		35.0%	16.6%	5.0%	6.0%		
	Enterprises		52.8%	48.4%	36.0%	18.0%		
	Higher education		10.9%	33.6%	41.0%	57.0%		
	Nonprofit organizations		1.4%	1.4%	18.0%	19.0%		
	Foreign							
Cuba	Government	55.1%	50.5%	53.1%				
	Enterprises	44.9%	49.5%	40.1%				
	Higher education							
	Nonprofit organizations							
	Foreign			6.8%				
Costa Rica	Government				12.3%	17.0%	11.4%	
	Enterprises				21.7%	24.8%	24.1%	
	Higher education				36.6%	36.1%	60.5%	
	Nonprofit organizations				29.3%	22.2%	4.0%	
	Foreign							
Ecuador	Government		39.8%	90.6%	45.1%	61.9%		
	Enterprises		32.5%		9.1%	4.8%		
	Higher education				38.2%	16.1%		
	Nonprofit organizations		4.9%	0.5%	7.8%	17.2%		
	Foreign		22.9%	8.9%				

Table 3 continued

El Salvador	Government			51.9%				41.7%
	Enterprises			1.2%				
	Higher education			13.2%				43.7%
	Non-profit organizations			10.4%				14.6%
	Foreign			23.4%				
Mexico	Government		66.2%	59.1%	63.6%	44.0%	31.0%	
	Enterprises		17.6%	24.3%	19.0%	26.3%	10.3%	
	Higher education		8.4%	10.8%	7.7%	26.2%	57.8%	
	Non-profit organizations		1.1%	0.1%	0.6%	3.5%	0.9%	
	Foreign		6.7%	5.6%				
Panama	Government		45.5%	34.4%	43.0%	62.2%	41.0%	64.3%
	Enterprises		0.5%	0.6%				
	Higher education		0.9%	0.4%	8.2%	7.1%	45.8%	19.9%
	Non-profit organizations		1.1%	0.7%	48.8%	30.6%	13.2%	15.7%
	Foreign		52.0%	64.1%				
Paraguay	Government			51.1%		36.4%		28.5%
	Enterprises			3.9%				
	Higher education			4.0%		19.3%		46.2%
	Non-profit organizations			0.8%		44.4%		25.3%
	Foreign			40.1%				
Uruguay	Government	15.0%	6.1%	20.3%	18.5%	25.0%		5.0%
	Enterprises	58.0%	31.1%	39.3%	31.2%	39.3%		5.0%
	Higher education	27.0%	50.3%	35.7%	50.3%	35.7%		90.0%
	Non-profit organizations							
	Foreign		12.5%	4.8%				
Venezuela	Government	47.5%	46.2%	51.0%				
	Enterprises	37.3%	30.2%	32.8%				
	Higher education	15.2%	23.6%	16.1%				
	Non-profit organizations							
	Foreign							
Total Latin America and Caribbean	Government	65.2%	56.3%	56.7%	18.6%	24.6%	22.5	24.3
	Enterprises	26.1%	34.3%	32.6%	37.9%	36.2%	11.2	11
	Higher education	5.7%	6.9%	8.3%	40.9%	37.5%	62.3	59.4
	Non-profit organizations	1.3%	0.8%	0.4%	2.6%	1.6%	4.7	9.5
	Foreign	1.7%	1.7%	2.0%				

Source: Adapted from RICYT 2002.

Table 4. Expenditure on R&D by socioeconomic objective, 2000.

	Argentina	Brazil	Chile	Cuba	Ecuador	El Salvador	Mexico	Panama	Paraguay	Peru	Trinidad and Tobago	Uruguay
Agriculture, forestry and fishing	17.0%	11.3%	23.1%	23.9%	44.0%	19.2%	22.0%	39.8%	50.5%	26.4%	73.0%	31.7%
Industrial development technology	26.7%	1.5%	6.3%	29.4%	4.8%	5.4%	20.0%	5.1%	3.2%	29.0%	7.7%	6.7%
Energy	1.8%	2.1%	3.2%	11.5%	0.3%	0.8%	7.4%	1.3%	0.3%	6.9%	2.4%	0.2%
Infrastructure	2.0%	0.4%	5.8%	2.1%	0.9%	2.8%	5.3%	6.0%		0.7%	13.0%	
Environment	4.2%	0.2%		10.9%	16.1%	21.6%	11.8%	9.0%	0.5%			4.2%
Health (excluding pollution)	14.0%	9.1%		20.0%	5.3%	7.3%	12.4%	6.1%	2.8%	1.6%	3.9%	
Social development and services	5.7%	0.1%		0.9%	6.9%	29.3%	6.1%	10.0%	20.2%			0.0%
Earth and atmosphere	4.7%	1.0%	14.5%		12.8%	2.6%	1.0%	0.6%		1.9%		2.3%
General promotion of knowledge	15.6%	71.4%	46.2%		8.8%	11.1%	4.3%	21.2%	18.3%	33.5%		45.1%
Civil space	1.7%	2.6%						0.3%	0.2%			
Defence	0.8%	0.4%	0.5%		0.2%				0.4%			
Not specified	5.8%			1.3%			9.7%	0.6%	3.6%			9.8%

Source: RICYT 2002.

Table 5. Researchers by scientific field, 2000 (or nearest year).

	Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	El Salvador	Mexico	Panama	Paraguay	Trinidad & Tobago	Uruguay	Venezuela	LAC
Natural Sciences	27.4%	27.0%	26.0%	30.9%	24.5%	27.3%	14.3%	6.5%	26.7%	8.5%	42.4%	31.3%	21.7%	26.2%
Engineering and Tech.	18.7%	20.0%	16.2%	13.6%	21.2%	18.2%	8.0%	17.2%	10.8%	6.3%	17.4%	16.3%	13.1%	16.4%
Medical Sciences	12.8%	24.0%	19.7%	14.6%	13.6%	14.6%	13.4%	12.6%	11.6%	26.2%	8.4%	14.3%	34.9%	18.4%
Agro Sciences	12.6%	15.0%	11.8%	10.8%	7.4%	28.4%	9.7%	2.8%	21.0%	30.9%	22.1%	16.7%	9.0%	16.5%
Social Sciences	15.5%	10.0%	16.4%	20.1%	29.1%	8.3%	47.8%	58.5%	23.4%	26.3%	9.7%	17.5%	21.4%	25.3%
Humanities	13.0%	4.0%	9.8%	10.0%	4.1%	3.3%	6.8%	2.4%	6.5%	1.9%		3.9%		5.5%
Total no. researchers	35,015	1,050	77,822	6,105	4,987	1,422	1,172	26,479	446	543	547	2,513	4,756	
Total/workforce	2.2%	0.33%	0.98%	1.04%	0.27%	0.25%	0.46%	0.75%	0.4%	0.2%	0.98%	1.65%	0.46%	

Source: RICYT 2002.

Table 6. Formal qualification of researchers, 2000.

	Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	El Salvador	Mexico	Panama	Paraguay	Trinidad & Tobago	Uruguay	Venezuela
PhD	25.8%	20.0%	56.7%		12.1%	5.0%	3.0%	6.0%	4.7%	4.2%	35.1%	17.7%	
Masters	7.4%	35.0%	29.5%		25.3%	26.0%	77.0%	24.0%	16.1%	26.1%	53.0%	18.1%	
University degree or equivalent	63.9%	40.0%	13.6%		62.6%	69.0%	20.0%	64.0%	28.6%	30.7%	11.9%	17.0%	
Tertiary/ nonuniversity		5.0%							30.3%	24.0%		12.0%	
Other	2.9%		0.1%					6.0%	20.4%	15.0%		35.3%	

Source: RICYT 2002.

Table 7. S&T personnel by gender.

			1995	2000
Argentina	Researchers	Female	41.5%	48.1%
		Male	58.5%	51.9%
Bolivia	Researchers	Female		39.0%
		Male		61.0%
Brazil	Researchers	Female	38.6%	
		Male	61.4%	
Colombia	Researchers	Female	34.4%	37.6%
		Male	65.6%	62.4%
Ecuador	Researchers	Female	25.0%	31.5%
		Male	75.0%	68.6%
El Salvador	Researchers	Female		37.3%
		Male		62.7%
Honduras	Researchers	Female		33.4%
		Male		66.6%
Panama	Researchers	Female	26.5%	39.5%
		Male	73.5%	60.5%
Paraguay	Researchers	Female		49.9%
		Male		50.1%
Trinidad & Tobago	Researchers	Female		38.4%
		Male		61.6%
United States	Researchers	Female	19.0%	20.6%
		Male	81.0%	79.4%
Uruguay	Researchers	Female		41.6%
		Male		58.4%
Venezuela	Researchers	Female		42.0%
		Male		58.0%

Source. RICYT 2002.

Table 8. Regional and LAC portfolio of scientific articles, by field, 1999 (%).

Region and country	All Fields Number	All Fields (%)	Clinical medicine	Biomedical research	Biology & agric.	Chemistry	Physics & math	Earth & space	Engineering. & technology	S.Sciences & psych.	Profess. fields
Worldwide	528,643	100.00	30.0	14.7	7.0	12.5	17.3	5.4	6.8	4.7	1.8
North America	183,211	34.66	33.4	16.9	6.7	7.7	11.9	6.2	6.0	7.6	3.6
Western Europe	188,548	35.67	33.1	14.6	6.8	12.4	17.1	5.5	5.8	3.8	1.0
Asia	86,405	16.34	23.8	12.7	5.8	18.8	23.0	3.2	11.1	1.1	0.4
Near East and North Africa	9,086	1.72	28.7	9.9	7.2	16.0	20.0	3.9	9.3	3.5	1.3
Sub-Saharan Africa	3,632	0.69	34.9	11.0	22.0	6.8	7.2	7.5	2.8	5.8	1.8
Latin America	**12,034**	**2.28**	**25.1**	**13.9**	**13.2**	**12.2**	**21.9**	**6.0**	**5.4**	**2.0**	**0.4**
Argentina	2,361	0.45	24.3	13.5	16.1	14.0	20.4	5.2	4.6	1.9	0.1
Barbados	15	0	19.3	2.7	38.7	8.7	20.0	0.0	0.0	10.0	0.0
Bolivia	33	0	45.0	6.1	36.1	0.9	1.8	3.7	1.5	5.2	0.0
Brazil	5,144	0.97	24.6	14.8	10.3	11.9	25.4	4.7	6.2	1.7	0.4
Chile	879	0.17	33.7	13.1	14.2	11.8	11.7	9.9	3.3	1.9	0.4
Colombia	207	0.40	27.1	10.8	19.3	9.6	21.5	3.5	5.3	2.8	0.2
Costa Rica	69	0.01	29.2	8.9	36.8	8.6	8.1	4.7	3.4	0.4	0.0
Cuba	192	0.04	27.3	17.9	10.5	20.1	15.6	2.2	5.7	0.7	0.0
Dominican Republic	6	0.00	55.4	10.7	16.1	0.0	0.0	0.0	0.0	17.9	0.0
Ecuador	20	0.00	49.0	6.6	16.7	1.5	6.1	15.2	1.5	0.0	3.5
El Salvador	0	0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guatemala	14	0.00	44.2	28.3	15.9	3.6	0.0	0.0	0.0	7.9	0.0
Guyana	4	0.00	45.2	7.1	11.9	0.0	11.9	23.8	0.0	0.0	0.0
Haiti	1	0.00	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Honduras	110	0.02	62.3	9.4	23.6	0.0	0.0	0.0	0.0	4.7	0.0
Jamaica	44	0.01	33.6	12.6	11.0	17.6	2.3	8.5	2.3	9.6	2.7
Mexico	2,910	0.55	22.6	12.4	13.5	10.7	23.8	8.4	5.8	2.4	0.5
Nicaragua	8	0.00	43.2	21.0	18.5	0.0	0.0	12.3	3.7	0.0	0.0
Panama	370	0.07	9.3	18.3	51.5	0.0	6.0	4.6	2.7	7.6	0.0
Paraguay	4	0.01	80.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0
Peru	56	0.01	52.1	10.3	14.0	1.8	5.5	8.2	5.0	2.3	0.9
Trinidad and Tobago	37	0.01	41.2	4.3	33.2	9.2	0.0	1.3	5.4	2.7	2.7
Uruguay	144	0.03	28.2	18.9	17.4	12.6	16.9	4.4	1.0	0.7	0.0
Venezuela	448	0.09	18.7	14.3	12.8	18.1	17.8	8.8	7.1	1.9	0.6

Table 9. Citations by world's scientific papers to scientific literature, by region and country/economy, 1990 and 1999.
(All fields)

Cited region/country/economy	1990 Number	1990 World share (%)	1999 Number	1999 World share (%)
Total	2,098,342	100.00	2,749,022	100.00
North America	1,181,861	56.32	1,360,447	49.49
Western Europe	629,039	29.98	939,901	34.19
Asia	153,294	7.31	263,941	9.60
Pacific	49,881	2.38	64,051	2.33
Eastern Europe	42,145	2.01	56,488	2.05
Near East and North Africa	21,605	1.03	28,854	1.05
Sub-Saharan Africa	8,303	0.40	8,466	0.31
Latin America	**12,214**	**0.58**	**26,874**	**0.98**
Brazil	3,437	0.16	10,197	0.37
Argentina	3,136	0.15	5,691	0.21
Mexico	2,243	0.11	5,103	0.19
Chile	1,472	0.07	2,384	0.09
Venezuela	750	0.04	1,010	0.04
Colombia	229	0.01	512	0.02
Costa Rica	117	0.01	245	0.01
Cuba	110	0.01	389	0.01
Jamaica	114	0.01	153	0.01
Panama	124	0.01	217	0.01
Peru	166	0.01	139	0.01
Uruguay	82	0.00	383	0.01

Source: NSB 2002. Science and Engineering Indicators 2002, Appendix table 5-50.

Table 10. Assessing distance from the technological frontier: patents per 1,000 population, 1997-98.

Country	Patents per 1,000/pop.	Distance from frontier
USA	3.297	Closest
Japan	2.412	
Taiwan (China)	1.622	
S. Korea	0.657	
Singapore	0.386	
Venezuela	0.013	Closer
Argentina	0.011	
Chile	0.011	
Uruguay	0.009	
Mexico	0.009	
Ecuador	0.006	
Costa Rica	0.006	
Brazil	0.005	Further
Guatemala	0.002	
Colombia	0.002	
Honduras	0.002	
Bolivia	0.001	
Peru	0	
El Salvador	0	Furthest
Nicaragua	0	
Paraguay	0	

Source: Ferranti et al. 2003, p. 159.

Table 11. S&T Capacity Index vs. Technological Achievement Index.

		Technological Achievement Index (TAI)[a]			
		Leaders	Potential Leaders	Dynamic Adopters	Marginalized
Science and Technology Capacity Index[b] (STI)	Type I				
	Type II		• Mexico • Argentina • Chile	Brazil	
	Type III		• Costa Rica	• Jamaica • Colombia • Peru • Panama	
	Type IV			• Ecuador	
Countries not considered by the STI				• Bolivia • Dominican Republic • El Salvador • Honduras • Paraguay • Trinidad and Tobago • Uruguay	• Nicaragua

Source: Sagasti 2003, p. 130.

Note: [a] TAI dimensions and indicators: Creation of technology: patents granted per capita; receipts of royalty and license fees from abroad per capita; diffusion of recent innovations: Internet hosts per capita; high- and medium-technology exports as a share of all exports; diffusion of old innovations: logarithm of telephones per capita; logarithm of electricity consumption per capita; human skills: mean years of schooling; gross enrolment ratio at tertiary level in science, mathematics, and engineering.

[b]STI dimensions and indicators: Science: number of scientists and engineers; publications; Technology: expenditures on R&D/GDP; number of patent applications filed; Production: exports of high technology sectors/total exports; infrastructure, communications, and technology index.

Table 12. Science and Technology Institutions in Latin America and the Caribbean.

Country	**S&T Policy Institutions**	**Research Councils and Funds**	**Performing Institutions**
Argentina	Secretariat for Science, Technology and Innovation (linked to the Ministry for Education, Science and Technology)	National Research Council: CONICET ANPCYT; FONTAR; FONCYT	•1 Higher education: 36 public and 43 private universities •2 Public research institutes in: health, atomic energy, agriculture, environment and industrial development (regional and national level) e.g., INTA with 46 research centres in agriculture distributed in 18 regional centres
Bolivia	National Secretariat for S&T/Comité Ejecutivo de la Universidad Boliviana (SICYT-CEUB) (linked to the Presidency of the Republic)	National Research Council (CONACYT)	•1 Higher education: 12 public universities •2 Public research institutes: 14 (4 in agriculture, 2 environment, 1 education, 1 indigenous knowledge, 1 health) •3 NGOs: 5 (3 social science research, 2 indigenous knowledge and 1environment)
Brazil	Ministry of Science &Technology Main advisory committee: Council of Science and Technology (CCT)	National Research Council (CNPq), Financier of Projects (FINEP), Agency for Graduate Education (CAPES); State Foundations (FAPs)	•1 Higher education: 150 (77 public, 76 private) research universities; 820 nonuniversity institutions (16% public and 84% private) for professional education. •2 Public research institutes and state-owned enterprises: 22 (1 health, 1 environment, 1 education, 1 indigenous knowledge/Amazonian, 1 agriculture, 2 health, oil, mineral) •3 15 professional and national not-for-profit organizations (promotion, coordination, and services for agriculture, SMEs and technical training)
Chile	National Research Council (linked to National Office of Planning – ODEPLAN- which is linked directly to the Presidency of the Republic) National government level	National Research Council (CONICYT) FONDEF (productive sector) FIA (agricultural sector)	•1 Higher education: 67 universities, 72 professional education, and 128 for technical training (23 universities carry out research) •2 Public research institutes: 7 (health, environment, education, indigenous knowledge, agriculture, mineralogy) •3 NGOs and professional not-for-profit institutions: 150 •4 Stated-owned enterprises: 1 (defence)
Colombia	Ministry of Planning (Departamento de Planeacion Nacional) National Research Council: CNCyT, advisor to the National Government on matters of S&T	Secretary of S&T (Colciencias) Fondo Nacional de Garantias (SMEs)	•1 Higher education: 70 public, 132 private, and 119 nonuniversity institutions •2 Public research institutes: 18 (environmental; health; biotechnology; education; agroindustrial) •3 NGOs:17 •4 private sector: 7; technological development centres: 4
Costa Rica	Ministry for Science and Technology (MICIT)	National Research Council: CONICIT	•1 146 institutions dedicated to R&D: 100 in education; 16 in general services; 11 in the private sector; 3 regional and international •2 2 co-operatives and foundations.
Cuba	Ministry for Science and Technology and Environment / CITMA Cuban Academy of Sciences	CITMA	•1 Higher education: 62 public universities (50 universities are active in R&D) •2 200 research centres (agriculture and livestock; biotechnology and development of vaccines and pharmaceuticals; Health; industrial activities; sugar plantation; biodiversity and environment; social and economic problems) •3 Science and production poles: 14 territorial networks

Ecuador	SENACYT (similar to the Vice-president of Republic)	National Research Council: CONICIT (manages FUNDACYT)	•1 Higher education: 31 institutions with 150 R&D units •2 Public sector: 12 R&D units (5%) •3 Private sector: 46 R&D units (20%) •4 NGOs: 17 units of R%D (8%)
El Salvador	Ministry of Economics National Research Council: CONACYT	Department of funding for Development of S&T	•1 The institutions with major participation in S&T activities are from the governmental sector. There is little participation from the higher education sector, private sector, or NGOs
Guatemala	National Research Council: CONICYT	National Fund for S&T (FONACYT)	•2 Higher education: 1 public and 6 private universities •3 Public research institutes: 3 in agriculture, 2 in environment •4 Private sector: 1 Indigenous knowledge, 1 SMEs support
Guyana	Council for Science, Technology and Environment (linked to Presidency of the Republic)	National Research Council: CONICYT	•1 Higher education: 1 public and 6 private universities •2 Public research institute: 1 Guyana's Agriculture Information Network (13 agricultural research centres)
Honduras	Council for Science, Technology and Environment (linked directly to Presidency of the Republic)	National Research Council: COHCIT	•1 Higher education: 3 public universities •2 Public research institutes: 3 institutions in agriculture, 1 in public health, 1 in water quality and management
Jamaica	National Research Council: NCST		•1 Higher education: 1 public university •2 Public research institutes: 3 in agriculture, 2 in public health, 2 in environment and water, 2 in industry
Mexico	Secretariat for Public Education	National Research Council: CONACYT	•1 Higher education: 1,140 universities (35% public and 65% private) and 393 nonuniversity (28% public and 70% private) – most R&D concentrated in 3 public universities •2 research centers linked to public universities •3 Public research institutes: 29 centres SEP-CONACYT
Nicaragua	Nicaraguan Council on Science, Technology (linked to Ministry of Industry and Commerce)	National Research Council: COHCIT	•1 Higher education: 34 (4 public and 30 private). The public universities carry out most R&D activities. •2 Public research institutes: 1 environmental, 1 health, 1 education, 1 agriculture •3 NGOs: agriculture, forestry, industrial associations
Panama	National Secretariat for Science and Technology - SENACYT (linked directly to Presidency of the Republic)	National Research Council: CONACYT (manages FONACIT)	•1 Higher education: 4 public universities carry most R&D activities. •2 Public research institutes: 6 (1 health, 2 agriculture & livestock, 1 environment, 1 biology, 1 industry) •3 NGOs: 4 (1 health, 1 economics, 2 social sciences)
Paraguay	National Research Council: CONACYT (linked to Presidency of the Republic)	National Fund for S&T (FONACYT)	•1 Higher education: 6 public universities involved with R&D •2 Public research institutes: agriculture, health, education, communications and industry and commerce •3 NGOs: 14 (3 on environment)

Peru	National Research Council: CONCYTEC (linked to Ministry of Education)	National Fund for Development of S&T (FONDECYT)	•1 Higher education: Total 78 (33 public and 45 private) •2 Public research institutes: 1 health, 1 environment, 1 indigenous knowledge (Amazonian); 2 agriculture and fisheries •3 NGOs: 1 agriculture (e.g.., Cipotato)
Trinidad & Tobago	National Institute of Higher Education, Research, S&T- NIHERST (linked to Presidency of the Republic)		•4 1 public university •5 1 regional research institute
Uruguay	National Research Council: CONICYT (linked to the Ministry of Education and Culture) Sectoral Commission of Scientific Investigation (CSIC)	DINACYT- OPP (Office of Planning and Budget - National Directorate of S&T and Innovation)	•1 Higher education: 6 universities (1 public concentrates infrastructure and most research groups; and 5 private of which 3 do not carry out R&D) •2 Public research institutes: 3 (agriculture, livestock and fisheries) •3 State enterprises: 2 (electricity generation and supply; telecommunications)
Venezuela	Ministry of Science and Technology	National Research Council: CONICIT (manages National Fund of Research – FONAIAP)	•1 Higher education: 37 university institutions (17 public, 20 private) and 94 nonuniversities (52% public and 48%) •2 Public research institutes: 9 (1 petroleum, 2 agriculture, 2 health, 1 geology, 1 astronomy) •3 NGOs: 4

Source: Author extrapolation from RICYT, 2000. CDRom available at http://www.ricyt.edu.ar
Brazil: Indicadores de C&T em S.P- 2001, FAPESP and MEC/INEP/
Chile: http://www.cse.cl/Indices/Estadisticas/fr_estadista.htm
Colombia: http://www.Icfes.gov.co/ Resumen Estadistico 1990-1999
Cuba: Fte: http://www.cuba.cu/educacion
Mexico: Estadísticas de la educación superior 2000: http://www.anuies.mx.
- Peru: www.concytec.gob.pe http://www.iesalc.unesco.org.ve/documentosenlinea.htm

Table 13. Earned S&E doctoral degrees in selected regions and locations, 1999 (or latest available year).

Region/location	All fields	Math and natural sciences	Math and computer sciences	Biology and agriculture	Social and behavioural sciences	Engineering	Non-S&E
Asia							
China	10,160	25		4	5	32	33
India	10,408	34		9	n.a.	3	54
Japan	14,800	1,481		1,094	420	3,580	8,225
South Korea	5,586	10		3	6	26	56
Taiwan	1,337	150	119	76	65	482	445
Oceania							
Australia	3,271	816	188	182	220	398	1,467
Europe							
Finland	1,708	254	77	40	235	312	790
France	10,582	3,924	845	179	1,559	1,852	2,223
Germany	24,545	6,271	980	522	1,982	2,229	12,561
Spain	5,931	1,517	253	245	229	381	3,306
United Kingdom	11,338	3,668	680	326	907	1,805	3,952
North America							
Canada	3,347	763	204	178	562	544	1,096
Mexico	730	236	15	39	141	67	232
United States	41,140	9,989	1,935	965	7,727	5,337	15,187
South America							
Argentina	408	218	8	97	18	41	26
Brazil	6,042	788	NA	1,519	1,501	765	1,469
Chile	88	63	NA	0	0	5	7

Source: NSB. 2002. Science and Engineering Indicators 2002, Appendix table 2-42.

Table 14. LAC output in the SCI (Search), coauthored with researchers from the USA & Canada, European Union, and other LAC countries.

	1993 SCI	Collaboration with			1995 SCI	Collaboration with			1997 SCI	Collaboration with			1999 SCI	Collaboration with		
	Total	USA & CA	LAC	EU	Total	USA & CA	LAC	EU	Total	USA & CA	LAC	EU	Total	USA & CA	LAC	EU
Argentina	2476	12.1	4.6	11.9	3159	9.2	5.3	12.2	4262	10.7	5.9	12.7	4874	11.4	7.8	15.6
Barbados	42	38.1	2.4	7.1	47	29.8	12.8	8.5	50	34.0	2.0	16.0	46	32.6	4.4	8.7
Bolivia	65	21.5	3.1	33.9	62	27.4	11.3	59.7	86	15.1	17.4	43.0	105	19.1	35.2	60.0
Brazil	4908	15.6	2.5	14.9	6727	15.9	2.8	14.9	8972	13.7	3.8	13.7	11729	14.7	5.0	13.6
Chile	1404	15.9	5.0	14.9	1629	17.2	7.1	17.3	1770	14.3	10.5	19.7	2078	18.1	10.9	22.1
Colombia	237	32.1	15.2	14.8	358	32.7	19.0	21.5	545	32.3	16.3	18.5	608	35.9	19.9	24.5
CostaRica	173	24.9	7.5	9.8	177	31.6	10.2	23.7	281	28.5	12.5	12.8	220	36.8	11.8	25.9
Cuba	284	2.5	3.2	14.8	355	5.4	11.3	18.9	435	5.8	16.3	23.2	682	5.3	20.1	23.0
Ecuador	48	35.4	16.7	31.3	94	31.9	7.5	26.6	115	33.0	9.6	33.0	103	35.0	26.2	31.1
El Salvador	11	27.3	100.0	9.1	4	50.0	0.0	0.0	14	28.6	35.7	7.1	6	16.7	33.3	16.7
Guatemala	74	41.9	35.1	2.7	57	64.9	40.4	1.8	64	53.1	26.6	15.6	69	55.1	46.4	13.0
Honduras	17	52.9	17.7	11.8	17	70.6	17.7	0.0	27	51.9	0.0	14.8	26	30.8	26.9	23.1
Jamaica	326	62.0	2.2	8.3	288	62.9	1.4	11.5	269	57.3	3.4	13.4	292	60.3	1.4	1.7
Mexico	2497	16.1	3.6	11.7	3261	18.1	5.1	12.6	4129	17.0	4.9	12.5	4942	20.6	6.0	15.9
Nicaragua	18	44.4	0.0	22.2	12	66.7	41.7	25.0	30	20.0	20.0	26.7	25	44.0	16.0	12.0
Panama	88	35.2	27.3	10.2	88	77.3	23.9	19.3	106	80.2	15.1	16.0	131	72.5	20.6	28.2
Paraguay	12	33.3	0.0	25.0	17	17.7	5.9	11.8	20	15.0	0.0	25.0	23	39.1	4.4	69.6
Peru	106	53.8	14.2	26.4	177	39.6	13.6	25.4	173	43.9	14.5	20.2	175	41.1	20.6	30.9
TyTobago	99	18.2	3.0	25.3	94	23.4	6.4	11.7	84	21.4	1.2	19.1	98	20.4	2.0	23.5
Uruguay	161	11.2	13.7	11.8	201	11.9	15.9	19.9	293	18.1	24.2	17.4	353	18.4	25.8	24.4
Venezuela	257	56.0	10.1	45.1	736	20.2	3.7	17.7	972	16.4	5.6	17.2	1077	22.2	6.4	17.1

Source: Analysis by A.Roa-Atlinson, especially for this report. SCI, Science Citation Index Expanded, 1993; and www.ricyt.edu.ar

Note: European Union included: France or Germany or Italy or England or Denmark or Belgium or Netherlands or Portugal or Greece or Luxembourg or Ireland or Spain.

USA and Canada: Canada or any US state: NY or CA or MA or AZ or CO or CT or DC or Fl or GA or IL or KS or LA or MD or ML or NC or NJ or OH or TX or UT or VA or WA or WI.

LAC: included papers co-authored between (Xcountry) and (LAC country).

For the purpose of this table, the total output was calculated individually country by country by listing all the papers whose addresses contained the country name. E.g Argentina = (argentina not paraguay), Mexico = (mexico not new mexico), Paraguay = (paraguay not (argentina or chile or uruguay), Venezuela = (venezuela not brasil), Peru = (peru not peru state), Panama= (panama not (panama st or fl))

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