



Science and Technology Division
Social Sector
Vice-Presidency for Sectors and Knowledge

Science, Technology, and Innovation in Latin America and the Caribbean

A Statistical Compendium of Indicators

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Inter-American Development Bank

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Foreword



The advent of the knowledge society has highlighted the growing importance of innovation and intellectual assets as sources of competitiveness and long-term economic growth. Increasingly, the solutions to the greatest challenges faced by countries around the world—climate change, clean energy supply, pandemics—have a strong technological component. In response to challenges like these, both the public and the private sector recognize that investing in knowledge and innovation is an indispensable component of productivity growth and national economic strategies.

The countries of Latin America and the Caribbean (LAC) must continue to seek ways to meet the basic needs of their populations, through nutrition and sanitation programs, poverty reduction, universal quality education, and economic modernization. At the same time, they must do their part to address global challenges. In such a context, leveraging the opportunities presented by technological change in a globalized economy becomes a necessity for any emerging economy.

Reliable, updated, and contextualized information is a prerequisite for good policy making. Appropriate indicators enable decision makers to make policies and design long-term strategies that are based on solid evidence, thereby increasing their effectiveness. This volume compiles and presents the most up-to-date information on the current status of science, technology, and innovation in Latin America and the Caribbean. The information presented in the graphs, tables, and narrative underscores a stark reality: the economies of Latin America and the Caribbean are ill-prepared to face the challenges of the knowledge society. Investment in science, technology and innovation continues to lag behind comparable levels in many other regions. Most of the elements needed to remedy this situation—researchers, universities, innovative firms—are in place, but they are plagued by poor coordination, lack of funding, and other shortcomings.

There are, however, some promising findings presented here. The impressive rate of growth of scientific publications in the region in recent years has closed part of the gap with other regions of the world. The adoption of cellular telephony has reached near-saturation levels in all countries much faster than the pace of diffusion of other technologies would have suggested, thus closing the digital divide in at least one critical information and communication technology and creating still untapped

possibilities for populations previously marginalized from the benefits of modern technology. A great many firms in the region call themselves innovative and practice innovation in some shape or form. Public policy in the sector has steadily matured, gaining institutional strength and technical sophistication in a number of countries. An uptick in the level of resources channeled to R&D and innovation by both public and private sources reflects a growing awareness among policy makers and private sector leaders of the importance of knowledge for productivity growth.

Positive developments such as these, however, do not alter the overall picture of the region, characterized by low technological intensity and severe deficits in human capital, public and private R&D investment, technological infrastructures, and institutional coordination and effectiveness.

This Compendium presents the main dimensions of the problem. It looks at human capital and financial inputs into the innovation systems, scientific and innovation outputs, innovative behavior by firms, the links between changes in economic structure, technological intensity, and growth, institutional development and public policy, and the status of one key cross-cutting and enabling technological revolution: information and communication technology.

In keeping with its predecessor, “Education, Science and Technology in Latin America and the Caribbean: A Statistical Compendium,” published in 2006 by the IDB, an effort has been made to present meaningfully benchmarked LAC indicators by providing information on OECD countries or other relevant comparators, such as China. Yet this Compendium considerably expands the scope of the dimensions analyzed and the indicators included, in ways that can be fairly labeled as pioneering: for the first time, a section on innovation in firms contains micro-level comparable indicators reflecting knowledge production, adaptation, and use at the firm level for a handful of countries for which data were available. The message from micro realities matches the macro landscape: LAC firms are not typically R&D intensive, they employ few researchers, and most of their expenditure in innovation is allocated to the purchase of equipment incorporating technology, even though there is little in-house technological capacity to take full advantage of such equipment.

This Compendium also devotes a chapter to examining the argument that the low technological intensity of Latin American economies is the direct consequence of an economic structure that relies for the most part on low-intensity technological sectors, such as those linked to natural resource extraction. It concludes that, on the contrary, the region registers an “innovation shortfall,” meaning that it suffers from under-investment in technology, regardless of the economic structure prevailing in any particular country. This conclusion points to investment in innovation and R&D as key to closing the gap in productivity between LAC and the rest of the world.

A special effort has been made to identify and standardize indicators related to policy frameworks and institutional capacity. The corresponding section in the Compendium highlights the considerable diversity in the degree of institutional development of the national innovation systems found among countries in the region, and looks to metrics related to intellectual property rights systems, standards and metrology systems, and other aspects.

The section on ICT is far richer and deeper than in the previous compendium, thanks to the greater amount and quality of data and the policy analysis carried out at the Bank. Issues such as access and use of the main technologies involved (computers, cell phones, and broadband) are covered extensively. The digital divide is analyzed within countries, among LAC countries, and worldwide, in each case highlighting interesting lessons but generally pointing to the urgency of a comprehensive digital agenda if access to ICT is to reach beyond the top of the socio-economic ladder and benefit broader segments of society.

This Compendium also introduces some innovations of its own in terms of format and presentation. The reader will find a detailed section of technical notes, defining variables and in some cases explanations of the calculations involved in the construction of most of the indicators. Beyond that, a link supplied at the end of the technical notes will take the reader to a website in which the data on which the graphs were built have been stored. At several points in the Compendium, the reader will find Quick Response (QR) codes that are two dimensional bar codes designed to quickly take the reader from the physical world object (the Compendium) to a virtual interactive world. Once the QR codes are read by a

computer’s web camera, the screen will show dynamic graphs depicting the behavior of certain indicators in a way that a static piece of paper cannot. In other words, the experience of reading the physical Compendium of Indicators can be enhanced by the technological capabilities of virtual computer-generated imagery, also known as, augmented reality.

The Compendium would not have been possible without data gathered and made public by organizations such as RYCIT, OECD, CEPAL, the World Bank, UNESCO, WIPO, ITU, ISO, the government statistical offices of many countries, and other organizations. We are grateful to all of them. The IDB has contributed data from its own research efforts and worked intensively in processing and formatting to add value to the final product.

Overall, if there is a general lesson to be drawn from this effort, it is that data remain far too scarce. More often than not, indicators have been found for only a handful of countries, preventing more accurate comparisons and generalizations. Key policy areas are underrepresented because there is very little comparable information available. The basis of the analysis of firm innovation, its links with the innovation system, and the innovation survey are still only carried out in a few countries in the region. The Bank looks forward to investing efforts in changing this situation for the better, working in partnership with organizations such as those mentioned above.

The publication of this Compendium coincides with a palpable growing enthusiasm among the leadership of LAC about the importance of investing in science, technology, and innovation. The growing knowledge content of most goods and services circulating in today’s economy seems to have persuaded policy makers and business leaders of the importance of building modern national innovation systems. This Compendium aims to be a modest contribution to decision making and enlightened public debate on these issues.

Flora Montealegre Painter

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I · Human Capital and Knowledge





Introduction



This initial section of the Compendium looks directly at the core of technology and innovation: the inputs needed to produce, adapt, and disseminate knowledge and the outcomes of the process of knowledge production. For an innovation system to be strong, universities, research centers, and firms have to be staffed with specialized personnel able to detect opportunities for improvement, imagine innovations, and be aware of and able to adapt knowledge available elsewhere to local needs. They must know how to use, create, adapt, and communicate knowledge. They should know how to manage intellectual property and make the most out of it both for the success of their scientific projects and the profitability of their business. Public institutions and private firms have to be prepared to provide the right environment for intellect to flourish. They have to invest the resources needed to put in place the right equipment and infrastructure.

Thus, the key resource in any innovation system is a critical mass of human capital, sufficiently able, skilled, and specialized in science, technology, and innovation. In this area, the countries of the Latin America and Caribbean (LAC) region clearly lag behind almost any known benchmarks. Typically, there are relatively few scientists, researchers, technicians, or even engineers in LAC countries, given the size of their economies and populations. Even more troubling, these scarce resources are overwhelmingly absent from the productive sector: only occasionally are they incorporated into the private sector or productive processes. The concentration of researchers in public research institutions and universities does not seem to be producing an adequate boost in the research output of universities, which, almost without exception, and allowing for a few islands of academic excellence distributed across the region, rank very low whenever the quality of research at universities is measured and benchmarked at the international level.

Problems like these may very well be related to deeper deficiencies in the education systems in the region, which, in spite of phenomenal advances in coverage and enrollments, have proved unable to produce significant progress in the quality of education and in learning outcomes. The OECD-sponsored Program for International Student Assessment (PISA) test, which includes several LAC countries, has produced solid evidence of the poor results in the lower levels of education in Latin America, almost without exception, and particularly in areas such as math and science education. Clearly, this is a critical factor affecting the availability of well-trained and motivated students that can be recruited and developed into good researchers and technicians later in life. It also adversely affects the overall scientific literacy of the general population in the region.

Beyond human capital concerns, however, overall investment in R&D activities has traditionally been low among Latin American economies. Despite recent indications of a new trend, it remains far below any known benchmark, be it the OECD averages or the levels reached over the past couple of decades by emerging economic success stories such as South Korea or Ireland.

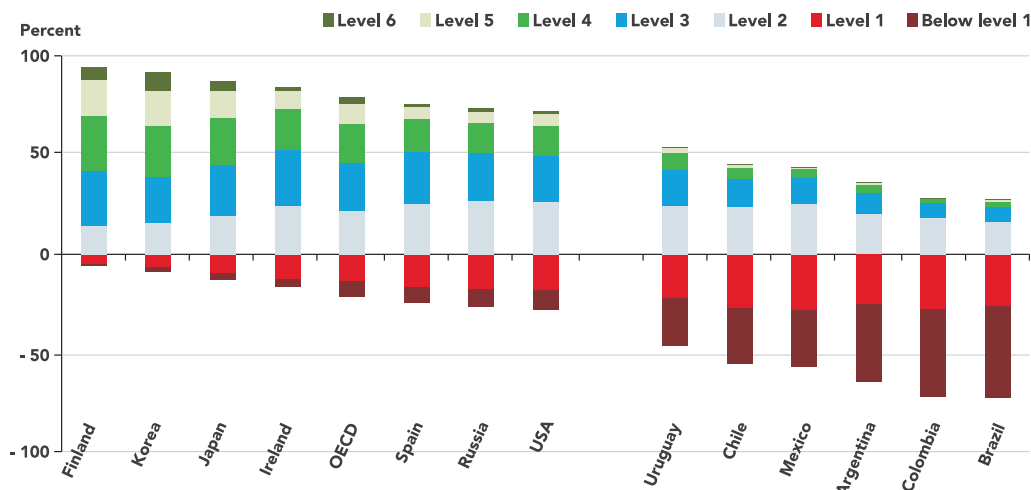
As this section shows, some output indicators, such as patent production and, even more clearly, the production of scientific publications, have recently exhibited substantial progress. This positive development helps balance the discouraging news coming from the other indicators. Yet such progress is heavily concentrated in a few countries, and it still leaves the region far behind when it comes to science and technology worldwide.

A. SECONDARY AND HIGHER EDUCATION

A.1. Learning in Science and Math in Secondary Education (PISA)

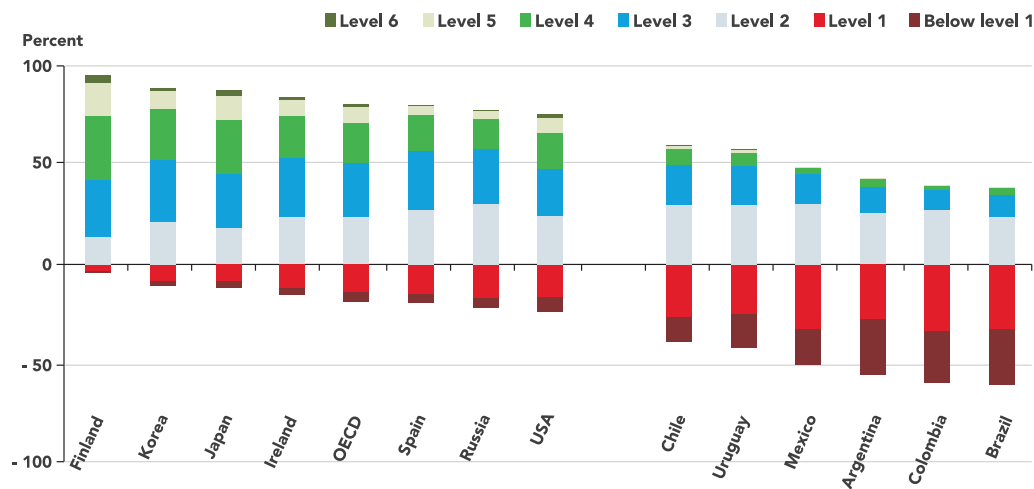
- A critical component of an innovation system is the skill base of the labor force. If the population as a whole lacks basic literacy, numeracy, and scientific skills, the overall process of creating, adapting, applying, and disseminating knowledge in society is likely to experience some sort of short circuit. Moreover, studies show that in order for new generations to become interested in pursuing science and engineering as professions, they must be exposed to and develop a liking for science before reaching 15 years of age. Otherwise, they will remain uninterested or utterly unable to create and manipulate scientific knowledge and technology as adults.
- The OECD's PISA test is the most widely recognized method of evaluating learning outcomes, as far as they can be captured by standardized testing. PISA results are reported both as average scores and as a distribution of test takers along a scale that represents reading (1 to 5) or math and science (1 to 6) performance levels. Among the Latin American countries participating, between 20 and 50 percent of students score below level one (the lowest performance level) in math and between 10 and 30 percent in science, which means that a larger proportion of 15-year-olds lack basic numeracy skills and the rudiments of scientific knowledge.
- The problem is not confined to the lower end of the distribution: In Uruguay, the region's top performer in mathematics, merely 11 percent of students perform at internationally competitive levels 4 to 6. A similar picture emerges in the case of Chile, the leading performer in science. The corresponding percentages of good performers for OECD members—Mexico and Turkey excluded—are about triple in the case of science and math.
- It is important to keep in mind that PISA is administered to 15-year-old students, regardless of the grade they are enrolled in. Given the widespread problem of repetition in Latin American school systems, any given country has between a half and a full two years of average cumulative overage among students of this target age, which results from anywhere between 20 to 50 percent of the student population enrolled at least one grade below their expected grade. These are pupils who have been in the system enough time to reach the 9th grade or beyond but have not in fact reached that level. Thus, they face the test, by definition, with a skill set that is not up to standards.
- Even more important, many Latin American youngsters are not included in the PISA study, since a good proportion of 15-year-olds are no longer enrolled in the system. They are mostly poor, handicapped, and rural. They have left school because of the need to contribute to their family's support, the lack of availability of secondary schools in their locality, or fatigue produced by boring or inadequate classes that turn them into failed students.

Figure 1 · Percentage of Students at Each Level of Proficiency on PISA Mathematics Scale (2006)



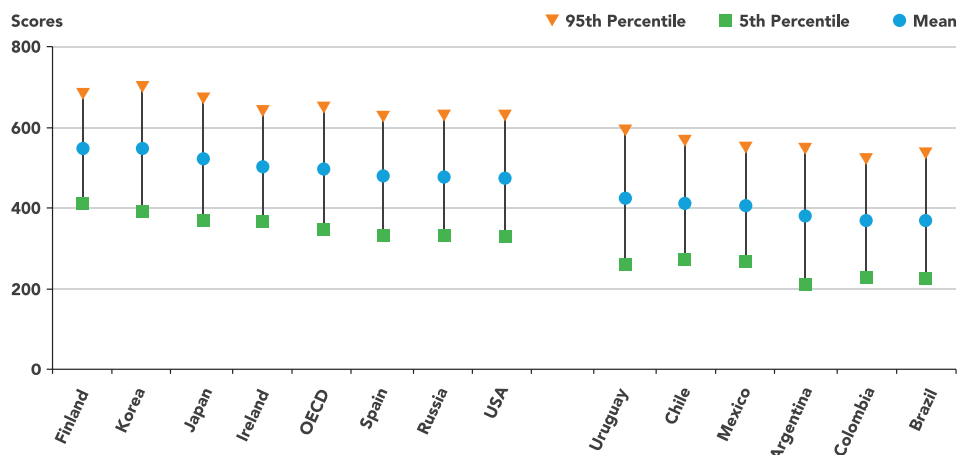
Source: OECD, PISA.

Figure 2 · Percentage of Students at Each Level of Proficiency on PISA Science Scale (2006)



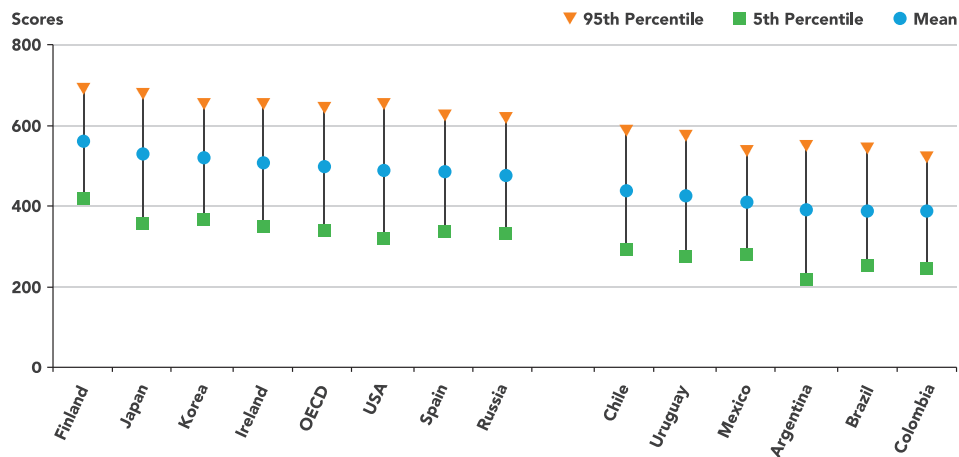
Source: OECD, PISA.

Figure 3 · PISA Scores on the Mathematics Scale (2006)



Source: OECD, PISA.

Figure 4 · PISA Scores on the Science Scale (2006)



Source: OECD, PISA.

Whatever the cause, a good proportion of students are no longer in class by age 15, and there is nothing that PISA can tell us about them. Yet all the evidence points to this group having lower skills than their peers who remain enrolled.

- Figures 3 and 4 show the same discouraging picture in terms of scores obtained by students of the seven Latin American countries that have participated in at least one out of the three rounds of PISA, compared to the OECD average. Figures like these point to the fact that the average score of 15-year-old students in participating countries in the region is at least the equivalent (60 points) of one school grade level below the average of OECD students tested. A similar comparison with leading countries such as Finland or Korea results in even more dismal conclusions for the quality of education in Latin American countries.

- A similar situation can be observed in the case of PISA results in science. To compensate for this overall rather negative outlook, some countries that have consistently invested in education over the past two decades, such as Chile, and to some extent Brazil and some Mexican states, have seen noticeable improvement in their PISA scores in the most recent round of testing. These results indicate that it is indeed possible to improve education quality in science and math.

A.2. University Degrees in Science and Engineering

- The availability of scientists and engineers is key for a strong innovation system. Even assuming that for many Latin American countries most innovation relates to technology transfer rather than creativity, highly specialized personnel well trained in the sciences and engineering are an indispensable resource in linking business, laboratories, and academic institutions and facilitating adaptation of innovations to local conditions.

- Figure 5 points to a significant heterogeneity in terms of the availability of scientists and engineers in the economy. Data from 2007 put a group of countries (Mexico, Colombia, and Chile,

among others) almost on par with the OECD in the proportion of science and engineering degrees as a percentage of all new tertiary education degrees, while others—notably Argentina and Brazil—tend to be well below that benchmark, indicating that scientific and engineering careers are less favored by the student population. It would be a mistake to infer from these figures directly a general assessment of the relative availability of engineers in the labor force, yet it is an indicator that, as a proxy, could be pointing at an important issue for some countries.

- The special role of engineering for technological progress is worth highlighting. Worldwide, engineering as a profession is at the very core of innovation activities: the application of state-of-the-art knowledge to processes and products in such a way that they can be made more efficiently, with better materials, with lower energy consumption, or with reduced environmental costs. Above all, engineering knowledge and practice are a requirement for the creation of entirely new products that open the way to whole new, highly competitive firms and industries. Engineering skills are also indispensable for the maintenance and adequate use of the technological infrastructure and equipment.

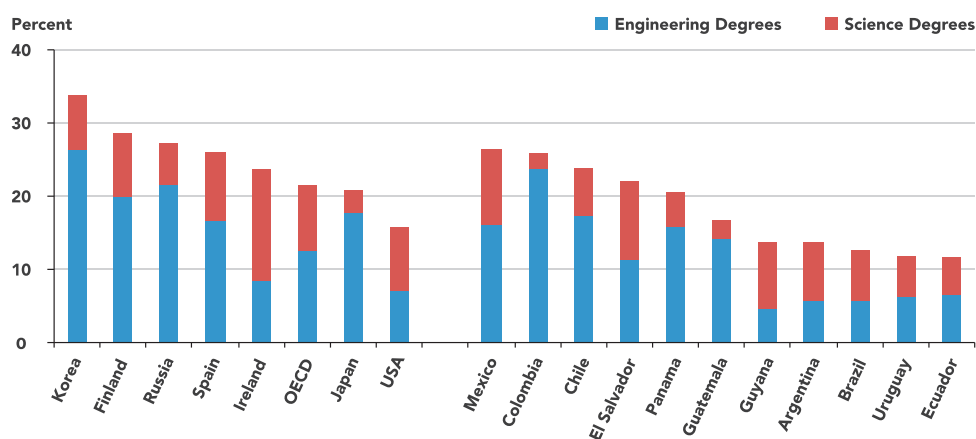
- The majority of innovative products and services in countries with well-integrated national innovation systems evolve from entrepreneurial ventures founded by engineers. LAC counts on top-level engineering programs in several countries, and these no doubt constitute a very important asset to harness innovation countries' potential. However, the development of the profession remains highly uneven both between and within countries.

A.3. Doctoral Degrees in Science and Engineering

- The number of doctoral graduates in science and engineering per 100,000 inhabitants is a proxy for the quality and depth of research and engineering personnel in countries.

- The distribution of people with doctorates in the LAC region is highly uneven: while doctoral degrees are far more abundant

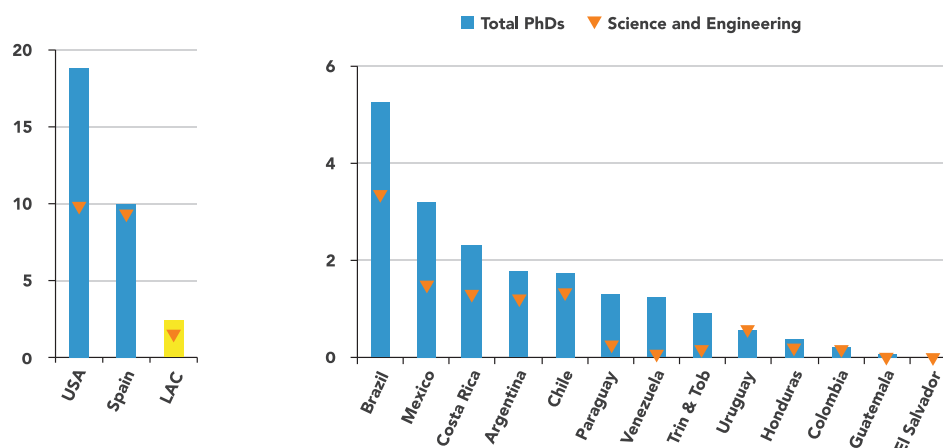
Figure 5 · Science and Engineering Tertiary Degrees, 2007 (or Latest Available) As a Percentage of All New Tertiary Degrees



Source: UNESCO Institute for Statistics.

Notes: The latest data available for Argentina, Australia, Belgium, and Hungary are 2006, and for Germany and Poland are 2005. 2005, 2006 and 2007 data, from which Canada and Luxembourg are missing, were used in the calculation of the 2007 OECD average; threshold for data depicted is 2005. See the technical notes for more details on the definitions of tertiary degree, Science and Engineering.

Figure 6 · Total Number of Doctoral Graduates and Graduates Concentrated in Science and Engineering per 100,000 Inhabitants 2007 (or Latest Available)



Source: RICYT.

Notes: There are two scales, one for each group of countries. The latest available data for Argentina, Honduras and the United States are 2006. Data for LAC are provided in the RICYT database and are estimates.

in countries such as Brazil or Mexico (with about five and three Ph.D.s per 100,000 inhabitants, respectively), other countries such as Guatemala and El Salvador (with less than one Ph.D. per 100,000 inhabitants) lag well behind. A look at the benchmark provided by the figures for Spain and United States shows how far even the leading countries of Latin America trail behind developed economies. In Spain there are more than 15 doctorates per 100,000 inhabitants, while in the United States this figure is about 18.

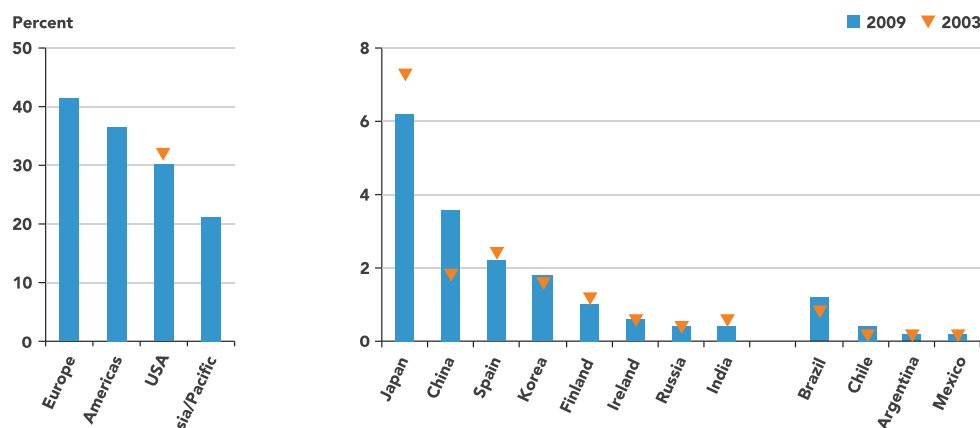
A.4. University Rankings

- Universities are a fundamental component of any national innovation system. They provide human capital and knowledge

needed for industry and productive systems to innovate and become more competitive. The quality of their research and consulting activities, their relationships with industry and government, and the environment they create to train new generations of scientist cannot be replaced easily if at all by any other actor.

- In the global competition for talent, the university sector in Latin America does not seem to be well positioned. The Shanghai Ranking results for LAC are a clear reason for concern. Only four countries in the region have universities ranked in the top 500, and the number of universities in each case is minimal (fewer than five in any of the four countries).

Figure 7 · Percentage of the World's Universities Ranked in the Top 500 by Country, 2003 and 2009



Source: ARWU.

Notes: There are two scales. The data for Europe, Americas, and Asia/Pacific regions are available for 2009 only. In 2009 there were 501 universities listed in the top 500; in 2003 there were 494 universities listed in the top 500. There are only four Latin American countries that have universities ranked in the top 500 in both 2003 and 2009. ARWU (also known as Shanghai Rankings) uses six indicators to rank universities around the world. See the technical notes for more details regarding the ranking methodology.

B. RESEARCHERS

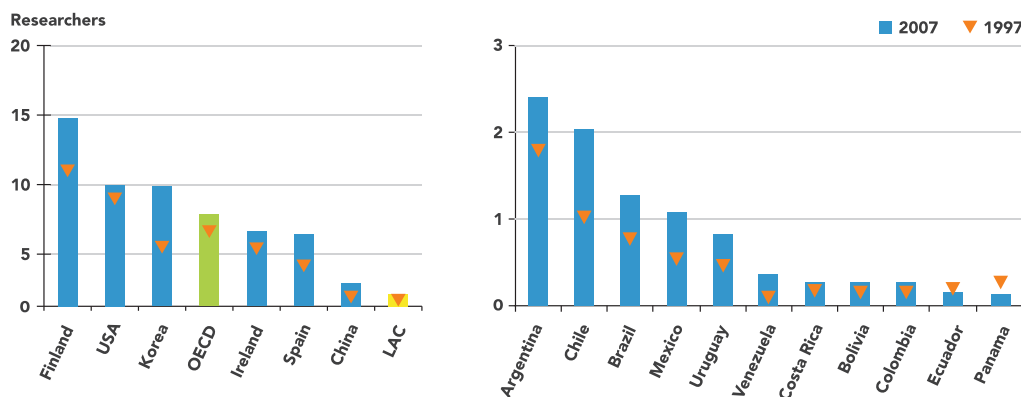
B.1. Researchers per 1000 Labor Force (Full Time Equivalent)

- According to the data available from 13 countries in the region, in 2007 there was on average only one researcher per 1000 workers in the labor force in Latin America and the Caribbean. This number is seven times smaller than the OECD average and nine times lower than in the United States. In China the figure is 1.8 and in Spain 5.4. In the region, Argentina leads the ranking with 2.4 researchers per 1000 workers, followed by Chile and Brazil, with 2.0 and 1.3 respectively. Guatemala and Paraguay show the smallest numbers, with less than 0.15 researchers per 1000 workers in the labor force.
- For most of the countries for which data are available, significant progress has been made. Chile and Mexico doubled this number, and Brazil increased this figure from 0.78 to 1.27 (around 70 percent). The region on average increased the number of researchers per economically active individuals by 57 percent (from 0.64 to 1) between 1997 and 2007. The only exceptions to

this trend are Ecuador and Panama, which report a significant decrease in this indicator (from 0.21 to 0.16 and from 0.28 to 0.14, respectively).

- In spite of the progress made, the gap continues to increase as the number of researchers continues to grow in industrialized countries: the difference in the number of researchers between the OECD and Latin America was 5.19 in 1997 and 6.14 in 2007. In OECD countries, the number of researchers in the total labor force increased by almost 20 percent between 1997 and 2007, with some countries such as Finland, Korea, and Spain making dramatic progress. Bridging this gap will require continuous efforts to increase the supply of human capital (achieve a critical mass) and improve its quality. Improving quality will require making national post-graduate programs more competitive, introducing accreditation criteria for post-graduate careers, repatriating researchers, and tackling the problem of low remuneration for highly-skilled people in the research labor market.

Figure 8 · Researchers per 1000 in the Labor Force in 1997 (or Nearest Available) and 2007 (or Latest Available)



Sources: RICYT and OECD Main Science and Technology Indicators 2009-1; (MSTI).

Notes: There are two scales, one for each group of countries. The nearest available data for Brazil are 1995, Bolivia and Venezuela are 1998 and for Uruguay are 1999. The latest available data for Bolivia and Uruguay are 2002, Chile and Panama are 2004 Costa Rica are 2005, and Mexico, Ireland, United States, and OECD are 2006. Threshold for both nearest and latest data is 2002. There is minor variation in values reported for the United States and Spain in the OECD and RICYT data sets, OECD data were used. LAC data are provided in the RICYT database and are estimates. OECD data are provided in the OECD database and are based on Secretariat estimates or projections based on national sources.

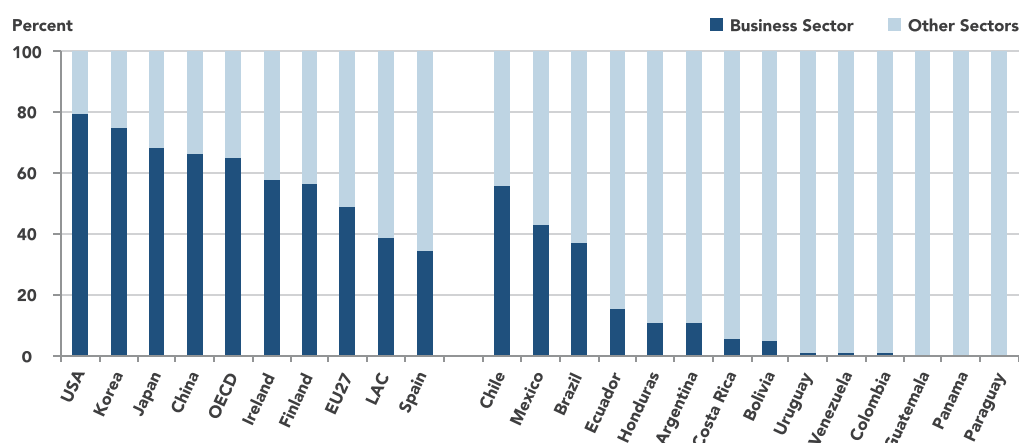
B.2. Researchers by Sector of Employment

- Researchers are the heart of technological activities. They are the foundation on which a firm develops knowledge, learning, and technological change. There are very few researchers in the business sector in Latin America. In 2007, the share of researchers working in business was 38.6 percent in Latin America and the Caribbean albeit this average is largely biased towards the largest countries. This pattern differs dramatically from industrialized countries where the private sector absorbs more than 50 percent of researchers (except for Spain).
- In Venezuela, Colombia, Guatemala, Panama and Paraguay, there are virtually no researchers employed in the business sector. However, this result should be viewed with caution, since the measurement and gathering of information on the employment of researchers is problematic. More than 40 percent of researchers in Chile, Mexico, and Brazil are in the business sector. This level

was achieved in a relatively short time. Between 2002 and 2007, Chile increased the share of researchers employed in industry from 14 percent to 56 percent, and Mexico increased it from 24.6 percent to 43.4 percent. Again, these figures should be interpreted with care, as some of the countries have changed methodologies or have just begun measuring these activities.

- The scant integration of researchers in industry can be attributed to several factors, such as the dominant orientation of research activities (too basic in some countries), and institutional settings that preserve the isolation of research and education systems from the private sector. Other factors include the lack of relevance of research for industry demands and the lack of awareness on the part of business about the utility of researchers and innovation more generally as an important element in their market strategies.

Figure 9 · Researchers by Sector of Employment, 2007 (or Nearest Available)



Sources: OECD and RICYT.

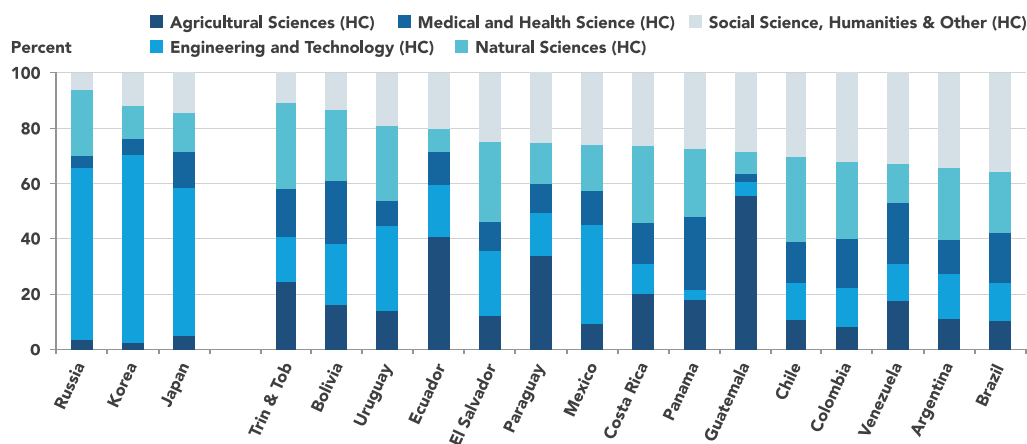
Notes: Government, Higher Education and Private Non-Profit have been combined to form the category "Other Sectors". The latest available data for Uruguay and Bolivia are 2002, Honduras are 2003, Chile are 2004, Costa Rica are 2005, and Mexico, Ireland, OECD and the United States are 2006. Threshold for data depicted is 2002. LAC data are provided in the RICYT database and are estimates. OECD and EU27 data are provided in the OECD database and are based on Secretariat estimates or projections based on national sources.

B.3 Researchers by Field of Science

- In Latin American and Caribbean countries there are more researchers working in social sciences and humanities (and in other unspecified fields) than in engineering and technology. In fact, except for Mexico and Uruguay, for the rest of the reporting countries, engineering and technology frequently has the smallest share (less than 20 percent). The natural and agricultural sciences continue to be the dominant fields of research: together they typically represent between 30 and 40 percent of researchers.

- Unfortunately, there are very few comparable data for industrialized or other emerging economies. The only three countries with data available for comparison are Japan, Korea, and Russia. The difference with Latin America is striking. Fifty percent of researchers in Japan and roughly 65 percent in Russia and Korea work in engineering and technology, whereas in Latin American countries, typically less than 30 percent of researchers are in engineering and technology.

Figure 10 · Researchers by Field of Science 2007 (or Latest Available)



Source: UNESCO Institute for Statistics.

Notes: Other includes not specified and any researchers not reported in the categories to total 100 percent. HC stands for Head count. The latest available data for Chile are 2000, Bolivia and Panama are 2001, Mexico are 2003, Costa Rica are 2005, and Argentina, Brazil, Colombia, Guatemala, Trinidad and Tobago, and Uruguay are 2006.

C. RESEARCH AND DEVELOPMENT

C.1. R&D Investment

- Research and development (R&D) is important for the performance of both individual firms and national economies. Investment in R&D is one of the main drivers of long-term economic growth. The R&D intensity, expressed by the percentage of gross domestic product (GDP) expended on R&D, has been growing steadily in most industrialized economies and tremendously in China. In 2007, R&D expenditure in the OECD area reached US\$886.3 billion (in current purchasing power parity, PPP), or about 2.29 percent of overall GDP. Countries reporting the highest rates of R&D intensity worldwide are Finland (3.5 percent), Korea (3.5 percent), Sweden (3.6 percent) and Israel (4.7 percent).

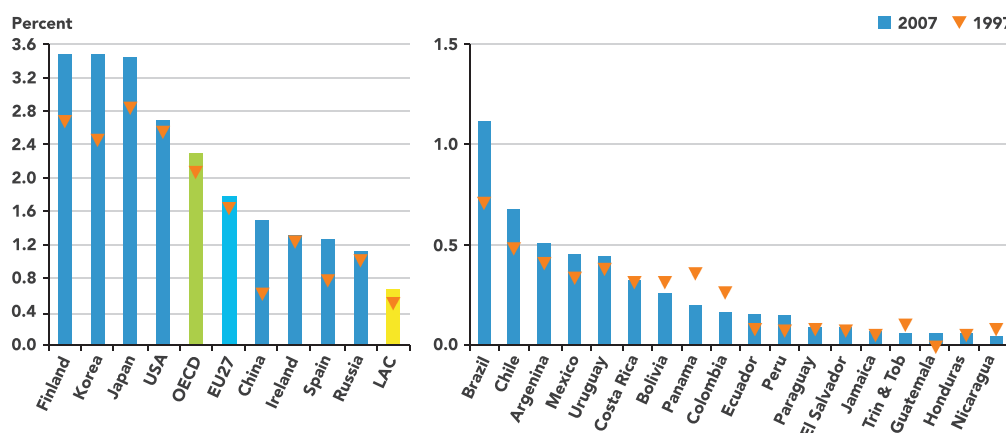
- In contrast, although some progress has been made in recent years, Latin America still invests significantly less in R&D than benchmark economies. According to Red de Indicadores de Ciencia y Tecnología (RICYT) estimates, R&D investment in the region represented 0.67 percent of GDP compared to 0.52 in

1997. Between 2000 and 2007, the R&D investment in the region grew at an average annual rate of 7.8 percent, a bit higher than the OECD rate of about 5.9 percent but at a significantly slower pace than in China (22.5 percent).

- These figures should be viewed with caution as most of the effort made is concentrated in very few countries. In fact, Brazil was responsible for 60 percent of the region's R&D expenditures in 2007. R&D intensity in Brazil is 1.11 percent of GDP, the highest in the region. It is followed by Chile, Argentina and Mexico, in which R&D intensity is above 0.4 percent.

- Even considering level of development, LAC countries still underperform in terms of R&D intensity. In other words, they invest significantly less than expected for their income level. The percentage difference between actual and expected amount of investment oscillates between 40 percent for Chile and almost 100 percent for Guatemala. The R&D gap with respect to the potential in the LAC region is smaller in Chile, Uruguay, Costa Rica, and Brazil (between 40 and 50 percent).

Figure 11 · R&D Expenditure as a Percentage of GDP 1997 (or Nearest Available) and 2007 (or Latest Available)



Sources: OECD Main Science and Technology Indicators 2009-1; (MSTI) and RICYT.

Notes: There are two scales, one for each group of countries. The earliest data available for El Salvador and Guatemala are 1998, for Honduras are 2000, and for Jamaica and Paraguay are 2001. Brazil had no available data for 1997, so data from 1996 are used. The latest data available for Bolivia, Jamaica and Nicaragua are 2002, for Chile, Honduras and Peru are 2004, and for Mexico and Paraguay are 2005. Data for LAC are provided in the RICYT database and are estimates. Data for Korea exclude R&D in the social sciences and the humanities. Data for the United States exclude capital expenditure. Data for Ireland (in 1997), OECD and EU27 are provided in the OECD database and are based on Secretariat estimates or projections derived from national sources.

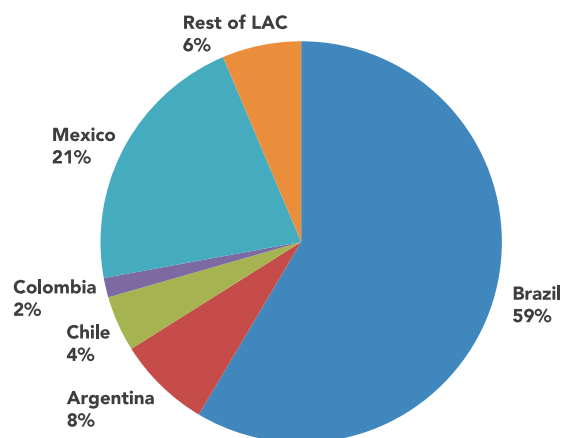


QR Code 1 · R&D in LAC versus South Korea from 1970 to 2007

To the left, is the first Quick Response (QR) code presented in the Compendium. To use this unique QR code, open your internet browser and enter the following web address:

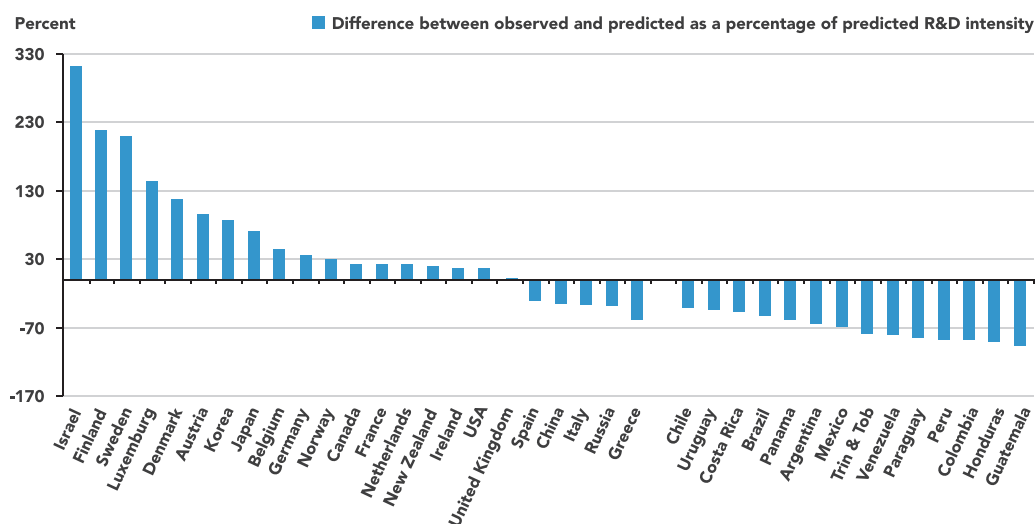
www.iadb.org/movingdata. Once the website has loaded, follow the prompts to see the dynamic graph associated with this QR code. Hold the Compendium steady, about 10 to 20 centimeters away from your computer and point the QR code directly at your computer's web camera. Shortly, your computer screen will be re-directed via hardlink to a URL where you can view and interact with a dynamic graph that compares R&D efforts in LAC to those in South Korea from 1970 to 2007. If you experience difficulties, see the technical notes for guidance in troubleshooting.

Figure 12 · Shares of R&D Expenditure by Selected Countries as a Percentage of Total R&D Expenditure in Latin America & the Caribbean, 2007 (Measured in Millions of PPP)



Source: RICYT, World Development Indicators and Lederman and Saenz (2005).
Notes: The countries included in 'Rest of LAC' are: Bolivia, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay, and Venezuela.

Figure 13 · Difference between Observed and Predicted R&D Intensity as a Percentage of Predicted R&D Intensity (As Predicted by National Income)



Sources: Authors' calculations based on World Development Indicators, UNESCO and RICYT.

Notes: The percentage difference refers to the difference between observed and predicted R&D Intensity as a percent of the predicted. It illustrates how much more (or less) a country invests relative to what is predicted by its national income. Calculations are based on linear regression between R&D intensity (share of GDP) in 2005 and income per capita PPP (log) in 2004. R&D data from 2004 were used for Peru, Guatemala, Costa Rica, and Chile.

- At the opposite end of the spectrum, countries such as Denmark, Sweden, Finland, and Israel are dramatic over-performers, with R&D intensity 100 percent above what their income level would predict. Israel is at the top, performing 3.12 times above expectations. Lederman and Maloney (2003) conclude that the main reasons why R&D efforts rise with the level of development are a combination of financial capacity, protection of intellectual property rights, the government's capacity to mobilize resources, and the quality of research institutions.

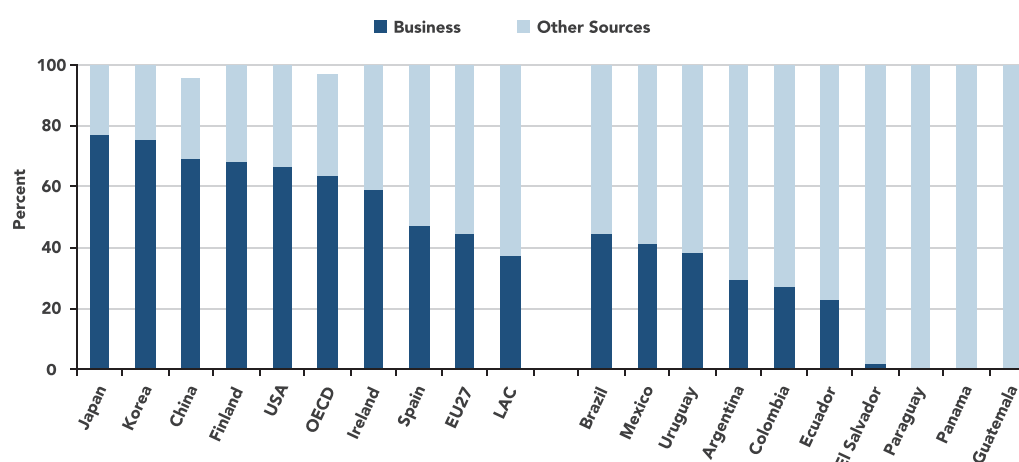
C.2. R&D Expenditure by Source of Financing

- In OECD countries, the business sector is the main and the fastest-growing source of R&D financing. Sixty-five percent of R&D expenditures on average are financed by business. In Japan, South Korea, the United States, and China, this share is above 70 percent. In Latin American and the Caribbean, business' share in R&D financing represents less than 40 percent. Between 1997 and 2007, this figure remained largely the same.
- Brazil, Chile, and Mexico lead the region, with percentages ranking about 40 percent. The smallest shares of business sector R&D funding are in Panama, Paraguay, Guatemala, and El Salvador, with less than 2 percent.

C.3. R&D Expenditure by Sector of Performance

- In technologically advanced countries, the government conducts a limited and declining portion of R&D (11 percent on average in OECD countries). The business sector is responsible for 70 percent of R&D expenditures and the higher education sector for 17 percent. Non-profit organizations account for the rest. In contrast, in LAC countries, one-fifth of R&D is conducted by the government, while firms conduct around 41 percent, almost as much as the higher education sector (38 percent).
- In several countries in the region, notably Guatemala, Ecuador, Peru, Paraguay, Chile, and Mexico, business has substantially increased its participation in R&D activities. Argentina and Uruguay report no significant change during the period under consideration, remaining at 30 percent and 23 percent, respectively.
- It is true that public R&D (performed by government organizations and universities) has led to important technological breakthroughs and is associated with substantial social rates of return. However, when R&D investment is overwhelmingly concentrated in the public sector, its impact on industrial productivity and national competitiveness can be less substantial. In contrast, if there is appropriate R&D capacity in the business sector, public R&D can stimulate industrial productivity through complementarities that reduce the effective cost of R&D in business and increase opportunities for innovation in the private sector.

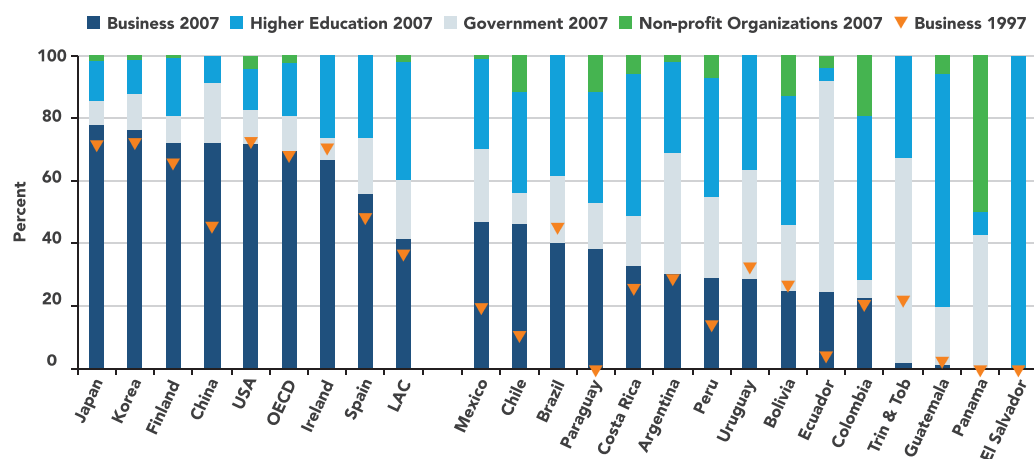
Figure 14 · R&D Expenditure by Funding Source 2007 (or Latest Available)



Sources: OECD Stat Research and Development Statistics Gross Domestic Expenditure on R&D by sector of performance and source of funds, and OECD Main Science and Technology Indicators database (MISTI) and RICYT.

Notes: Government, Higher Education, Private Non-Profit, Foreign and Other have been combined to form "Other Sources". Not all categories have been reported in all cases; regardless, they were collapsed into the aforementioned category, "Other Sources". Data for LAC are provided in the RICYT database and are estimates. Data for EU27 and OECD are provided in the OECD database and are based on Secretariat estimates or projections based on national sources. Earliest available data for China, Korea, Ireland, OECD and Spain are 2006 and for Mexico and Paraguay are 2005.

Figure 15 · R&D Expenditure by Sector of Performance, 1997 (or Earliest Available) and 2007 (or Latest Available)



Sources: OECD Stat Research and Development Statistics Gross Domestic Expenditure on R&D by sector of performance and source of funds, and OECD Main Science and Technology Indicators database (MISTI) and RICYT.

Notes: Latest available data for Bolivia are 2002, for Brazil, Chile and Peru are 2004 and for Paraguay are 2005. Earliest available data for Brazil are 1996, for Paraguay are 2001 and for Guatemala are 2005.

D. KNOWLEDGE AND INNOVATION OUTCOMES

D.1. Scientific Publications

- Overall, the number of scientific publications per capita continues to rise in Latin America and the Caribbean. Between 1994 and 2008, it grew at an average annual rate of 7 percent, significantly higher than the OECD average rate (3 percent) but lower than in China and Korea (16 percent), Ireland (7 percent), or Southeast Asia (10 percent). Some countries, however, report a contraction. Trinidad and Tobago, Costa Rica, Jamaica, Venezuela, Belize, Guatemala, and Honduras have all decreased their international position between the two periods considered (from 1994-1998 to 2004-2008).

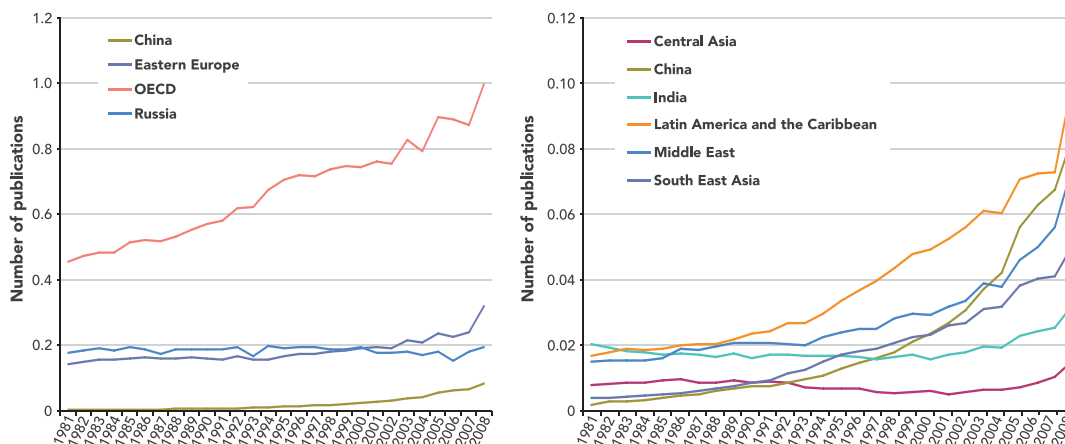
- Although the production of science is improving in LAC, it still remains low compared to industrialized nations. Internationally, the region ranks in the middle in terms of publications per capita, despite improvements. On a normalized scale of 0-10 (0 = lowest, 10 = highest), relative to the 182 and 183 countries available for this indicator in 1994-1998 and 2004-2008, respectively, the region's score increased from 5.3 to 5.7. However, if we were to normalize with a sample limited to OECD and emerging countries (BRICS), this score would fall to an average of 1.5.



QR Code 2 · Publications per Capita (Evolution over Time)

To use this unique QR code, open your internet browser and enter the following web address: www.iadb.org/movingdata. Once the website has loaded, follow the prompts to see the dynamic graph associated with this QR code. Hold the Compendium steady, about 10 to 20 centimeters away from your computer and point the QR code directly at your computer's web camera. Shortly, your computer screen will be re-directed via hardlink to a URL where you can view and interact with a dynamic graph that depicts the growth of scientific publications for individual LAC Countries, the United States and Spain from 1990 to 2007. If you experience difficulties, see the technical notes for guidance in troubleshooting.

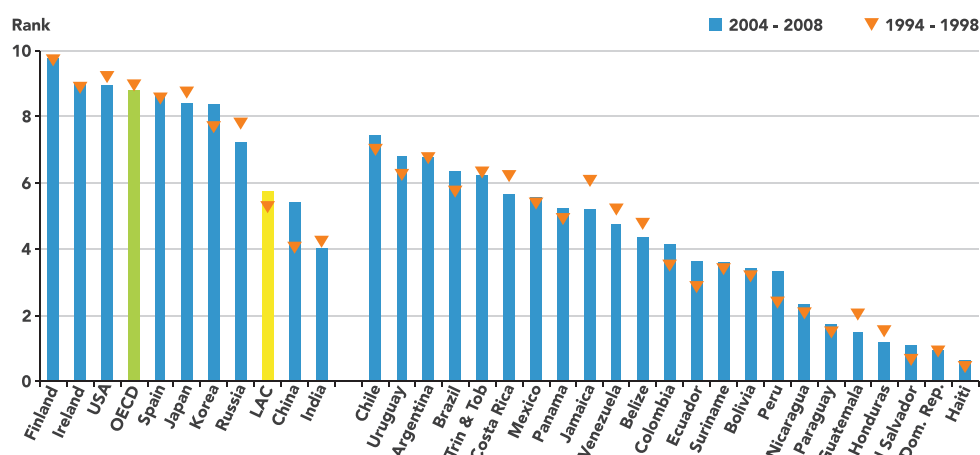
Figure 16 · Publications per Capita (Evolution over Time)



Sources: Authors' calculations based on Reuters-Thomson ISI(R) National Science Indicators (2008) and World Development Indicators.

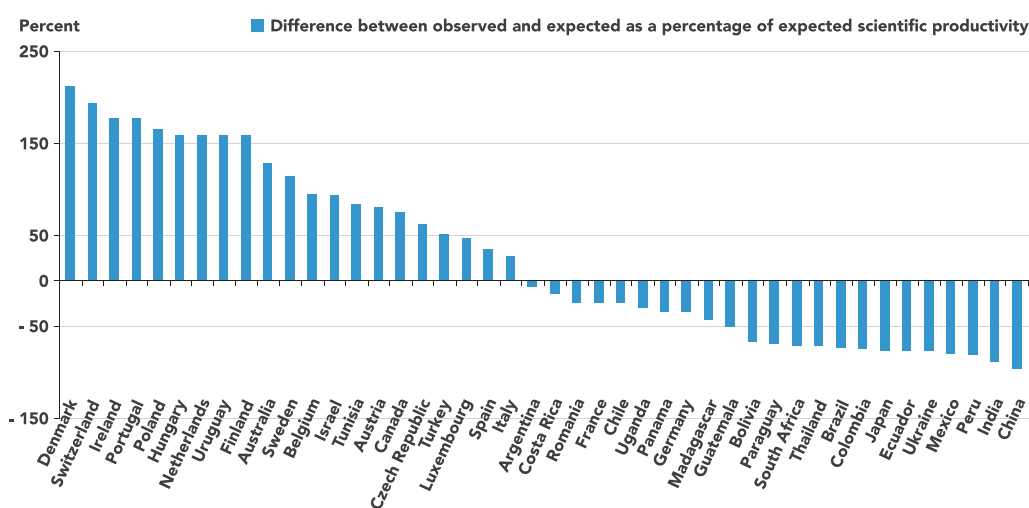
Note: There are two scales, one for each group of countries and regions.

Figure 17 · Normalized Country Rank (0-10) in Publications per 1000 in the Population, 1994-1998 and 2004-2008



Sources: Authors' calculations based on Reuters-Thomson ISI(R) National Science Indicators (2008) and World Development Indicators.
 Notes: All countries included in the ISI database for which there were corresponding population data in the WDI database were used to calculate the normalized rank. The Normalization Procedure is described by the World Bank for the KAM index (see the technical notes for more details).

Figure 18 · Difference between Observed and Expected Scientific Productivity as a Percentage of Expected Scientific Productivity in 2004-2008 (As Predicted by Public Research Expenditure)



Sources: Authors' calculations based on Reuters-Thomson ISI(R) National Science Indicators (2008), UNESCO and RYCYT.
 Notes: The percentage difference refers to the difference between observed and predicted number of papers per capita as percent of predicted. It illustrates how much more (or less) a country invests relative to what is predicted by its public R&D investment. We used linear regression on the natural logarithm of papers per capita (2004-2008) explained by the natural logarithm of R&D expenditures performed by higher education and government in 2004 (or latest available). The share of R&D performed (in total R&D) by public sector was included. 75 countries were used for the regression.

- Based on the normalization with respect to the world, Chile, Uruguay and Argentina are the top three countries in the region, recording scores above 6.5. Chile is the highest, with a score of 7.4. Countries such as South Korea, Japan, and Spain score above 8. Smaller countries such as Honduras, El Salvador, the Dominican Republic, and Haiti rank at the bottom.
- Compared to the scientific production predicted by the level of public R&D (R&D expenditure performed by the higher education sector and government), most of the countries from the region (for which data are available) underperform. Compared

to other Latin American countries, Uruguay stands as the most productive and appears, in fact, to be an over-performer. It is positioned between the Netherlands and Finland.

- The rest of LAC countries for which data are available appear to be underperformers in this category. Argentina, Costa Rica, Chile, and Panama display percentage differences less than 50 percent (they are 50 percent less productive than expected given their level of public R&D). Peru and Mexico are among those that have the greatest shortfalls. They are 80 percent less productive than expected given the level of public R&D expenditure.

Figure 19 · Relative Productivity (Publication per Population Relative to OECD)

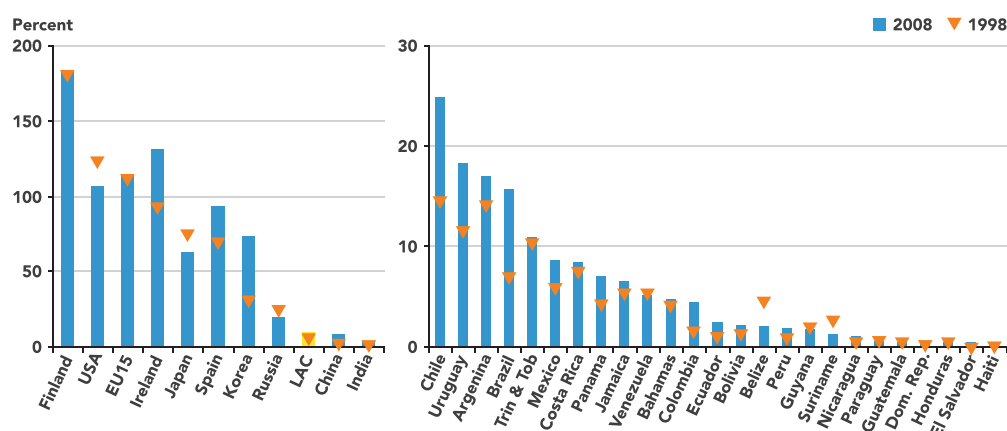
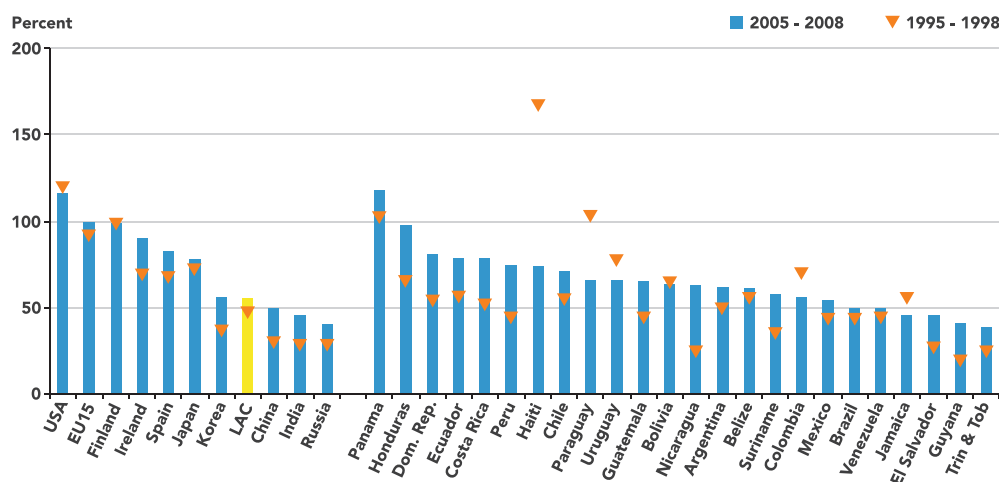


Figure 20 · Relative Quality (Citations per Publication Relative to OECD)



Sources: Authors' calculations based on Reuters-Thomson ISI(R) National Science Indicators (2008) and World Development Indicators. Notes: There are two scales in Figure 19. The relative quality refers to the number of citations received per publication until the most recent year available (2008). In order to reduce bias related to time in citations, two 5 year periods of comparison were chosen.

- The discrepancies between LAC and most technologically advanced countries are less prominent in terms of quality than quantity. We define the quality of publications as the number of times that all papers have been cited since publication (average citation impact). Thus, a country could have very low productivity because it publishes very little and very high quality because what is published is highly cited.
- In terms of papers per capita, Chile has published the most in the region, with scientific productivity being 25 percent of the OECD average. Most of the rest of the countries in the LAC region rank significantly behind Chile.
- In terms of quality (the number of citations received since publication), Uruguay, Venezuela, Trinidad & Tobago, and Chile produce papers with an average citation impact equivalent to or higher than that of OECD countries. The remaining LAC countries underperform substantially in terms of quality of papers. Even the largest countries in the region, such as Mexico, report half the citation impact of that of OECD. Overall, most LAC countries have seen improvements in quality.

D.2. Scientific Specialization

A country is specialized in a scientific area if it has a higher proportion of papers (relative to the country's total number of papers) in this field than the world average in the same scientific area; an index higher than one indicates specialization. Latin America and the Caribbean have four major areas of scientific specialization (revealed scientific specialization in agriculture sciences, plant and animal science, microbiology and environment ecology). The region has fewer relative scientific capacities in more “horizontal” sciences (that is, sciences with a cross-sector impact) such as engineering, materials and computer sciences, and multidisciplinary research. Having scientific competencies in these areas is important, as these fields serve as enablers for leveraging scientific productivity in other areas.

- More technologically advanced countries and emerging economies such as China and South Korea show a more diversified palette of scientific competences. China has revealed advantages in chemistry, physics, materials, and multidisciplinary research. South Korea is specialized in computers and materials sciences and pharmacology-toxicology. Germany and the United States have less skewed distributions as they have higher volumes of scientific production. That also means that they have qualified research competences across numerous fields.

Figure 21 · Relative Scientific Specialization of Latin American Countries (Selected Countries, 2004-2008)

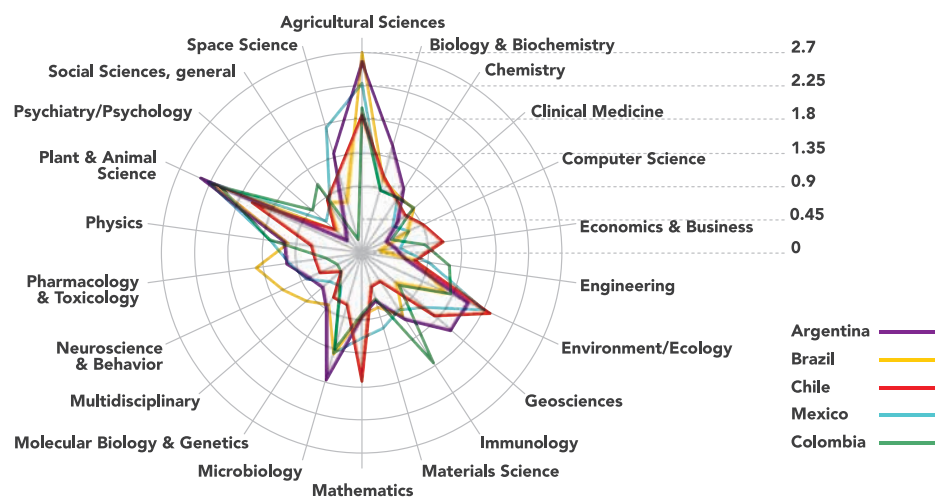
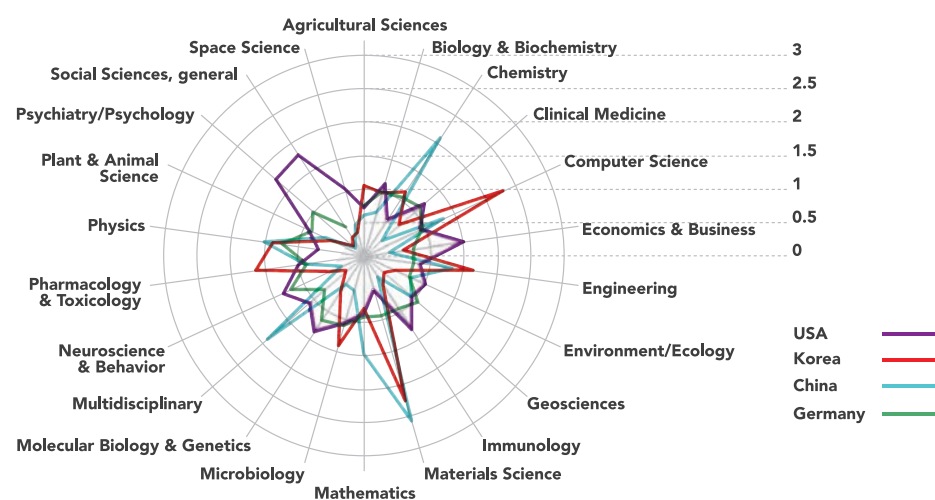


Figure 22 · Relative Scientific Specialization of Major Technologically Advanced Countries (Selected Countries, 2004-2008)



Source: Authors' calculations based on Reuters-Thomson ISI(R) National Science Indicators (2008).

Figure 23 · Relative Scientific Specialization (Publications from 2005 to 2008)



Source: Authors' calculations based on Reuters-Thomson ISI(R) National Science Indicators (2008).

Notes: Only countries that have at least 50 publications in the period 2005-2008 and have an index greater than zero in any of the two fields indicated are reported. Due to graphical representation, outlier data for specialization in Microbiology for Paraguay (6.05) were dropped.

D.3. Patents

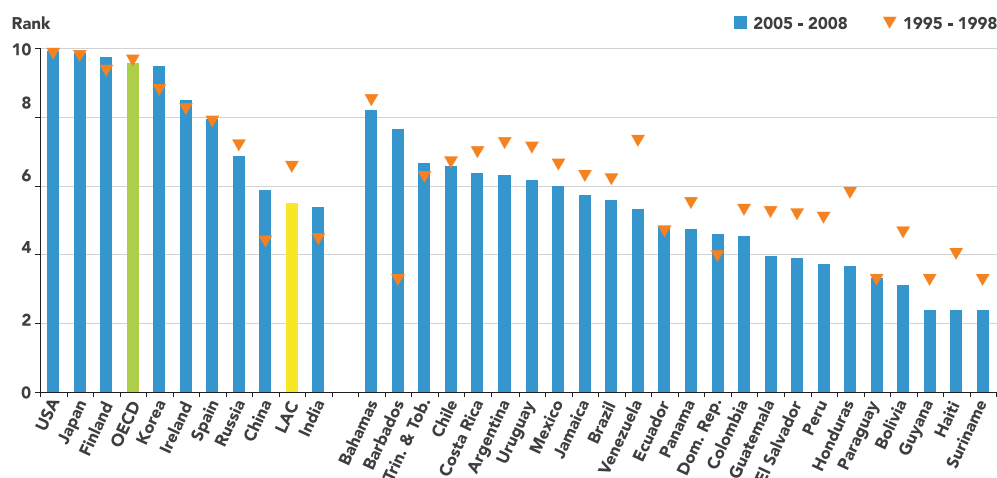
- Latin America and the Caribbean perform moderately with respect to the number of patents (granted at the United States Patent and Trademark Office) per capita. On a normalized scale from 0 to 10 (0 = lowest and 10 = highest), out of 163 countries in 2005-08, the region scores 5.4 out of 10. Chile, Costa Rica, Uruguay, Argentina, Trinidad and Tobago, Mexico, Jamaica, and Brazil are all above the regional average.
- The region's performance has deteriorated in relative terms between the mid-1990s and mid-2000s. This pattern is explained by the fast emergence of countries such as China and India in the global technology race. Patenting has been growing at an average annual rate of 3 percent (based on the consolidated sum of total patents generated in the region per year), which is less than the growth rate of patenting in OECD (7 percent) and considerably less than the growth of RIICS countries (Russia, India, Indonesia, and China) together (13 percent).
- As in the case of R&D investment, the production of patents is concentrated in very few countries. During the period 2005-08, three countries were responsible for 75 percent of the patents granted by USPTO to Latin American inventors (1042 in total). Thirty-seven percent of patents granted to the region were for inventions made in Brazil, 25 percent in Mexico, and 13 percent in Argentina.
- When reading these figures, one should bear in mind that technological specialization must be taken into account, as some industries are much more patent intensive than others. Natural resource-oriented economies or countries with a large proportion

of traditional sectors invest systematically less in technology and R&D. These are also industries where patents are less important to appropriate returns on investment in knowledge.

D.4. Trademarks

- Trademarks are an indicator of commercialization of new products and services. Products or services under trademark protection can be both technological and non-technological and include also traditional and artisanal products. Trademarks filed by non-Americans before the United States Patent and Trademark Office can be seen as indicators of commercialization (or intent to do so) and therefore may involve products and services of minimal quality.
- Latin America and the Caribbean scores in the mid-range (5.4) on a normalized scale of the number of trademarks per capita filed between 2005 and 2008 (the scale is from 0 to 10, 0 = lowest and 10 = highest and has been applied to 166 countries). As is the case with the previous indicator, the score is declining, as more countries apply for trademark protection and their filings rapidly increase. Belize, Panama, Jamaica, Costa Rica, Mexico, and Uruguay report a score above the regional average (around 6).
- In absolute numbers, between 1995 and 2008, the most striking expansions in the absolute number of trademarks are reported for Chile (it increased 6 times) and Panama (5.5 times); followed by Brazil, Colombia and Mexico (around 3 times). However, in the international ranking, all of them drop in the normalized score. This is due essentially to the increase in the number of emerging countries applying for trademark protection.

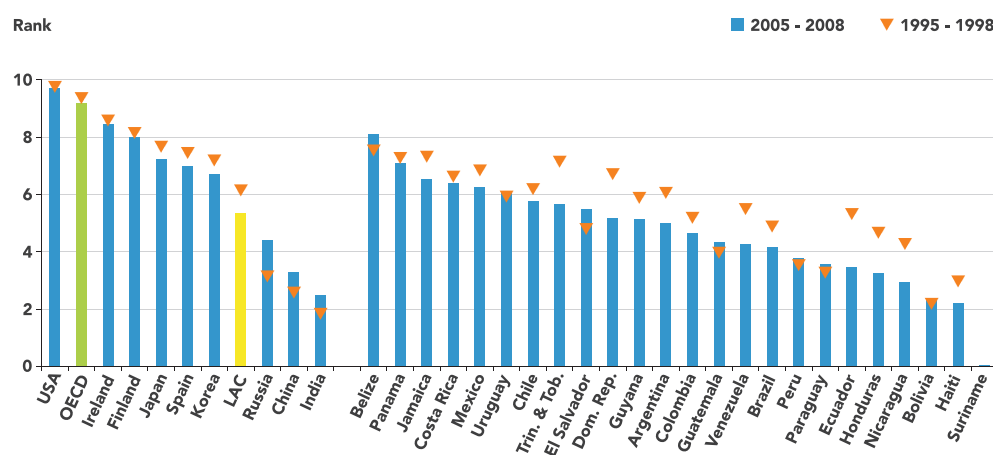
Figure 24 · Normalized Country Rank (0-10) Patents per 100,000 Inhabitants, 1995-1998 and 2005-2008



Sources: Authors' calculations based on USPTO and World Development Indicators.

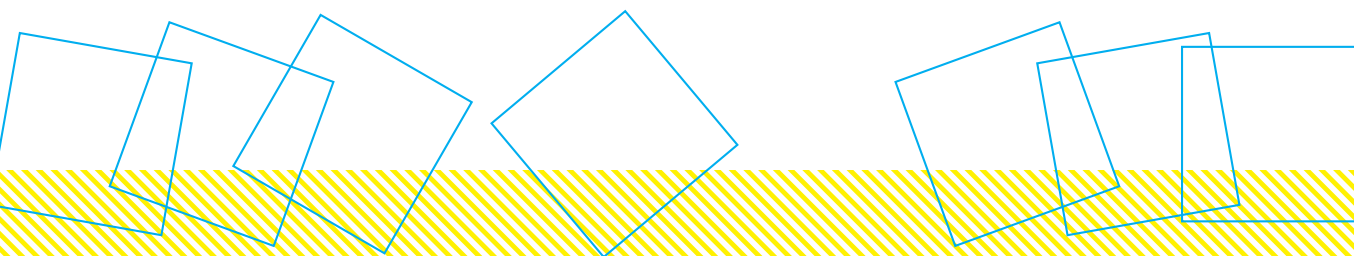
Notes: Patents refer to the number of patent grants. All countries reported by USPTO for which there were corresponding population data in the WDI database were used to calculate the rank. The Normalization Procedure is described by the World Bank for the KAM index (see the technical notes for more details).

Figure 25 · Normalized Country Rank (0-10) Trademark Applications per 100,000 Inhabitants, 1995-1998 and 2005-2008



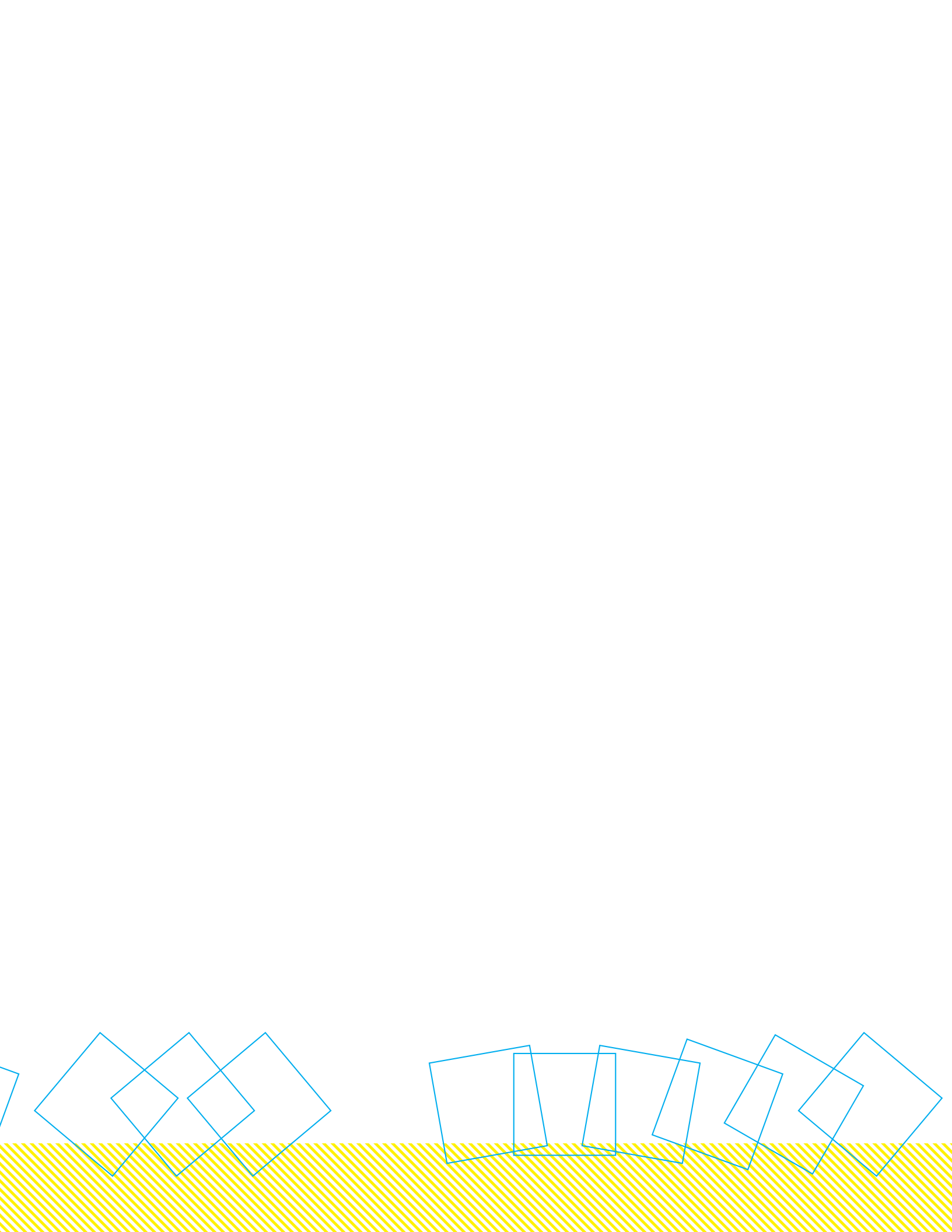
Sources: Authors' calculations based on USPTO and World Development Indicators.

Notes: All countries reported by USPTO for which there were corresponding population data in the WDI database were used to calculate the rank. The Normalization Procedure is described by the World Bank for the KAM index (see the technical notes for more details).





II · Innovation, Productivity and Economic Performance



Introduction



Productivity, that is, how efficiently economic resources (labor, physical capital, and human capital) are employed, is the main factor explaining international differences in economic growth and income levels (Hall and Jones, 1999).

Several studies show a synergistic circle in which R&D spending, innovation, productivity, and per capita income mutually reinforce each other (Cimoli, 2005) and lead countries to long-term, sustained growth rates. Further, developing countries' potential to drive development depends largely on their capacity to learn and absorb knowledge from abroad and use the opportunities offered by structural change to disseminate new technologies and innovations (new modes of production and new products) and knowledge throughout the economy.

Improving productivity is the most important challenge for LAC countries. A recent study (IDB, 2010) found that low productivity growth is the root cause of the region's poor economic growth in the last four decades. In fact, the per capita income gap with respect to the United States would largely disappear if the productivity gap were closed.

Increasing productivity, innovation, and knowledge is imperative. Policy makers and researchers alike recognize that beyond the simple accumulation of physical and human capital, innovation is a key determinant of long-term growth. Indeed, the application of advances in technology leads to a more effective use of productive resources. The transformation of new ideas into new economic solutions is a source of sustainable competitive advantages for firms and rising living standards for the population.

This chapter reviews the productivity levels and the structure of national economies in LAC countries and compares their evolution to that of wealthier economies from the perspective of innovation. It highlights the region's persistent inability to grow and the minor evolution in the structure of the economies over the last three decades, focusing particularly on the role of innovation.

The chapter will demonstrate that differences in productivity with respect to industrialized economies are mostly due to vast disparities in productivity within sectors of the economies rather than differences in the structure of the economies themselves. Furthermore, statistics confirm the existence of an innovation shortfall in each of the industries. The gap in national R&D investment with industrialized countries is not explained by the simple fact of having different economic structures but it is mostly due to the large differences in R&D investment in most economic sectors. In this regard, the central message of the indicators presented in this section reinforces the previous observation that R&D intensity in LAC lags far behind that of OECD economies.

E. PRODUCTIVITY AND ECONOMIC STRUCTURE

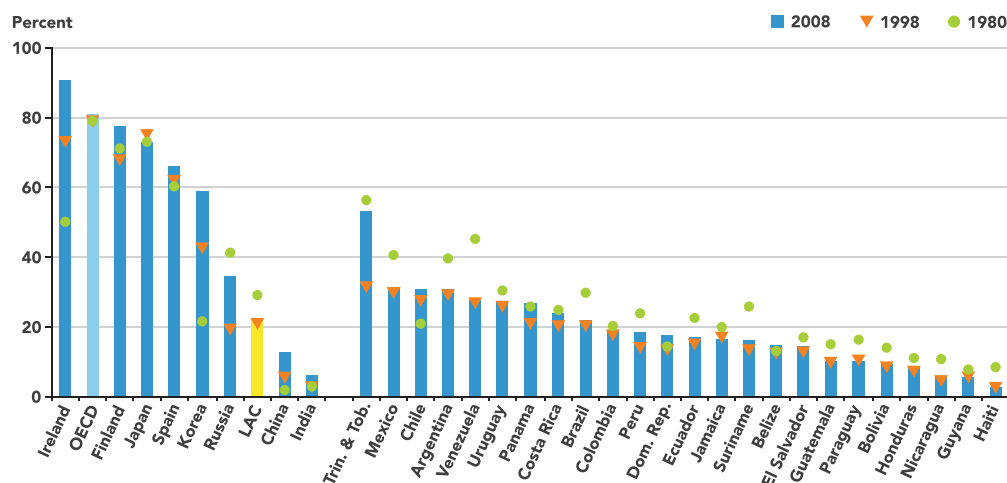
E.1. GDP per Capita and Growth Rates

- Per capita income reflects the level of economic development of a country. It is a measure of economic wealth per inhabitant and, in a broad sense, the quality of life of the population. In LAC countries, per capita income gaps (measured as GDP per capita relative to that of the United States) continue to open up.
- Between 1998 and 2008, with some exceptions, the income levels of most of the countries in the region have worsened compared to the United States. This is not a new trend; the region has been experiencing chronically slow economic growth since the 1970s (IDB, 2010).
- In 1980, the average per capita income in LAC was 29 percent of that of the United States, while in 1998 and 2008 it was 22 and 23 percent respectively. Conversely, countries such as Ireland, Korea, Ireland, Finland, and Spain continue to grow and are fast converging with the richest economies. In particular, Ireland increased its per capita income level relative to United States from 50 percent to 90 percent from 1980 to 2008 and from 73 to 90 percent in a single decade. Within the region, Mexico, Chile,

and Argentina have the highest per capita incomes relative to the United States, but they are still less than a third the U.S. per capita income. The per capita incomes of Paraguay, Bolivia, Honduras, Nicaragua, Guyana, and Haiti, the least developed economies in the region, are less than a tenth of that of the United States.

- The lack of economic growth is a persistent and common trend in LAC economies. On average, GDP per capita grew by 2 percent annually between 1998 and 2008. Countries such as Jamaica, Paraguay and Guyana report average annual growth rates lower than 1 percent, and Haiti shows in fact a contraction of its relative income level during this period.
- Likewise, in terms of labor productivity, growth rates have been very poor in most LAC countries. Between 1997 and 2007, the average annual rate of growth of labor productivity (measured as the average value added per worker) was less than 1 percent (0.72). In Colombia and Bolivia, labor productivity was largely stagnant (0.18 and 0.16 respectively), and in Venezuela and Paraguay, the average annual growth rate was negative (about -0.6 and -1.4 percent, respectively).

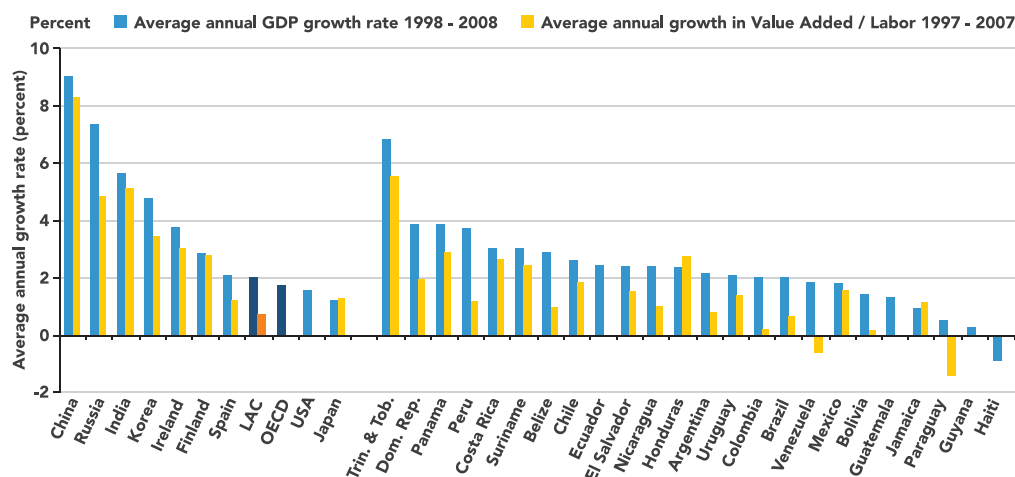
Figure 26 · GDP per Capita, Relative Gap with Respect to the United States, (Constant 2005 International Dollars), 2008, 1998 and 1980 (or Earliest Available)



Source: World Development Indicators.

Notes: For Russia, 1989 data are used for 1980. Data for LAC and high-income OECD countries (referred to as OECD in the figure) are provided in the WDI database.

Figure 27 · Average Annual Growth in GDP per Capita (Constant 2005 International Dollars), from 1998-2008 and Average Annual Growth in Value Added at Factor Cost (2000 Constant US Dollars) / Total Labor Force, from 1997-2007



Source: Authors' calculations based on World Development Indicators.

Notes: The following countries were missing data for particular years for the Gross Value / Labor calculations: the Dominican Republic from 1997, China from 1997, 1998 and 2007, and Ireland, Japan, Korea, and Suriname from 2007. Data for LAC and high income OECD countries (referred to as OECD in the figure) are provided in the WDI database.

- These indicators contrast sharply with those emerging economies in other regions, if we ignore the most recent years due to the global economic crisis. Between 1998 and 2008, GDP per capita in China, Russia, and India grew at annual average rates above 5 percent. China's growth rate was the highest, averaging 9 percent annually. Labor productivity in China, Russia, and India has been growing at growth rates higher than 5 percent annually.

- Labor productivity is a standard but partial measure of productivity. The indicator does not disaggregate productivity growth, distinguishing growth that can be attributed to accumulation of resources from growth due to better use of inputs due to new ideas, inventions, or organizational change from other aspects affecting efficiency (e.g., policy and market contexts). Therefore, increases in production due to higher average education or more physical capital would be captured as increases in productivity. Another indicator, TFP (total factor productivity) corrects these biases.

E.2. Total Factor Productivity and Catching Up

- Total factor productivity is a standard indicator used to measure the efficiency with which the economy transforms its accumulated factors of production into output. A 1 percent increase in TFP implies that 1 percent more of the product is being created with the same inputs. It indicates that capital and labor, including human capital, are 1 percent more efficient.

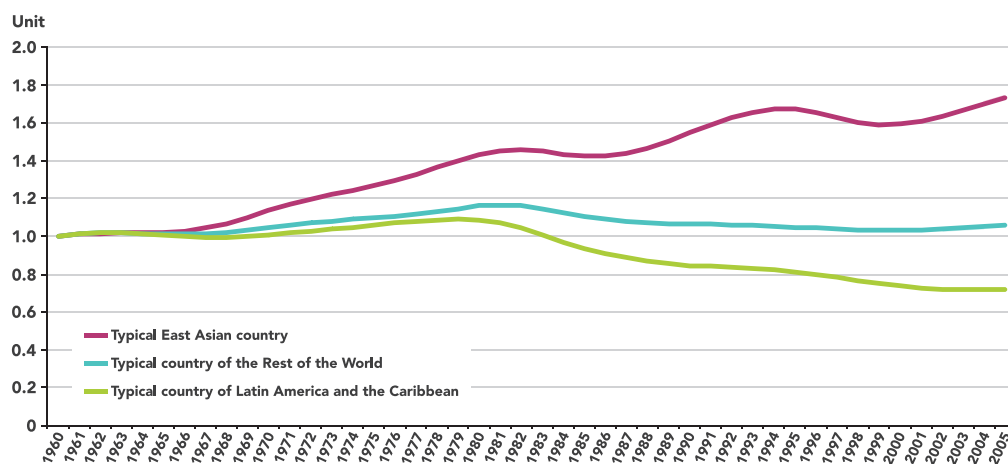
- Figure 28 shows the evolution of TFP in the typical countries of the benchmarking regions relative to the frontier (normalizing the indexes to 1 by 1960). While the rest of the world tends to follow the expected convergence pattern in productivity (TFP), LAC deviates substantially. Until the debt crisis of the 1980s,

the typical country in Latin America was slower in catching up and has actually distanced itself further since then (IDB, 2010). Conversely, the typical East Asian country has shown a reversed pattern; TFP has been constantly increasing, reaching 1.7 times in 2005.

- Recent studies show that income gaps in LAC are widening not due to a lack of physical investment or education or to the slow growth of the labor force, but rather to a chronic productivity growth deficit. In other words, the growth gap is essentially a problem of efficiency rather than a problem of lack of investment in productive resources (Daude and Fernandez Arias, 2010). Accordingly, if TFP increased to its potential and if factor inputs are kept constant, the per capita income of the typical Latin American country would actually double (to about a third of that of the United States). Further, the evidence shows that productivity increases leverage private returns to physical and human capital, which in turn reinforces incentives to invest in productive resources.

- As Figure 29 shows, the failure to catch up on productivity is evident across Latin American countries. Compared to 1987, all countries but Chile, Uruguay, and the Dominican Republic decreased their relative position in TFP with respect to the United States. Further, between 1997 and 2007, TFP ratios remained almost unchanged in most of the countries. In 2007, the aggregate productivity of the average LAC country is about half (51 percent) of aggregate productivity in the United States. Among the countries for which data are available, Chile, Argentina, Uruguay, Venezuela, and Brazil are at the top, with TFP ratios about 65 percent of that of the United States in 2007. At the opposite end, Nicaragua, Honduras, and Peru are among the countries farthest from the frontier, with TFP in those countries being less than 40 percent of TFP in the United States.

Figure 28 · Productivity Catch-Up (Total Factor Productivity Index Relative to the United States, 1960=1) – Contrasted with Selected Regions



Sources: IDB, 2010. Data are from Daude and Fernandez Arias (2010) based on Heston, Summers and Aten (2006), World Bank (2008), Barro and Lee (2000).

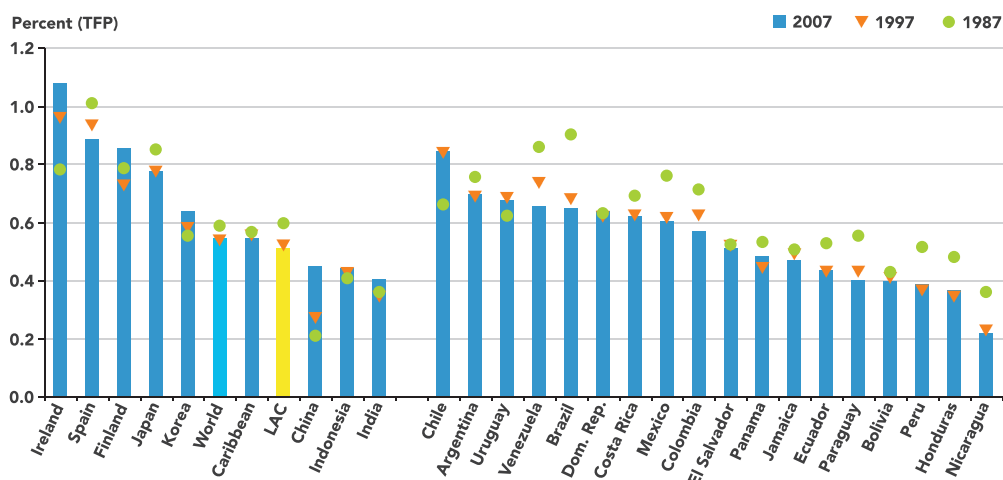
Notes: Productivity index relative to the United States. The reference year is 1960. The typical country refers to the simple average of the log of Total Factor Productivity for the countries within that region.



QR Code 3 · Productivity Catch-Up
TFP Index Relative to the United States from 1960-2005

To use this unique QR code, open your internet browser and enter the following web address: www.iadb.org/movingdata. Once the website has loaded, follow the prompts to see the dynamic graph associated with this QR code. Hold the Compendium steady, about 10 to 20 centimeters away from your computer and point the QR code directly at your computer's web camera. Shortly, your computer screen will be re-directed via hardlink to a URL where you can view and interact with a dynamic graph that depicts the Total Factor Productivity Index (relative to the United States) for individual LAC countries from 1960 to 2005. If you experience difficulties, see the technical notes for guidance in troubleshooting.

Figure 29 · Total Factor Productivity Relative to the United States, 1987, 1997, and 2007

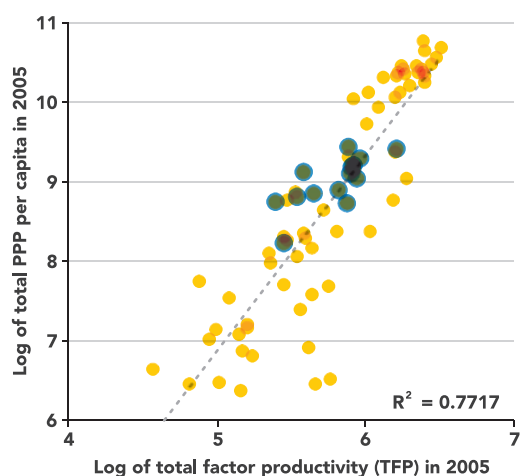


Sources: IDB, 2010. Calculations are based on data from Daude and Fernandez Arias (2010).

- Figure 30b shows the close positive association between R&D investment and TFP. Additionally, available evidence from OECD countries points to the fact that it is investment in R&D that causes productivity growth and not the other way around

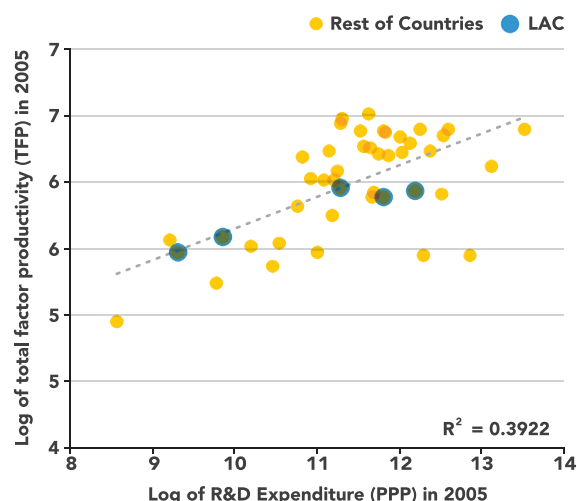
for which data are available, the share of the manufacturing sector in the total economy, which is assumed to lead the economy to higher value-added activities, remains almost unchanged between 1975 and 2005.

Figure 30a · Relationship between Income (PPP per Capita) and Total Factor Productivity (TFP), 2005



Sources: IDB, 2010. Calculations are based on data from Daude and Fernandez Arias (2010) and World Development Indicators.

Figure 30b · Relationship between Total Factor Productivity (TFP) and R&D Expenditure, 2005



Sources: IDB, 2010. Calculations are based on data from Daude and Fernandez Arias (2010), Lederman and Saenz (2005) and RICYT.

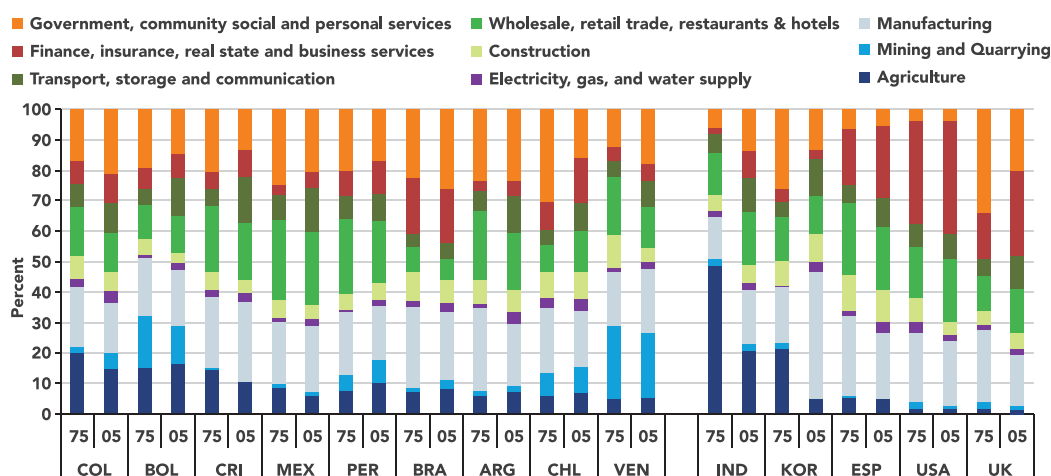
(Rouvinen, 2002). In other words, innovation investments are a critical input in long-term growth, rather than a simple result of that growth.

E.3. Structure of the Economy

- With very few exceptions, LAC's attempts to become industrialized have been only partially successful. For countries

- There have been, however, important changes in employment across sectors, notably a shift from agriculture and mining towards the service sector. Unlike developed countries, which first prospered with industrialization and then transformed themselves into service economies, the LAC economies became tertiary (or service based) halfway along the road from poverty to prosperity (IDB, 2010).

Figure 31 · Structure of the Economy (Distribution of Value Added): 1975 and 2005



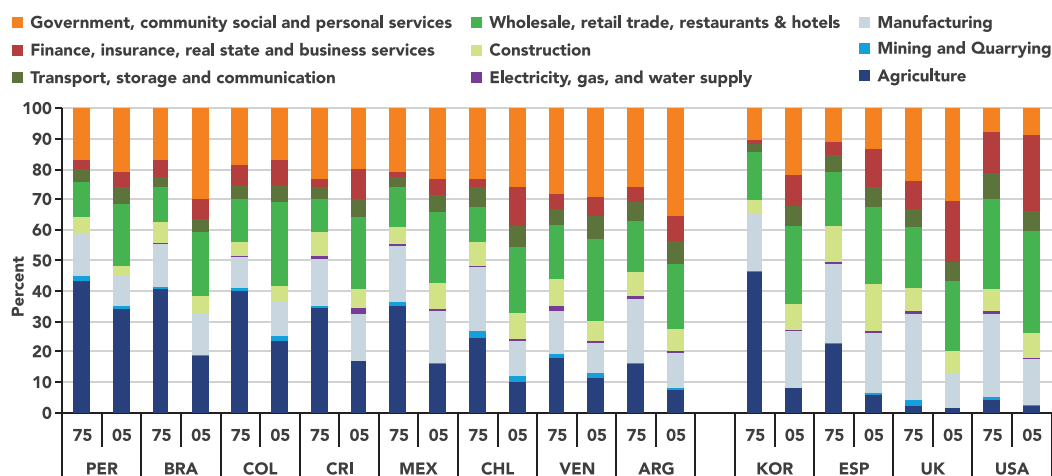
Source: GGDC, University of Groningen.

Note: COL = Colombia, BOL = Bolivia, CRI = Costa Rica, MEX = Mexico, PER = Peru, BRA = Brazil, ARG = Argentina, CHL = Chile, VEN = Venezuela, IND = India, KOR = South Korea, ESP = Spain, USA = the United States, UK = United Kingdom.

• The statistic shows the heterogeneity of economic structures across LAC countries. In 2005, countries like Bolivia and Venezuela still had a large share of natural resource-intensive sectors in total national value added (agriculture and mining and quarrying represent 29 and 26 percent, respectively, of national value added and 22 percent in Colombia) while in Mexico and Costa Rica, this sectors represents only 11 and 7 percent of the economy.

• The most noteworthy change concerns the service sector, including finance, insurance, real estate and business, wholesale, retail trade, restaurants and hotels which now has a stronger presence in the economy. As services have gained importance, the share of the manufacturing sector in total value added have decreased in some economies. This is the case in Argentina, Brazil, and Chile. In contrast, over the same period, in South Korea, the share of manufacturing in the total economy doubled. Another interesting case is India, where the weight of the service sector in total value added jumped from 35 to 59 percent, although manufacturing in India remains nearly the same as in 1975.

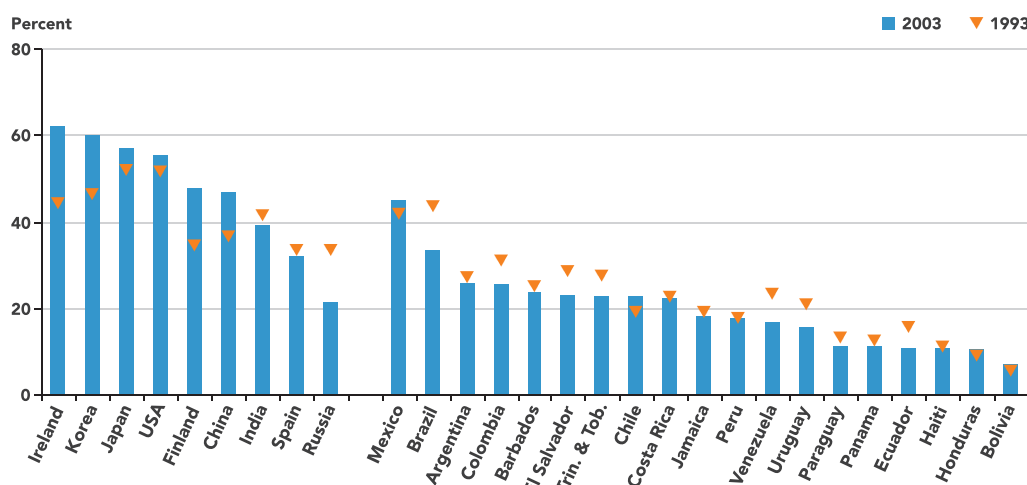
Figure 32 · Structure of Employment in the Economy: 1975 and 2005



Source: GGDC, University of Groningen.

Note: PER = Peru, BRA = Brazil, COL = Colombia, CRI = Costa Rica, MEX = Mexico, CHL = Chile, VEN = Venezuela, ARG = Argentina, KOR = Korea, ESP = Spain, UK = United Kingdom and USA = the United States.

Figure 33 · Share of Medium and High-tech Value Added in Total Manufacturing Value Added (Percentage), 1993 and 2003



Source: UNIDO.

Notes: 2003 data are estimates for the Bahamas, Colombia, Barbados, El Salvador, Chile, Jamaica, Peru, Venezuela, Panama, Haiti, and Honduras. 2002 data are used instead of 2003 data for Argentina, Trinidad and Tobago, Ireland, Korea, Japan, USA, and Finland. 2001 data are used instead of 1993 data for Paraguay and Bolivia.

- Employment statistics confirm the significant expansion of jobs in the service sector, coupled with a decline in employment in agriculture. In Argentina, for example, the participation of service sector jobs increased from 62 to 80 percent, in Brazil from 45 to 67 percent, in Chile from 52 to 76 percent, and in Mexico from 45 to 66 percent. Remarkably, the share of industrial employment is now lower in Latin America than in both East Asia and the developed world.

- Given the importance of services in national economies, substantial gains in aggregate productivity would be achieved if productivity in this sector improved. It is imperative to increase productivity in these industries also because of their synergistic effect on other sectors. According to some estimates (IDB, 2010), aggregate productivity could double if productive growth in the very laggard services sectors rose to match the productivity growth of the sectors in East Asia (ibid.).

E.4. Medium and High Tech in Value Added

- All advanced economies, to different degrees but without exception, are becoming technology-intensive. The evidence shows that economies that engage in more high technology-intensive activities experience productivity gains not only in these industries but throughout the economy. High-tech manufacturing is associated with benefits such as innovation, higher value-added production, and success in global markets. Since these industries require higher levels of skills (as they are R&D intensive), workers are better paid.

- As Figure 33 shows, countries for which data are available at the industry level, medium and high-tech manufacturing has grown in importance in almost all industrialized nations and in the newly industrialized economies of East Asia, notably South Korea and China. In this decade alone, South Korea

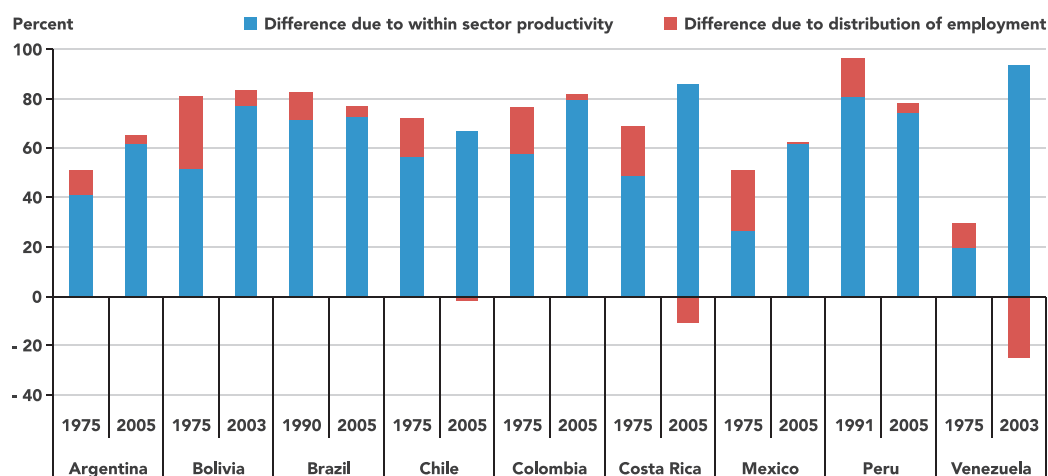
increased the share of medium and high-tech value added in total manufacturing value added from 46 to 60 percent, while in China it increased from 37 to 47 percent. These figures are even higher now and continue to rise.

- Some LAC countries, particularly Brazil, Costa Rica, and Mexico, have made important advances in production and trade in high-technology manufacturing but have been substantially outpaced by East Asia. Mexico, Brazil, Argentina, and Colombia have the highest portion of high-tech and medium-high-tech value added in total manufacturing (value added) in Latin America, with shares above 25 percent. Mexico is at the top, with 45 percent. In many countries of the region, however, the shares of medium and high-tech value added in total manufacturing decreased over the period under consideration. Contractions occurred in Brazil, Venezuela, Uruguay, Ecuador, Colombia, El Salvador, and Trinidad and Tobago. Paraguay, Panama, Ecuador, Haiti, Honduras, and Bolivia report the lowest shares (about 10 percent).

E.5. Decomposing the Rate of Growth

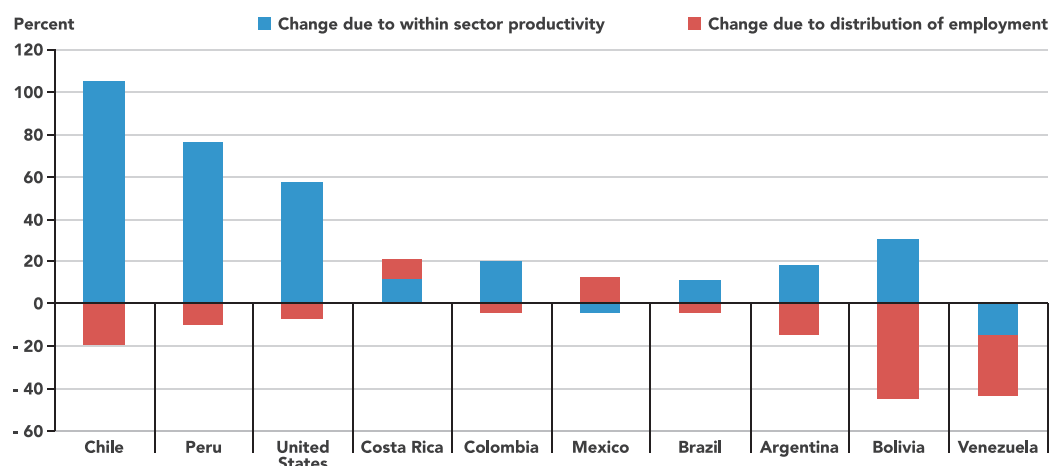
- The analysis of aggregate productivity decomposition (see the technical notes for more details regarding the decomposition calculation) shows that most of the gap is due to the “within-sector” productivity gap and its importance in explaining the gap has actually increased between 1975 and 2005 (or the latest year for which data are available). In other words, it is not that productivity is lower in LAC because the economy is concentrated in economic sectors in which productivity grows more slowly; rather, for any given sector, its productivity is lower than the same sector in an OECD economy. This analysis is possible only for a few countries for which data are available at the industry level (CEPAL).

Figure 34 · Decomposition of the Productivity Difference in LAC Countries with Respect to the United States, 1975 (or Earliest Available) and 2005 (or Latest Available)
Differences are Expressed as a Percentage of the United States Productivity Level



Source: Authors' calculations based on GGDC, University of Groningen.

Figure 35 · Decomposition of Productivity Growth, from 1975 (or Earliest Available) to 2005 (or Latest Available)



Source: Authors' calculations based on GGDC, University of Groningen.

Notes: Earliest available data for Brazil are 1990 and for Peru are 1991. Latest available data for Bolivia and Venezuela are 2003.

Accordingly, between 62 (Argentina, 2005) and 93 percent (Venezuela, 2003) of the gap in labor productivity with respect to the United States would be eliminated if productivity within each sector of the economy of these LAC countries were raised to the level in the same sector in the United States. Today, most sectors of LAC economies continue to lag substantially behind those of U.S. industrial sectors.

- A very small part of the productivity gap is explained by structural change, that is, by re-distribution of employment across sectors (Figure 34). In 2005, if each sector's share of employment in LAC economies had been equal to that same sector's share of employment in the United States, holding each sector's labor productivity fixed, few gains in productivity would have been achieved: the gains oscillate between 1 percent (Mexico) and 7 percent (Bolivia). An employment structure similar to that of the United States would actually lead Costa Rica to an widening of the gap (a decrease of 10 percent in the productivity gap with respect to the United States) and a substantial deterioration of productivity in Venezuela (-25 percent).

- In terms of productivity growth between 1975 and 2005 (or latest year for which data are available), the decomposition of growth rates over time shows that although countries diverge substantially from the United States, some improvements have occurred within countries since 1975. The average annual growth rates are very small; yet we are able to decompose how much is due to a new industry mix (reallocation of employment across sectors) and how much is due to within-sector changes in productivity.

- Countries have grown, although modestly, mostly because of productivity changes within sectors. Peru and Chile are interesting cases: their growth in total labor productivity between 1975 and 2005 is mostly explained by within-sector productivity changes. In fact, with the exception of Costa Rica and Mexico, which report a substantial part of the change as due to distribution of employment (a new industry mix between 1975 and 2005), in

the rest of reporting countries productivity growth was pulled backwards by changes in the distribution of employment. This result implies that employment has been reallocated in sectors which have lower productivity compared to the initial structure of the economy in 1975. The negative growth rates of labor productivity experienced in Bolivia and Venezuela are largely explained by changes in the distribution of employment.

E.6. The Structural Effect in R&D Investment: the Innovation Shortfall

- The differences in R&D intensity between two countries can be decomposed into differences due to the structure of the economies and differences due to divergences in the level of investment within sectors. For LAC economies, the gap in R&D investment by business (as a share of GDP) with the United States is essentially due to profound disparities in the levels of R&D investment (relative to value added) in each of the economic sectors rather than to the economic structure of the countries themselves. A notable exception is Chile, where the two effects are similar. In other words, there is an innovation investment shortfall in the region. Industries in LAC invest substantially less than their peer sectors in industrialized countries.

- The general dearth of data limited the number of Latin American countries for which this analysis could be performed. The table is constructed combining methodologies used by Griffith et al. (2003) and by Maloney and Rodriguez-Clare (2007). In this table, column A represents the difference between the U.S. and the Latin American business sectors in R&D Intensity relative to value added, and column C represents the sum of the difference of each sector's value added (within the business sector) between the United States and the Latin American country, multiplied by the R&D intensity in the United States for each particular sector, minus the entire United States R&D intensity in the business sector. Subtracting C from A allows us to infer B, which is the part of the gap between the United States and the LAC country in R&D relative to value-added that is due to lack of sufficient R&D

Table 1 · Decomposition of R&D Intensity / Value-added in the Business Sectors for Selected LAC Countries, 2002

Country	A	B	C
Argentina	2.23	2.03	0.20
Brazil	1.15	0.45	0.70
Chile	1.98	0.91	1.07
Colombia	2.28	1.72	0.56
Mexico	2.04	1.23	0.81

A: U.S. Business R&D Expenditure / Value-added
- LAC Business R&D Expenditure / Value-added

B: Implicit Part of the Gap between U.S. and
LAC that is due to R&D Intensity

C: Part of the Gap between U.S. and LAC that is
Due to Sectoral Shares of Value-added

Sources: Authors' calculations based on IMF, OECD, PADWIN dataset (CEPAL) and GGDC, University of Groningen.

intensity (or investment) across sectors on the part of that Latin American business sector. Please refer to the technical notes for more details regarding these calculations¹.

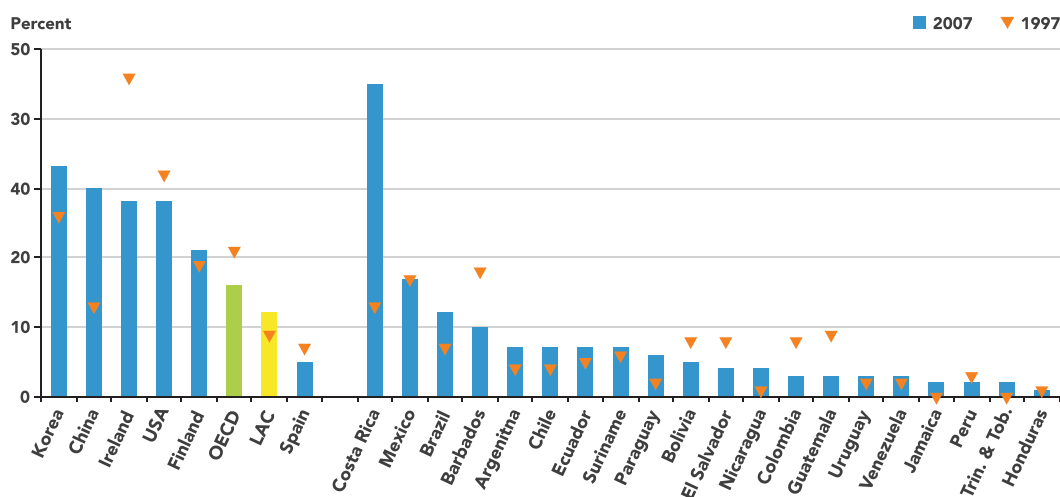
E.7. High Technology Exports, Technology Balance of Payments, R&D Investment by Foreign Multinationals

- One indicator of technological performance (or outcome measure) is the percent of exports in high-technology sectors (R&D intensive industries) in total manufactured exports. The global market for high-technology goods—aircraft,

pharmaceuticals, communications equipment, and computer and office machinery—has been growing rapidly. High-tech goods are a key sector driving worldwide economic growth.

- On average, 16 percent of OECD exports in manufacturing are high tech, and this share is expanding over time. Korea, Ireland, and China show rates above 20 percent. There are notable differences between OECD (and China) and Latin America and the Caribbean. On average, only 12 percent of the LAC region's exports in manufacturing are high tech.

Figure 36 · High Technology Exports (as a Percent of Manufactured Exports) 1997 and 2007 (or Latest Available)



Source: World Development Indicators.

Notes: Latest available data for Suriname are 2001, and for Chile, Costa Rica, Guyana and Venezuela are 2006. Data for LAC and high income OECD countries (referred to as OECD in the figure) are provided in the WDI database.

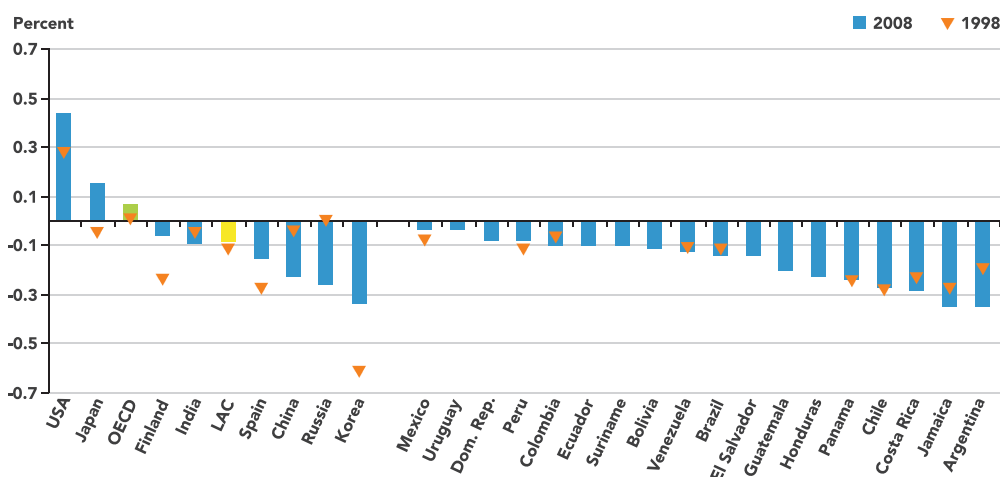
¹ As a caveat to the reader, care should be exercised when interpreting the results of Table 1. First, data on R&D intensity disaggregated by sector are very limited even for the United States. For example, data were not available for R&D intensity for the Agriculture, Forestry, and Fishing; Mining and Quarrying; and Government, community, Social and Personal Services sectors. Therefore, this analysis has been restricted to the business sector. Second, in order to generate this table, value-added data from the University of Groningen were for Public Utilities; Construction; Wholesale and Retail Trade, Hotels and Restaurants; Transport, Storage, and Communication and Finance, Insurance, and Real Estate; but more disaggregated data were used from the PADWIN dataset from CEPAL for Manufacturing. In each case the R&D Intensity as reported by the OECD for the United States were matched with the value added for the each sector and within the manufacturing sector. Exact matches were possible with the coding of OECD and University of Groningen data, but some assumptions were made for the matching of OECD and PADWIN.

- With respect to the evolution of this indicator, two groups of countries are performing in opposite directions in the region. One group, consisting of Barbados, Bolivia, El Salvador, Colombia, Guatemala, and Peru, experienced significant decreases in this ratio between 1997 and 2007. The other, which includes Costa Rica and Nicaragua, experienced threefold and fourfold increases in this ratio, while Brazil, Chile, and Argentina have all nearly doubled (1.7 times) the percentage of high technology exports in manufacturing. As a whole, the region has expanded its market share in medium and high-tech exports, but this topic deserves closer analysis. Mexico alone accounts for almost three-quarters of the region's increase in market share in the last decade (ECLAC, 2008).

R&D Investment by Foreign Multinationals

- During the last decade, LAC has not been favored in decision making on technology investment by multinational corporations albeit the growing tendency to disperse and delocalize R&D activities geographically, notably in emerging economies. The emergence of new technology hot spots and new pools of talent in East Asia and China has driven many multinationals to locate R&D labs and engage in technology alliances with local firms and institutions.
- Between 1997 and 2006, the share of R&D investment made overseas by multinational firms from the United States in Asia and Pacific countries increased from 12 to 20 percent, whereas R&D investment in LAC decreased 4 to 3 percent.

Figure 37 · Technology Balance as a Percent of GDP, 1998 and 2008 (or Latest Available)



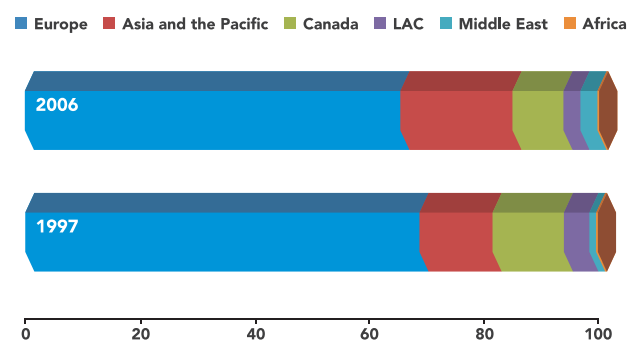
Source: World Development Indicators.

Notes: Latest available data for Costa Rica are 2005, and for India and Mexico are 2006. Data for LAC and high income OECD countries (referred to as OECD in the figure) are provided in the WDI database.

Technology Balance of Payments

- Modern economies increasingly depend on the capacity to generate, adapt, and utilize knowledge as the foundation of productivity growth. The lack of national R&D investment limits the absorption of foreign knowledge and the exploitation of technology.
- According to trade balance statistics, LAC countries have increased their dependence on technology services from abroad. Payments for cross-border licensing, purchase of intellectual property, R&D services and engineering contracting, and other technology services surpass receipts to a large extent.
- This trend concerns most of the countries, including the largest ones such as Argentina, Brazil, and Chile. Conversely, countries such as Finland or Spain exhibit a contraction in the technology balance of payments deficit.

Figure 38 · R&D Performed Abroad by Majority-Owned Foreign Affiliates of U.S. Parent Companies, 1997 and 2006



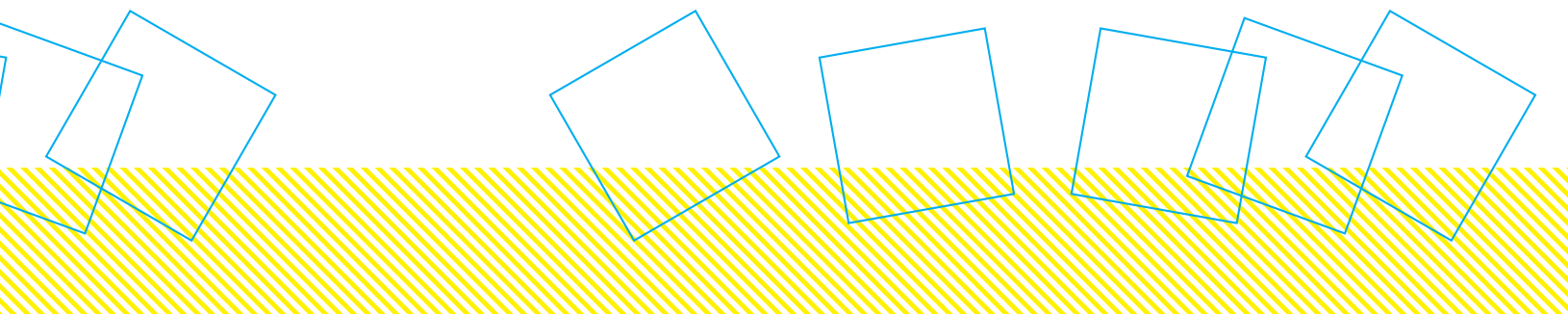
Source: Science and Engineering Indicators 2010, National Science Foundation.

Notes: Expenditures included for R&D conducted by foreign affiliates, whether for themselves or others under contract. Expenditures excluded for R&D conducted by others for affiliates under contract.



III · Innovation in Firms





Introduction



Innovation and productivity are closely linked at the firm level. This means that firms' use of knowledge is one of the final arbiters of whether an innovation system is performing adequately. Recent Latin American experience points to the fact that a given country can make visible progress in its capacity to produce scientific outputs—as measured, for instance, by the number or scientific articles produced by its researchers and other indicators described in the first section of this compendium—and still experience little or no transfer of knowledge from academia to industry and services.

For technology transfer to succeed and firms absorb external knowledge, investment in R&D is a key determinant. Investment in R&D has a twofold advantage for firms. In addition to generating new ideas, investment in R&D also has a direct effect on the creation of absorptive capacities. R&D competences are fundamental for the development of new competencies and skills needed to search out, acquire and adapt existing technology. In other words, investment in innovation is a key driver of productivity catching-up.

Therefore it is crucial to assess what firms are doing in terms of innovation and R&D. Are they concerned about innovation as a part of their competitive strategy? Have they devoted resources to

R&D? Do they have the capacity to transfer and adapt technology that could make them more productive? What kind of innovation is occurring and what kind of technology is being incorporated?

This section represents a pioneering effort to answer some of these questions for Latin American countries. It has little precedent, because it compares countries' progress using indicators gathered from the available innovation and industrial surveys. Such surveys in LAC countries have been few and far between. Only a handful of countries have undertaken them consistently in recent times, which explains why only a few economies are represented in the graphs.

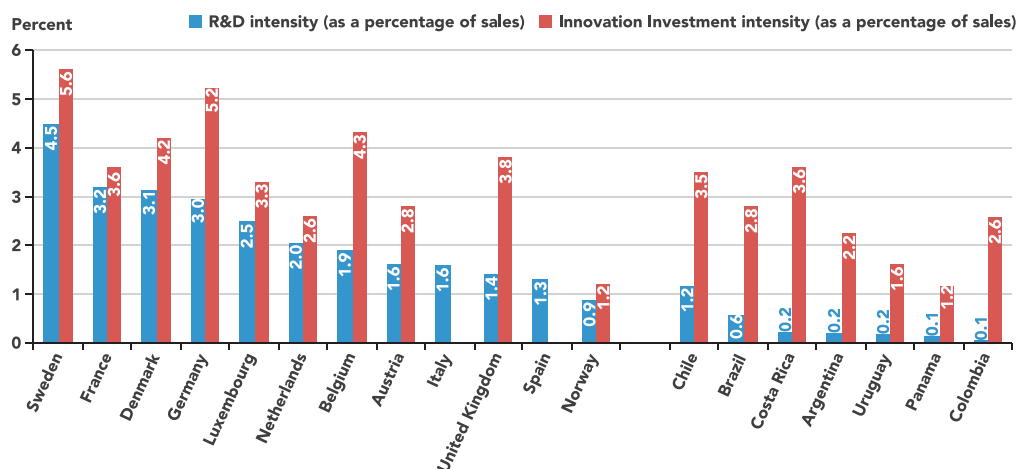
From the available information, it is clear that Latin American firms are innovating on many levels. Yet innovation activity is highly concentrated in incremental changes that bring something new to a particular firm, but are not new to the international market or even to the domestic market in which the company operates. Investment in innovation is mostly non R&D related. Innovation expenditure in LAC is concentrated in the purchase of machinery that incorporates advanced technology. But the overall picture points to little in-house R&D capacity that would allow LAC firms to turn embedded technology into self-sustaining innovation capacity.

F. INNOVATION IN FIRMS

F.1. Investment in Innovation by Firms

- For companies, innovation means the transformation of ideas and knowledge into new economic advantages such as higher productivity growth, opening of new markets, and higher market shares. Hence, firms play a major role in national innovation systems: they are the agents in charge of transforming knowledge into new economic solutions for their own benefit and that of the economy as a whole.
- In LAC, innovation by firms reflects in essence the weaknesses that exist at the national level in terms of science and technology. Firms in LAC conduct different kinds of innovation activities than firms in industrialized nations. Most of them are far from the technological frontier, and innovation strategies are essentially oriented to the acquisition of embodied (foreign) technology. Firms are mainly concerned with how to integrate foreign technology into production systems.
- One characteristic is the low level of expenditure and intensity of effort in R&D (Figure 39). On average, firms' R&D intensity as a percentage of sales is lower than 0.2 percent, considerably less than the 1.61 European or the 1.89 OECD averages. As shown in Figure 45, the differences between LAC and OECD countries in terms of the intensity of innovation investment by firms are less pronounced when taking the broad definition of innovation activities into account.
- A second feature is the high concentration of the innovation effort on the purchase of capital goods and equipment related to innovation activities (Figure 40). Expenditure on these items represents between 50 and 81 percent of total expenditure on innovation, while the corresponding share in OECD countries varies in a range between 10 and 40 percent. In OECD countries, R&D expenditure is frequently the main item of innovation investment.

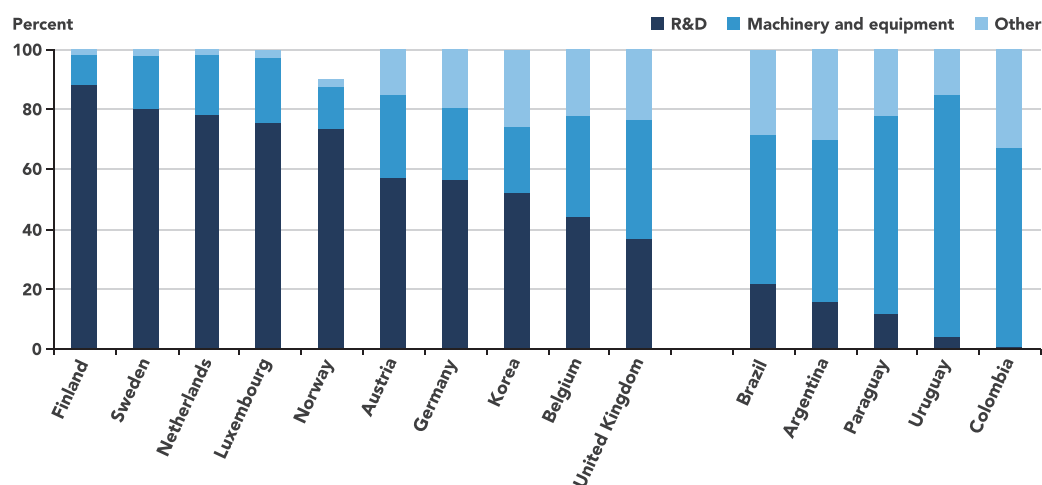
Figure 39 · Investment in Innovation by Firms



Sources: Innovation Surveys (Argentina: 1998-2001; Brazil: 2005; Chile: 2004-2005; Colombia: 2003-2004; Costa Rica: 2008; Panama: 2008; Uruguay: 2005-2006). Data for OECD countries are from OECD (2009) except for Spain and Italy (Eurostat).

Notes: Indicators refer to the Manufacturing Industry. Weighted shares are reported only in the case of OECD countries and Brazil. The indicators reported are averages in the total sample of companies (except for Chile, Spain, and Italy, whose averages correspond to shares of the total number of innovating companies).

Figure 40 · Distribution of Innovation Expenditure



Sources: Innovation Surveys (Argentina: 1998-2001; Brazil: 2005; Colombia: 2003-2004; 2008; Uruguay: 2005-2006; Paraguay: 2004-2006). Data for OECD countries are from OECD (2009).

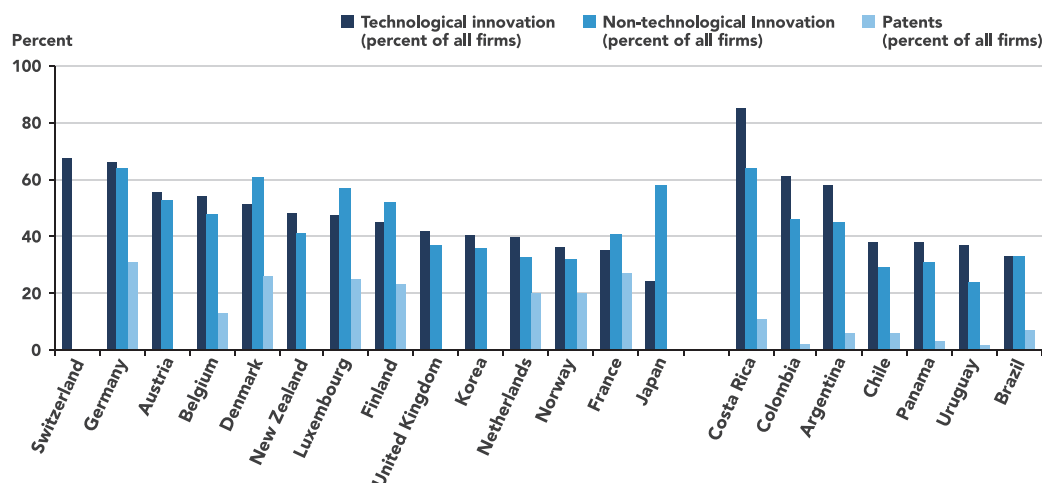
Notes: Indicators refer to the Manufacturing Industry. Indicators are weighted except for Uruguay, Argentina, and Colombia.

F.2. Types of Innovation

- According to the Oslo Manual (OECD-Eurostat, 2005), innovation is understood as the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations. Firms develop technological (product and/or process) and non-technological innovation (e.g. new managerial and marketing practices).

- The concept of innovation as perceived by firms in LAC is broader than in the case of countries with the most experience in conducting innovation surveys. (See the definitions from the Bogota and OECD Manual in the technical notes.) The definition of innovation is still misunderstood. Firms consider minor changes in products and services or the adoption of technology developed by other firms to be innovation. Thus, statistics can be misleading. Accordingly, technological innovation by firms in the manufacturing sector is more frequent than non-technological innovation in LAC countries, and the former appears larger than in many OECD countries. The percent of firms introducing technological innovation is particularly high in Costa Rica, which recently began implementing the innovation survey.

Figure 41 · Technological and Non-technological Innovation

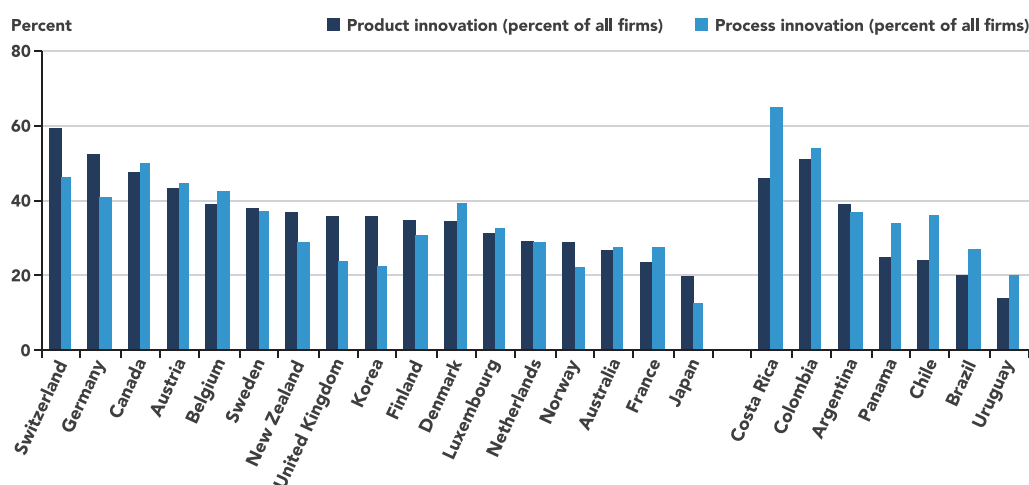


Sources: Innovation Surveys (Argentina: 1998-2001; Brazil: 2005; Chile: 2004-2005; Colombia: 2003-2004; Costa Rica: 2008; Panama: 2008; Uruguay: 2005-2006). Data for OECD countries are from OECD (2009).

Notes: Indicators refer to the Manufacturing Industry. Indicators are weighted for OECD countries and Brazil; data for Argentina, Colombia, Chile, Panama and Uruguay are provided by researchers and are un-weighted.

- A more realistic picture is portrayed by the percentage of firms that have applied for patents. This share is much lower in firms from LAC than in OECD countries. Six percent of firms in Chile and Argentina filed for a patent application, whereas in Germany and France these figures were 31 and 27 percent respectively.
- In LAC countries, with the exception of Costa Rica, process innovation is more frequent than product innovation. This seems to be related to the pattern of acquiring knowledge embedded into capital goods, since embedded technology should have a direct impact on improving production processes. Conversely, in many OECD countries, such as Japan, Germany, the United
- In European firms, customers and suppliers are consistently the most important sources of knowledge. Competitors are third in importance, and universities, other educational institutions, and public agencies are frequently at the bottom in the order of importance.
- One plausible reason for this weaker use of scientific knowledge as a source of ideas for innovation compared to market sources is the limited knowledge exchange between scientific institutions and firms. This is due in part to the limited absorptive capacity of firms to take advantage of scientific discoveries (e.g., limited skills to absorb knowledge and the irrelevance of public research for business needs, among other barriers).

Figure 42 · Product and Process Innovation



Sources: Innovation Surveys (Argentina: 2006; Brazil: 2005; Chile: 2004-2005; Colombia: 2003-2004; Costa Rica: 2008; Panama: 2008; Uruguay: 2005-2006). Data for OECD countries are from OECD (2009).

Notes: Indicators refer to the Manufacturing Industry. Indicators are weighted for OECD countries and Brazil, Uruguay and Argentina; data for Costa Rica, Colombia, Chile and Panama are provided by researchers and are un-weighted.

Kingdom, Switzerland, Norway, and Finland, product innovation is more frequent than process innovation, which illustrates the superior technological sophistication of firms in those countries.

- The technological backwardness of LAC firms is evident in the nature of innovation (IDB, 2010; Navarro et al., 2010). Technological innovation is highly concentrated in innovations of the adaptive and incremental type. As a result, the novelty of product innovations is low and product innovation is mostly “new to the firm” rather than “new to the market.” Hence, firms are technology followers whose main innovation strategy consists of adopting technology that has already been developed somewhere else.

F.3. Sources of Information for Innovation

- In general, Latin American firms rely more on sources of information from the market—suppliers, clients, and competitors—than from scientific institutions to innovate. Latin American firms are not so different from European ones in the use or importance given to the source of information.

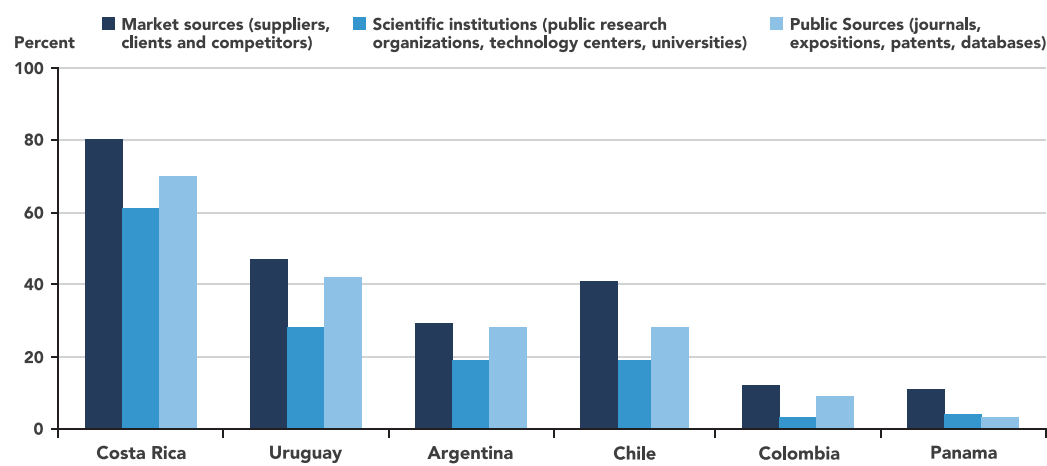
F.4. Firm Co-operation in Innovation

- Worldwide, innovation has become more open and collaborative. To be competitive and at the forefront of technology, firms increasingly need to collaborate with other firms and with various public or private institutions. The importance of collaborative innovation has grown substantially as technologies have become more complex and new products and services demand an increasing range of technological competencies. Firms also collaborate due to the increasing costs of innovation.

- Collaboration can have important benefits for firms. Cooperation with clients and suppliers is frequently associated with increased innovation performance and productivity gains. In particular, cooperation with customers appears to boost market acceptance and diffusion of product innovation.

- The concept of cooperation in innovation activities differs widely across innovation surveys from LAC countries. For instance, some surveys ask solely about collaboration on R&D, whereas others ask about different types of collaboration. In some countries (e.g., Mexico and Chile), the questions on collaboration refer only to firms that claim to have innovated.

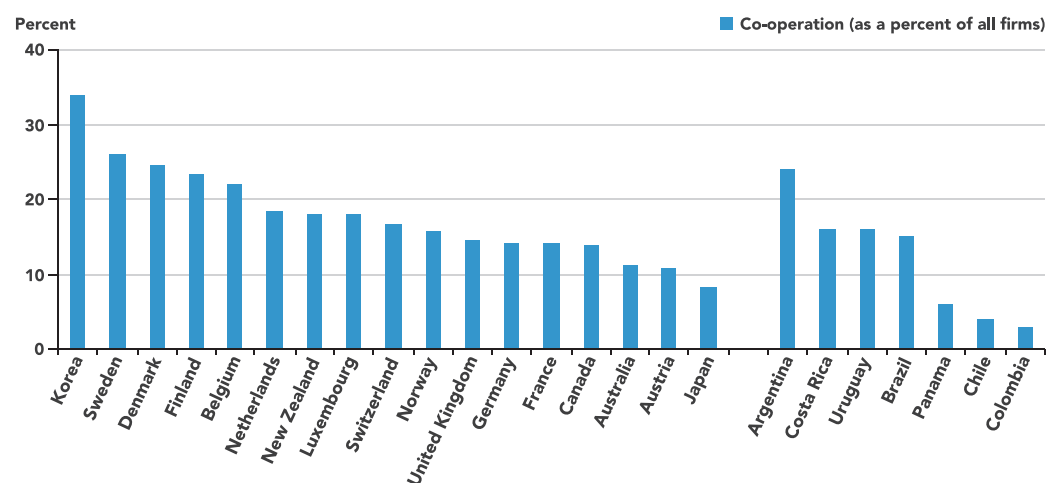
Figure 43: Sources of Information for Innovation (Percent of Firms Declaring such Sources as Very Important)



Sources: Innovation Surveys (Argentina: 1998-2001; Brazil: 2005; Chile: 2004- 2005; Colombia: 2003-2004; Costa Rica: 2008; Panama: 2008; Uruguay: 2005-2006). Data for OECD countries are from OECD (2009).

Notes: Indicators refer to the Manufacturing Industry. Indicators are weighted for OECD countries and Brazil; data for Argentina, Colombia, Chile, Panama and Uruguay are provided by researchers and are un-weighted.

Figure 44 · Firm Co-operation in Innovation (as a Percent of All Firms)



Sources: Innovation Surveys (Argentina: 1998-2001; Brazil: 2005; Chile: 2004- 2005; Colombia: 2003-2004; Costa Rica: 2008; Panama: 2008; Uruguay: 2005-2006). Data for OECD countries are from OECD (2009).

Notes: Indicators refer to the manufacturing industry. Indicators are weighted for OECD countries; data for LAC countries (except Brazil) are provided by researchers and are un-weighted. For Costa Rica, collaboration refers to firms that collaborate on R&D with universities.

F.5. Obstacles to Firm Innovation

- According to innovation surveys, the main obstacles to innovation reported by firms in Latin America are: (i) constraints in securing financing for innovation (high costs of innovation and risks), (ii) the inability by firms to wait for long periods of time (perceived or real) before investments can be recovered or a positive return realized (rates of return), (iii) the small size of the market, and (iv) the shortage of qualified personnel.

- Innovation surveys point to lack of financing as a major barrier to innovation investment in LAC firms (Navarro et al., 2010; Anllo and Suarez, 2009). This situation might reflect, in part, problems in the functioning of financial markets. Yet some of the failures in financial markets are intrinsically due to the intangible nature of knowledge and the fact that it can be appropriated by others, as well as the inherent riskiness of innovation investments.

- The reported lack of skilled personnel reflects deficits in the supply of technological services and capacity, as well as poor coordination between different components of national innovation systems, such as universities and commercial firms. This is true even for the larger economies in the region.

- Problems linked to market structure and market size suggest a lack of integration of the regional market, which confines many businesses to their domestic—often small—markets. If true, this would imply diseconomies of scale for innovation projects, many of which require relatively large investments upfront and longer time horizons to realize a profit.

F.6. Public Financial Support for Innovation Activities in Firms

- Given the riskiness of innovation investments, access to credit is difficult for innovating firms. Returns on investment in innovation (notably R&D) are uncertain, as it is difficult to

know ex-ante the success or outcomes of R&D or the economic impact that will be achieved. In addition, innovation, in a climate of absent or inadequate intellectual property rights, can be appropriated by others. Therefore, it is difficult to negotiate a loan over insecure assets and to enter into contracts using knowledge assets as collateral or guarantees.

- To tackle the problem of “market failure” in financing, several countries in the region have been implementing support programs through subsidies or tax incentives. By pooling risk, governments contribute to reducing the uncertainty of innovation and therefore encourage companies to invest in R&D. However, these programs have so far failed to reach a critical mass of potentially innovative firms.

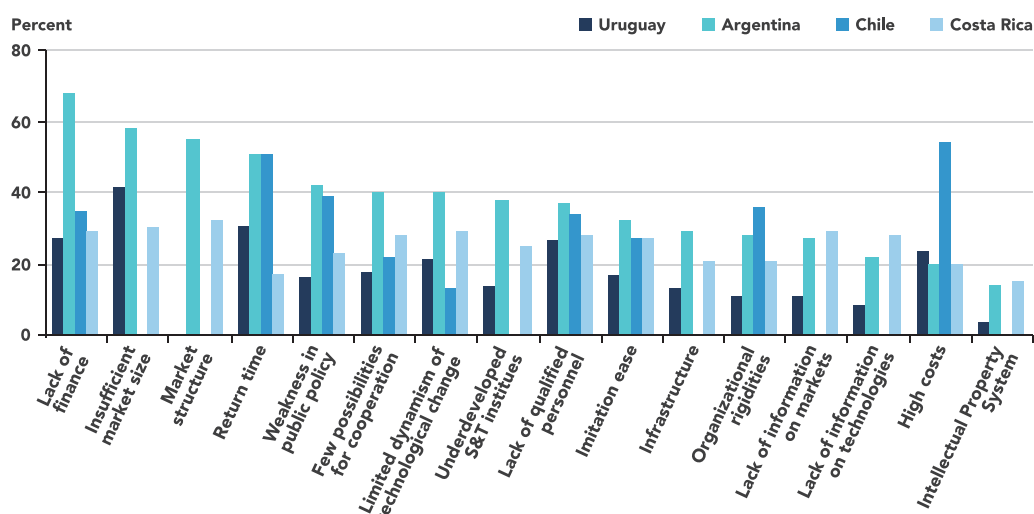
- Support to private firms through these types of policy instruments is frequently confined to a small share of business in LAC countries, far from the level common in European economies. According to innovation surveys, 1 percent of firms



QR Code 4 · Obstacles to Firm Innovation

To use this unique QR code, open your internet browser and enter the following web address: www.iadb.org/movingdata. Once the website has loaded, follow the prompts to see the dynamic graph associated with this QR code. Hold the Compendium steady, about 10 to 20 centimeters away from your computer and point the QR code directly at your computer's web camera. Shortly, your computer screen will be re-directed via hardlink to a URL where you can view and interact with a dynamic graph that reveals the obstacles to firm innovation in selected LAC countries. If you experience difficulties, see the technical notes for guidance in troubleshooting.

Figure 45 · Obstacles to Firm Innovation
(Percent of All Firms that Consider these Obstacles to be of High or Medium Importance)



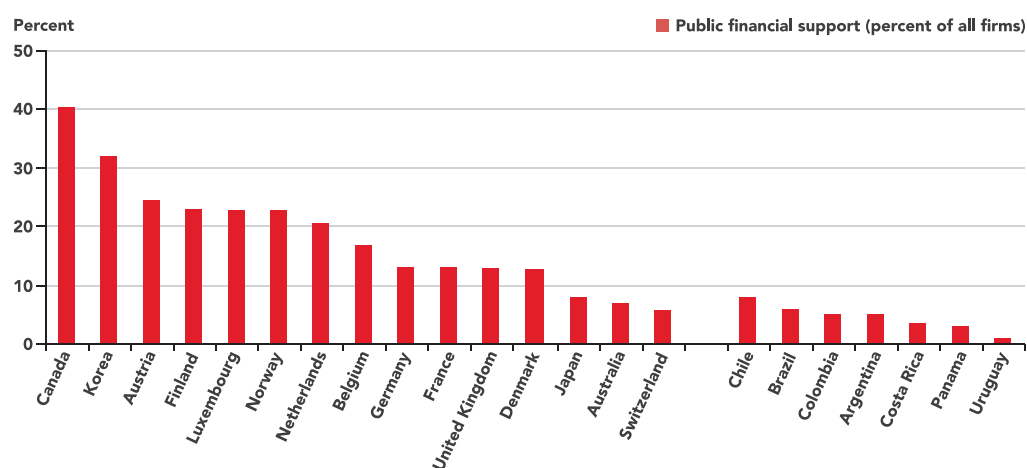
Sources: Innovation Surveys (Argentina: 1998-2001; Chile: 2004-2005; Costa Rica: 2008; Uruguay: 2005-2006).

Notes: Indicators refer to the manufacturing industry. Data for Argentina, Chile, and Uruguay are weighted and data for Costa Rica are un-weighted.

in Uruguay received public funding, 5 percent in Colombia, 5 percent in Argentina, 6 percent in Brazil, and 8 percent in Chile, the highest in the region. These shares contrast substantially with the equivalent figures reported for Germany and France (13 percent of firms received public financing) and more drastically with countries such as Belgium (17 percent) or Austria (25 percent).

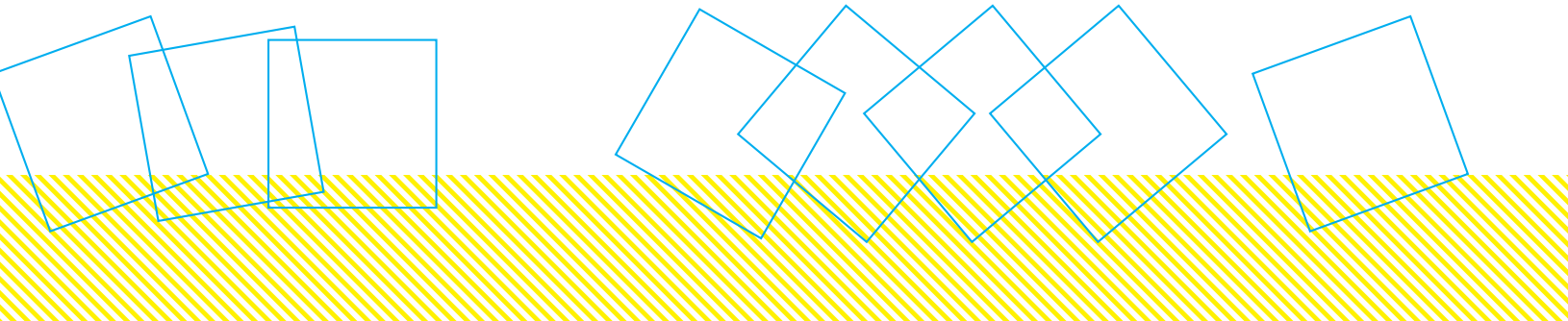
- According to a recent econometric analysis (IDB, 2010), public financial support for innovation leverages firms' innovation efforts. Firms in Chile, Colombia, and Costa Rica that received public financial support invest significantly more in innovation than firms that do not have access to this type of assistance.

Figure 46 · Percent of Firms that Received Public Support to Finance Innovation Activities



Sources: Innovation Surveys (Argentina: 1998-2001; Brazil: 2005; Chile: 2004-2005; Colombia: 2003-2004; Costa Rica: 2008; Panama: 2008; Uruguay: 2005-2006). Data for OECD countries are from OECD (2009).

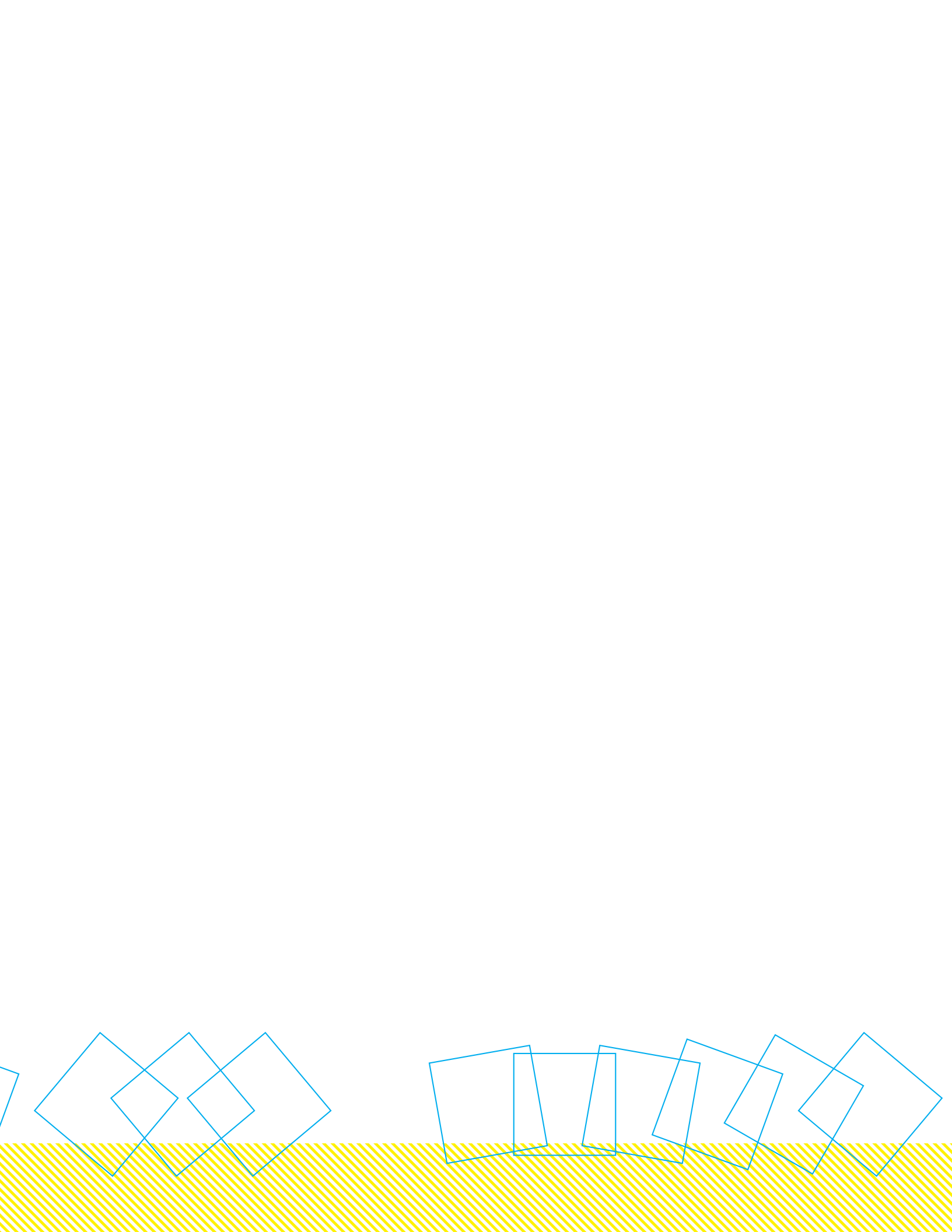
Notes: Indicators refer to the Manufacturing Industry. Indicators are weighted for OECD countries; data for LAC countries (excepting Brazil) are provided by researchers and are un-weighted.





IV · Policy, Governance and Institutional Structure to Support Innovation





Introduction



Institutional development is a key component of a national innovation system. Productive and well-coordinated relationships between business, academia, and government cannot be taken for granted. They can result in high transaction costs and suboptimal results unless the right kind of public policies, regulations, trust, and mechanisms for coordination emerge.

This dimension, although very important, is difficult to capture in a series of clear, easy to interpret, and comparable indicators. History, tradition, and local economic, political, and social conditions produce many institutional variations on how to arrange the components of an innovation system. Some of these variations are less productive than others, yet it remains impossible to argue in favor of an ideal institutional setting.

On the contrary, diverse institutional arrangements and policy combinations are bound to be best suited to different national contexts.

What follows is an attempt to compare and contrast key institutional dimensions affecting innovation: innovation policy instruments, intellectual property regimes, institutional development of metrology and standards infrastructure, conditions for the creation of new business ventures, and overall regulatory quality. The limited number of indicators covering these aspects of the institutional environment surrounding innovation does not exhaust the list of important components of such environments, but they represent a first step in building a set of comparable indicators in this area.

G. INNOVATION POLICY IN LATIN AMERICA

G.1: Innovation Policy Instruments

- There are three main areas of action in innovation policy: (i) supply-oriented policies, (ii) demand-oriented policies, and (iii) strategy-oriented and coordination policies. In essence, each of these three approaches represents a policy pillar and each one tackles key components in the building of national innovation systems. The first one addresses the development of public goods for innovation, notably human capital, scientific capabilities and infrastructure; the second targets the business sector, and the last group centers on the development of strategic policy programs and the coordination of national innovation systems.
- This last approach in particular highlights the need to design new, coordinated, and more comprehensive programs addressing specific problems and weaknesses in sectors, technologies, groups

of firms, or regions. These policy approaches have been gradually implemented by countries over time. They are not substitutes for each other but rather sub-components of a broad policy strategy. They can complement each other, depending on the country's policy concerns and targets.

- The maturity and development of institutions and policies for innovation in the region vary widely. At present, a variety of instruments are being implemented in LAC countries. There is still remarkable heterogeneity in policy priorities and availability of instruments. Countries such as Argentina, Brazil, Chile, Mexico, and Uruguay employ a wide array of policy mechanisms, while the Dominican Republic, Guatemala, and Costa Rica focus only on one or two of the elements of the national innovation system.

Figure 47 · Innovation Policy Instruments in Selected Latin American Countries (2008): Supply Instruments

Instrument/Country	ARG	BRA	CHL	COL	CRI	DOM	GTM	MEX	PAN	PER	PRY	SLV	URY
Supply instruments													
S&T Funds													
Support to centers of excellence													
Scholarships for undergraduate, graduate and postgraduates in S&T													
Support programs for national postgraduates in S&T													
Salary incentives to research in S&T													
Affiliation with national researchers abroad													

Source: Navarro, Llisterri, and Zúñiga (2010). Based on Políticas e Instrumentos en Ciencia, Tecnología e Innovación en América Latina y el Caribe 2009: IDB, REDES and RICYT, and contributions from experts. Website: <http://www.politicascsti.net/>.

Notes: ARG = Argentina, BRA = Brazil, CHL = Chile, COL = Colombia, CRI = Costa Rica, DOM = the Dominican Republic, GTM = Guatemala, MEX = Mexico, PAN = Panama, PER = Peru, PRY = Paraguay, SLV = El Salvador, and URY = Uruguay.

- In general, all countries have at least a few ways of developing human capital for innovation. By contrast, countries have fewer instruments devoted to strategic and selective policies, even those with the most developed innovation policy institutions. The adoption of a specific approach to innovation policy and

the array of instruments that accompanies it are not the result of automatic decisions or plans. Experience has shown that the emergence of a new “innovation policy” approach has always come with institutional development and new governance mechanisms.

Figure 48 · Innovation Policy Instruments in Selected Latin American Countries (2008):
Demand and Strategy-Articulation Instruments

Instrument/Country	ARG	BRA	CHL	COL	CRI	DOM	GTM	MEX	PAN	PER	PRY	SLV	URY
Demand instruments													
Technology and Competitiveness funds													
Venture capital and other financial funding for firms													
Fiscal incentives for R&D													
Promotion of technology and knowledge transfer (extension technology services)													
Strategy and Articulation instruments													
Sectoral Funds													
Priority Areas Programs													
Innovation clusters, promotion of conglomerates, business incubators, etc.													
Mechanisms for enhancing regional innovation systems													
Coordination mechanisms between actors of National Innovation Systems (technology tables, innovation chambers)													

Sources: Navarro, Llisterri, and Zúñiga (2010). Based on Políticas e Instrumentos en Ciencia, Tecnología e Innovación en América Latina y el Caribe 2009: IDB, REDES and RICYT, and contributions from experts. Website: <http://www.politicascti.net/>.

Note: ARG = Argentina, BRA = Brazil, CHL = Chile, COL = Colombia, CRI = Costa Rica, DOM = the Dominican Republic, GTM = Guatemala, MEX = Mexico, PAN = Panama, PER = Peru, PRY = Paraguay, SLV = El Salvador, and URY = Uruguay.

H. REGULATION

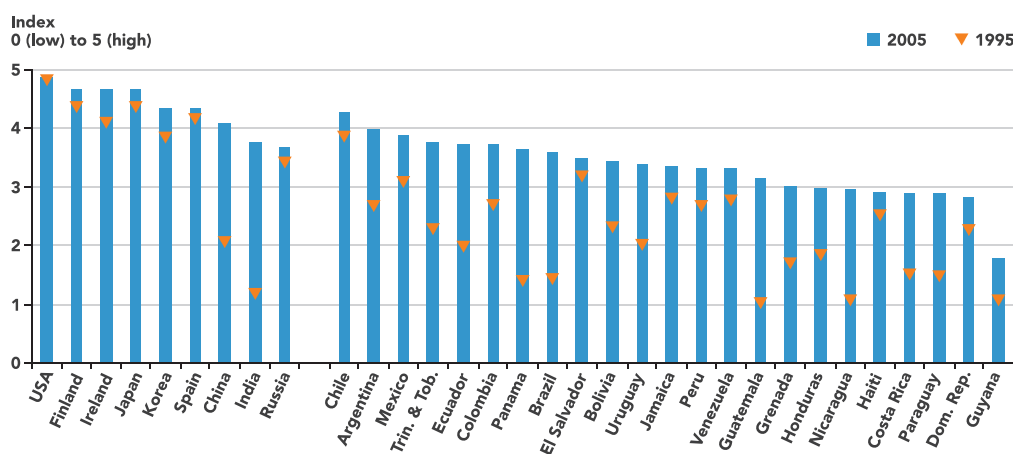
H.1 Intellectual Property Systems

- The lack of legal protection against imitation is one of the main reasons why the level of investment in R&D is below the social optimum (Arrow, 1962). Intellectual property rights (IPRs) (such as patents, trademarks, and copyrights) aim at alleviating this failure by providing legal rights to protect innovation and creative works.
- As economies develop and acquire valuable knowledge assets, agents have a vested interest in building IPR institutions and protecting patentable innovations (Park, 2008). A patent is a policy instrument which, by providing legal protection to inventors, promotes investment in research and the subsequent innovative work that will put those inventions to practical use (OECD, 2009). Additionally, through disclosure of inventions,

the patent system intends to counterbalance market exclusion by ensuring the dissemination of new knowledge, which deters needless duplication of R&D. The functioning and effectiveness of patent systems are closely related to other economic policies (notably competition and antitrust policies) and market conditions favorable to entrepreneurial activities.

- According to the index developed by Park (2008), in LAC, the average level of patent protection is about two-thirds the level of protection in industrialized countries. Numerous countries in the region continue to strengthen their patent laws, although the most significant changes were introduced in the mid-1990s with the creation of the Trade Related Intellectual Property Rights Agreements (TRIPs) at the General Agreement on Tariffs and Trade (GATT) in 1994.

Figure 49 · International Patent Protection, 1995 and 2005



Source: Park (2008).

Notes: From Park (2008) "The index is the un-weighted sum of five separate scores for: coverage (inventions that are patentable); membership in international treaties; duration of protection; enforcement mechanisms; and restrictions (for example, compulsory licensing in the event that a patented invention is not sufficiently exploited)." Please refer to the technical notes for more details regarding the five components of the index.

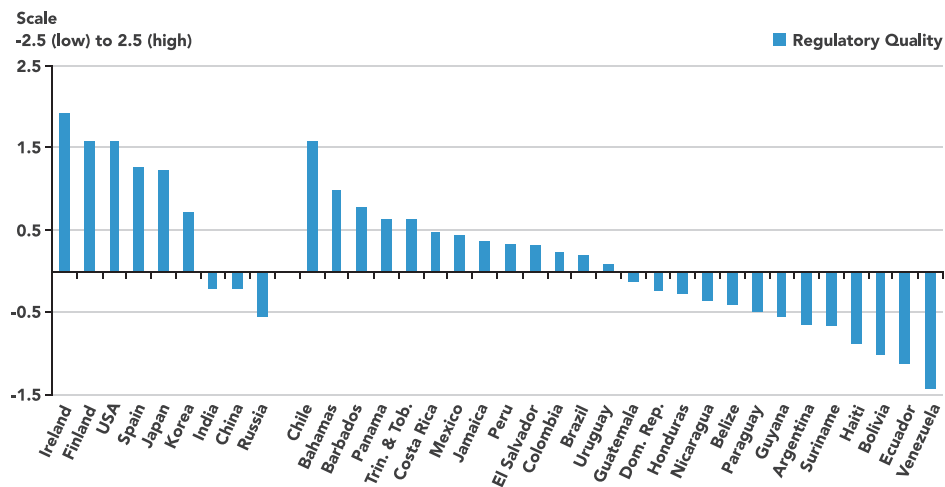
H.2 Regulatory Quality

- Having an appropriate, transparent, and well-enforced regulatory framework for business development (e.g., laws regarding market competition, commercial laws, foreign direct investment, and environmental protection, among others) is important for innovation. It provides certainty for entrepreneurs and inventors to invest in risky activities such as R&D and commercialization of new products and services, as well as appropriate economic returns from them.
- Kaufmann et al. (2009) have identified regulatory quality as one of the six dimensions of governance. They define regulatory quality as “capturing perceptions of the ability of government to

estimated to be on par or higher than nearly all of the comparison countries presented in Figure 50.

- A forthcoming study uses econometric analysis to estimate the determinants of ICT penetration gaps between the average OECD country and the average LAC country where the gap is assumed to be related to the following explanatory variables: (i) the level of income per capita; (ii) the stock of human capital, measured by average years of schooling; (iii) the population density; (iv) the regulatory quality; and (v) the degree of trade openness (IDB, forthcoming). Decomposition of the ICT penetration gaps finds that the majority of each of the gaps between the two regions can be explained by the differences in these explanatory variables. This is referred to as the explained part of the gap.

Figure 50 · Estimated Regulatory Quality, 2008 (Indicator is Measured in Units that Range from -2.5 to 2.5, Higher Values Correspond to Better Regulatory Quality)



Source: WGI Aggregate Governance Indicators.

formulate and implement sound policies and regulations that permit and promote private sector development” and cover 212 countries, drawing from 35 data sources from 33 different organizations.

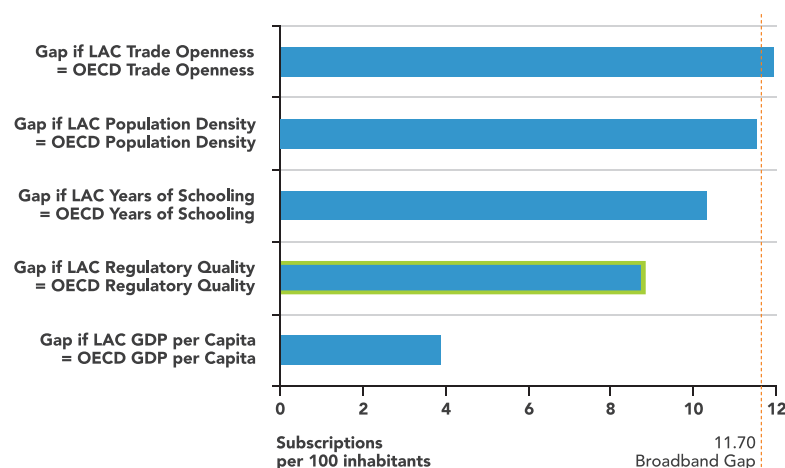
- Regulatory quality is measured in units ranging from about -2.5 to 2.5, with higher values corresponding to better governance outcomes. According to this indicator, many countries in the LAC region are estimated to have weak regulatory quality; half of the LAC countries for which data are available are estimated to have a level of regulatory quality that is below zero. Chile stands out as an exception in the region, because its regulatory quality is

- The actual total gap between the OECD and LAC average for broadband penetration was 14.09 subscriptions per 100 inhabitants from 2004 to 2008 and for computer penetration it was 37.71 computers per 100 inhabitants from 2002 to 2006. The vertical line in Figures 51 and 52 represents the explained part of the broadband gap (11.70) and computer gap (33.74) respectively.

• Figures 51 and 52 illustrate hypothetical scenarios – what could be. Further analysis of the results of the decomposition allow for a simulation of the reduction or increase of the explained gap that, controlling for other factors, could be attributed to each of the explanatory variables. The largest reduction in the gap would occur if the average GDP per capita in LAC increased to the average levels of GDP per capita in the OECD. The next largest reduction in the gaps between the two regions for both broadband and computers would occur if regulatory quality in LAC were brought up to the regulatory quality standards in the OECD.

• If the regulatory quality in LAC were equal to that of the OECD, the explained part of the gap in broadband penetration would shrink from 11.70 to 8.77 subscriptions per 100 inhabitants and in computer penetration it would shrink from 33.74 to 29.64 computers per 100 inhabitants. In other words, approximately there would be a 25 percent reduction in the broadband gap and a 12 percent reduction in the computer gap.

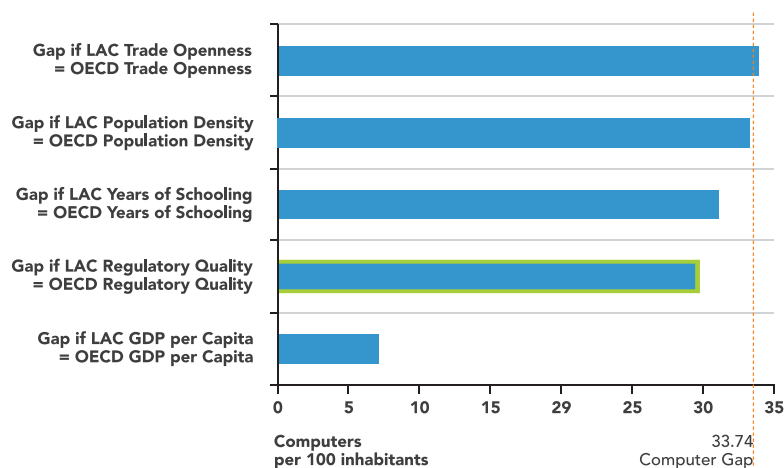
Figure 51 · Simulation of the Effect of Explanatory Variables on the Gap between OECD and LAC Broadband Penetration Levels 2004-2008



Sources: Authors' Calculations based on IDB (forthcoming).

Note: Please see the technical notes for more details regarding the decomposition analysis.

Figure 52 · Simulation of the Effect of Explanatory Variables on the Gap between OECD and LAC Computer Penetration Levels 2002-2006



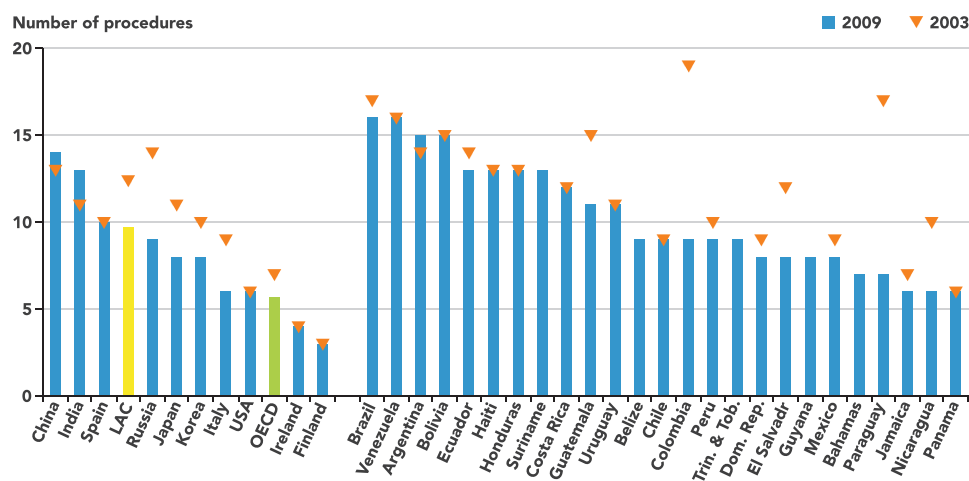
Sources: Authors' Calculations based on IDB (forthcoming).

Note: Please see the technical notes for more details regarding the decomposition analysis.

I. BUSINESS CREATION

- Entrepreneurship is important for the vitality of industries and the dynamism of economies. The dynamic process of new firm creation introduces and diffuses innovative products, processes, services, and organizational structures throughout the economy. It is widely documented that new firms are a major source of employment, productivity, and economic growth.
- A policy and business environment that fosters the start-up and growth of new firms is essential for economies to prosper. Studies show that firm creation is positively associated with the quality of the legal and regulatory environment (e.g., approximated by the number of procedures to start a business), and the ease of access to finance, whereas it is negatively correlated to the prevalence of informality (Klapper et al., 2007).
- In 2009, the average number of procedures to register a business was about 6 in OECD countries, whereas in LAC it was about 10. The region has slightly decreased this number with respect to 2003. Colombia, Paraguay, Nicaragua, and Guatemala have considerably simplified procedures for firm registration. Yet the regulatory burden for firm creation continues to be high in some LAC countries. In 2009, it took 67 days to register a new firm, whereas it took 13 days on average in OECD economies. In Mexico, Panama, Jamaica, and Peru it took fewer days than this average. At the opposite end of the spectrum, in Haiti, Brazil, and Venezuela, it took more than 100 days (195, 120, and 141 days, respectively).

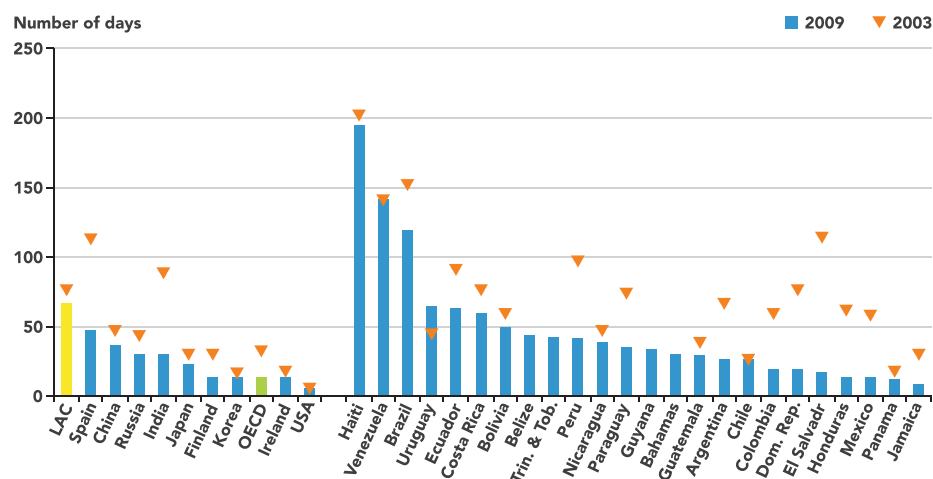
Figure 53 · Number of Start-up Procedures Required to Register a Business, 2003 and 2009



Source: World Development Indicators.

Notes: Data for LAC and high income OECD countries (referred to as OECD in the figure) are provided in the WDI database.

Figure 54 · Number of Days it Takes to Start a Business, 2003 and 2009



Source: World Development Indicators.

Notes: Data from Suriname (694 days in 2009) were suppressed. Data for LAC and high income OECD countries (referred to as OECD in the figure) are provided in the WDI database.

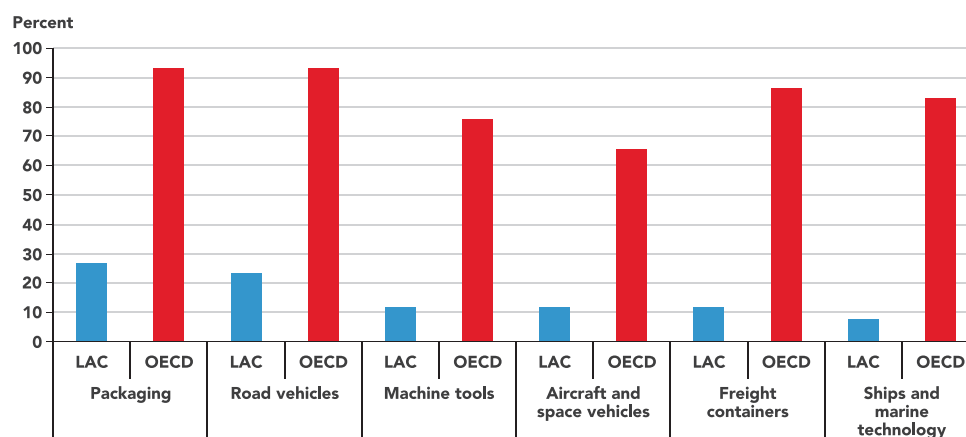
J. METROLOGY AND STANDARDS

- Figures 55 to 60 present information regarding participation of LAC Countries in the Technical Committees of the ISO (International Organization for Standardization). The ISO is the main body engaged at the global level in defining, disseminating, and supporting the verification of the many technical and quality standards embodied in myriad services and industrial products. Its work is at the core of the international economy. Most products traded worldwide, or even produced and commercialized within the borders of a single country, would encounter serious difficulties in being used, applied, or combined with others in the absence of norms and standards. These standards have substantial technical and scientific components, since they deal with issues of measurement and physical and chemical qualities. Lack of compliance with quality standards is one of the main factors, and in some economies actually the most important factor, behind failed attempts at exporting industrial or primary products: merchandise is returned because it does not fit, or because it is rejected by consumers for a variety of reasons that reflect the absence of standards in their manufacturing, processing, or packaging and transport.
- The availability of resources and institutions for quality and standards measurement and certification is a necessary component of modern economies. It is heavily dependent

on scientific and technological resources. The presence of these resources is normally taken for granted in advanced economies, but their development in smaller and less developed economies represents challenges in areas such as institutional development, education, and infrastructure, all of which take time and substantial funding. Their absence, however, is a sign of an underdeveloped innovation system and poor integration of technological capabilities and the economy, and constitutes a drag to the economic and competitive prospects of any nation.

- Given the difficulties in measuring and comparing the degree of institutional and scientific sophistication of any set of countries along this key dimension, the information shown here constitutes an indirect look at is the level of involvement of each economy in LAC with respect to the development and application of standards in a series of economic sectors. It measures the strength of countries' participation in the technical committees of ISO, which are the main bodies that work on an ongoing basis on defining standards in those sectors. The bars indicate the strength of LAC participation in each committee, calculated as the number of countries participating in each committee out of a total of 26 LAC countries. A similar figure for OECD is provided as a benchmark.

Figure 55 · Machinery and Transport Equipment, and Related International Organization for Standardization (ISO) Technical Committee (TC)
Members: Proportion of LAC and OECD Countries that are TC members



Source: ISO.

Notes: The proportion of TC members are considered out of the 26 LAC countries in the region. See the technical notes for a list of the countries. Mexico is included in the LAC region and not in the OECD; therefore the proportion of OECD TC members is considered out of the remaining 29 OECD member countries.

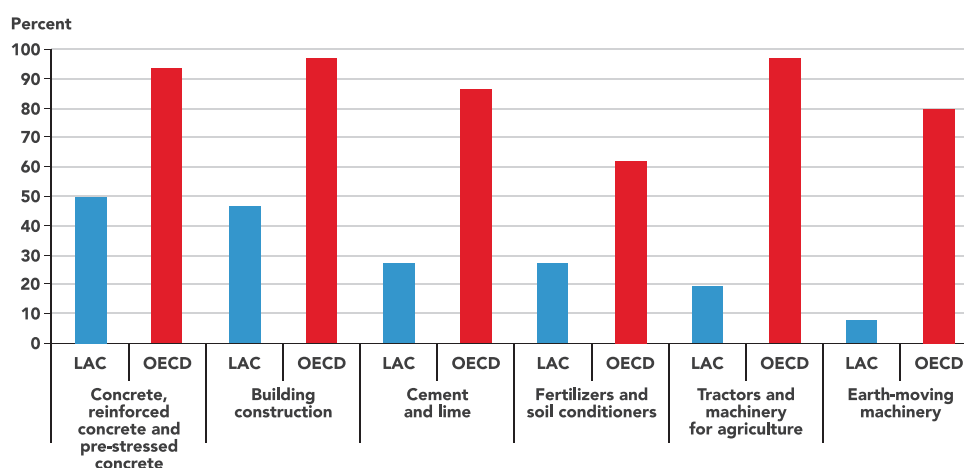
J.1: LAC Participation in International Organization for Standardization (ISO) Technical Committees

- The overall picture indicates scant participation of the region's economies in most economic sectors. This information points to low averages on issues such as the institutional development of standard certification and metrology services bodies, relatively weak penetration of standards in the economy, and a scarcity of human resources and equipment needed for the tasks involved. More specifically, participation in any given committee is normally around 20 to 30 percent of countries, never above 50 percent, and often around 10 percent of LAC countries, particularly in

cases involving a technology-intensive industry (for example, laboratory equipment or optics).

- Figure 60 (on page 60) allows the same information to be assessed in terms of the extent of involvement of each country. Here, it is very clear that the regional average veils what in practice is a heavy involvement of a small subset of countries (Brazil, Argentina, and Mexico) combined by weak participation by many others. As in other dimensions, the region shows strong heterogeneity when it comes to this key dimension of innovation systems.

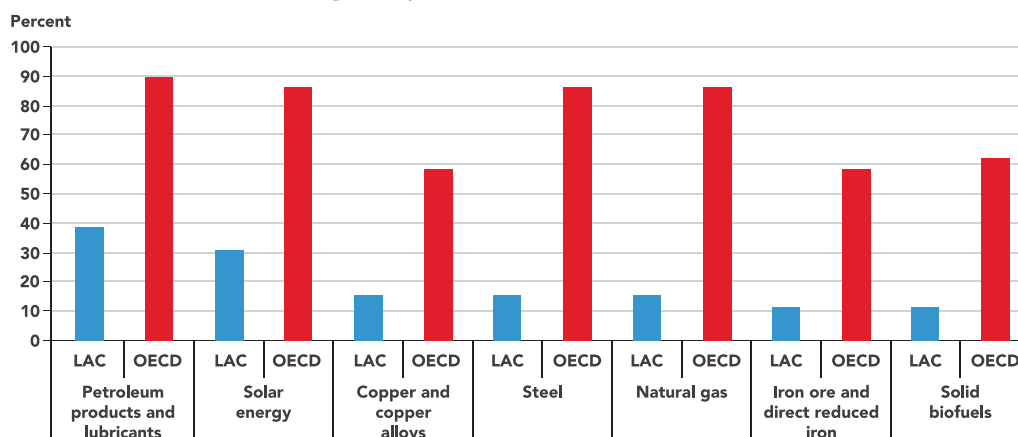
Figure 56 · Construction, Agriculture and Related International Organization for Standardization (ISO) Technical Committee (TC)
Members: *Proportion of LAC and OECD Countries that are TC members*



Source: ISO.

Notes: The proportion of TC members is considered out of the 26 LAC countries in the region. See the technical notes for a list of the countries. Mexico is included in the LAC region and not in the OECD; therefore the proportion of OECD TC members is considered out of the remaining 29 OECD member countries.

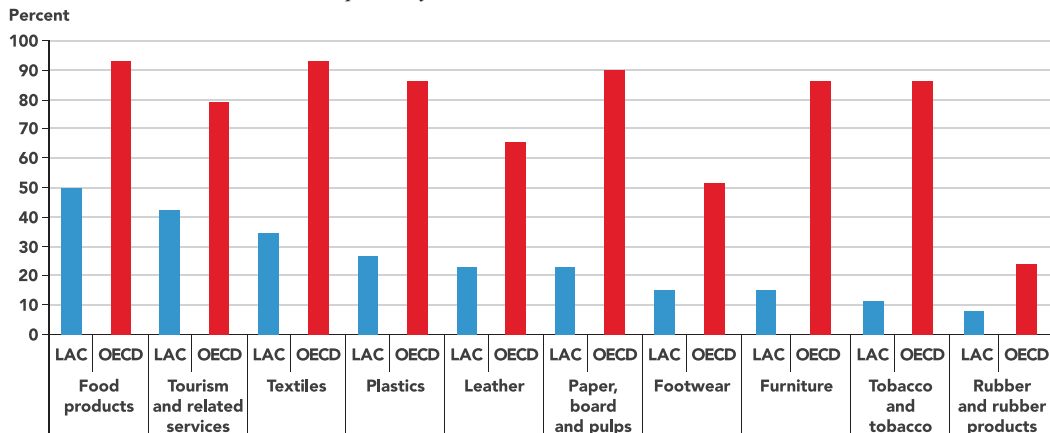
Figure 57 · Metal, Fuel, Energy and Related International Organization for Standardization (ISO) Technical Committee (TC)
Members: *Proportion of LAC and OECD Countries that are TC members*



Source: ISO.

Notes: The proportion of TC members are considered out of the 26 LAC countries in the region. See the technical notes for a list of the countries. Mexico is included in the LAC region and not in the OECD; therefore the proportion of OECD TC members is considered out of the remaining 29 OECD member countries.

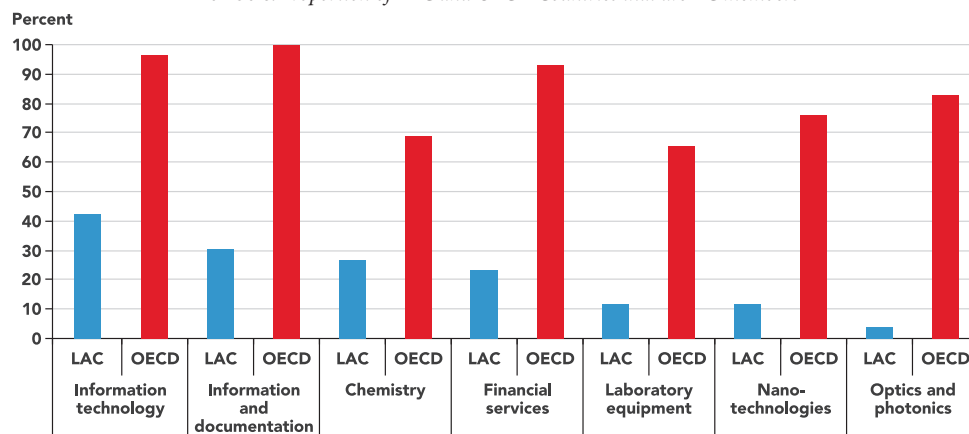
Figure 58 · Food, Tourism, Paper and Textile International Organization for Standardization (ISO) Technical Committee (TC)
Members: *Proportion of LAC and OECD Countries that are TC members*



Source: ISO.

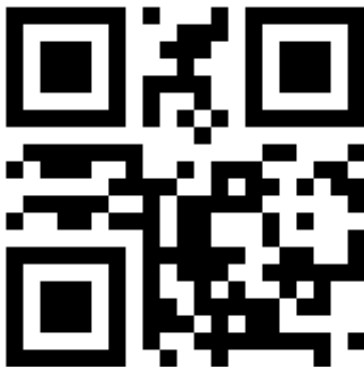
Notes: The proportion of TC members are considered out of the 26 LAC countries in the region. See the technical notes for a list of the countries. Mexico is included in the LAC region and not in the OECD; therefore the proportion of OECD TC members is considered out of the remaining 29 OECD member countries.

Figure 59: Information Technology and Documentation, Financial Services and High-Technology and Related International Organization for Standardization (ISO) Technical Committee (TC)
Members: *Proportion of LAC and OECD Countries that are TC members*



Source: ISO.

Notes: The proportion of TC members are considered out of the 26 LAC countries in the region. See the technical notes for a list of the countries. Mexico is included in the LAC region and not in the OECD; therefore the proportion of OECD TC members is considered out of the remaining 29 OECD member countries.



QR Code 5 · Latin American and Caribbean Participation in Selected ISO Technical Committees

To use this unique QR code, open your internet browser and enter the following web address: www.iadb.org/movingdata. Once the website has loaded, follow the prompts to see the dynamic graph associated with this QR code. Hold the Compendium steady, about 10 to 20 centimeters away from your computer and point the QR code directly at your computer's web camera. Shortly, your computer screen will be re-directed via hardlink to a URL where you can view and interact with a dynamic map that shows the level of participation by individual LAC countries in selected ISO TCs. If you experience difficulties, see the technical notes for guidance in troubleshooting.

Figure 60 · Latin American and Caribbean Participation in Selected ISO Technical Committees

	ARG	BRB	BOL	BRA	CHL	COL	CRI	ECU	JAM	MEX	PAN	PER	SLV	TTO	URY
Aircraft and space vehicles															
Building construction															
Cement and lime															
Chemistry															
Concrete, reinforced concrete and pre-stressed concrete															
Copper and copper alloys															
Earth-moving machinery															
Fertilizers and soil conditioners															
Financial services															
Food products															
Footwear															
Freight containers															
Furniture															
Information and documentation															
Information technology															
Iron ore and direct reduced iron															
Laboratory equipment															
Leather															
Machine tools															
Nanotechnologies															
Natural gas															
Optics and photonics															
Packaging															
Paper, board and pulps															
Petroleum products and lubricants															
Plastics															
Road vehicles															
Rubber and rubber products															
Ships and marine technology															
Solar energy															
Solid biofuels															
Steel															
Textiles															
Tobacco and tobacco products															
Tourism and related services															
Tractors and machinery for agriculture and forestry															

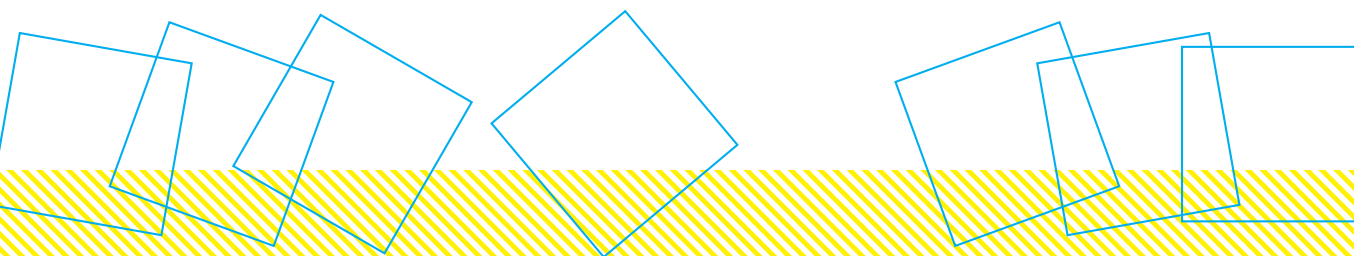
Observing (Correspondent)
 Observing
 Participating
 Secretariat

Source: ISO.

Notes: TC members are considered out of the following 26 LAC countries in the region; ARG = Argentina, BHS = Bahamas, BRB = Barbados, BLZ = Belize, BOL = Bolivia, BRA = Brazil, CHL = Chile, COL = Colombia, CRI = Costa Rica, DOM = the Dominican Republic, ECU = Ecuador, GTM = Guatemala, GUY = Guyana, HTI = Haiti, HND = Honduras, JAM = Jamaica, MEX = Mexico, NIC = Nicaragua, PAN = Panama, PRY = Paraguay, PER = Peru, SLV = El Salvador, SUR = Suriname, TTO = Trinidad & Tobago, URY = Uruguay, and VEN = Venezuela. If a country does not appear in Figure 60, it is because that country is not a member of any of the 36 ISO TCs analyzed.



V · Information and Communications Technology (ICT)



Introduction



This chapter represents a compilation of statistics and indicators that, taken together, tell a story about the state of affairs of information and communications technology (ICT) in Latin America and the Caribbean. In the case of ICT access, the story includes a short history of how penetration has progressed over roughly the last decade. The relative position of the region regarding these technologies is assessed at three different levels of analysis: (i) the global divide—mostly between the OECD and Latin American countries, (ii) the intra-regional divide between different regional countries, and (iii) the internal divide within Latin American countries. The chapter analyzes the difference between ICT access and use in Latin America and the Caribbean. The chapter uses several available indicators to examine the relationship between price and access to ICTs. Mobile telephony is highlighted as the anomaly among the ICTs, because levels of adoption have sky-rocketed in the region at a pace that is unprecedented by older technologies such as fixed telephony and unmatched by newer technologies such as computers and fixed broadband. There are many factors that may enable such high levels of adoption of mobile telephony; low cost, creative pricing schemes such as pre-paid options, and a more agile underlying technological infrastructure. The chapter closes with a brief assessment of the presence and pervasiveness of the Internet in government and businesses.

Effective analysis of ICT access and use continues to be hampered by the lack of sufficient, reliable and internationally comparable data. As the region and the world adjust to the fact that these technologies are becoming integral to nearly every aspect of life, from communication to information access and storage, to enhancing business transactions and generating higher levels of productivity, every effort must be made to accurately track and assess macro and micro trends in ICT adoption, diffusion, and use in households, the public sector and business.

Another complication in the statistical treatment of ICTs is the incredibly rapid pace at which the available technologies are changing. Creative destruction is a concept easily applied to new technologies that essentially render the previous models obsolete. This affects the analysis on three levels. First, we are not always comparing apples and apples (i.e., a computer from 1985 is not the same as a computer in 2008; internet (at least in the OECD) is

now nearly synonymous with broadband, though it may not have been ten years ago). Second, fixed telephony (voice) penetration levels are on the decline in the OECD, most likely because consumers in the region are using mobile phones instead. We continue to include this technology throughout the analysis in this chapter, because fixed telephone lines can be seen as a proxy for the available infrastructure for fixed broadband, reflecting past trends and the potential of the region to support the newer technology. Third, due to the natural time lag in collecting, reporting and analyzing data, it is important to remember that these statistics represent the state of affairs in the region in 2008. Since then, the status of each ICT may have progressed, for example the adoption rates of mobile broadband in the region may have accelerated beyond the data that we present here. In the future, with additional statistics it would be worthwhile to study the inter-dependence of ICT devices (such as computers and smart phones) and fixed and mobile broadband.

The findings are technology specific, but in general show that while ICT penetration in the region is increasing, it is increasing in other regions as well. Therefore, ICT adoption and diffusion in Latin America and the Caribbean has not necessarily advanced vis-à-vis other regions, such as the OECD countries. Furthermore, countries within Latin America are diverse with respect to factors that influence ICT diffusion, such as income, infrastructure, education, and regulatory quality. Therefore, ICT penetration in some countries is much higher and increases more rapidly than in other countries in the region. Finally, the same factors that affect intra-regional heterogeneity also affect the adoption and diffusion of ICTs within each country. The data tend to confirm that the poorest households within countries and the least developed countries within the region have the least access to ICTs. In some cases, private sector markets may work to lower prices of ICTs to a point where higher levels of demand can be met. In other cases, particularly when lack of infrastructure presents a significant obstacle, it will require intervention and investment by the public sector. The developmental challenge is to equip individuals with the skills to use ICTs and boost connectivity and access to ICTs in households, public areas, firms, and governments with the aim of eliminating societal gaps in technological advancement.

K. ICT ACCESS IN HOUSEHOLDS²

K.1. The Digital Divide between OECD and LAC

- The global divide between the OECD and Latin American and Caribbean countries persists (Figure 61 and Table 2). While LAC has made progress, so too have the OECD countries. The trends in terms of access gaps can be summarized as follows:

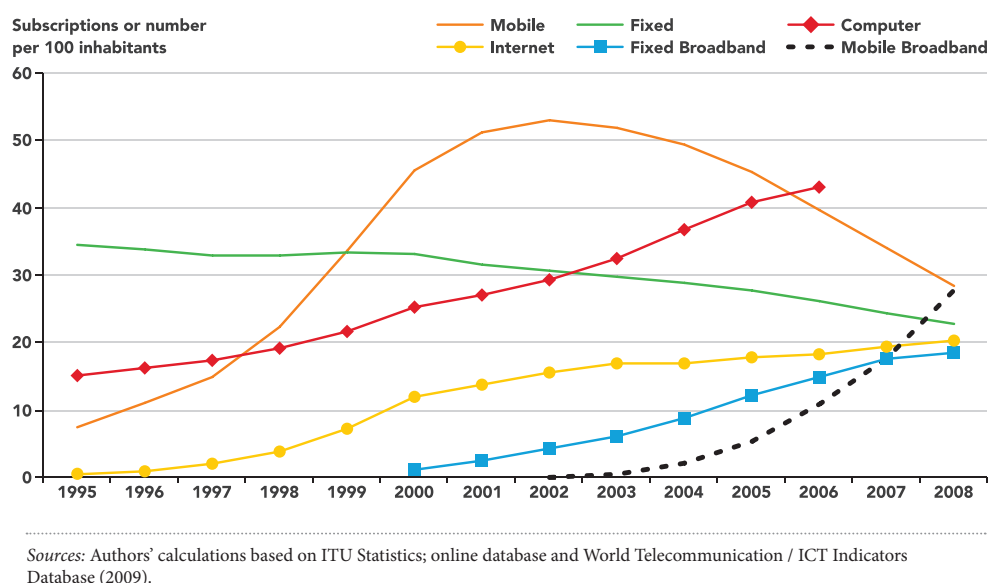
- The gaps in penetration rates for **mobile and fixed telephony** are both decreasing. However, the history related to the trends in these two technologies is very different.

- In the case of *fixed telephony*, the gap has been steadily narrowing since 1995, due to an absolute decrease in the number of fixed telephone lines per 100 inhabitants in OECD countries (from 51.1 in 1998 to 43.8 in 2008), whereas figures for LAC countries have slightly increased (from 18.1 to 21.1 from 1998 to 2008). This suggests that the narrowing of the gap is mainly related to consumers in OECD countries using mobile phones instead of

fixed phones, rather than to sharp increases in the adoption of fixed telephony in LAC. From a standpoint of proxying for fixed broadband infrastructure, we see that the penetration of fixed telephone lines has progressed, but at a slow pace, and in 2008 benchmarked at roughly half the capacity of the OECD.

- After steadily widening in the 1990s, the gap in *mobile telephony* has been narrowing since the early 2000s, when adoption rates took off in Latin America. In recent years, the LAC region has adopted this technology at an impressive pace (subscriptions per 100 inhabitants grew from 3.4 to 86.3 from 1998 to 2008, respectively), opening up opportunities for leveraging it to deliver business and social services.³ In OECD countries, mobile phone penetration expanded substantially over the same period (from 25.7 to 114.8). However, while in OECD countries it increased less than five times from 1998 to 2008, mobile phone penetration in 2008 in LAC is 25 times what it was in 1998.

Figure 61 · ICT Gaps between LAC and OECD, 1995 to 2008



² Please see the technical notes for all additional notes regarding figures in the ICT section.

³ It is noteworthy that information communications technology is currently evolving very quickly (for example the arrival of the smart-phone technology, computer hardware and disk storage capacity [Peres and Hilbert, 2009], broadband speed and quality [Vicente and Gil-de-Bernabé, 2010]). Although the overall access gap between LAC and the OECD might be narrowing, we cannot disregard an increase in "quality" gaps if, as expected, new and improved applications and technologies are spreading faster in the OECD than in LAC.

Table 2 · ICT Subscriptions per 100 Inhabitants, OECD and LAC Countries

	Subscriptions per 100 Inhabitants			
ICT	OECD 1998	OECD 2008	LAC 1998	LAC 2008
Mobile	25.7	114.8	3.4	86.3
Fixed	51.1	43.8	18.1	21.1
Internet	4.7	27.3	0.8	6.9
ICT	OECD 2000	OECD 2008	LAC 2000	LAC 2008
Fixed Broadband	1.1	24.7	0.03	6.2
ICT	OECD 2002	OECD 2008	LAC 2002	LAC 2008
Mobile Broadband	0.03	29.7	0.0	1.9
	Number of Personal Computers per 100 Inhabitants			
ICT	OECD 1998	OECD 2006	LAC 1998	LAC 2006
Computer	24.8	54.4	5.5	11.3

Sources: Authors' calculations based on ITU Statistics: online database and World Telecommunication / ICT Indicators Database (2009).

Despite recent progress in LAC countries, there is still a substantial access gap in both telephone technologies with respect to OECD countries.

- In terms of **access to computers**, the gap between Latin America and the OECD is widening. The number of personal computers per 100 inhabitants has expanded in the region from 5.5 in 1995 to 11.3 in 2006, while in OECD countries this ratio grew from 24.8 to 54.4. Therefore, the gap in penetration rates is persistently rising (from 19.3 to 43.1 computers per 100 inhabitants).

- The digital gap in **internet and broadband subscriptions** is widening substantially. The number of internet subscribers in the LAC region has increased from 0.8 to 6.9 per 100 inhabitants between 1998 and 2008. OECD penetration rates have also grown from 4.7 to 27.3. As a result, the gap between the two regions reached a record level of 20.4 subscribers in 2008.

- The divide is increasing even faster in the case of broadband due to the faster pace of diffusion of this technology in OECD countries. The penetration rate in LAC countries has increased from 0.03 subscribers per 100 inhabitants in 1998 to 6.2 in 2008, while in the OECD it jumped from 1.1 to 24.7 during the same period.

- The digital gap for mobile broadband is growing the fastest of the three, mainly as a result of the important lag in the adoption time of this technology in LAC. Indeed, while mobile broadband technologies had barely started to diffuse in the region by 2008, the average penetration rate in the OECD had already reached 29.7 subscribers per 100 inhabitants,

roughly the same diffusion level as that of fixed broadband. As mentioned in the introduction, since 2008, experts suggest that Mobile broadband penetration is expanding quite rapidly in the LAC region.⁴

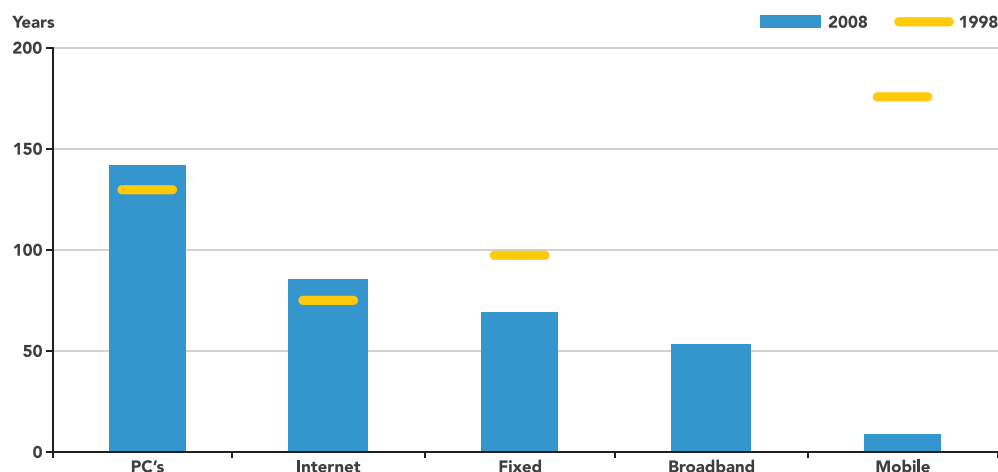
- By dividing the present penetration gap by the historical pace of diffusion in each country, it is possible to infer how long it would take a given country to reach the current OECD level. Figure 62 offers an indicator of the magnitude of the time lags under two assumptions: (i) business as usual (which means that the country keeps diffusing in the future at the same pace as it has done it in the past) and (ii) that OECD countries will not make further progress (they have reached the saturation level point). Although such assumptions can bias the estimated lags in both directions, this approach can still provide some insight into the implications of the digital divide.

- The capability-lag analysis points to the persistence of the digital divide(s). If adoption rates continue to progress as they have been, LAC is not likely to reach current OECD levels within a reasonable timeframe. Figure 62 summarizes the capability lag for the typical (median) LAC country in 1998 and 2008. The figure suggests that the only technology where the region shows a robust convergence is mobile telephony. In this case, the region has managed to shorten the time lag from approximately 180 years in 1998 to only about 9 years in 2008.

- Another technology in which the region is also converging with OECD countries is fixed telephony. Nevertheless, the progress in this technology has been far more modest, as the time that would be needed to reach the OECD levels has been reduced from

⁴ For example, more than 330,000 customers started to use mobile broadband in Chile in 2008-2009 (Anta, et. al., 2010).

Figure 62 · Capability Lags: Median Number of Years Required for LAC to Reach OECD Capability Levels, Assuming a Steady Adoption Rate, 1998 (or Earliest Available) and 2008 (or Latest Available)



Sources: Authors' calculations based on ITU Statistics; online database and World Telecommunication / ICT Indicators Database (2009).



QR Code 6 · Capability Lags: Median Number of Years Required for LAC to Reach OECD Capability Levels, Assuming a Steady Adoption Rate, 1998 (or Earliest Available) and 2008 (or Latest Available)

To use this unique QR code, open your internet browser and enter the following web address: www.iadb.org/movingdata. Once the website has loaded, follow the prompts to see the dynamic graph associated with this QR code. Hold the Compendium steady, about 10 to 20 centimeters away from your computer and point the QR code directly at your computer's web camera. Shortly, your computer screen will be re-directed via hardlink to a URL where you can view and interact with a dynamic graph depicting capability lags. If you experience difficulties, see the technical notes for guidance in troubleshooting.

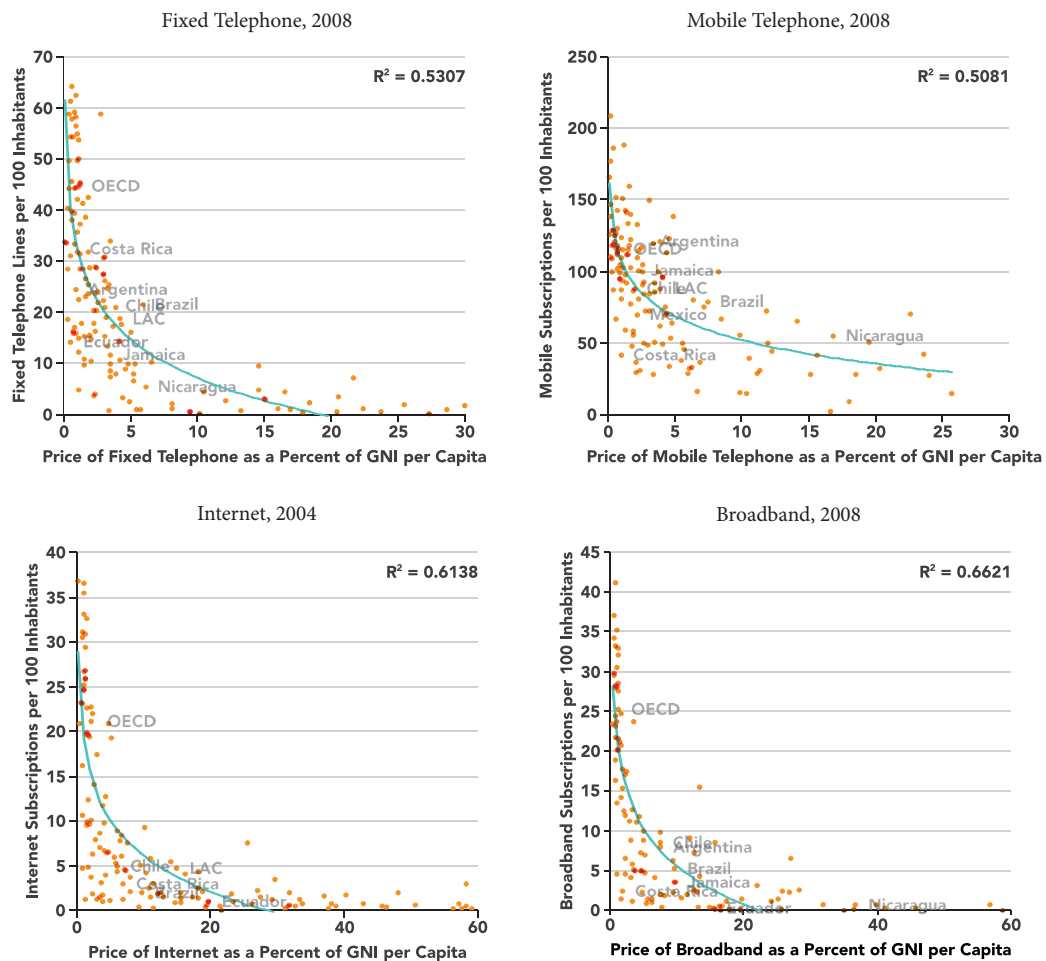
around 97 years in 1998 to around 70 years in 2008. This could be an indication of slow but steady progress within the region with respect to the potential for fixed broadband infrastructure capabilities, but this trend may also be dominated by a few of the larger economies within the region. With respect to other ICTs, the region is not showing any sign of convergence. For example, the time required to reach the level of computer penetration of OECD countries has grown from 130 to about 142 years. With respect to the Internet, the time lag has increased from 75 to 80 years. Finally, the time lag of Latin America in (fixed) broadband is already around 50 years, despite the fact that it is a relatively new technology.

- Price and availability⁵ are often considered two of the most critical determinants of the adoption of new technology. In an effort to explore the delay of ICT diffusion in LAC, Figure 63 plots ICT penetration rates against prices as a percentage of monthly per capita income for the full sample of countries for which data are available.
- The results clearly show a strong and significantly negative correlation between penetration rates and relative prices for the four ICTs. In this figure the data for the internet are from 2004 and are based on either narrowband (dial-up) or broadband prices. By 2008, only data for price of broadband access to the internet were available.⁶ So, the data from 2004 for the Internet and the

⁵ Availability relates to the overall coverage of the ICT service provider. In some cases, individuals (especially in rural areas) in a country may be able to afford broadband, but the obstacle lies in the lack of available service or the technological infrastructure to reach that person's home or business.

⁶ Price of Internet in 2004 refers to the cost of 20 hours of dial-up (or, when cheaper, broadband) internet use per month. Price includes monthly charges paid to the Internet Service Provider (ISP), plus additional charges once free hours have been used, plus the amount payable to the telephone company for charges for 20 hours of use per month as a percent of GNI per capita (ITU, 2006). Price of Broadband refers to fixed broadband and is the cost of a monthly subscription to and entry broadband place (based on 1 Gigabyte of data transferred) as a percent of the national average monthly GNI per capita (ITU, 2010).

Figure 63 · The Relationship between Price as a Percent of Monthly GNI and ICT Access



Sources: ITU Measuring the Information Society, 2010; ITU online database and World Telecommunication / ICT Indicators Database (2009).



QR Code 7 · Diffusion of Personal Computers and Mobile Telephony in LAC and the OECD, 1990 to 2007

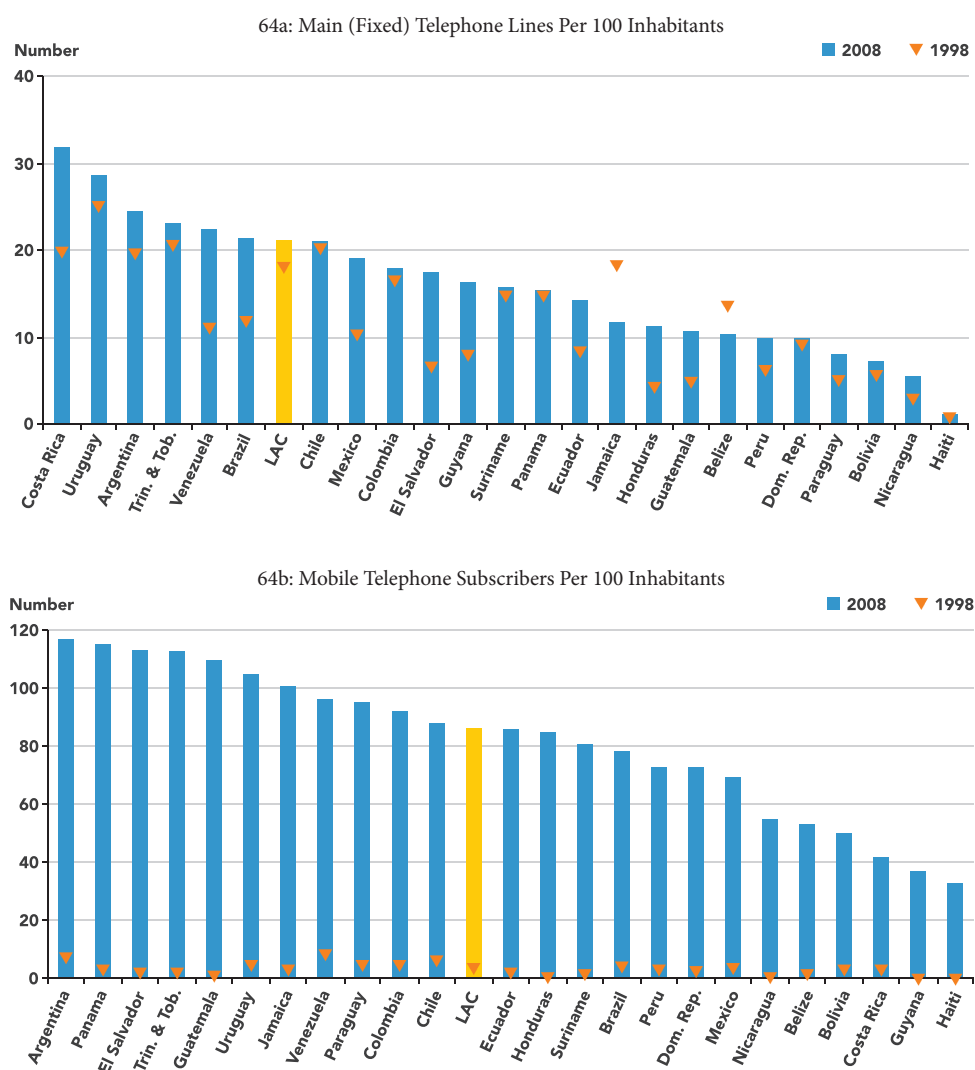
To use this unique QR code, open your internet browser and enter the following web address: www.iadb.org/movingdata. Once the website has loaded, follow the prompts to see the dynamic graph associated with this QR code. Hold the Compendium steady, about 10 to 20 centimeters away from your computer and point the QR code directly at your computer's web camera. Shortly, your computer screen will be re-directed via hardlink to a URL where you can view and interact with dynamic graphs depicting the diffusion of Personal Computers and Mobile Telephony in LAC and the OECD over the last two decades. If you experience difficulties, see the technical notes for guidance in troubleshooting.

data from 2008 for broadband act as a proxy for analysis over two points in time. The relationship between ICT access and price has remained very stable over time, even despite the changes in the underlying technology (the switch from dial-up to broadband internet access). Moreover, the relationship between penetration rates and affordability seems to be strongly non-linear. For the majority of the countries in the world, ICT costs are within 10 percent or less of monthly per capita incomes, and this is the case for LAC's front-runners such as Argentina, Brazil, Chile, and Costa Rica (in all technologies). In many of the world's developed economies ICT costs are less than 3 percent of the monthly per capita incomes. However, in poor countries, where ICT costs represent a substantial part of monthly per capita income, they are considerably less affordable. In Nicaragua, the cost of fixed broadband is almost 40 percent of monthly per capita income, to afford fixed broadband; the Nicaraguan consumer would have to forego many other goods. In Ireland, the cost of fixed broadband in 2008 was 0.95% (less than 1 percent) of monthly per capita income, a much more affordable prospect.

- Overall, fixed and mobile telephony costs represent around 4 percent of monthly per capita income for the average LAC country as compared to 1 percent and 0.8 percent respectively for the average OECD country, but these figures rise to 15 percent and 27 percent of monthly income in the case of the Internet (2004) and broadband. The figures for OECD countries are 2.2 percent and 1.3 percent.

- The non-linearity between penetration rates and affordability implies that for many countries, particularly the poorest ones, marginal changes in ICT pricing will have very limited impact on penetration rates. A striking regularity in the case of ICTs is that penetration rates only rise when prices represent less than 5 percent of monthly per capita income (see Figure 63). For countries where prices are at or above 20 percent of monthly per capita incomes, radical changes in pricing policies (and associated regulations) may be needed.

Figure 64 · Heterogeneity in ICT Subscriptions within Latin America and the Caribbean, Earliest and Latest Available



Sources: ITU Statistics: online database and World Telecommunication / ICT Indicators Database (2009).

K.2: Differences within the Latin American and Caribbean Region

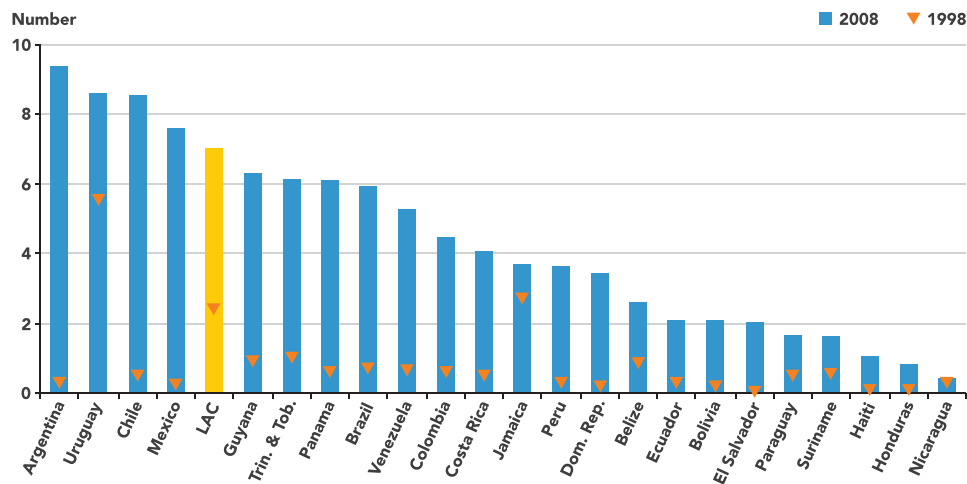
- Beyond the global digital divide, the relevance of variables such as income, education, and regulatory quality as determinants of ICT diffusion suggests that strong differences in ICT penetration rates may also be expected across countries in the same region. Indeed, statistics reveal an important heterogeneity within Latin America (Figure 64).

- In Internet and broadband subscriptions, Argentina, Uruguay, Chile, and Mexico are regional leaders, whereas low-income countries such as Haiti, Honduras and Nicaragua rank among the countries with the lowest diffusion. With respect to fixed telephone lines, Costa Rica, Uruguay, and Argentina are the front-runners, while Bolivia, Nicaragua, and Haiti have the lowest penetration rates. Finally, in terms of mobile subscriptions, Argentina, Panama, and El Salvador lead the region, whereas Bolivia, Guyana, and Haiti are at the bottom.

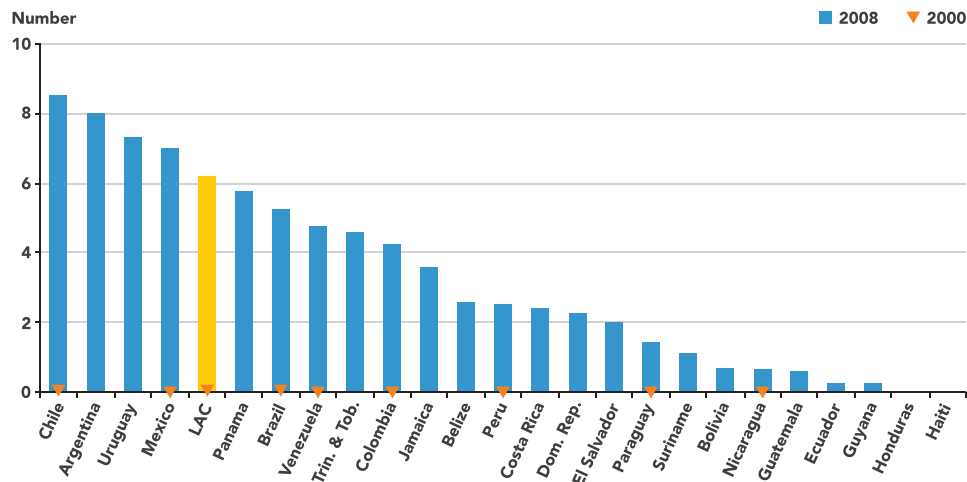
- Interestingly, mobile telephony is the only ICT where Central American countries have kept pace with the LAC average. This suggests that, in this case, barriers such as lack of infrastructure, cost, and income may be less constraining for low-income countries. Provided that network infrastructure exists and is affordable, access to mobile phone technologies requires very little initial investment (phone sets can be very cheap) and does not necessarily require a subscription, as pre-paid cards are widely available in the region.

- A substantial disparity across countries also exists in access to computers (Figure 65). In terms of percentage of households having a computer at home, Costa Rica leads the region, with more than 20 computers per 100 inhabitants, followed by Brazil, Trinidad and Tobago, Chile, Mexico, and Uruguay. At the opposite end, the Dominican Republic, Bolivia, Guatemala, and Honduras have fewer than five personal computers per 100 inhabitants.

64c: Internet Subscribers Per 100 Inhabitants

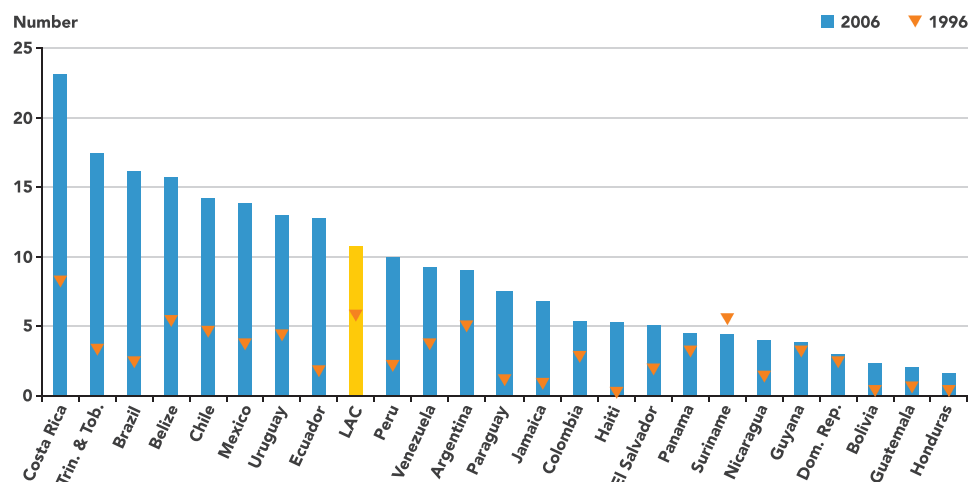


64d: Broadband Subscribers Per 100 Inhabitants



Sources: ITU Statistics: online database and World Telecommunication / ICT Indicators Database (2009).

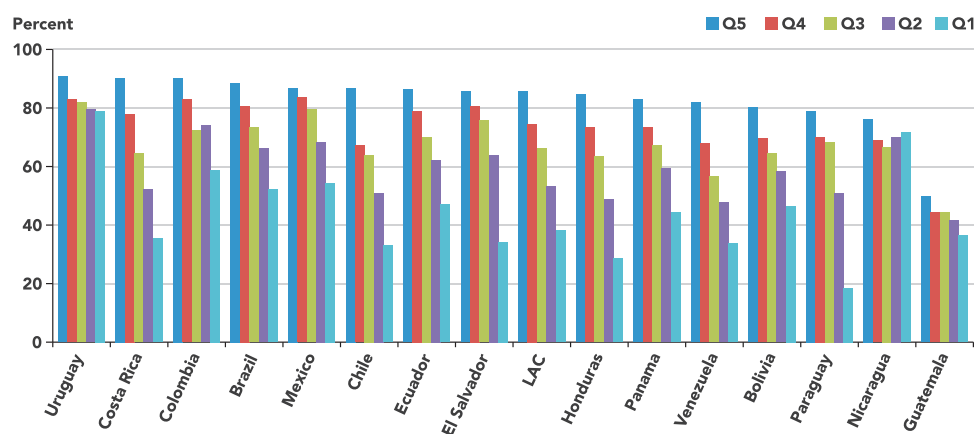
Figure 65 · Number of Personal Computers per 100 Inhabitants, 1996 and 2006



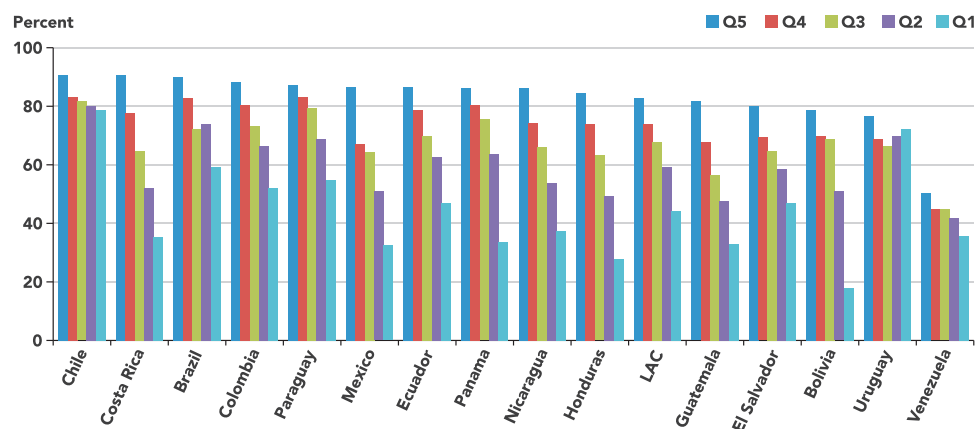
Sources: ITU Statistics: online database and World Telecommunication / ICT Indicators Database (2009).

Figure 66 · Percent of Households with Access to ICTs in the Home by Income Quintile (1-5), 2008 (or Latest Available)

66a: Percent of Households with Access to a Fixed Telephone Line in the Home by Income



66b: Percent of Households with Access to a Mobile Telephone in the Home by Income



Source: OSILAC, Cepal. Authors' elaborations on National Survey data.

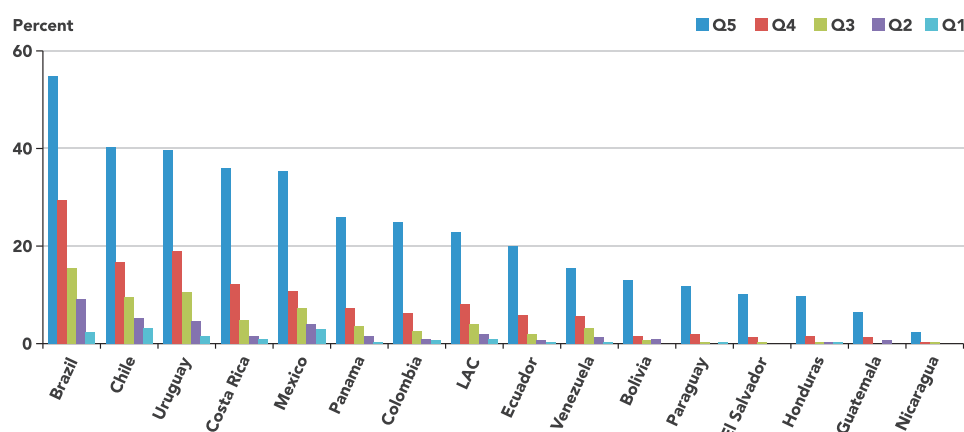
K.3. Differences within Countries: The Internal Digital Divide

- The third dimension of the digital divide occurs within countries—the internal divide—where the diffusion of ICT technologies is also very unequal. ICT penetration differs substantially across income levels. ICT access is highly income-sensitive. Thus, internal disparities could lead to the exclusion from the ICT revolution of important strata of the population, even in countries that are closing the macro digital divide.
- Figure 66 compares the percentage of households with access to ICTs at home by income level. This information, based on data from household surveys, is presented in five income quintiles.⁷ For all countries, the highest ICT penetration rates are in the

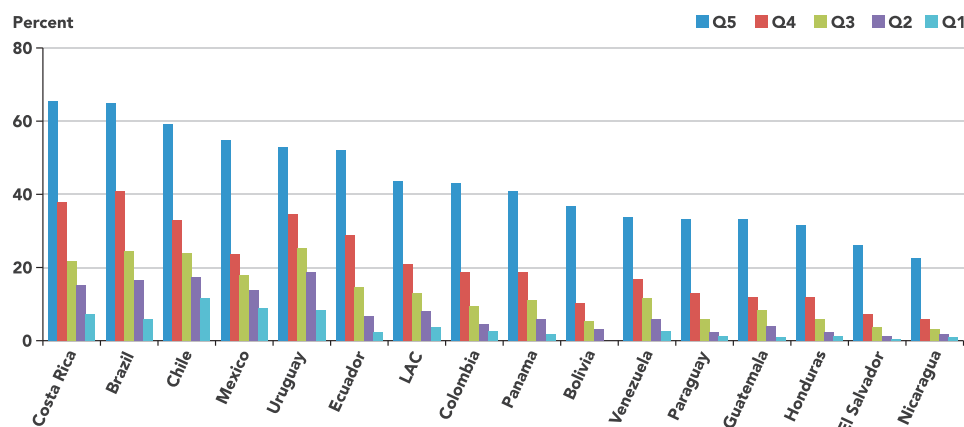
fifth income quintile (the richest income bracket). As we move to lower quintiles, household income decreases, and along with it the proportion of households with access to ICTs sharply declines.

- The figure reveals that households in the highest income quintiles in the LAC region (and in the countries that are the regional front-runners such as Brazil, Chile, Uruguay, Costa Rica, and Mexico) report roughly the same percentage as the typical OECD country (with the exception of mobile technologies). Nevertheless, in poor countries such as Nicaragua or Guatemala, even the highest income brackets have very low levels of access to ICTs at home (sometimes negligible levels, as in the case of the Internet).

66c: Percent of Households with Access to the Internet in the Home by Income



66d: Percent of Households with Access to a Computer in the Home by Income



Source: OSILAC, Cepal. Authors' elaborations on National Survey data.

⁷ Data on broadband are not included as household surveys do not normally report data on access to this technology.

L. INTERNET USE

- Reaping the benefits of the ICT revolution requires not only the possibility of access to ICTs, but also the capacity to use them in effective and productive ways. Although today the majority of developing countries are still stuck in the analysis of access stage (ITU, 2010), as ICT penetration increases, the use divide with the developed world will become more relevant. However, when assessing the actual dimension of ICT use gaps, problems due to limitations of the data become evident. In fact, the only effective way to measure the real intensity of ICT use in a country is by gathering information from household surveys. However, in developing countries, national surveys only recently began including questions about ICT use, and these questions are mostly related to the Internet. Moreover, the degree of international comparability of different surveys is clearly low.

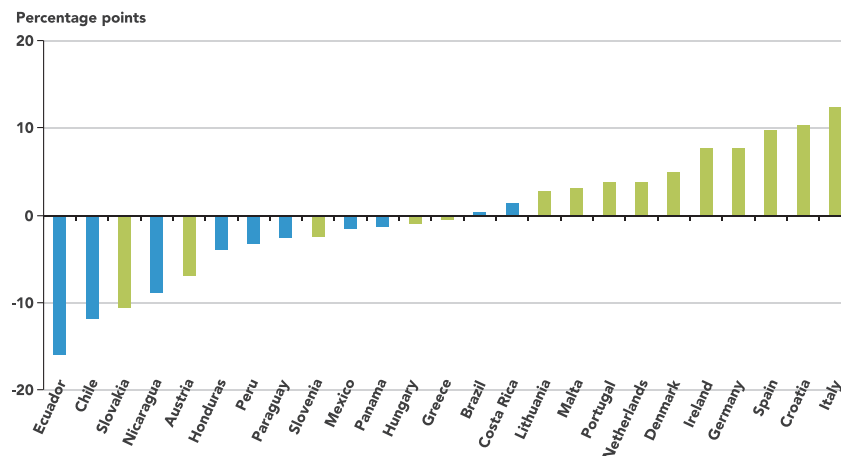
- In Figure 67, the ITU estimated Internet users for several countries in Latin America and Europe are compared with the information derived from household surveys for the same year.⁸ The figure displays the simple difference between figures from ITU (Internet access based on subscribers) and the corresponding data from household surveys for each country (Internet use as reported by the individuals surveyed).

- As Figure 67 shows, in most Latin American countries the share of the population that uses the Internet is seriously underestimated if measured by the number of subscribers to Internet services. A possible explanation of this result has to do with the role played by public access points in providing internet access to a much larger part of population in the LAC region when compared to Europe, where access is essentially private. Given this situation, there are reasons to believe that the Internet use gap between OECD and LAC countries, if computed with ITU data, may be overestimated. In addition, if, as it seems, ITU underestimates use rates in countries with lower technology diffusion, the effective intra-regional spread will be smaller.

L.1: Location and Type of Internet Use

- In addition to allowing a correct evaluation of the use divide across countries, micro data from household surveys enables an analysis of Internet use patterns. In a small sample of LAC countries, enough information exists to assess two important issues: (i) the place of use and (ii) the typology of use.

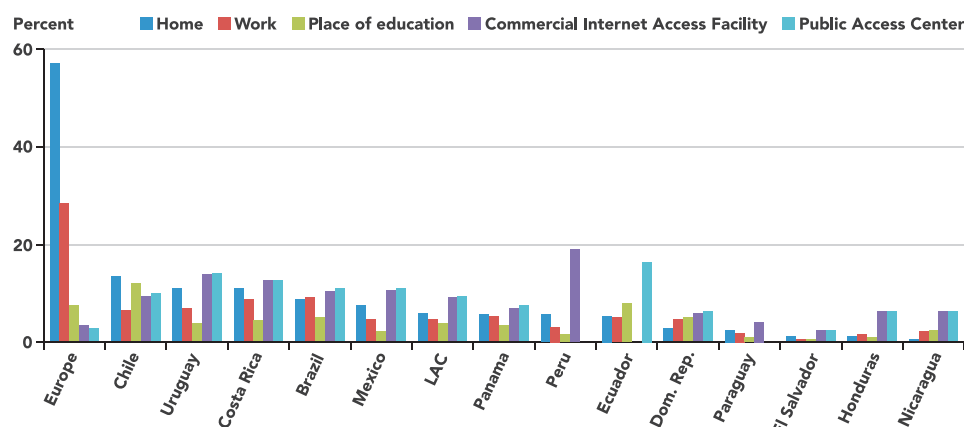
Figure 67 · Differences between ITU Estimated Internet Subscribers and Internet Users as derived from Household Surveys in Selected European and Latin American Countries (Percent of Individuals; 2006-2008)



Sources: Authors' elaborations on data from ITU, OSILAC and EUROSTAT.

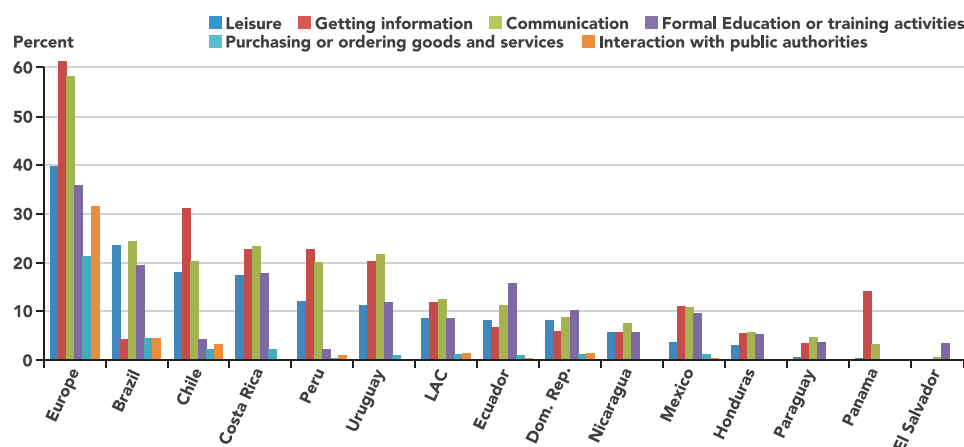
⁸ The Internet user data provided by ITU differ from the data that were analyzed in the previous section of this chapter, which were the number of subscriptions per 100 inhabitants (commonly referred to as access).

Figure 68 · Location of Internet Use (Proportion of Individuals), 2008 (or Latest Available)



Sources: OSILAC, Cepal. Authors' elaborations on National Survey data and Eurostat.

Figure 69 · Type of Internet Use (Proportion of Individuals), 2008 (or Latest Available)



Sources: OSILAC, Cepal. Authors' elaborations on National Survey data and Eurostat.

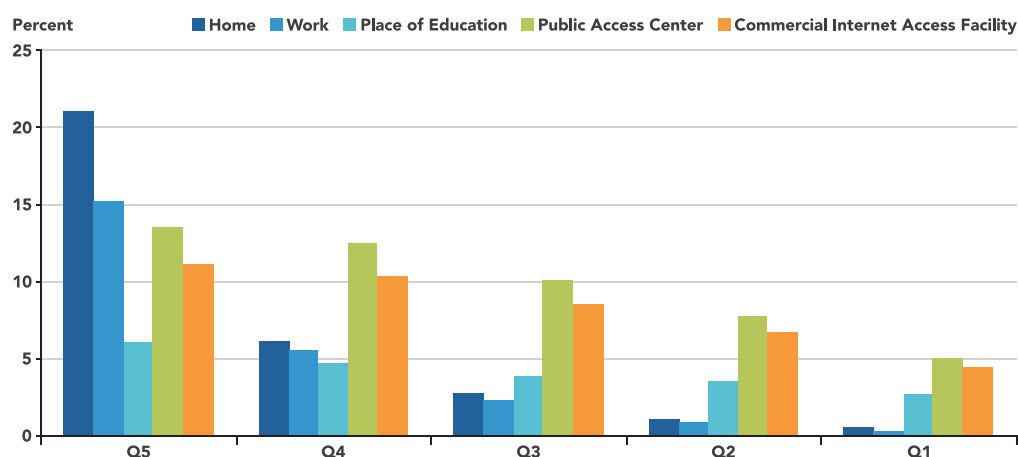
- Available information indicates that the most common place of Internet use for the average LAC country is at public access centers, followed by commercial facilities. The least common place of use is schools (or other places where education is provided), while use at home or at work lies in between (Figure 68). This contrasts with the situation in Europe (EU15), where the dominant use locations are at home and at work and community-based use is marginal.

- The importance of the place of use changes dramatically when one moves from high-income to low-income. In high-income countries such as Chile, Uruguay, and Costa Rica, use at home and at work is as prevalent as use in public facilities. But, in low-income countries such as Nicaragua or Honduras, use at public or commercial facilities is clearly the dominant modality. These

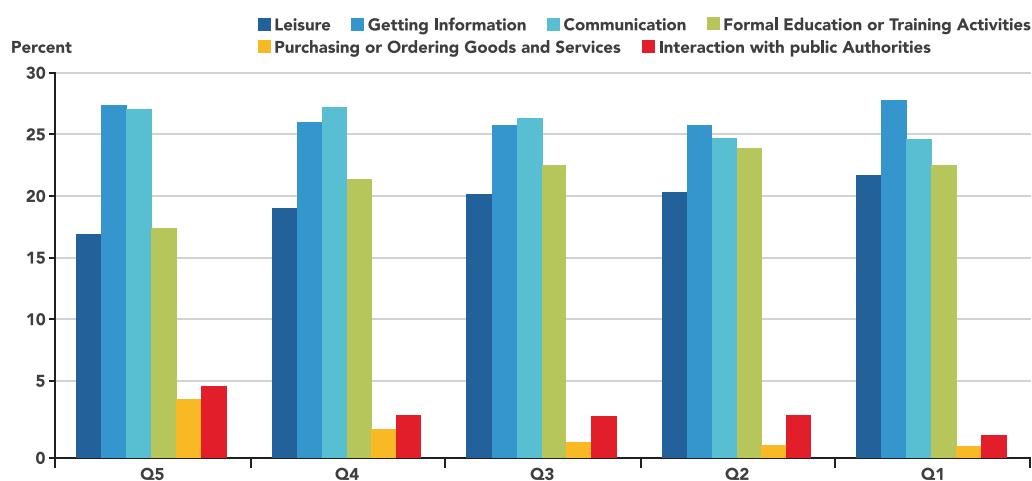
findings point to the relevance of subsidized and commercial public access solutions (telecenters and cyber-cafes) to narrow the Internet digital gap in the poorest countries of the region.

- Citizens of the typical LAC country employ the Internet mostly for information gathering and communication. The two least frequent uses are for e-commerce (purchasing or ordering goods and services) and e-government, while use for leisure and education and training falls in-between (Figure 69). In other words, Internet use is concentrated in the kinds of applications that suggest that a full transition toward the information society is far from complete. In Europe, while use for communication and information is also dominant, there is a much higher presence of other types of use, in particular for educational purposes and interaction with public authorities.⁹

⁹ When comparing Internet use between LAC and Europe, the figures do not control for the duration of use, as such information is not available. So it is likely that the gaps shown in this section are underestimated.

Figure 70 · Location of Internet Use in LAC by Individual Users within their Income Quintile (5-1), 2008 (or Latest Available)

Source: OSILAC, Cepal. Authors' elaborations on National Survey data.

Figure 71 · Patterns of Internet Use in LAC by Individual Users within their Income Quintile (5-1), 2008 (or Latest Available)

Source: OSILAC, Cepal. Authors' elaborations on National Survey data.

- Even if there is some heterogeneity across Latin American countries in terms of the intensity of use by type, there is similarity in the relative importance of the different applications. The Internet is used mostly for information gathering and communication in almost all of the countries in the region. In some countries, however, such as Brazil, Ecuador, Costa Rica and Uruguay, Internet use for educational purposes is significant.

- Figure 70 shows how the usage location pattern for the average LAC country changes according to household income quintile. The figures reflect the situation in many countries outside the region: the wealthiest households use Internet mainly at home

and at work, while these two places of use are almost irrelevant for the poorest households.

- The analysis regarding the different types of Internet usage by income categories [Figure 71] shows that the patterns of use are remarkably stable across the different quintiles. The most important type for all the quintiles is for information and communication purposes. In Figure 71 the different types of use are ordered according to their complexity. In general, when one moves from low complexity types of use (such as getting information) to high complexity ones (such as e-government), the intensity of use declines.

- When comparing the patterns of use across the different quintiles, two findings immediately emerge. First, there is an increase in the proportion of users that use Internet for educational or training activities when one moves from the top to the bottom quintiles.
- The second finding refers to the large decline in advanced types of Internet use when one moves from the top to the bottom quintiles. Indeed, sophisticated types of use, such as e-commerce or e-government, are far more relevant in the case of the highest quintile of the income distribution. Given that numbers in Figure 71 refer to users, i.e. to people who have been connected to the web, this drop may be related to other types of inequalities, such as lack of human capital or liquidity constraints (the need for a credit card to participate in e-commerce) or informality (which might hinder interaction with public authorities).
- The results of the preceding section indicate that lack of Internet access in the home is not synonymous with lack of Internet use. In fact, different business models (collective access points such as Internet cafés, telecenters, schools, libraries, etc.) have been put in place in the region to guarantee access to individuals that otherwise could not afford it. As for the type of use, only a small fraction of the population (usually the wealthiest) uses the Internet for market transactions and government interactions. As household income drops (for those individuals that are users), there is a steady rise in Internet use for educational purposes. This finding seems to suggest both the potential importance of education to close the digital divide and the potential of the Internet as an educational input for the poor.

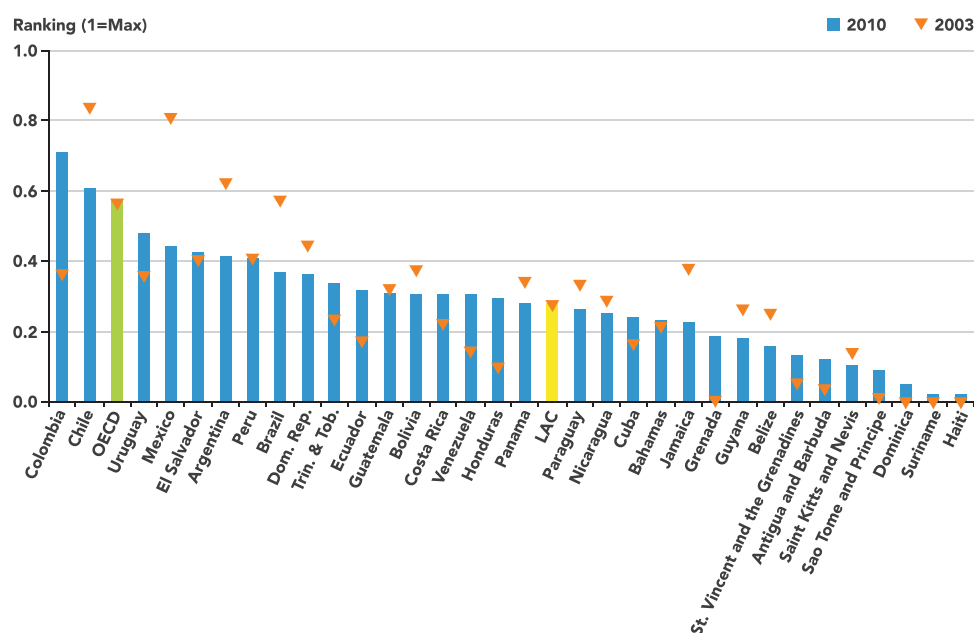
M. ONLINE GOVERNMENT SERVICES

- In the case of ICTs, governments can become important agents of change. ICTs are characterized by the presence of network externalities that might lead to a pace of diffusion that is slower than the social optimum: many users feel little incentive to join unless a large number is already connected. Thus, large numbers will not initially join, creating a vicious circle. However given its large size, the government can take advantage of network externalities even though it is the only agent that adopts the technology.
- The Online Services Index, shown in Figure 72, indicates the relative position of each country on an ordinal scale. A reduction in the index score between 2003 and 2010 only means that a country is dropping in the international rankings, without revealing information on its absolute performance (which might be increasing). In other words, a country whose performance

is improving might present a reduction in its score relative to countries that are improving more. Figure 72 shows that the LAC region clearly lags behind the OECD. Not only does the typical LAC country present an index score which is approximately half the value for the OECD average, but its relative position is the same as it was in 2003.

- The LAC leaders, Colombia and Chile, show index values even higher than the OECD average. Nevertheless, their score is the result of very different trajectories. Colombia's position has improved between 2003 and 2008, while Chile shows a strong deterioration in its relative position. Other countries in the region that have shown significant improvement in their relative positions are Uruguay, Ecuador, Costa Rica, and Venezuela. On the other hand, the region's largest economies (Argentina, Brazil, and Mexico) are falling behind (or others are catching up).

Figure 72 · United Nations Ratings of Relative Online Services of National Governments, 2010 and 2003
Based on a Comprehensive Survey of all 192 Member States (Maximum score = 1 and Minimum Score = 0).



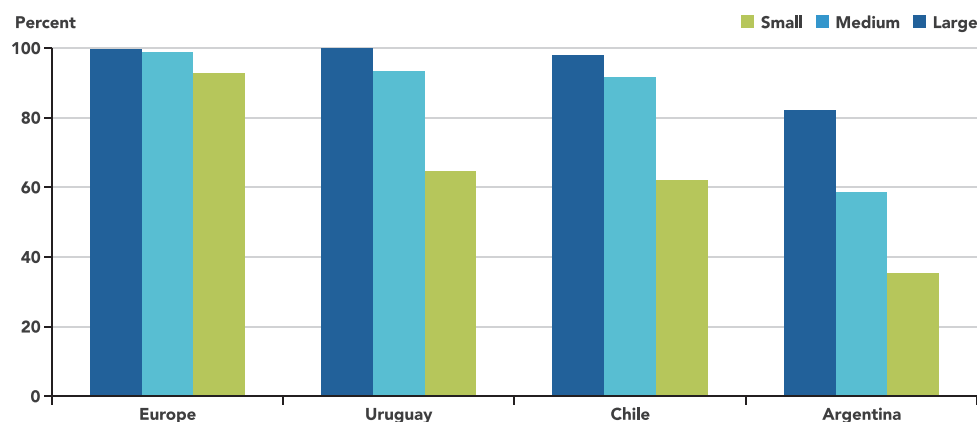
Source: United Nations E-government Survey (2010).

Note: See the technical notes for a more complete description of this indicator.

N. THE INTERNET IN FIRMS

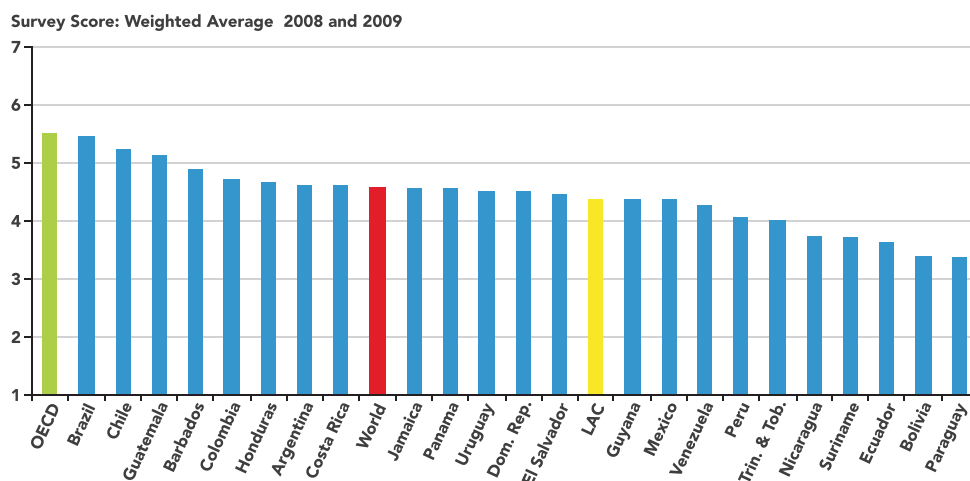
- The ICT revolution has not only changed the lives and habits of individuals and households, but it has also radically revolutionized how business is conducted. ICTs benefit business chiefly by enhancing firms' productivity through increased efficiency of internal processes and by broadening market reach, both domestically and internationally, through new marketing and commercialization approaches (e.g. e-commerce).
- The magnitude of the Internet divide in the business sector largely depends on the size of the firm. While in the developed world the differences between small and large firms in terms of Internet penetration rates are quite marginal (less than 10 percentage points), in the three Latin American countries included in Figure 73, there are significant adoption gaps by firm size. While large firms in Uruguay and Chile (less so in Argentina) show adoption rates similar to those of large firms in developed countries, the gap between large and small firms in the countries reporting is more than 30 percentage points. Thus, a large digital divide affects small firms in the region, not only compared to European enterprises of the same size, but also compared to larger LAC firms.
- Data on access to the Internet in business do not capture use. This can be overcome by making use of the "extent of business Internet use" variable in the World Economic Forum's Executive Opinion Survey. This survey collects subjective information from a sample of business leaders from several countries. Responses are combined and aggregated at the country level in order to produce country scores. While the responses are perceptions, which introduces an unknown degree of error that could affect comparability, the survey covers a large sample of countries, allowing for benchmarking of relative performance.
- Figure 74 shows that at the moment of turning to the business sector, the LAC region clearly lags behind the OECD average (at least in terms of business perceptions). However, the figure also points to the presence of an important intra-regional heterogeneity. For example, while Brazil and Chile's scores are not very far from the OECD average, Paraguay and Bolivia show important lags.

Figure 73 · Percentage of Businesses with Access to the Internet, by Firm Size

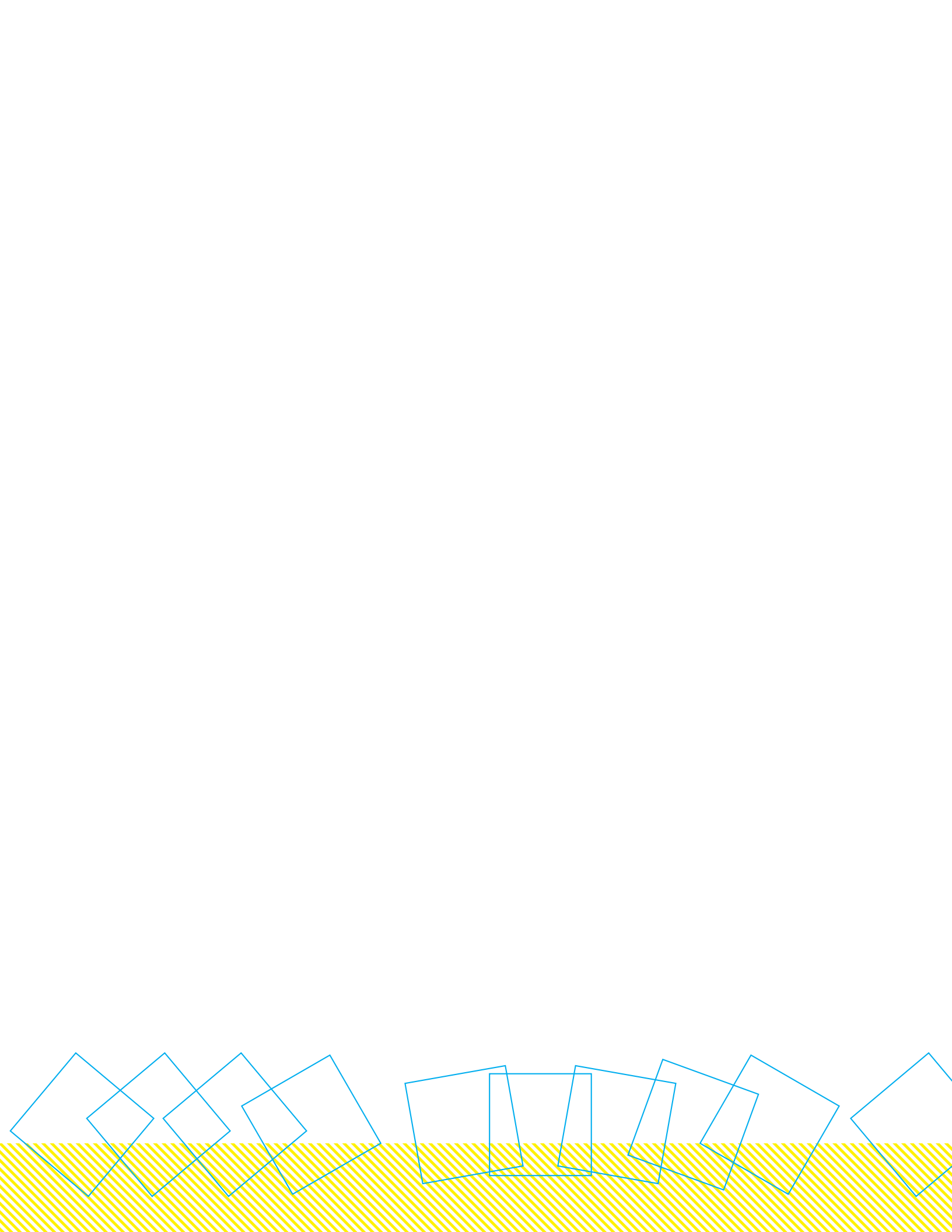


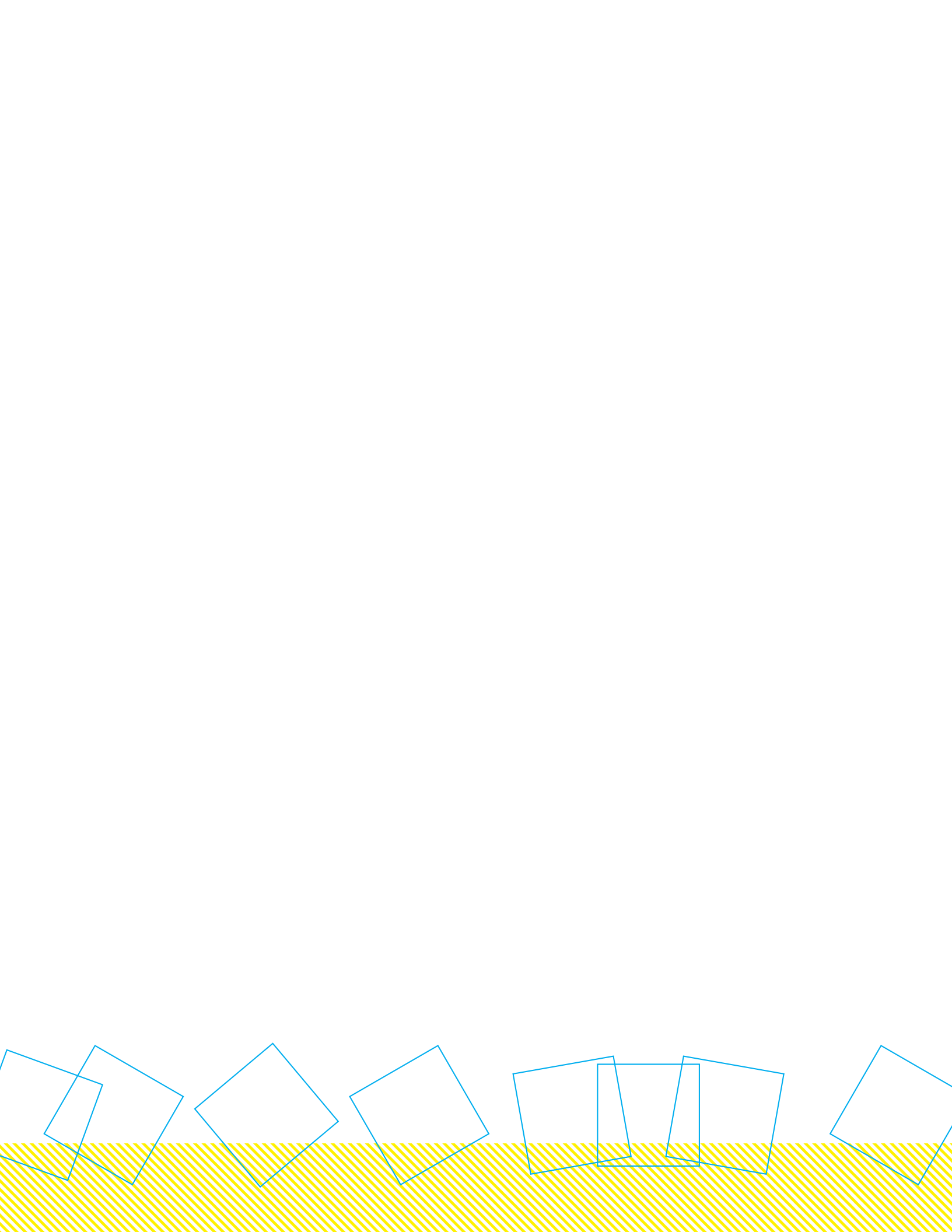
Sources: Eurostat (2006), La Innovación en la Industria Uruguaya [2001-2003], Argentina Encuesta Nacional a Empresas sobre Innovación, I+D y TICs [2002-2004], Acceso y Uso de Tecnologías de Información y Comunicación en las Empresas Chilenas [2006].

Figure 74 · Extent of Business Internet Use, Weighted Average of 2008 and 2009. Aggregate Responses to the World Economic Forum's Executive Opinion Survey question, "To What Extent do Companies within Your Country Use the Internet for their Business Activities (e.g., Buying and Selling Goods, for Interacting with Customers and Suppliers)?" (1=Not at All; 7=Extremely).

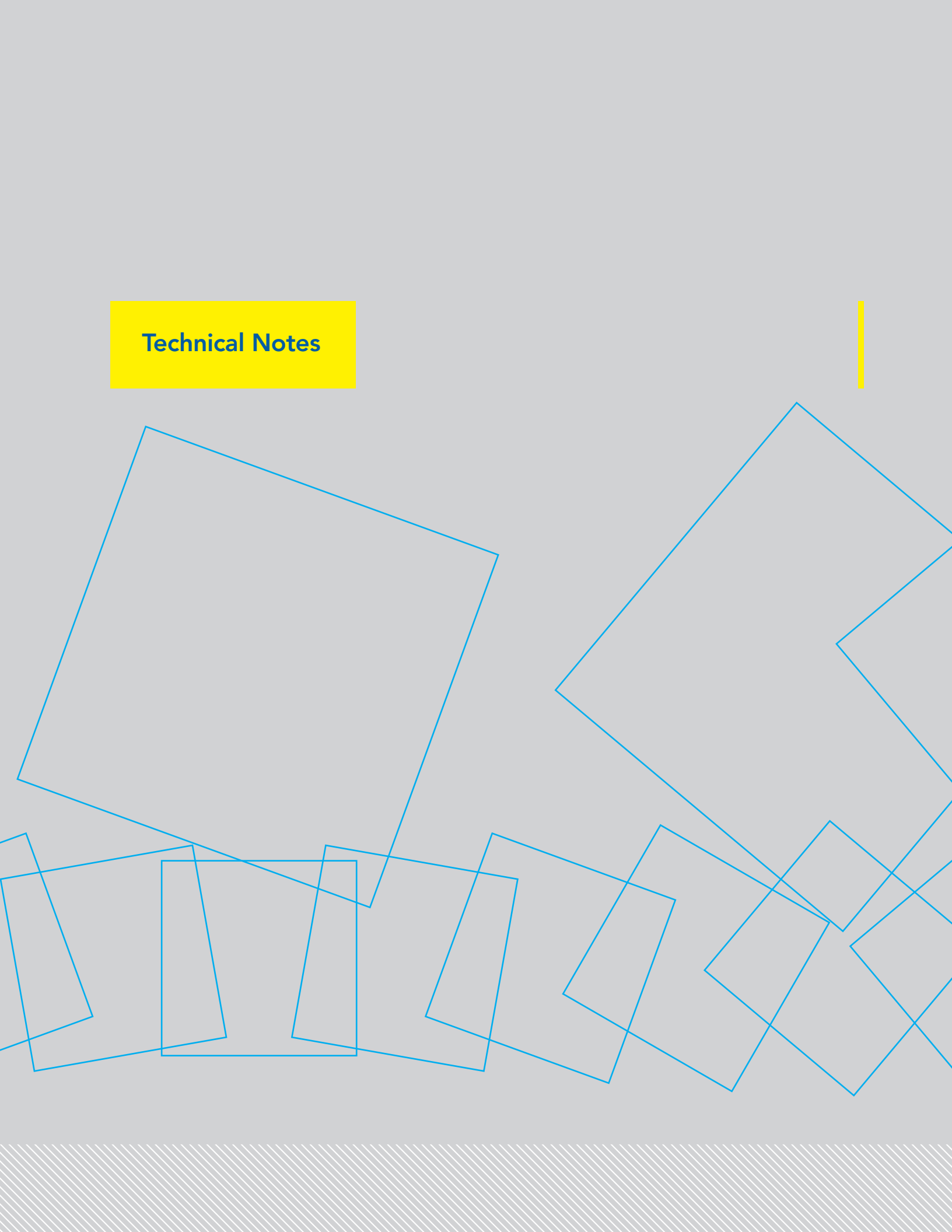


Source: World Economic Forum Global Information Technology Report (2009-2010).





Technical Notes



I • Human Capital and Knowledge

Data trends in this section are drawn primarily from the following sources:

- Organization for Economic Cooperation and Development (OECD)
- Program for International Student Assessment (PISA)
- Red de Indicadores de Ciencia y Tecnología (RICYT)
- Reuters-Thomson ISI® National Science Indicators (2008)
- United Nations Educational Scientific and Cultural Organization (UNESCO) Institute for Statistics
- United States Patent and Trademark Office (USPTO)
- The World Bank World Development Indicators (WDI)
- World Intellectual Property Organization (WIPO)

A. Secondary and Higher Education

Figure 1 • Percentage of Students at Each Level of Proficiency on PISA Mathematics Scale (2006)

“The Program for International Student Assessment (PISA) is an internationally standardized assessment that was jointly developed by participating economies and administered to 15-year-olds in schools.

Three assessments have so far been carried out, in 2000, 2003, and 2006. Data for the fourth assessment is being collected in 2009, with results scheduled for release at the end of 2010. The 2009 scores and database will be made available on December 7, 2010. Tests are typically administered to between 4,500 and 10,000 students in each country.”¹⁰

To date, eight Latin American Countries have participated (or are participating) in PISA tests:

2000	2003	2006	2009
Argentina	..	Argentina	Argentina
..	Brazil	Brazil	Brazil
Chile	..	Chile	Chile
..	..	Colombia	Colombia
..	Mexico	Mexico	Mexico
..	Panama
Peru	Peru
..	Uruguay	Uruguay	Uruguay

Although Mexico is a member of the OECD, it is presented with the Latin American participants in the graphs.

“The aim of the PISA study, with regard to mathematics, is to develop indicators that show how effectively countries have prepared their 15-year-old students to become active, reflective, and intelligent citizens from the perspective of their uses of mathematics. To achieve this, PISA has developed assessments that focus on determining the extent to which students can use what they have learned. They emphasize mathematical knowledge and understanding to solve problems that arise out of day-to-day experience and provide a variety of problems with varying degrees of built-in guidance and structure, but pushing towards authentic problems where students must do the thinking themselves.

Mathematical problems are based on real-world contexts. Students are required to identify features of a problem that might involve thinking in terms of mathematics. In turn they use their knowledge of mathematics to solve the particular problem.

In PISA 2003 and PISA 2006 **four different aspects of mathematics** were tested.

Space and shape: space and geometry and the properties of objects

¹⁰ Source: Organization for Economic Cooperation and Development (OECD)/ Program for International Student Assessment (PISA). Available at: http://www.oecd.org/pages/0,3417,en_32252351_32235907_1_1_1_1_1,00.html and <http://pisa.country.acer.edu.au/>

Change and relationships: relationships between variables (i.e. any finding that can change e.g. height and weight are variables) and understanding how they can be represented including equations.

Quantity: relationships and patterns involving numbers

Uncertainty: probability and statistics.”¹¹

Summary Proficiency Level Descriptors for Mathematical Literacy, 2006

“Proficiency at Level 6

Students at Level 6 can conceptualize, generalize, and utilize information based on their investigations and modeling of complex problem situations. They can link different information sources and representations and flexibly translate among them. They are capable of advanced mathematical thinking and reasoning. They can apply this insight and understanding along with a mastery of symbolic and formal mathematical operations and relationships to develop new approaches and strategies for attacking novel situations. They can formulate and precisely communicate their actions and reflections regarding their findings, interpretations, arguments, and the appropriateness of these to the original situations.

Proficiency at Level 5

Students at Level 5 can develop and work with models for complex situations, identifying constraints and specifying assumptions. They can select, compare, and evaluate appropriate problem-solving strategies for dealing with complex problems related to these models. They can work strategically using broad, well-developed thinking and reasoning skills, appropriately linked representations, symbolic and formal characterizations, and insight pertaining to these situations. They can reflect on their actions and formulate and communicate their interpretations and reasoning.

Proficiency at Level 4

Students at Level 4 can work effectively with explicit models for complex concrete situations that may involve constraints or call for making assumptions. They can select and integrate different representations, including symbolic, linking them directly to aspects of real-world situations. They can utilize well-developed skills and reason flexibly, with some insight, in these contexts. They can construct and communicate explanations and arguments based on their interpretations, arguments, and actions.

Proficiency at Level 3

Students at Level 3 can execute clearly described procedures, including those that require sequential decisions. They can select and apply simple problem-solving strategies. They can interpret and use representations based on different information sources and reason directly from them. They can develop short communications, reporting their interpretations, results, and reasoning.

Proficiency at Level 2

Students at Level 2 can interpret and recognize situations in contexts that require no more than direct inference. They can extract relevant information from a single source and make use of a single representational mode. They can employ basic algorithms, formulae, procedures, or conventions. They are capable of direct reasoning and making literal interpretations of the results.

Proficiency at Level 1

Students at Level 1 can answer questions involving familiar contexts where all relevant information is present and the questions are clearly defined. They are able to identify information and to carry out routine procedures according to direct instructions in explicit situations. They can perform actions that are obvious and follow immediately from the given stimuli.”

Figure 2 • Percentage of Students at Each Level of Proficiency on PISA Science Scale (2006)

“Science was the major testing domain for the first time in PISA 2006. The definition of scientific literacy has been elaborated and expanded from that used in PISA 2000 and 2003. A major innovation is to include students’ attitudinal responses toward scientific issues, not just in an accompanying questionnaire but in additional questions about attitudes toward scientific issues juxtaposed with test questions relating to the same issues. In addition, there is an increased emphasis on students’ understanding of the nature and methodology of science itself (their knowledge about science), and of the role of science-based technology.”¹²

“**Scientific literacy** is the capacity to use scientific knowledge, to identify questions, and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity.

¹¹ Source: OECD/PISA.

Available at: http://www.oecd.org/document/50/0,3343,en_32252351_32236173_37627442_1_1_1_1,00.html#Mathematics

¹² Source: OECD/PISA.

Available at: <http://lysander.sourceoecd.org/vl=1309205/cl=13/nw=1/rpsv/cgi-bin/fulltextew.pl?prpsv=/ij/oecdthemes/99980029/v2006n11/s1/p11.idx>

There are three additional categories related to science. (1) **Identifying Scientific Issues requires students to recognize issues that can be explored scientifically, and to recognize the key features of a scientific investigation. **Explaining Phenomena Scientifically** requires students to apply knowledge of science in a given situation to describe or interpret phenomena scientifically and predict changes. **Using Scientific Evidence** requires students to interpret the evidence to draw conclusions, to explain them, to identify the assumptions, evidence and reasoning that underpin them and to reflect on their implications.”¹³

Summary Proficiency Level Descriptors for Scientific Literacy, 2006

“Proficiency at Level 6

Students at Level 6 can consistently identify, explain, and apply scientific knowledge and knowledge about science in a variety of complex life situations. They can link different information sources and explanations and use evidence from those sources to justify decisions. They clearly and consistently demonstrate advanced scientific thinking and reasoning, and they demonstrate willingness to use their scientific understanding in support of solutions to unfamiliar scientific and technological situations. Students at this level can use scientific knowledge and develop arguments in support of recommendations and decisions that center on personal, social, or global situations.

Proficiency at Level 5

Students at Level 5 can identify the scientific components of many complex life situations, apply both scientific concepts and knowledge about science to these situations, and can compare, select and evaluate appropriate scientific evidence for responding to life situations. Students at this level can use well-developed inquiry abilities, link knowledge appropriately and bring critical insights to situations. They can construct explanations based on evidence and arguments based on their critical analysis.

Proficiency at Level 4

Students at Level 4 can work effectively with situations and issues that may involve explicit phenomena requiring them to make inferences about the role of science or technology. They can select and integrate explanations from different disciplines of science or technology and link those explanations directly to aspects of life situations. Students at this level can reflect on their actions and they can communicate decisions using scientific knowledge and evidence.

Proficiency at Level 3

Students at Level 3 can identify clearly described scientific issues in a range of contexts. They can select facts and knowledge to explain phenomena and apply simple models or inquiry strategies. Students at this level can interpret and use scientific concepts from different disciplines and can apply them directly. They can develop short statements using facts and make decision based on scientific knowledge.

Proficiency at Level 2

Students at Level 2 have adequate scientific knowledge to provide possible explanations in familiar contexts or draw conclusions based on simple investigations. They are capable of direct reasoning and making literal interpretations of the results of scientific inquiry or technological problem solving.

Proficiency at Level 1

Students at Level 1 have such limited scientific knowledge that it can only be applied to a few familiar situations. They can present scientific explanations that are obvious and follow explicitly from given evidence.”¹⁴

Figure 3 · PISA Scores on the Mathematics Scale (2006)

“Results from PISA have been reported using scales with an average score of 500 and a standard deviation of 100 for all three domains, which means that two-thirds of students across OECD countries scored between 400 and 600 points. These scores represent degrees of proficiency in a particular aspect of literacy.”¹⁵

Figure 4 · PISA Scores on the Science Scale (2006)

“Results from PISA have been reported using scales with an average score of 500 and a standard deviation of 100 for all three domains, which means that two-thirds of students across OECD countries scored between 400 and 600 points. These scores represent degrees of proficiency in a particular aspect of literacy.”¹⁶

¹³ Source: OECD / PISA. Scores and results in these three categories can be accessed on the OECD/PISA website: Available at: <http://pisacountry.acer.edu.au/>

¹⁴ Source: Organization for Economic Cooperation and Development (OECD), Program for International Student Assessment (PISA), <http://pisacountry.acer.edu.au/>.

¹⁵ Source: OECD/PISA. Available at: <http://lysander.sourceoecd.org/vl=1309205/cl=13/nw=1/rpsv/cgi-bin/fulltextew.pl?prpsv=/ij/oecdthemes/99980029/v2006n11/s1/p11.idx>

¹⁶ Source: OECD/PISA. Available at: <http://lysander.sourceoecd.org/vl=1309205/cl=13/nw=1/rpsv/cgi-bin/fulltextew.pl?prpsv=/ij/oecdthemes/99980029/v2006n11/s1/p11.idx>

Figure 5 • Science and Engineering Tertiary Degrees, 2007 (or latest available)
As a percentage of all new tertiary degrees

The following definitions apply to the data in the chart:

“*New university graduates* encompass all those who receive tertiary degrees delivered at the levels 5A and 6 of the 1997 International Standard Classification of Education (ISCED-1997). Doctoral graduates are those who complete an advanced research programme at ISCED level 6.

Science degrees include the following ISCED-1997 fields of study: life sciences; physical sciences; mathematics and statistics; and computing.

Engineering degrees comprise the following fields of study: engineering and engineering trades; manufacturing and processing; and architecture and building.”¹⁷

Figure 6 • Total Number of Doctoral Graduates and Graduates Concentrated in Science and Engineering per 100,000 Inhabitants 2007 (or Latest Available)

Natural Sciences, Engineering and Technology, Medical Sciences, and Agro Sciences were summed to create the category ‘Science and Engineering’. The number of graduates in ‘Science and Engineering’ and the ‘Total Ph.D.s’ were divided by data for the population per 100,000 inhabitants. If the latest available data for a country were from a year prior to 2007, corresponding populations were used (i.e., Argentina Total Ph.D.s in 2006 were divided by Argentina’s population per 100,000 inhabitants in 2006). The data for Latin America and the Caribbean (referred to as LAC in the graph) are provided in the RICYT database and are estimates.

Figure 7 • Percentage of the World’s Universities Ranked in the Top 500 by Country, 2003 and 2009

In the raw data, each country is identified by its flag. The flags were hand-matched to the country, sorted and summed by country, and divided by the total number of universities in the Top 500.

“ARWU (also known as Shanghai Rankings) uses six objective indicators to rank world universities, including:

1. The number of alumni and staff winning Nobel Prizes and Fields Medals
2. The number of highly cited researchers selected by Thomson Scientific
3. The number of articles published in journals of Nature and Science
4. The number of articles indexed in Science Citation Index - Expanded and Social Sciences Citation Index
5. And per capita performance with respect to the size of an institution.

More than 1000 universities are actually ranked by ARWU every year and the best 500 are published on the web.”¹⁸

B. Researchers

General practice as guided by the “OECD methodology for R&D statistics entitled The Measurement of Scientific and Technological Activities: Proposed Standard Practice for Surveys of Research and Experimental Development -- Frascati Manual 2002 (OECD) is that personnel data are expressed in full-time equivalent (FTE) on R&D (i.e. a person working half-time on R&D is counted as 0.5 person years) and headcount.”¹⁹ Figures 8 and 9 report FTE researchers; Figure 10 reports researchers by headcount.

Figure 8 • Researchers Per 1000 in the labor force in 1997 (or nearest available) and 2007 (or latest available)

Data from RICYT refer to full time equivalent researchers per 1000 economically active population (EAP). Data from OECD Main Science and Technology Indicators (MISTI) database refer to researchers per 1000 in the labor force.

The data for the subtotal Latin America and the Caribbean (referred to as LAC in the graph) are provided in the RICYT database and are estimates. In the case of Argentina, Bolivia, Brazil, Chile, Colombia, Nicaragua, Paraguay, Trinidad and Tobago, and Uruguay, the researchers include R&D fellows. In the case of Brazil, the EAP reported for 2000 is based on data from 1999.

¹⁷ Source: OECD <http://oberon.sourceoecd.org/vl=380876/cl=32/nw=1/rpsv/sti2007/b-1.htm>

¹⁸ Source: ARWU. Accessed December 29, 2009 from, <http://www.arwu.org/Methodology2009.jsp>.

¹⁹ Source: MSTI Full Documentation. Accessed January 5, 2010 from, <http://www.oecd.org/dataoecd/52/43/43143328.pdf?contentId=43143329>

Data for the OECD are estimates or secretariat projections. Data for Finland in 1997 are university graduates rather than researchers. In the case of Korea, data exclude R&D in social sciences and the humanities.

Figure 9 • Researchers by Sector of Employment, 2007 (or nearest available)

These data indicate the number of researchers in the business sector as a percentage of total full-time equivalent researchers.

The sectors of employment for RICYT and OECD data are: government, business enterprise, higher education and private non-profit.

The data for the subtotal Latin America and the Caribbean (referred to as LAC in the graph) are provided in the RICYT database and are estimates. Researchers include R&D fellows.

The data for China do not correspond exactly with OECD norms. Data for Finland refer to university graduates instead of researchers. Data for Ireland in 2006 are provisional. Data for Korea exclude R&D in the social sciences and humanities. Data for the United States are based on estimates in 2006, and its government sector excludes defense and is only federal or central government. Data for OECD and EU27 are provided in the OECD database and are based on Secretariat estimates or projections based on national sources.

Figure 10 • Researchers by Field of Science 2007 (or latest available)

The following categories of ‘Researchers by Fields of Science’ were available for download from the UNESCO website:

Researchers (FTE) - Natural sciences
 Researchers (FTE) - Engineering and technology
 Researchers (FTE) - Medical and Health Sciences
 Researchers (FTE) - Agricultural sciences
 Researchers (FTE) - Social sciences
 Researchers (FTE) - Humanities
 Researchers (FTE) - Not specified
 Researchers (HC) - Natural sciences
 Researchers (HC) - Engineering and technology
 Researchers (HC) - Medical and Health Sciences
 Researchers (HC) - Agricultural sciences
 Researchers (HC) - Social sciences
 Researchers (HC) - Humanities
 Researchers (HC) - Not specified
 Researchers (HC) - Total

In the graph head count (HC) for Natural sciences, Engineering and Technology, Medical and Health Sciences, and Agricultural sciences are reported as a percentage of Researchers (HC) - Total. The sum of the breakdown of the 7 categories downloaded did not always equal Researchers (HC) - Total. For Figure 10, the category ‘Social Science, Humanities & Other’ was created and includes Social Science, Humanities, Not Specified and any shortfall in summing to the total. HC data were used instead of FTE, because many more countries reported the data in HC than FTE.

C. Research and Development

“The data from OECD were collected and presented in line with standard OECD methodology for R&D statistics entitled The Measurement of Scientific and Technological Activities: Proposed Standard Practice for Surveys of Research and Experimental Development -- Frascati Manual 2002 (OECD).”²⁰

The Frascati Manual definition²¹ of R&D is:

Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

²⁰ Source: MSTI Full Documentation. Available at: <http://www.oecd.org/dataoecd/52/43/43143328.pdf?contentId=43143329>

²¹ Source: OECD (2002) page 30.

“The standard expenditure measure is the Gross Domestic Expenditure on Research and Experimental Development (GERD), which covers all R&D carried out on national territory in the year concerned. This excludes payments to international organizations and other performers abroad.”²²

Figure 11 · R&D Expenditure as a percentage of GDP 1997 (or nearest available) and 2007 (or latest available)

Data for China (1997) are underestimated or based on underestimates. Data for Ireland (1997) are based on national estimates or projections. Data for Korea exclude R&D in the social sciences and humanities. Data for the United States exclude most or all capital expenditure. Data for EU27 and OECD are provided in the OECD database and are based on Secretariat estimates or projections based on national sources.

The data for the subtotal Latin America and the Caribbean (referred to as LAC in the graph) are provided in the RICYT database and are estimates. Data for Panama include expenditure of the Smithsonian Tropical Research Institute (STRI), which represents 29 percent of total expenditure on R & D. Data for Venezuela for 1994, 1995, and 1996 include the cost of manufacturing. CONCYTEC recalculated R & D expenditure data for Peru for 1997.

Figure 12 · Shares of R&D Expenditure by Selected Countries as a Percentage of Total R&D Expenditure in Latin America & the Caribbean, 2007 (Measured in Millions of PPP)

1. GDP in PPP of the LAC country * R&D Expenditure as a Percent of GDP for that LAC country = R&D in PPP.
2. The Σ of R&D in PPP for the following LAC countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Nicaragua, Mexico, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay, and Venezuela.
3. The individual R&D expenditure in PPP for Argentina, Brazil, Chile, Colombia and Mexico were taken as a proportion of the Σ of R&D in PPP for the LAC countries listed above, and the remainder formed the ‘Rest of LAC’.

“GDP per capita based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States.”²³

Figure 13 · Percentage Difference between Observed R&D Intensity relative to the R&D Intensity Predicted by Income Level

There are no additional notes for this figure.

Figure 14 · R&D Expenditure by Funding Source 1997 (or earliest available) and 2007 (or latest available)

Data for the Latin America and the Caribbean (referred to as LAC in the graph) are provided by RICYT and are estimates. Percentages are calculated based on the breakdown of allocated expenditures, which when summed – may not equal the total.

For China, the sum of the breakdown does not add to the total. Data for Korea exclude R&D in Social Sciences and the Humanities. Data for the United States exclude more or all capital expenditure. Data for EU27 and OECD are based on Secretariat estimates or projections based on national sources. For the OECD, percent of R&D Expenditure financed abroad were not reported.

Figure 15 · R&D Expenditure by Sector of Performance, 1997 (or earliest available) for the Business Sector and 2007 (or latest available) for All Sectors

Data for Latin America and the Caribbean (referred to as LAC in the graph) are provided by RICYT and are estimates. The breakdown of allocated expenditures does not match the total expenditure. Percentages are calculated based on the breakdown of allocated expenditures. For Costa Rica 27.4495 million Costa Rican colones (Costa Rican currency) in 2007 were unassigned, as a result of implementing a new methodology. The data for 2007 differ between others in determining the selection of sectors or companies, coverage techniques, quality of response, including with respect to 2005 data.

²² Source: MSTI Full Documentation. Available at: <http://www.oecd.org/dataoecd/52/43/43143328.pdf?contentId=43143329>

²³ World Bank: <http://search.worldbank.org/data?qterm=definition%20of%20purchasing%20power%20parity&language=EN&format=html>

For China, the sum of the breakdown does not add to the total (1997) and the data are overestimated (in 1997). Data for Ireland (1997) are national estimates or projections. Data for Korea excludes R&D in Social Sciences and the Humanities. Data for the United States on R&D Expenditure in the Government Performance Sector reports Federal or central government amounts only. Data for OECD are provided in the OECD database and are based on Secretariat estimates or projections based on national sources.

D. Knowledge and Innovation Outcomes

Normalization Procedure

The data from ISI* on Scientific Publications per 1000,000 inhabitants and the data from USPTO on patents and trademarks per 100,000 inhabitants were normalized. The normalization process was adopted and followed according to the procedure described by the World Bank.²⁴ The basic process is as follows:

1. Actual data (μ) are used to assign a rank to each country in the dataset. Countries with the same performance (i.e. two countries have exactly two patents per 100,000 in the population) are assigned the same rank. The rank of 1 is assigned to the country with the best performance (i.e. the most number of publications per 100,000 in the population); the rank of 2 is assigned to the country with the next best performance, etc.
2. The number of countries with a higher rank (N_{hr}) is calculated for each country.
3. The following formula is then used to arrive at the normalized score of every country in relation to the total number of countries in the sample (N_c). If nearly all countries in the world are included in the dataset, the normalized score could be a proxy for a world ranking. The formula will assign a normalized score between 0 and 10 for each country. A normalized score of 10 is the 'best' and a normalized score of 0 is the 'most lagged'.

$$\text{Normalized } (\mu) = 10 * (1 - N^{hr} / N^c)$$

Where:

μ = each data point in the dataset

N_{hr} = number of countries with a higher rank

N_c = number of countries

One of the primary advantages to normalizing the data is that it reduces some of the noise in the figures. LAC countries often lag considerably behind developed countries in the actual data. These lags can be distorted even when population differences are mitigated (by dividing data by the population). In addition, once normalized, the figures provide additional information, since the rank can be used to infer where each country stands with respect to the rest of the countries in the dataset (approximately the global rank, as long as most countries in the world are present in the dataset).

Figure 16 • Publications per Capita (Evolution over Time)

There are no additional notes for this figure.

Figure 17 • Normalized Country Rank (0-10) in Publications per 1000 in the Population, 1994-1998 and 2004-2008

After matching ISI* data matched with WDI population, there were 182 countries ($n=182$ includes two regions; LAC and OECD) in the global dataset for the 1994-1998 normalization calculations and 183 countries ($n=183$ includes two regions; LAC and OECD) in the global dataset for the 2004-2008 normalization calculations. The regional averages were calculated as the total number of publications in the LAC or OECD region divided by the total population of the same LAC or OECD region. Regional averages were then treated as if they were a country to obtain the ranking of the region with respect other countries within the global dataset.

The following countries were included in the LAC regional average (1994-98 and 2004-08): Argentina, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, the Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad & Tobago, Uruguay, and Venezuela.

The following countries were included in the OECD regional average (1994-98 and 2004-08): Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, South Korea, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Figure 18-23 ·

There are no additional notes for these figures.

Figure 24 · Normalized Country Rank (0-10) Patents per 100,000 Inhabitants, 1995-1998 and 2005-2008

After matching USPTO data matched with WDI population, there were 161 countries (n=161 two regions; LAC and OECD) in the global dataset for the 1995-1998 normalization calculations and 163 countries (n=163 includes two regions; LAC and OECD) in the global dataset for the 2005-2008 normalization calculations. The regional averages were calculated taking an average of the countries patents per population within the LAC or OECD region. Regional averages were then treated as if they were a country to obtain the ranking of the region with respect other countries within the global dataset.

The following countries were included in the LAC regional average (1995-98 and 2005-08): Argentina, Bahamas, Barbados, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, the Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago, Uruguay, and Venezuela.

The following countries were included in the OECD regional average (1995-98* and 2005-2008): Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic,* South Korea, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

**Please note that Slovak Republic was not included in the OECD average for 1995-1998 data, because it joined the OECD in 2000. Also, Mexico was included in the LAC average and not in the OECD average.

Figure 25 · Normalized Country Rank (0-10) Trademark Applications per 100,000 Inhabitants, 1995-1998 and 2005-2008

In the USPTO data matched with WDI population, there were 158 countries (n=158 includes two regions; LAC and OECD) in the global dataset for the 1995-1998 normalization calculations and 166 countries (n=166 includes two regions; LAC and OECD) in the global dataset for the 2005-2008 normalization calculations. The regional averages were calculated as the total number of trademark applications filed by country of residence in the LAC or OECD region divided by the total population of the same LAC or OECD region. Regional averages were then treated as if they were a country to obtain the ranking of the region with respect to other countries within the global dataset.

The following countries were included in the LAC regional average (1995-98 and 2005-08): Argentina, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, the Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, the Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago, Uruguay, and Venezuela.

The following countries were included in the OECD regional average (1995-98* and 2005-08): Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic,* South Korea, Spain, Sweden, Switzerland, Turkey, the United Kingdom and United States.

**Please note that Slovak Republic was not included in the OECD average for 1995-1998 data, because it joined the OECD in 2000. Also, Mexico was included in the LAC average and not in the OECD average.

II. Production Systems and Innovation by Firms

Data trends in this section are drawn primarily from the following sources:

- Barro and Lee, 2000
- Daude and Fernandez Arias, 2010
- European Commission Eurostat database
- GGDC, University of Groningen
- Heston Summers and Aten, 2006
- IDB, 2010
- Organization for Economic Cooperation and Development (OECD)
- PADWIN, Cepal
- Science and Technology Indicators, 2010 National Science Foundation (NSF)
- United Nations Industrial Development Organization (UNIDO)
- World Development Indicators (WDI) from the World Bank

E. Productivity and Economic Structure

Figure 26 • GDP per capita, Relative Gap with Respect to the United States, Measured in PPP (Constant 2005 International \$), 2008, 1998 and 1980 (or Earliest Available)

$$GDP\ per\ Capita^{LAC\ Country} / GDP\ per\ Capita^{USA}$$

Where GDP per capita is expressed in constant 2005 International Dollars (PPP).

GDP per capita based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States.²⁵

For each year mentioned the GDP per capita for each country (LAC and comparison) is divided by the GDP per capita for the United States.

Figure 27 • Average Growth in GDP per Capita (Measured in PPP Constant 2005 International dollars), from 1998-2008 and Average Growth in Value Added at Factor Cost (Measured in 2000 Constant US dollars) / Total Labor Force), from 1997-2007

The growth rate between each year (e.g., from 1998 to 1999, from 1999 to 2000, from 2000 to 2001 and so on until 2008) for each variable for each country is calculated:

$$(V_t - V_{t-1}) / V_{t-1}$$

Where V = value of GDP per Capita or Value Added at Factor Cost

The average of the growth rates over the 10 year time period is then taken for each variable for each country.

Figures 28 and 29 • Production Functions and Total Factor Productivity were calculated using the following methodology, borrowed from IDB, 2010.

Production Functions and Total Factor Productivity were calculated using the following methodology, borrowed from IDB, 2010.

“Standard economic analysis posits mapping accumulated factors of production or physical and human capital, K and H, respectively, to output Y. This mapping is assumed to have constant returns to scale (i.e., if factor inputs K and H increase by x percent, output Y would also increase by x percent, as if the same economy “expanded” by x percent). Consider the mapping $Y = AF(K, H)$, where the constant-to-scale function $F(\cdot)$ describes how the combinations of accumulated factors can be transformed into output Y. Output per worker Y/L can be similarly decomposed expressing factors of production in per-worker terms ($k = K/L$ and $h = H/L$) to obtain $Y/L = AF(k, h)$.

In these formulas, the parameter A represents the level of aggregate efficiency or TFP: a higher A means that more output is produced with the same factors of production input, either total or per-worker. TFP is estimated as a residual to reconcile observed output with what is not accounted for by F(K,H), or F(k,h) in the case of output per worker. The key to estimating TFP is how to model the function F(.).

The standard Cobb-Douglas production function has been used:

$$Y = AK^\alpha H^{1-\alpha} = AK^\alpha (hL)^{1-\alpha}$$

Where α is the output elasticity to (physical) capital.* A standard value of $\alpha = 1/3$ is used.**

The decomposition of income per capita $y = Y/N$, where N is the size of the population as opposed to the labor force, gives rise to an extra term reflecting the share of the population in the labor force (L/N , denoted by f), which in turn results from the share of the working-age population (a demographic factor) and the rate of its participation in the labor force:

$$y = \frac{Y}{N} = A \left(\frac{K}{L}\right)^\alpha h^{1-\alpha} \frac{L}{N} = Ak^\alpha h^{1-\alpha} f$$

*Output Y is computed as PPP adjusted to real gross domestic product (GDP) from Heston, Summers, and Aten (2006); labor input and population from the World Bank (2008); education input from Barro and Lee (2000) database following Psacharopoulos (1994), and capital input from Penn World Tables (PWT) following Easterly and Levine (2001). Given data availability, the sample consists of 76 countries, of which 18 are in Latin America and the Caribbean, for the period of 1960-2005. Small countries with less than one million inhabitants are excluded from the analysis. Annual series are filtered with the Hodrick-Prescott filter to retain the trend using a smoothing parameter of 7. TFP obtained as a residual.

**See Klenow and Rodriguez-Clare (2005). Although there is some debate regarding the validity of this assumption, Gollin (2002) shows that once informal labor and household entrepreneurship are taken into account, there is no systematic difference in this parameter across countries associated with the level of development (GDP per capita) or any time trend. Hence its uniformity across countries and time appears to be a reasonable assumption.”²⁶

Figures 30-33

There are no additional notes for these figures.

Figure 34 • Decomposition of the Productivity Difference in LAC Countries with Respect to the United States, 1975 (or Earliest Available) and 2005 (or Latest Available) Differences are Expressed as a Percentage of the United States Productivity Level

Borrowing from the methodology used by Griffith et al. (2003), the following equation was used:

$$\begin{aligned} P^{USA} - P^{LAC \text{ Country}} &= \sum_i P_i^{USA} S_i^{USA} - \sum_i P_i^{LAC} S_i^{LAC} \\ &= \sum_i (P_i^{USA} - P_i^{LAC}) S_i^{LAC} + \sum_i P_i^{USA} (S_i^{USA} - S_i^{LAC}) \\ &\quad \underbrace{\hspace{1.5cm}}_{1st \text{ Term}} \quad + \quad \underbrace{\hspace{1.5cm}}_{2nd \text{ Term}} \\ &= \sum_i (P_i^{USA} - P_i^{LAC}) S_i^{LAC} + \sum_i (P_i^{USA} - P^{USA}) (S_i^{USA} - S_i^{LAC}) \end{aligned}$$

Where the final equality holds because $\sum_i S_i^{USA} = \sum_i P_i^{LAC \text{ Country}}$

²⁶ Source: Excerpted from IDB, 2010.

This equation decomposes the difference in overall productivity between the United States and a given LAC country into two components which can be named; 1st term and 2nd term.

The 1st term refers to the “within sector” component of the gap and “represents the part of the gap that would be eliminated if labor productivity within each sector in the LAC country was raised to the level in the same sector in the United States, holding the each sector’s share of the LAC country’s employment fixed. The 2nd term represents the remaining part of the gap that would be eliminated if each sector’s share of employment in the LAC country was made equal to the same sector’s share of employment in the United States, holding each sector’s labor productivity fixed.”²⁷

These calculations are done for the years 1975 and 2005 for each LAC country. Data for the LAC countries were first converted into constant 1995 US dollars, in order to be comparable with the data from the United States.

$$\text{Difference Due to Within Sector Productivity} \\ (\text{Expressed as a Percentage of the United States Productivity Level}) = \frac{1st\ Term^{LAC\ Country}}{p^{USA}}$$

$$\text{Difference Due to Distribution of Employment} \\ (\text{Expressed as a Percentage of the United States Productivity Level}) = \frac{2nd\ Term^{LAC\ Country}}{p^{USA}}$$

Figure 35 • Decomposition of Productivity Growth, from 1975 (or Earliest Available) to 2005 (or Latest Available)

Borrowing from the methodology used by Griffith et al. (2003), the following equation was used:

$$\begin{aligned} P^t - P^{t-1} &= \sum_i P_i^t S_i^t - \sum_i P_i^{t-1} S_i^{t-1} \\ &= \sum_i (P_i^t - P_i^{t-1}) S_i^{t-1} + \sum_i P_i^t (S_i^t - S_i^{t-1}) \\ &\quad \underbrace{\hspace{1.5cm}}_{1st\ Term} \quad + \quad \underbrace{\hspace{1.5cm}}_{2nd\ Term} \\ &= \sum_i (P_i^t - P_i^{t-1}) S_i^{t-1} + \sum_i (P_i^t - P^t) (S_i^t - S_i^{t-1}) \end{aligned}$$

Where the final equality holds because $\sum_i S_i^t = \sum_i P_i^{t-1}$
Where t = 2005 and t-1 = 1975

The same equation that was used to decompose the difference in overall productivity between the United States and a given LAC country can be used to decompose the change in productivity within a particular LAC country from 1975 to 2005. The decomposition of the difference in productivity from 1975 to 2005 is decomposed into two components which can again be named; 1st and 2nd term.

The 1st term refers to the “within sector” component of the gap and “represents the part of the gap that would be eliminated if labor productivity within each sector in the LAC country in 1975 was raised to the level in the same sector in that LAC country in 2005, holding the each sector’s share of employment fixed. The 2nd term represents the remaining part of the gap that would be eliminated if each sector’s share of employment in the LAC country in 1975 was made equal to the same sector’s share of employment in the LAC country in 2005, holding each sector’s labor productivity fixed.”

In this case, constant national currency data for the LAC countries were used, since no conversion into US dollars was necessary.

$$\text{Change Due to Within Sector Productivity} = \frac{1st\ Term}{p^t - p^{t-1}}$$

$$\text{Change Due to Distribution of Employment} = \frac{2nd\ Term}{p^t - p^{t-1}}$$

Table 1 • Decomposition of R&D Intensity / Value-added in the Business Sectors for Selected LAC Countries

Borrowing from the methodology used by Griffith et al. (2003), the following equation was used $A = B + C$:

$$\begin{aligned} & \overbrace{(R\&D/VA)^{USA} - (R\&D/VA)^{LAC}}^A \\ &= \sum_i \underbrace{(R\&D/VA_i^{USA} - R\&D/VA_i^{LAC})}_B + \sum_i \underbrace{(R\&D/VA_i^{USA} - R\&D/VA^{USA})(S_i^{USA} - S_i^{LAC})}_C \\ &= \quad \quad \quad B \quad \quad \quad + \quad \quad \quad C \end{aligned}$$

Where VA = Value Added and S = Sectoral share of total value added

$$B = \sum_i (R\&D/VA_i^{USA} - R\&D/VA_i^{LAC})$$

which cannot be known since there are no data available for R&D Intensity by sector for Latin American countries.

Therefore this equation ($B=A-C$) is used to solve for B.

A and C are derived in the following manner:

$$A = R\&D / VA^{Country}$$

was calculated using the following steps:

1. R&D Expenditure in PPP for particular country (RICYT) in 2002 * the percentage of R&D funded by the business sector (RICYT) in 2002 = R&D Intensity in the Business Sector^{Country}
2. R&D Intensity in the Business Sector^{Country} / (The sum of value added across the business sectors only (Groningen) in 2002 / IMF Implied PPP conversion rate from 2002)

$$3. (R\&D/VA)^{USA} - (R\&D/VA)^{LAC}$$

$$C = \sum_i (R\&D/VA_i^{USA} - R\&D/VA^{USA})(S_i^{USA} - S_i^{LAC})$$

1. R&D in millions of US Dollars (OECD Research and Development Expenditure in Industry database) / value added for that sector in millions of US dollars * Sector's share of value added
 - a. Value added for Public Utilities; Construction; Wholesale and Retail Trade, Hotels and Restaurants; Transport, Storage, and Communication and Finance, Insurance, and Real Estate (University of Groningen)
 - b. Value added for disaggregated manufacturing (PADWIN dataset, Cepal).
2. Sum the results from step 1 across sectors to get $(R\&D / VA)^{USA}$
3. Calculate each sector's share of the total business sector's value added

$$4. \sum_i (R\&D / VA_i^{USA} - R\&D / VA^{USA}) (S_i^{USA} - S_i^{LAC})$$

Data on R&D intensity disaggregated by sector are very limited even for the United States. For example, data were not available for R&D intensity for the Agriculture, Forestry, and Fishing; Mining and Quarrying; and Government, community, Social and Personal Services sectors. Therefore, this analysis has been restricted to the business sector. Second, in order to generate this table, value-added data from the University of Groningen were for Public Utilities; Construction; Wholesale and Retail Trade, Hotels and Restaurants; Transport, Storage, and Communication and Finance, Insurance, and Real Estate; but more disaggregated data were used from the PADWIN dataset for the Manufacturing sector. Data from PADWI are available for the small set of LAC countries presented in the table for 2002. In each case the R&D Intensity as reported by the OECD for the United States were matched with the value added for the each sector and within the manufacturing sector. Exact matches were possible with the coding of OECD and University of Groningen data, but some assumptions were made for the matching of OECD and PADWIN.

Figure 36 • High Technology Exports (Percent of Manufactured Exports) 1997 and 2007 (or Latest Available)

There are no additional notes for this figure.

Figure 37 • Technology Balance as a Percent of GDP, 1997 and 2007 (or Latest Available)

The technology balance as a percent of GDP is calculated as follows:

$$\text{Technology Balance of Payments} = (X - Y)/Z$$

Where X = Royalty and license fees, receipts (Balance of Payments (BoP) in US\$) and Y = Royalty and license payments (BoP in US\$) Z = GDP (Current US\$)

Figure 38 • R&D Performed Abroad by Majority-Owned Foreign Affiliates of US Parent Companies, 1997 and 2006

There are no additional notes for this figure.

III. Innovation in Firms

F. Innovation in Firms

Data trends in this section are drawn primarily from the following sources:

- Innovation Surveys used by researchers for LAC countries:
 - Argentina: Encuesta Nacional a Empresas Sobre Innovación, I+D y TICs, - 2002-2004, Buenos Aires, Argentina, SECYT-INDEC.
 - Brazil: Pesquisa industrial – inovação tecnológica 2005. Rio de Janeiro: IBGE.
 - Chile: Cuarta Encuesta de Innovación Tecnológica 2005, Instituto Nacional de Estadísticas, INE.
 - Colombia: Segunda Encuesta de Desarrollo e Innovación tecnológica 2005, DANE-DNP-Colciencias.
 - Panamá: Encuesta de investigación, desarrollo e innovación al sector privado, 2008, SENACYT.
 - Paraguay: CONACYT-DGEEC (2008). Encuesta para la determinación de la línea de base de innovación tecnológica en empresas paraguayas. Proyecto FAPEP1691/OC-PR: Programa de Apoyo al Desarrollo de la Ciencia, Tecnología e Innovación.
 - Uruguay: III Encuesta de Actividades de Innovación en la industria uruguaya (2004-2006). Agencia Nacional de Investigación e Innovación (ANII), Uruguay.
- Organization for Economic Cooperation and Development (OECD), 2010: "Innovation in Firms: A Microeconomic Perspective", OECD, Paris.

Defining Innovation:

“The Frascati and Oslo Manuals of the Organization for Economic Co-operation and Development (OECD) are international references for the measurement of technology and innovation activities (OECD, 2002; OECD and Eurostat, 2005). The Oslo Manual presents the guidelines to follow in analyzing and measuring innovation activities in firms. The innovation survey is widely used in most OECD countries. The Bogota Manual (RICYT et al, 2001), which is based on the Oslo Manual, is of particular importance for Latin American countries since it deepens the measurement of innovation, notably the areas of human resources, training, and organizational change. The most recent (third) edition of the Oslo Manual incorporates recommendations for the measurement of innovation in developing economies and adopts the essence of the message from the Bogotá Manual.

The latest edition of the Oslo Manual defines innovation as the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations. The first two types are traditionally more closely related with technological innovation. Firms are considered innovative if they have implemented an innovation during the period under review (usually two to three years).

Some surveys include additional questions on the degree of novelty of innovations. The Oslo Manual distinguishes three concepts: new to the firm, new to the market, and new to the world. Companies that innovate for local and international markets can be considered drivers of technological innovation. Many new ideas and knowledge originate from these firms. Information about the degree of novelty can be used to identify the developers and adopters of innovations, examine patterns of diffusion, and identify market leaders and followers.”²⁸

Bogota Manual: Innovation and Innovation Activities

Most innovation surveys in Latin America combine concepts of both Oslo and the Bogota Manual and have further sections of national interest. As a result, there is high discrepancy in questionnaires and comparability of indicators is in many cases imperfect. Further harmonization is needed for an appropriate international comparison, even solely within the region.

According to the Bogota Manual, “the concept of innovation is broader than the defined in the Oslo Manual. The definition of “Innovation Activities” in the Bogota Manual takes into account not only what the Oslo Manual calls “Innovation Activities,” that is, innovation activities for creative and technological change but also activities constituting so-called *technological effort* too (*ibid.*). Within the heading of innovation activities comes any action taken by a firm which aims to implement any concepts, ideas, and methods necessary for acquiring, assimilating, and incorporating new knowledge. It includes R&D expenditures and other innovation expenditures such as design, installation of new machinery (machinery and equipment linked to the implementation of innovations), and industrial engineering and embodied and disembodied technology²⁹, marketing and training. It also includes the accumulation of physical capital as well as other forms of capital, such as human (including managerial) capital and knowledge (including informational) capital.”³⁰

According to the Bogota Manual, “technological product and process (TPP) innovations include technologically new products and processes, as well as significant technological improvements in products and processes. A technological innovation in products and processes is considered to have been implemented if it has been introduced into the marketplace (product innovation) or has been used in a production process (process innovation). According to the Bogota Manual:

- A technologically new product is a product whose technological characteristics or intended uses differ significantly from those of previously produced products. Such innovations may involve radically new technologies, be based on combining existing technologies in new contexts, or be derived from the use of new knowledge.
- A technologically improved product is an existing product whose performance has been significantly enhanced or upgraded. A simple product may be improved (in terms of performance or cost) by upgrading its components or materials, or a complex product consisting of a number of integrated technical sub-systems may be improved by partial changes to one of the sub-systems.
- Technological process innovation is the adoption of technologically new or significantly improved production methods, including product delivery methods. These methods may involve changes in equipment or the organization of production or a combination of both, or even derive from the use of new knowledge. The methods may be intended to produce or deliver technologically new or improved products that cannot be produced or delivered with conventional production methods, or even to enhance basic production or delivery efficiency of existing products.

²⁸ Source: OECD (2009)

²⁹ Disembodied technology acquisition include patents, non-patented inventions, licenses, disclosures of knowhow, trademarks, designs, computer and other scientific and technical services related to the implementation of product and process innovations, as well as the acquisition of packaged software not listed elsewhere).

³⁰ RICYT et al, (2001)

- Organizational innovations are changes in the way the firm is organized and managed; changes in the organization and management of the production process; incorporation of significantly modified organizational structures and implementation of new or substantially modified strategic corporate orientations.
- Marketing innovation is the marketing of new products. New methods of product delivery. Changes in packaging.”³¹

Figures 39 – 46 •

There are no additional notes for these figures.

IV. Policy, Governance and Institutions

Data trends in this section are drawn primarily from the following sources:

- Barro and Lee, 2000
- International Standardization Organization (ISO)
- Navarro, Llisterri and Zuniga, 2010
- Park, 2008
- Políticas e Instrumentos en Ciencia, Tecnología e Innovación en América Latina y el Caribe, 2009
- Red de Indicadores de Ciencia y Tecnología (RICYT)
- World Development Indicators (WDI) from the World Bank
- World Governance Indicators (WGI) from the World Bank

G. Innovation Policy in Latin America

Figures 47 and 48 •

There are no additional notes for these figures.

H. Regulation

Figure 49 • International Patent Protection, 1995 and 2005

The following table, which is reproduced from Walter Park's paper on International Patent Protection (2008), describes the components of the patent rights index. Available points are summed from components 1-5 to generate a score along the index for each country.

Where f is the duration of protection as a *fraction* of 20 years from the date of application or 17 years from the date of grant (for grant based patent systems).³²

"(1) Coverage	Available	Not Available
Patentability of pharmaceuticals	1/8	0
Patentability of chemicals	1/8	0
Patentability of food	1/8	0
Patentability of surgical products	1/8	0
Patentability of microorganisms	1/8	0
Patentability of utility models	1/8	0
Patentability of software	1/8	0
Patentability of plant and animal varieties	1/8	0
(2) Membership in international treaties	Signatory	Not Signatory
Paris convention and revisions	1/5	0
Patent cooperation treaty	1/5	0
Protection of new varieties (UPOV)	1/5	0
Budapest treaty (microorganism deposits)	1/5	0
Trade-related intellectual property rights (TRIPS)	1/5	0
(3) Duration of Protection	Full	Partial
	1	$0 < f < 1$
(4) Enforcement Mechanisms	Available	Not Available
Preliminary (pre-trial) injunctions	1/3	0
Contributory infringement	1/3	0
Burden of proof reversal	1/3	0
(5) Restrictions on patent rights	Exists	Does not exist
Working requirements	1/3	0
Compulsory licensing	1/3	0
Revocation of patents	1/3	0

Figure 50 • Estimated Regulatory Quality, 2008 (Indicator is Measured in Units that Range from -2.5 to 2.5, Higher Values Correspond to Better Regulatory Quality)

One of the aggregate indicators of six dimensions of governance defined by the World Bank governance indicators is *Regulatory Quality (RQ)*. It is defined as "the capturing perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development." For more information about this indicator, please refer to: <http://info.worldbank.org/governance/wgi/index.asp>

³² Source: Park (2008)

Figures 51 and 52

IDB forthcoming uses the following equation to estimate a model where the penetration rate of ICTs such as Broadband and Computers are a function of a set of variables that capture demand and supply shifts:

ICT Penetration GAP (OECD Average – LAC Average) 2004-2008 = β_0 + Income + Regulatory Quality + Education + Population Density + Trade Openness + Year Dummies + ϵ

Variable	Description	Source
Income	GDP per Capita (Constant 2005 International dollars)	World Development Indicators (World Bank)
Regulatory Quality	Index measured in units that range from -2.5 to 2.5 (see notes for figure 50)	World Governance Indicators
Education	Years of schooling of the total population over the age of 15	Barro and Lee dataset (2000)
Population Density	Share of the total population living in areas defined as urban in each country	International Telecommunication Union
Trade Openness	Exports of goods and services (% of GDP) + Imports of goods and services (% of GDP) This variable is included under the assumption that in countries with more open economies, inhabitants will place a higher value on connectivity for business purposes.	World Development Indicators (World Bank)

The equations for fixed and mobile telephony, computers, broadband and the Internet are estimated by pooled Ordinary Least Squares regressions using the last 5 years of available data (2004-2008 for all except computers where 2002-2006 data were used).

The results from the regression analysis help to identify the main factors that may contribute to the global digital divide, but do not help to identify the relative importance of each one of these. Therefore, in order to use this reduced-form model as an accounting framework for the digital divide, the analysis in IDB (forthcoming) follows Chinn and Fairlie (2006, 2010), complementing the regression analysis with a technique commonly used to decompose earnings gap between different groups (Oaxaca, 1973; Blinder, 1973). This technique allows for the decomposition of differences between observed dependent variables of two groups into a part that is “explained” by observable group attributes and a residual part that cannot be accounted for by such attributes (Jann, 2008). Formally, the difference between the average outcome Y for groups i and j can be expressed as:

$$\bar{Y}_i - \bar{Y}_j = (\bar{X}_i - \bar{X}_j)\hat{\beta}^i + \hat{X}_j(\hat{\beta}^i - \hat{\beta}^j) \quad (1)$$

where \bar{X}^i and \bar{X}^j are vectors of attributes average values, and $\hat{\beta}^i$ and $\hat{\beta}^j$ are vectors of coefficient estimates for group i and j, respectively. In order to quantify the separate contributions to the global digital divide between Latin America and the OECD from the different independent variables included in the regressions, this section focuses on the first term of the decomposition, modifying it by using coefficient estimates from regressions that include all the countries in the sample. Thus, the first term of equation (1) becomes:

$$(\bar{X}^{OECD} - \bar{X}^{LAC}) \hat{\beta}^* \quad (2)$$

where \bar{X}^{OECD} and \bar{X}^{LAC} represent the five-year averages of the independent variables for OECD and Latin American countries and $\hat{\beta}^*$ the coefficients from the pooled regression.

Figures 51 and 52 show the results of this decomposition summarizing the contribution of differences accounted for by each explanatory variable to the gaps in ICT penetration rates between the average OECD country and the average LAC country.

I. Business Creation

Figures 53 and 54 ·

There are no additional notes for these figures.

J. Metrology and Standards

Figures 55-60 ·

The proportion of TC members are considered out of the following 26 LAC countries in the region: Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad & Tobago, Uruguay, and Venezuela. Mexico is included in the LAC region and not in the OECD; therefore, for the OECD, the proportion of TC members is considered out of the remaining 29 member countries.

V. Information and Communications Technology

Data trends in this section are drawn primarily from the following sources:

- Barro and Lee, 2000
- European Commission Eurostat database
- International Telecommunications Union (ITU)
- Observatory for the Information Society in Latin America and the Caribbean (OSILAC)
- United Nations E-government Survey, 2010
- World Economic Forum Global Information Technology Report (2009-2010)

K. ICT Access in Households

Figure 61 · ICT Gaps between LAC and OECD, 1995 to 2008 and Table 2: ICT Subscriptions per 100 Inhabitants, OECD and LAC countries

Regions: Latin America and the Caribbean (LAC) = Antigua and Barbuda, Argentina, Bahamas, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Rep., Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Sao Tome and Principe, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, and Venezuela. Organization of Economic Cooperation and Development (OECD) = Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, South Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

Notes: Mexico is included in LAC and not in OECD. Data from OECD countries are included only once the country has become a member of OECD. If new membership occurred from January-June the data are included that same year. If new membership occurred from July-December the data are included the following year. In this figure the following OECD countries were affected;

the Czech Republic (December 1995), South Korea (December 1996), Poland (November 1996) and the Slovak Republic (December 2000).

Fixed = Main (fixed) telephone lines per 100 inhabitants. Mobile = Mobile cellular subscriptions per 100 inhabitants. Internet = Internet subscriptions per 100 inhabitants. Broadband = Broadband subscriptions per 100 inhabitants. Computer = Number of Personal Computers per 100 inhabitants.

Data were extrapolated and interpolated to create a uniform set of observations across time periods and countries. When data were available for Internet users and not for Internet subscribers, the trend of the ratio between the two was used to deduce internet subscriber data.

Figure 62 · Capability Lags: Median Number of Years Required for LAC to Reach OECD Capability Levels, Assuming a Steady Adoption Rate, 1998 (or earliest available) and 2008 (or latest available)

The time distance methodology proposed here is relatively different from the one used by ITU (2010). In fact, to determine the delay of a country, the ITU identifies which country is at the technological frontier in a given year and then tracks when the leader had the same level of adoption that the comparison country has now. Although this methodology works relatively well for mature technologies such as fixed telephony, it tends to underestimate the time distance for new-generation technologies, such as Internet or broadband, that show a shorter time span since the time when they became commercially available. Breakthrough technological, marketing or business-model related innovations can also lead to substantial reductions in the time span needed for emerging economies to catch up, as the case of mobile telephony shows.

Regions: Latin America and the Caribbean (LAC) = Antigua and Barbuda, Argentina, Bahamas, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Sao Tome and Principe, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, and Venezuela. Organization of Economic Cooperation and Development (OECD) = Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, South Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States.

Notes: Data for Computers are from 2006 (or latest available) and 1996 (or latest available). “LAC” is the median of the region. Data from OECD countries are included only once the country has become a member of OECD. If new membership occurred from January–June the data are included that same year. If new membership occurred from July–December, the data are included the following year. In this figure, data from the Slovak Republic were not included in the 1998 OECD penetration.

The LAC capability lags are calculated by first deriving the annual pace of adoption using the earliest period that the technology was available in each LAC country (Fixed: 1960; Mobile: 1980; Internet: 1988; Broadband: 1998; Computers: 1975). If, for example, a country did not report data for the earliest period, earliest available data were used. Earliest available data for the First Penetration Period for Fixed Telephone Lines for Ecuador, El Salvador, Peru and Trinidad and Tobago are 1965, for Antigua and Barbuda, the Bahamas, Dominica, Martinique, Nicaragua and St. Vincent and the Grenadines are 1970, for Honduras, Suriname are 1975, for Panama are 1978, for Bolivia the Dominican Republic are 1980, for Haiti are 1981 and for St. Kitts and Nevis are 1983. The Second Penetration Period was either 2008 or 1998 for Fixed, Mobile and Internet, 2006 or 1996 for Computers, and 2008 only for Broadband. If data were not available for those specific years, nearest available data were used. For Mobile telephones data, earliest available data for the second penetration period for Sao Tome and Principe were 2002. For the Internet earliest available data for the second penetration period (representing 1998) for Ecuador and Guyana are 1999, Colombia, Dominica, Haiti, Martinique, Nicaragua and Paraguay are 2000, Saint Kitts and Nevis are 2002, Cuba are 2003, Antigua and Barbuda and Bermuda are 2004, Uruguay are 2005, Jamaica are 2006. For Computers, earliest available data for the second penetration period (representing 1996) for Costa Rica, Cuba and Honduras are 1997, from Grenada, Guyana, Saint Kitts and Nevis, Martinique, Panama, Paraguay, and St. Vincent and the Grenadines are 1998, from Dominica and El Salvador 1999, from Antigua and Barbuda, Dominican Rep., Haiti, Sao Tome and Principe and Suriname are 2001, from Bahamas are 2002. Latest available data for the Third Penetration Period (representing 2008) for Broadband for Saint Kitts and Nevis are 2006 and Martinique are 2007; Haiti and Honduras never report penetration levels above zero, their capability lags are not included in the LAC median for broadband. Latest available data for the third penetration period (representing 2006) for Computers for Bermuda, Dominica, Grenada, Saint Kitts and Nevis and Martinique are 2004 and for Argentina, Bahamas, Bolivia, Brazil, Chile, Costa Rica, Guatemala, Guyana, Jamaica, Nicaragua, Panama, Peru, Paraguay, El Salvador, Sao Tome and Principe, Suriname, Uruguay, St. Vincent and the Grenadines and Venezuela are 2005.

Fixed = Main (fixed) telephone lines per 100 inhabitants. Mobile = Mobile cellular subscriptions per 100 inhabitants. Internet =

Internet subscriptions per 100 in habitants. Broadband = Broadband subscriptions per 100 inhabitants. Computer = Number of Personal Computers per 100 inhabitants.

Figure 63 • The Relationship between Price as a Percent of Monthly GNI and ICT Access

Fixed, Mobile, Broadband

Regions: Latin America and the Caribbean (LAC) = Argentina, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Rep., Ecuador, El Salvador, Grenada, Guatemala, Guyana, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Lucia, Sao Tome and Principe, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, and Venezuela.

Organization of Economic Cooperation and Development (OECD) = Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, South Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

Fixed Notes: Due to graphical representation, Price was cut off at 30 percent of Monthly GNI per capita and data from the following countries were suppressed; Central African Republic:33.43, Madagascar:68.5, Mozambique:66.2, Niger:58.16, Tanzania:32.83, Togo:43.62, Uganda:44.45, Zambia:41.56. **Mobile Notes:** Due to graphical representation, price was cut off at 30 percent of Monthly GNI per Capita and data from the following countries were suppressed; Benin:32.71, Burkina Faso:47.06, Central African Republic:39.75, Madagascar:46.64, Malawi:57.39, Mozambique:37.9, Niger:59, Rwanda:37.62, Tanzania:33.25, Togo:60.05, Uganda:36.78. **Broadband Notes:** Due to graphical representation, price was cut off at 60 percent of Monthly GNI per Capita and data from the following countries were suppressed; Angola:76.67, Bangladesh:137.73, Benin:220.38, Burkina Faso:5193.56, Cambodia:201.24, Cote d'Ivoire:61.35, Gambia:1439.28, Ghana:130.96, Kenya:296.12, Lao P.D.R.:555.08, Madagascar:450.25, Malawi:4320, Mali:139.58, Mauritania:89.18, Mozambique:375.28, Nepal:80.43, Nigeria:890.41, Rwanda:344.35, Samoa:83.59, Sao Tome and Principe:377.22, Senegal:61.28, Swaziland:873.24, Tanzania:204.01, Togo:352.82, Uganda:600, Vanuatu:293.47, Zambia:137.19. Broadband subscriptions per 100 inhabitants were cut off at 60 and the data from Barbados:64.81 were suppressed.

Internet

Regions: Latin America and the Caribbean (LAC) = Antigua and Barbuda, Argentina, Aruba, Bahamas, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, French Guiana, Grenada, Guyana, Haiti, Honduras, Martinique, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Sao Tome and Principe, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, and Venezuela.

Organization of Economic Cooperation and Development (OECD) = Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, South Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

Internet Notes: Due to graphical representation, price was cut off at 60 percent of Monthly GNI per Capita and data from the following countries were suppressed; Angola:71.4, Azerbaijan:75.8, Burundi:1017.3, Benin:165.6, Burkina Faso:338, Central African Republic:773.1, Cote d'Ivoire:303.2, Cameroon:94.8, Congo:223.8, Comoros:101.6, Djibouti:146, Eritrea:328.9, Ethiopia:349.7, Ghana:122.2, Guinea:169.2, Gambia:62.7, Guinea-Bissau:900.8, Haiti:390, Kenya:205, Kyrgyzstan:134.6, Cambodia:215.7, Kiribati:263.1, Lao P.D.R.:186.7, Lesotho:129.2, Madagascar:199.2, Myanmar:77.8, Mozambique:285.7, Mauritania:127.3, Malawi:475, Niger:760.5, Nigeria:254.7, Nicaragua:86.6, Rwanda:301.9, Solomon Islands:175.9, Sierra Leone:96.1, Sao Tome and Principe:361.7, Chad:427.7, Togo:155.1, Tajikistan:310.6, Tanzania:468, Uganda:434.9, Yemen:67.4, Congo (Democratic Republic of the):1110.4, Zambia:111.3. Internet subscriptions per 100 inhabitants were cut off at 40 and data from Singapore: 53.37 were suppressed.

Figure 64 • Heterogeneity in ICT Subscriptions within Latin America and the Caribbean

Latin America and the Caribbean (LAC) = Antigua and Barbuda, Argentina, Bahamas, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Sao Tome and Principe, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, and Venezuela.

Notes: Due to graphical representation the following countries were suppressed from the figures; Antigua and Barbuda, the Bahamas, Cuba, Dominica, Grenada, Martinique Saint Kitts and Nevis, Sao Tome and Principe and St. Vincent and the Grenadines. The data

from these countries were included in regional LAC averages. Internet notes: Earliest available data for Ecuador and Guyana are 1999, Colombia, Dominica, Haiti, Nicaragua and Paraguay are 2000, Bermuda are 2004, Uruguay are 2005, and Jamaica are 2006. Broadband notes: Latest data available for Honduras and Haiti are 2005 and each are reported as zero therefore, Honduras and Haiti do not appear in the graph.

Figure 65 • Number of Personal Computers per 100 Inhabitants, 1996 and 2006

Latin America and the Caribbean (LAC) = Antigua and Barbuda, Argentina, Bahamas, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Sao Tome and Principe, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela.

Due to graphical representation the following countries were suppressed from the figures; Antigua and Barbuda, the Bahamas, Cuba, Dominica, Grenada, Martinique Saint Kitts and Nevis, Sao Tome and Principe and St. Vincent and the Grenadines. The data from these countries were included in regional LAC averages.

Computer notes: Earliest available data for Costa Rica and Honduras are 1997, for Panama and Paraguay are 1998, for El Salvador are 1999, and for the Dominican Republic, Haiti, and Suriname are 2001. Latest available data for Argentina, Bolivia, Brazil, Chile, Costa Rica, Guatemala, Guyana, Jamaica, Nicaragua, Panama, Peru, Paraguay, El Salvador, Suriname, Uruguay, and Venezuela are 2005.

Figure 66 • Percent of Households with Access to ICTs in the Home by Income Quintile (1-5), 2008 (or latest available)

Fixed Notes: Latest available data for Bolivia, El Salvador, Honduras, Mexico, Panama, Paraguay, Uruguay and Venezuela are 2007, and for Chile, Guatemala, and Nicaragua are 2006. Mobile Notes: Latest available data for Bolivia, El Salvador, Honduras, Mexico, Panama, Paraguay, Uruguay and Venezuela are 2007, and for Chile, Guatemala, and Nicaragua are 2006. Internet Notes: Latest available data for Bolivia, El Salvador, Honduras, Mexico, Panama, Paraguay, Uruguay and Venezuela are 2007, and for Chile, Guatemala, and Nicaragua are 2006. Computer Notes: Latest available data for El Salvador, Honduras, Mexico, Panama, Paraguay, Uruguay and Venezuela are 2007, for Chile, Guatemala, and Nicaragua 2006 and for Bolivia are 2005.

L. Internet Use

Figure 67 • Differences between ITU Estimated Internet subscribers and Internet users as derived from Household Surveys in Selected European and Latin American Countries (Percent of Individuals; 2006-2008)

Data refers to 2008, except for Chile (2006); and Honduras, Mexico, Panama and Paraguay (2007). In the case of Brazil and Costa Rica, ITU data are for 2007, while OSILAC data are for 2008.

Figure 68 • Location of Internet Use (Proportion of Individuals), 2008 (or latest available)

The LAC average is computed using the countries in the graph that report data. Ecuador does not report data for 'Commercial Internet Access Facility' and Peru and Paraguay do not report data for 'Public Access Center'. The variables used from Eurostat for Europe were: Home = In the last 3 months, I have accessed the Internet at home 2008 Work = In the last 3 months, I have accessed the Internet at place of work (other than home) 2008 Place of Education = In the last 3 months, I have accessed the Internet at place of education 2008 Public Access Center = In the last 3 months, I have accessed the Internet at the public library 2008 Commercial Access Facility = In the last 3 months, I have accessed the Internet in an Internet Café 2008. For Home, Work and Place of Education Europe = the EU15 countries (data provided by Eurostat): Austria, Belgium, Denmark, Finland, Germany, Greece, France, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. For Commercial and Public Access, the following European countries' data were averaged: Belgium, Denmark, Finland, Greece, Hungary, Ireland, Luxembourg, the Netherlands, Norway Portugal, Slovak Republic, Spain, Sweden, and the United Kingdom.

Figure 69 • Type of Internet Use (Proportion of Individuals), 2008 (or latest available)

The LAC average is computed using the countries in the graph that report data. Costa Rica, Uruguay, Honduras, Nicaragua, and Paraguay do not report data for 'Interaction with Public Authorities' and El Salvador reports that zero percent of individuals use the internet for 'Interaction with Public Authorities'. The variables used from Eurostat for Europe were: Leisure = I have used Internet, in the last 3 months, for leisure activities related to obtaining and sharing audiovisual content 2008 Getting Information = I have used a search engine to find information 2007 Communication = I have used Internet, in the last 3 months for communication 2008 Formal Education or Training Activities = I have used Internet, in the last 3 months, for training and education 2008 Purchasing or Ordering Goods and Services = I have used Internet, in the last 3 months, for purchasing/ordering goods or services (excluding

shares/financial services) 2005 Interaction with Public Authorities = I have used Internet, in the last 3 months, for interaction with public authorities 2008. Europe = the EU15 countries (data provided by Eurostat): Austria, Belgium, Denmark, Finland, Germany, Greece, France, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

Figure 70 • Location of Internet Use in LAC by Individual Users within their Income Quintile (5-1), 2008 (or Latest Available)

In general, data from the following countries and years were averaged: Brazil 2008, Chile 2006, Costa Rica 2008, Ecuador 2008, El Salvador 2007, Honduras 2007, Mexico 2007, Nicaragua 2006, Panama 2007, and Paraguay 2008. Exceptions (Home: data for Brazil were from 2005, Work and Place of Education: data for Paraguay were from 2007, Public Access: No Paraguay data were used, Commercial Access Facility: No Ecuador data were used).

Figure 71 • Patterns of Internet Use in LAC by Individual Users within their Income Quintile (5-1), 2008 (or Latest Available)

Data are normalized by dividing each particular type of use by the sum proportion of uses in the quintile. In general, data from the following countries and years were averaged: Brazil 2008, Chile 2006, Costa Rica 2008, Ecuador 2008, El Salvador 2007, Honduras 2007, Mexico 2007, Nicaragua 2006, Panama 2007, and Paraguay 2008. Exceptions (Getting Information: data for Brazil were from 2005, Paraguay 2006 and no data for El Salvador were used, Purchasing or Ordering Goods and Services: No data were available for Panama and Paraguay for the first quintile and for El Salvador for the first and second quintile. Interaction with Public Authorities: the following countries and years were averaged: Brazil 2008, Chile 2006, El Salvador 2007, Mexico 2007 and Panama 2007, no data are available for Panama for the first and second quintile and for El Salvador for the first, second and third quintile).

M. Government Online Service

Figure 72 • United Nations Ratings of Relative On-line Service of National Governments, 2010 and 2003

One obvious problem when assessing the extent to which governments are adopting ICTs is the lack of internationally comparable data. One of the few data sets available on this subject is the United Nations (UN) e-Government Index. It is an indicator that approximates the capacity of governments and citizens to interact over the web with regard to government-citizen-government transactions. This capacity is evaluated in three dimensions: (i) The Online Service Index (ii) telecommunications infrastructure; and (iii) human capital. Given that (ii) it is treated in other parts of this chapter and that (iii) captures general, non ICT-specific human capital indicators, the analysis that follows is based only on the first component of the index: the Online Service index. In order to build the Online Service Index, a research team assesses each country's national website—as well as the websites of the ministries of education, labor, social services, health, and finance—according to the presence of four different categories of attributes: (i) emerging online presence, (ii) enhanced presence, (iii) transactional presence, and (iv) connected presence. In this procedure, the evaluators follow a citizen-centric approach by putting themselves in the place of the average user (UNPAN, 2010). This approach has limitations to the extent that it does not capture other dimensions that could also be considered an integral part of e-government, such as government-businesses and government-government interactions. Nor it does capture the extent to which e-government tools are actually being used to promote citizens' participation in decision making and empowerment. Moreover, the index does not represent the degree of computerization or digitalization of other government operations (for example, the installation of corporate management systems). However, despite these shortcomings, the index is a valuable tool for comparative dynamic analysis, as it presents information for the period 2003-10.

Regions: Latin America and the Caribbean (LAC) = the average of the LAC countries that appear in the figure. Organization of Economic Cooperation and Development (OECD) = Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, South Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and United States.

N. Internet in Firms

Figure 73 • Percentage of Businesses with Access to the Internet, by Firm Size

Similar to the case of e-government, when assessing regional performance with regards to e-business, the lack of internationally comparable objective data becomes a serious problem. Only a handful of countries have carried out official surveys based on business registers. Even in these cases, questionnaires have been so ad hoc that data are not strictly comparable across countries. In addition, confidentiality issues make accessibility to the surveys very restricted. However, information on Internet access by firms is relatively reliable and comparable in Argentina, Chile, and Uruguay. Figures on these three countries can be also compared with similar data from the developed countries.

The classification of business size varies by data source. Europe (EU15): Small enterprises (10-49 persons employed) Medium, (50-249 persons employed), Large: (250 persons employed or more). For Europe, the data for businesses do not include the financial

sector. Uruguay: Small business (5-19 persons employed), medium (20-99 persons employed) and large (100 persons employed or more). Argentina's classification is based on company revenue: Small (Less than 50 million pesos) Medium (between 200 Million Pesos and 50 Million Pesos), Large (More than 200 million pesos). Chile's classification is based on annual sales in Unidad de Fomento: Small (2,401 to 25,000 UF), Medium (50,001 to 100,000 UF), Medium-Small (25,001-50,000 UF), Large (100,001 and more UF). Data from Medium and Medium-small were averaged to create the medium used for comparative purposes. Europe = EU15 countries (data provided by Eurostat) Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Spain, the Netherlands, Portugal, Sweden, and the United Kingdom.

Figure 74 • Extent of Business Internet Use, Weighted Average of 2008 and 2009

Data are compiled from the World Economic Forum's Executive Opinion Survey. Survey questions ask for response on a scale of 1 to 7, where 1 corresponds to the lowest possible score and 7 corresponds to the highest possible score. For each Survey question, individual responses from the 2008 and 2009 editions of the Survey are combined and aggregated at the country level in order to produce country scores. For more information on the Executive Opinion Survey please refer to Chapter 1.1 <http://www.weforum.org/documents.GITR10/index.html>.

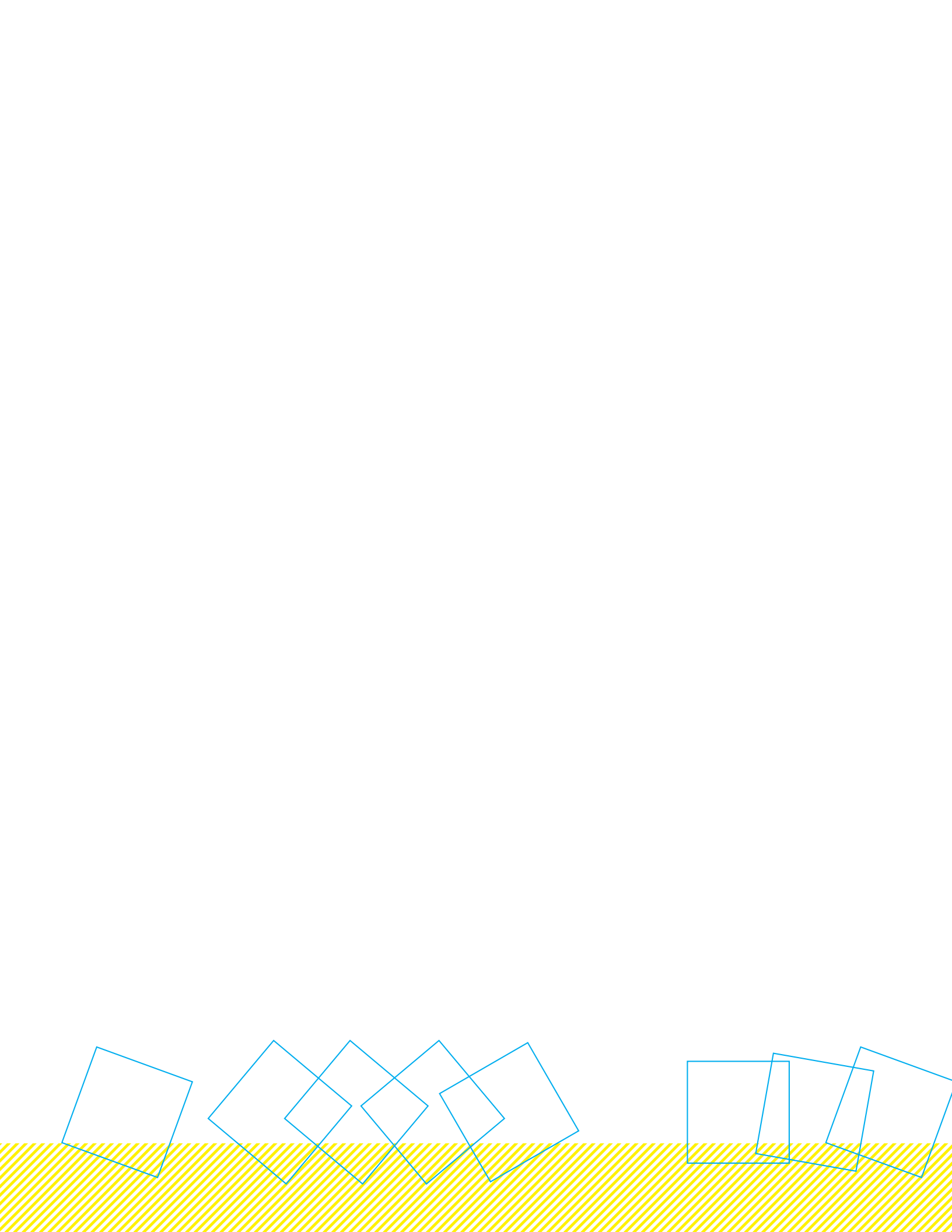
Regions: Latin America and the Caribbean (LAC) = the average of the LAC countries that appear in the figure. Organization of Economic Cooperation and Development (OECD) = Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, South Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. There are 133 countries that participated in the Survey, World = the average of the 133 participating countries.

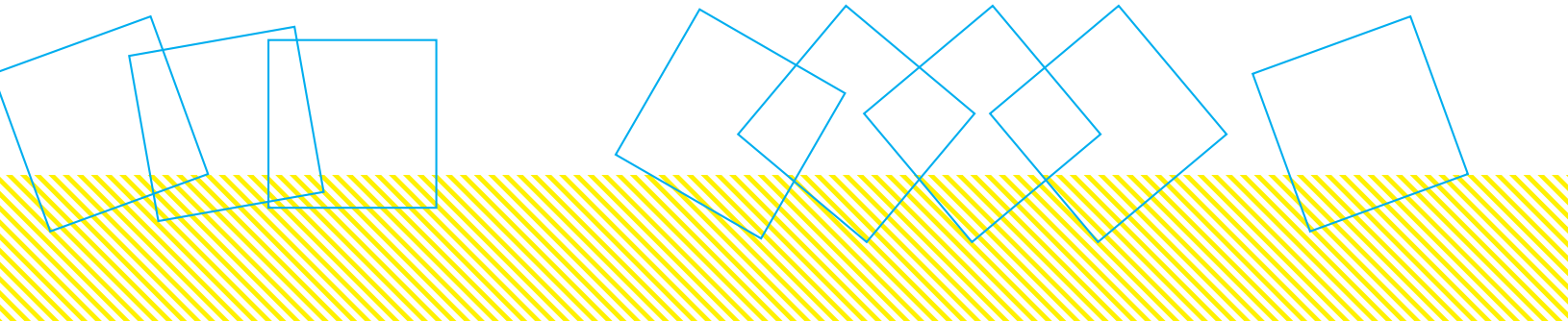
Compendium QR Code Troubleshooting

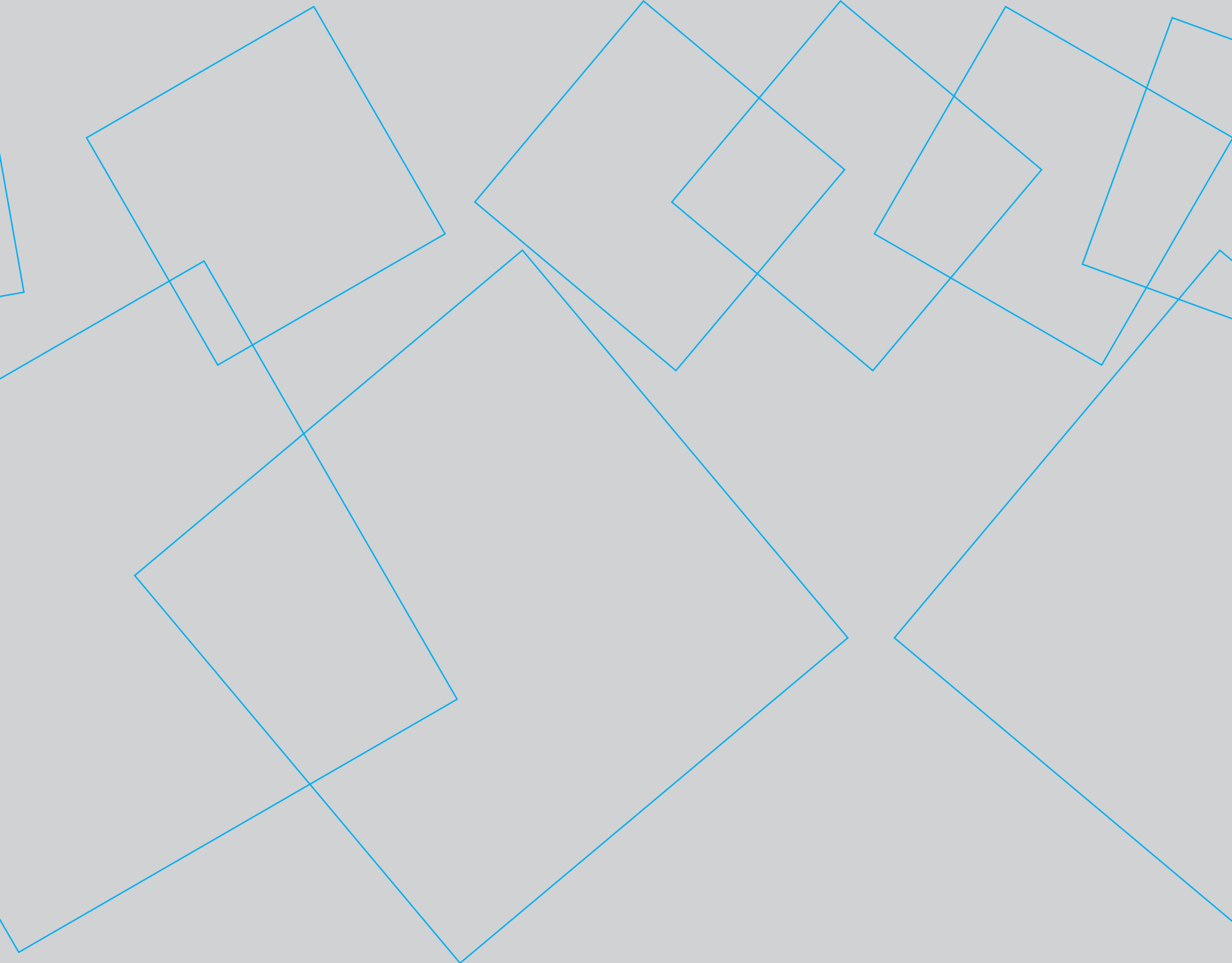
1. Make sure that your web camera is turned on and working.
2. Hold the compendium steady. This will help your web camera detect the unique QR code.
3. Check to make sure that you are in a room with normal levels of lighting. Bright lights can make it difficult for your web camera to read the QR codes.
4. Do not hold or tilt the Compendium at an angle; check to make sure that the Compendium is not bent, creased or folded.

To access selected raw data that were used to construct indicators, figures and tables, please visit www.iadb.org/tech.









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