The Age of Productivity

Transforming Economies from the Bottom Up

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The Age of Productivity

Productivity isn't everything, but in the long run it is almost everything.

Paul Krugman

The economies of Latin America and the Caribbean suffer from a chronic low-growth disease. Unfortunately, the region has become so accustomed to this economic ailment, that it no longer considers growth its most pressing problem. And yet, the countries of the region are paying dearly for not assigning economic growth the highest priority.

How costly has the lack of growth been for the region? Some counterfactuals provide a vivid illustration. Take, for example, Argentina, which in 2006 had an income per capita of US$12,258 (purchasing power parity [or PPP] adjusted).[1] If from 1960 onwards, it had grown at the same rate as the rest of the world, excluding Latin America and the Caribbean, in 2006 it would have had an income per capita similar to that of the United Kingdom (US$27,800). By the same calculation, Venezuela and Uruguay would have had in 2006 the income per capita of Israel and Spain, respectively; that is almost three times Venezuela's current income and twice that of Uruguay's. Similarly, the income per capita of Bolivia, Honduras, Jamaica, Peru, and El Salvador would have been more than double what they reported in 2006, and in Nicaragua, more than triple. Even Chile, a country heralded for its superior economic performance over the past 25 years, underperformed the rest of the world when assessed from a long-term perspective. Had Chile grown on par with the rest of the world since 1960, its income per capita in 2006 would have been the same as that of Portugal and Greece. Brazil, which has suffered relatively less when measured with this yardstick, would nonetheless be relishing an income per capita almost 25 percent higher than what it is enjoying today. Only two countries, Panama and the Dominican Republic, have grown at levels comparable to the world average (excluding the region). Given

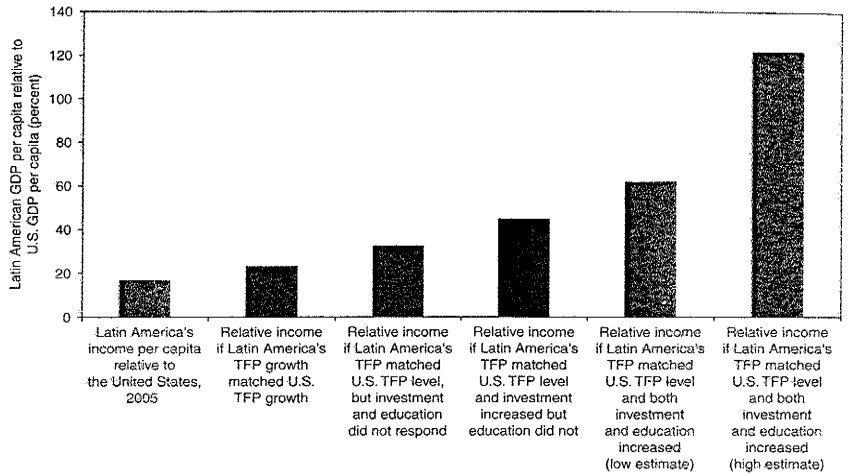
these figures, it is not surprising that in 1960, the average income per capita in Latin America and the Caribbean was almost one-quarter that of the United States while today it is only one-sixth. In contrast, several East Asian countries, which in 1960 had income levels much below Latin America and the Caribbean, are fast approaching or have joined the ranks of high-income nations.

This book argues that low productivity growth is the root cause of Latin America's poor economic growth and that achieving higher productivity must be at the epicenter of the current economic debate. Escaping relatively unscathed from the worst international financial crisis since the Great Depression, the region should avoid basking in complacency or proceeding down the road of diminished expectations; instead, it should seize the opportunity to pursue a determined, ambitious productivity agenda. Why productivity? Because income gaps opened up, not due to a lack of investment in physical and human capital or to the slow growth of the labor force, but rather, due to a chronic productivity growth deficit. If productivity in Latin America and the Caribbean (referred to in this book as the region) had grown at the same rate as that in the United States, the income per capita of the region relative to the United States would have remained unchanged at one-quarter, even with the reported investments in human and physical capital. If, on the other hand, productivity had converged to the U.S. level—that is, if the physical and human resources that Latin American and Caribbean countries currently enjoy were used with the productive efficiency of those in the United States—per capita income would have doubled and the income of the region relative to that of the United States would have been one-third. However, with higher productivity, investment and education would certainly have increased as well, narrowing the gap even further and over time converging on the income levels of developed countries (see Figure 1.1).

The good news is that while increasing the stock of physical or human capital may require resources that are unavailable in low-income countries and may even be wasteful if productivity is low, boosting productivity may "simply" require the willingness to transform policies and institutions in light of successful experiences elsewhere. The objective of this study is not only to investigate the causes of the region's poor productivity performance, but also, crucially, to identify and propose policy options to unleash an age of productivity in Latin America and the Caribbean.

The productivity challenge cannot wait. Millions of people in Latin America and the Caribbean are suffering from limitations that could be solved if existing resources were better utilized. Millions of workers are condemned to low productivity jobs that do not pay enough to lift themselves and their families out of poverty. Over a decade ago, the region pioneered a

Figure 1.1 Latin American GDP Per Capita Relative to U.S. GDP Per Capita, 2005: Typical Latin American Country under Different Scenarios



Source: Authors' calculations based on World Bank (2008), Barro and Lee (2000), Heston, Summers, and Aten (2006). For details see Chapter 2.

new generation of programs to combat poverty by means of income transfers linked to investment in the human capital of poor families. On balance, these programs have had a positive impact but by themselves cannot achieve a central objective: to provide poor workers with higher incomes thanks to higher productivity rather than transfers from the national budget. Unless productivity increases, poor children and young people who are now benefiting from these programs will eventually be healthier and more educated than their parents when they join the labor force, but will still be poor.

Doing More with the Same

Raising productivity implies finding better ways to more efficiently use the existing labor, physical capital, and human capital of the region. One standard way to measure gains in efficiency is to compute increases in total factor productivity (TFP), that is, the efficiency with which the economy transforms its accumulated factors of production into output. Reporting that TFP grew 1 percent is equivalent to saying that 1 percent more output was obtained from the same productive resources. This is the preferred measure of productivity in this book, yet it is computationally demanding

because it requires measuring all inputs used in production, something that is not always feasible. Other partial measures of productivity are also commonly used. Distinguishing between TFP and these other indicators is important because they capture different things. For example, one often-used measure of productivity is output per worker, which is calculated on the basis of the size of the labor force. This measure does not consider education or capital as factors of production, and therefore, the increase in production due to higher average education or more physical capital would be measured as an increase in productivity. Output per worker then is a reflection of factor accumulation—more physical capital and more human capital—and pure efficiency gains. As stated, a key result presented in this book is that the GDP growth gap of the region is mostly associated with efficiency growth gaps rather than accumulation gaps. Consequently, the focus of this study is on the drivers of the level and growth of TFP rather than on the determinants of human or physical capital accumulation.

Beyond Technological Progress

Typically, efficiency gains are calculated as a residual, that is, as the portion of growth that cannot be accounted for by the accumulation of factors. In that way productivity becomes—as Robert Solow, Nobel laureate and creator of the modern theory of economic growth, famously said—"a measure of our ignorance." Since Solow's seminal work in 1957, this residual has often been treated as a measure of technology, with technological progress credited as the main determinant of productivity growth.

This book, however, argues that attaining aggregate efficiency gains is a very complex problem that goes well beyond technological growth. It requires incentives to be aligned, fair competition for resources, and the opportunity for firms with good ideas to thrive and grow. Low productivity is often the unintended result of a myriad of market failures and poor economic policies that distort incentives for innovation, prevent efficient companies from expanding, and promote the survival and growth of inefficient firms. These market and policy failures are more prominent in developing economies—Latin America is no exception—and are an important factor explaining their relatively lower levels of productivity. Thus, economic development requires shedding layers of bad policies and correcting for key market failures that conspire against productivity growth. The upshot is that while high-income economies must rely to a larger extent on promoting innovation to grow, the region can explore additional avenues for growth. This does not imply that innovation and technology adoption are not important sources of productivity growth in developing countries;

quite the opposite. It simply means that in addition to increasing the productivity of each firm by promoting innovation and technology adoption, other potential sources of growth are available to developing countries and should be considered and tried, if appropriate. While such advances would provide only temporary sources of growth, they could provide a huge leap forward similar to the gains enjoyed during the rapid urbanization and structural transformation of the 1950s and 1960s.

Beyond Manufacturing

The diagnoses and policy proposals on the productivity problems of Latin American and Caribbean economies concentrate almost exclusively on the industrial sectors, and sometimes on manufacturing alone. However, in order to boost growth and per capita income, the region must boost productivity of the nontradable sector.

Industrialization and prosperity are usually considered synonymous, and with good reason: developed countries became rich when, thanks to the industrial revolution, the labor force that was concentrated in the agricultural and traditional craft sectors shifted to industrial manufacturing, which has much higher productivity.

Latin American countries tried to follow this route to prosperity during the second half of the twentieth century, but their attempts at industrialization were only partially successful. Quite remarkably, the share of industrial employment is now lower in Latin America than in both East Asia and the developed world. Combined with the declining share of employment in agriculture, this situation has swelled the ranks of the service sector and contributed to its meager productivity growth compared to either developed or fast-growing East Asian economies. Unlike developed countries, which first prospered with industry and then transformed themselves into service economies, the region's economies became tertiary (or service-based) halfway along the road from poverty to prosperity.

Since industrial sectors in Latin America and the Caribbean account for barely 20 percent of the labor force, solving the problems of competitiveness or technological backwardness in this sector will do little to overcome underdevelopment. It is estimated that raising the growth of productivity of the manufacturing sector to the rate of that in East Asia would hardly change aggregate productivity growth. In contrast, aggregate productivity could double if productive growth in the very laggard service sectors rose to match the productivity growth of these sectors in East Asia.

Raising the productivity of services is a must to improve the standard of living of all Latin American and Caribbean people: most workers are

employed in the service sector, and the competitiveness of the primary and industrial sectors depends on having good transport and communications, efficient storage and distribution systems, and many other services.

The Many Faces of Low Productivity

Low productivity is not universal; it is concentrated in some firms. This study uncovers dramatic differences in productivity, even within narrowly defined sectors. Across countries, the least productive companies tend to be the smallest ones, and, throughout the region, size and productivity are related. Small companies (particularly those with fewer than ten employees) account for the bulk of the economy in Latin America, more so than in higher income economies, while there is a dearth of medium-level—and in some cases high-level—productivity firms.[2] But the problem goes beyond the large number of small firms with low productivity. Much of the labor force in Latin America and the Caribbean is self-employed, often selling their products in the streets of the region's cities. If these workers are considered one-person enterprises, as in fact they are, the phenomenon of pulverization of economic activity into millions of tiny enterprises with low productivity is even more significant.

Reducing the share of small manufacturing firms and increasing the share of medium-sized manufacturing firms so as to match the size distribution of manufacturing firms in the United States—leaving productivity levels of individual firms unchanged—would almost double manufacturing productivity in the countries for which this computation can be performed. This boost would be large enough to close the manufacturing productivity gap with the United States. This means that, unlike other regions of the world, the overwhelming presence of small companies and self-employed workers is a sign of failure, not of success. In some countries, highly productive small firms face growth constraints, such as limited access to credit, in becoming medium or large firms. In others, the excess of small firms appears to be associated with a plethora of implicit subsidies to small firms; they can more easily evade taxes, social security mandates, and other regulations than medium and large firms. These subsidies help low productivity firms gain market share and prevent high productivity firms from gaining the same.

The large proportion of very small firms also manifests the failure of many small companies to innovate and become medium-level productivity firms and of medium productivity firms to enter the market and attract labor from small, less-productive firms. While all firms spend few resources on research and development relative to developed economies, small firms are even less likely than larger firms to innovate. Large businesses can distribute the high fixed costs of innovation across a larger volume of sales, and have better access to financial services, technology, consulting, and specialized human-capital markets.

The proliferation of many small firms of very low productivity is particularly acute in the service sectors where millions of Latin American and Caribbean workers have taken refuge and the problems of low earnings and high levels of poverty are more extreme.

Clearly, the region is making poor use of its available resources. Much capital and many workers could be much more productive if employed more efficiently, even if they performed similar activities within the same economic sector. In Latin America, reallocating resources could increase aggregate productivity by approximately 50–60 percent. In some countries, such as Mexico, these gains could be around 100 percent. Yet, the greatest room for improvement lies outside the manufacturing sectors. The commercial retail sector, is a potential reserve of enormous gains: in Mexico and Brazil the productivity of this sector could be catapulted to around 260 percent, and similar gains could be achieved in other services. Extensive resource misallocation is a symptom of the lack of fair competition for resources, as policies, market failures, or location advantages favor some firms over others for reasons other than their relative efficiency.

In sum, productivity levels in a given economy are the result of forces and incentives guiding the decisions of existing and prospective firms that determine the mix of firms in an economy, the productivity of each firm, and the firm's size, given its productivity. Each of these factors can be altered by market and policy failures in ways that reduce productivity. The question then becomes, which policies or market failures are associated with Latin America's poor productivity performance and how can they be transformed to unleash an age of productivity?

Policies for Productivity

With the right economic policies, Latin American governments can go a long way toward solving the productivity problem. Many of the problems arise from market failures that have yet to be properly addressed, and others from failed economic policies that, often unintentionally, have taken a toll on productivity. In particular, this book explores whether policies on trade, credit, taxes, social protection, aid to small firms, innovation, and industrial promotion are at the root of the problem, or instead part of the cure for the low productivity growth disease of the region. This list is not exhaustive and some of the omissions, such as education or regulatory

policies, may surprise readers. However, this book focuses on the less-studied dimensions of productivity that may be vitally important for the design of public policy in Latin America and the Caribbean. One of the major conclusions of this study is that many policies—often in areas not commonly associated with productivity—may have intended, or even unintended, effects on efficiency. These often-overlooked policy areas are the focus of this book while many of the absent topics have been left to the ongoing research agenda of the IDB.

Trade and the High Productivity Toll of Transport Costs

Free trade has often been touted as a boon to productivity. Opening the door to imports should expose producers to greater competition, forcing them to cut costs and increase their efficiency while providing greater access to more and better inputs, particularly capital goods. But there are other very important channels through which international trade affects productivity that have been less studied. Even without changing the productivity levels of firms, international trade can boost aggregate productivity by helping to reallocate resources in favor of more productive uses.

Unfortunately, transport costs have in large part prevented the region from capitalizing on the productivity potential of international trade. For most countries, transport costs represent the highest percentage of the cost of trade, especially exports, and distance or geography are not the only reasons why. Cargo transport costs of Central American countries, as a proportion of the value of their exports to the United States, are higher than China's. Why? Their ports and airports are grossly inefficient. And the situation in Latin America is not much different. Inadequate physical infrastructure is to blame in some countries, but more important are the support activities for the movement of cargo and the inefficiencies caused by inadequate regulation, lack of competition in services, and deficient operating procedures and information systems. Inefficiencies in domestic cargo transport are even greater than those of international transport; crumbling infrastructure and traffic congestion seriously affect the productivity of firms operating in Latin American cities.

Too Little Credit

Despite the financial deregulation of the 1990s, the depth of Latin American credit systems remains very low by international standards. Consequently, lack of credit is one reason why there is so much dispersion

in the productivity of firms. Without credit, productive firms cannot expand and less-productive firms cannot make the technological changes and investments needed to raise their productivity. The credit drought has another damaging effect on productivity: it weakens the incentives for informal firms to comply with tax, legal, and social security provisions. This hurts productivity by allowing unproductive firms to survive because they have lower costs than their formal counterparts. Expansion of credit would make a strong contribution to formalizing employment.

However, increasing the supply of credit is not enough to improve productivity; it must be sustainable. Continued episodes of credit boom and bust, typical of Latin America in the past, tend to be harmful for productivity in the long term. If credit crises are frequent, small, but potentially efficient, firms have no more chance of surviving than inefficient ones. Moreover, firms have a greater incentive to invest in more malleable but less-productive technologies, better suited to a volatile economic environment.

Latin America and the Caribbean have made notable financial progress in the last decade, helping the region weather with relative success the financial earthquake of 2008–2009. Still, it is too early to shout victory. The region is far behind in its capacity to create, identify, and execute property rights over the assets and obligations of firms. This is perhaps the most difficult and crucial step if financial systems are to support the growth of productivity. Moreover, more credit for enterprises is not always synonymous with higher productivity; loans must be channeled to enterprises with higher productive potential. When credit is granted to unproductive enterprises, it perpetuates the misallocation of effort, work, and capital that reduces a country's productivity. National development banks or public credit subsidies are classic cases in point. Certainly, these banks and programs can contribute much to productivity growth, but targeted mechanisms must ensure that credit flows to the most productive—or potentially productive—firms. This distinction is not easy, but is indispensable to avoid wasting the country's productive resources.

Taxes: Simplify, Simplify, Simplify

Although the worst aberrations have already been corrected, tax systems in the region remain extremely complex, segmented, and ineffective. It takes an average of 320 hours per year for Latin American and Caribbean firms to file taxes compared to an average of 177 hours in high-income countries. In some countries tax-related transactions can take as many as 2,000 hours a year. Almost all countries have multiple tax regimes for

firms of different sizes, and tax collection is decidedly low (17 percent of gross domestic product [GDP] in 2005 compared to 36 percent in industrial countries). Taxes on profits are high by international standards, yet collection is very inefficient due to high evasion, particularly among small and microfirms. Evasion is not only a problem of collection but also of productivity. Tax systems distort the allocation of productive resources: the sectors and firms that expand are not necessarily the most productive but rather those that enjoy higher tax breaks or can evade their tax obligations more easily.

Since tax systems are so complex and smaller enterprises contribute minimally to tax collection, tax administrations in 13 of the 17 Latin American countries studied have established simplified regimes for them, and two other countries simply exempt them from taxes. Since the simplified regimes benefit small enterprises with sales and employee levels below certain limits, firms try to stay within these limits to avoid a sharp drop in their profitability; this maneuvering contributes to the low number of intermediate-sized enterprises in Latin America. Simplified tax regimes for small enterprises are a collection of all the defects of a bad tax system: discrimination by size, easier evasion, less cross-control between firms, and limited information for tax control.

Latin American tax regimes bear much of the responsibility for the region's productivity problems because they encourage the survival of unproductive firms, obstruct the growth of small and large enterprises alike, and foster a deeply unequal and segmented business universe. Tax regimes differentiated by sector, size of enterprise, or for other reasons distort the allocation of resources, divert the scarce managerial resources of enterprises, and are an extra burden for the public administration, while paradoxically decreasing collection. A well-designed tax system should create incentives to pay taxes and prevent evasion. Simplifying, unifying, and enforcing the tax provisions that apply to enterprises could contribute greatly to productivity; in turn, higher productivity would boost both GDP and tax receipts.

Redrafting Social Policy

Only one out of three Latin American workers is covered by social security systems and other compulsory benefits for legal wage earners, such as health insurance, pensions, unemployment and disability insurance, and home finance. This limited coverage is not surprising given the cost for both employers and workers and the low value many workers appear to assign to these benefits. Often, workers prefer to work independently or

for a company that evades contributions to these programs, in exchange for a slightly higher net wage than they would receive in a formal enterprise. These behaviors help explain the pulverization of economic activity and the tragedy of low productivity in the region.

Given the limited coverage of social security programs and other labor benefits, governments have implemented various social protection programs for workers without coverage.

Social security and protection systems are justifiable for many reasons, and a vigorous social policy is clearly essential in a region characterized by so many deficiencies and inequities. However, well-intended but poorly conceived remedial solutions to low coverage reinforce the incentives for informal employment and aggravate their negative impact on productivity. Over time, the coexistence of parallel social security and protection regimes can trap the region in a vicious circle that is harmful to productivity. Since lower productivity results in lower real wages, governments understandably try to buoy workers' standards of living with more social programs, particularly for those in the informal sector. This further widens the gap between the cost of formal and informal work and leads to more self-employment and microenterprises that do not offer their workers social security coverage. This trend generates more low productivity jobs, decreases the labor supply for more productive formal enterprises, and prevents increases in real wages, closing the circle.

The answer is not to eliminate social protection mechanisms but to cut the linkage of benefits and funding with employment. Universal coverage services, such as health insurance, or even retirement pensions, can be funded with fewer distortions by general taxation and supplemental payments. Services such as universal education funded from general state budgets do not generate strategic behavior toward informality, or impact negatively on productivity. Services that depend on preferences, savings options, and household income levels, such as home finance, can be offered more efficiently by the financial market, with direct subsidies for the poorest families. Only insurance against risks inherent in the employment relationship, such as unemployment or industrial accidents, should be tied to it.

SME Programs: Can One Size Fit All?

Large companies are, in general, more productive than small ones but it is important to understand why. One possibility is that productivity causes size, that is, firms with better projects, ideas, or management find it more profitable to be bigger. Another reason might be economies of

scale: having several automobile production plants is inefficient when a single plant could produce the same number of automobiles with fewer resources. Finally, larger companies may be more productive because they have better access to credit or can train their workers more easily. In light of this, firms in a sector do not need to consolidate—which could lead to unproductive monopolies—but they do need expanded financial services and training programs. This has been the logic behind the numerous support programs for small- and medium-sized enterprises (SMEs) in Latin America, most of which are aimed at improving access to credit, offering training, fostering product innovation, and achieving standardized quality certifications (ISO).

For micro- and SME-support programs to make a significant contribution to productivity, they need to raise the productivity of enterprises far above the cost of the programs, or the additional capital and labor used by these enterprises can be more productively used by other enterprises. However, on average, small firms—particularly the smallest ones—do not necessarily use additional resources more productively than medium and large firms. If anything, most of the evidence suggests the opposite: many of the smallest firms are actually too large relative to what they should be because they benefit from implicit subsidies in the form of unpaid taxes and social security contributions. Thus, they may not be able to employ additional labor or capital very productively, particularly relative to larger firms.

Do SME programs increase firms' productivity? Unfortunately, evaluations of these programs have been few and far between and when done, the variable of focus has been employment rather than productivity. Yet, the objective should not be to create jobs but to create productive jobs, which can occur in an enterprise of any size, including but not limited to SMEs. Estimates in this volume suggest that SME programs may indeed boost the productivity of beneficiary firms; however, in the aggregate, the effects would be greater if support was not restricted to SMEs but, rather, was open to all firms. Focusing attention on SMEs is to target an instrument rather than an objective, with the risk of developing a large mass of very small enterprises that survive thanks to public subsidies and creating many low productivity jobs that could have been high productivity jobs if created elsewhere. To minimize this risk, in addition to opening up support programs to firms of all sizes, they should be targeted to formal firms. This has the double advantage of selecting firms that are more likely to benefit from these programs—the evidence, for example, indicates that small formal firms are more likely to benefit from such programs than small informal firms—and in addition, provides incentives for the formalization of firms.

New Ideas for Innovation

Although many Latin American firms invest in innovation, their financial commitment amounts to a mere 0.5 percent of gross revenue compared to 2 percent, or four times higher, in countries associated with the Organization for Economic Cooperation and Development (OECD). Latin American enterprises spend most of their innovation dollars on assimilating the technology in new equipment and machinery, while developed countries invest primarily in research and development. Unfortunately, the long-term return on this investment in innovation is reduced by firms' limited technological ability to assimilate imported technology.

Who invests the most in innovation? It is not the largest firms, or the biggest exporters, or even those that receive the most foreign investment. Investment in innovation as a percentage of sales is the highest in enterprises with good access to finance, effective intellectual property protection, and technological cooperation with their clients, suppliers, or entities involved in the transmission of applied knowledge. In some countries, the market creates incentives for enterprises to invest more in innovation. The main obstacles to innovation are lack of finance, long return periods, small domestic markets, and a shortage of trained personnel. Consequently, deepening credit markets, lowering transportation costs, and improving education and worker training can boost the incentives for firms to innovate.

Enterprises are not the only agent of innovation. In fact, the public sector is the biggest spender on research and development, but its focus is on basic research rather than productive activity. Activity is concentrated in universities and public research centers, which, with valuable exceptions, have little influence on productive innovation and have a low scientific performance by international standards.

Today's deficiencies in innovation are the legacy of a first generation of policies that emphasized the supply of human capital and scientific infrastructure, ignoring demand and evaluation and neglecting connections with productive sectors. A second generation of policies in fashion during the last two decades attempted to fill this vacuum by creating incentives for innovation in firms, especially by means of innovation funds awarded by competition or through tax breaks. Now, a third generation of policies is focusing on solving failures in communication among the various actors in innovation systems and overcoming previously identified problems.

Working Together

Innovation is not the only productivity policy plagued by coordination failures. The success of a large hotel project depends on, among other

factors, adequate water and electrical services, a nearby airport, good access routes to sites of interest, and tourist safety. From the extraction of natural resources to the provision of health services, everything depends on the coordinated efforts of individuals, enterprises, and institutions in the private and public sectors.

"Leveling the playing field" so that all sectors have access to all resources under equal conditions was the slogan during the heyday of the Washington Consensus. Although valid in some respects, this slogan is not useful for sectoral policy, because sectors are unique and may require inputs and support institutions specific to them.

Industrial policies are back in vogue but styled differently than in the past. Today they are understood as a set of instruments and institutions that facilitate coordination and generate specific public inputs required by specific sectors. Although the final product may be exports or goods tradable internationally, that is not the objective of these new industrial policies. Rather, the goal is to resolve coordination problems and provide inputs for sectors handpicked for their potential comparative advantages or externalities over other sectors. In fact, a better name for these policies is productive development policies to emphasize that they are not limited to the industrial sector and to link them directly to productivity rather than to promoting an economic activity as an end in itself.

Some successful new productive development policies have been in traditional sectors, such as agriculture, in which public-private partnerships have achieved groundbreaking technical developments. Outstanding examples are genetically improved rice varieties or soy seeds adapted to the Brazilian *savannas.* Other successes have been in completely different sectors such as information or nanotechnology.

Since the new productive development policies identify sectors ("doomed to choose")[3] with no guarantee of success and must promote exploration of new activities and forms of production, they must be proactive but restricted in their scope. This requires institutions that promote public-private cooperation, exploit the information advantages of the private sector, create incentives for risk-taking, and above all discourage rent-seeking behavior—a major challenge indeed.

Why So Difficult?

Since productivity is the art of achieving more with the same, policies aimed at increasing productivity should be the sweethearts of any political system. Unfortunately, raising productivity is a complex task that requires identifying appropriate policies, understanding the conflicts between

different objectives, securing the resources to implement the policies, dealing with those who would prefer the status quo or other policies, and maintaining sustained efforts in complementary areas until they bear fruit. It is such an uncertain task, which requires so much coordination, effort and patience, that it is rarely the priority of political systems. Distributing subsidies to unproductive enterprises or increasing social programs for the unemployed, low-income families, small firms, or informal workers is easier and reaps greater and more immediate political returns.

If enterprises are champions of productivity their interests tend to coincide with the general well-being of society. This is a rarity for individual firms operating in isolation but is more likely when businesses join forces in high-level associations to spawn policies. When firms must interact before presenting their demands, they are more likely to take into account the indirect effects on the rest of the economy. In an economy with a centralized government, a stable political system, and a small number of parties, a highly structured business influence that may be driven by a concentrated economic structure will likely favor the adoption of policies that promote productivity not only for the individuals in the main sector but also for those in others. However, in many countries, productive structures have become diversified, the powers of national governments have been decentralized, and in some cases weakened, and political systems are now more participative and porous, which has led to a Balkanization of the effort to derive benefits from public policies.

With terrifying frequency, productivity is the innocent victim of that effort resulting in enterprises that are highly profitable not because they are productive but because they extract income through special concessions or special regulations; labor unions that create barriers to entry and carve out special benefits for their members and higher costs for everyone else; small private enterprises that despite being unproductive manage to stay in business because they evade taxes and social security contributions; sectors—agriculture, mining, manufacturing, transport or commerce—that extract benefits from special tax treatment or some subsidy hidden in a corner of the national budget; informal workers who receive social benefits for which they would have to pay if they were formal; and public enterprises whose monopoly position allows them to drag down the productivity of everyone with their bad service and high costs. In short, countless behaviors add up to benefits for particular enterprises or workers that are not based on higher productivity and that, taken together, are part of the explanation of the tragedy of low productivity in the region.

Putting policies that raise productivity into practice depends on how private interests are organized. But more crucially, it depends on the capacity of the state and the political system to (a) maintain stable and

credible policies that enable the private sector to invest and innovate with a long-term horizon; (b) adapt policies to changes in economic circumstances; and (c) coordinate the policies of different areas—economic, social and institutional—taking into account their effects on each other. If the government lacks these capabilities, business organizations or influential economic groups will advocate policies that offer immediate benefits, even at the cost of aggregate productivity and, ultimately, the welfare of society as a whole.

The productivity of a country is the composite of the actions of millions of individual enterprises and workers. With few exceptions, no isolated action of a company or worker can be sufficiently important to have a measurable impact on aggregate productivity. But the sum of all actions is decisive. An understanding of the tragedy of productivity in the region requires not only an understanding of how individual policies (tax, social, commercial, credit) impact productivity, but how the political economy of a country impacts these policies as well.

Productivity as a national objective faces problems of "collective action": everyone would benefit individually if others paid taxes, were more productive, faced more competition, and worked harder, as long as the burden of responsibility does not lie with them personally. As in a football stadium, if everyone is seated, the one person standing sees the game better. But when many are standing, no one can enjoy the game. How can everyone be made to sit down simultaneously, when the person who sits down first loses out if the others fail to follow suit? How can every enterprise and worker—in the public and private sectors—be convinced to act in a manner conducive to greater individual productivity? How can a country's political system be forced to internalize the objective of productivity as an integral part of its normal actions?

What to Do

To have even a possibility of success, policy recommendations for raising productivity must take into account the way private interests are organized and the capacity of the state and the political system to articulate and implement policies. Although these circumstances are difficult to change radically, the possibilities of success can improve by concentrating on just a few points.

Make productivity a central theme of the public discourse, as growth, inflation, or unemployment currently are, and as on occasion even something as diffuse as "competitiveness" can be. Raising productivity depends on citizens and opinion leaders demanding adequate policies from the political system. In some cases, setting up national councils can be a valuable tool, provided they are institutionalized by law and endure over time. This requires an institutional framework that separates strategy from policy design and evaluation, has great credibility, and is protected from particular rent-seeking conducts.

Disseminate the effects of policies on long-term productivity. This applies to both direct policies to improve productivity and others with indirect effects such as social or tax policies. Explain how these policies affect the productivity of the benefited sectors—such as microenterprises or informal workers—as well as the aggregate productivity of all productive sectors. This implies creating independent and transparent institutions to monitor and evaluate the impact.

Incorporate business and labor into the policy debate through organizations at the highest level that represent national interests, rather than through more specific sectoral or interest groups. It is also useful to promote the formation of groupings with the broadest possible coverage and strengthen their capacities.

Invest in developing the capacity of the state to adopt long-term policies. When they have long-term career prospects, lawmakers, public officials, and judges can invest more in their capacities and in developing effective forms of cooperation with other actors. A judicial branch with stability and political independence are crucial for credible policies.

Involve entities that guarantee credibility thanks to their political independence, technical seriousness, and permanence on the national scene. Certain academic bodies, nongovernmental organizations, or multilateral organizations that can facilitate political transactions and oversee compliance with commitments could all fit this bill.

Anticipate the indirect consequences of reforms on political actions. Decentralization of the state and the emergence of new political parties can be desirable for increasing citizen participation and opening channels of representation to excluded social groups, but they can also have negative effects on the capacity of the political system to adopt policies to raise productivity. The instruments of economic and social policy that most affect productivity must be isolated from these trends toward fragmentation.

It would be risky to propose a policy recipe to improve productivity since each country's specific economic, social, institutional, and political circumstances determine the advisability, viability, effectiveness, and stability of policies. However, the following is a tentative list of "what to do" and "what not to do" in each of the major areas analyzed in this report. It is

Table 1.1 How to Improve Productivity

	What to do	*What not to do*
General strategy	Make productivity an objective of the state.	Identify productivity with international competitiveness or, even less, with exports.
	Facilitate access to productive resources for all types of enterprises.	Concentrate on industry or some "fashionable" sector.
	Look for productivity gains within enterprises as well as between them, facilitating the movement of resources from less productive to more productive firms.	Confuse social policies with productivity policies.
	Support success, not failure; support what has growth potential, not what is stagnant with no prospects.	Support the weakest, most unproductive or smallest enterprises simply because they are small.
	Evaluate the impact of public policies on productivity and disseminate the results widely.	
	Design mechanisms against the regulatory capture of programs and institutions that allocate credit, subsidies, authorizations, concessions, or support of any type.	
Trade and transport infrastructure policy	Generate conditions to promote port and airport efficiency. Create competition when possible (open markets, seas and skies to all).	Defend route monopolies.
	Promote consultation and coordination of service suppliers to exploit economies of scale and complementarities.	Postpone or save on maintenance costs of transport infrastructure.
	Eliminate customs inefficiencies.	Protect inefficient enterprises, rejecting the use of mechanisms such as safeguards and antidumping tariffs.
Financial policy	Facilitate the use of a good credit-and-guarantee reputation to access credit.	Intervene in credit markets through specific allocations or controls on interest rates.
	Make property and company registries more flexible and cheaper.	Allocate credit using first-tier public banks.
	Strengthen systems to protect creditor rights.	Be complacent about macroeconomic achievements and weaken fiscal strengthening processes.
	Strengthen credit information systems.	

(continued on next page)

Table 1.1 Continued

	What to do	*What not to do*
	Expand supervision and financial regulation to include macroeconomic risks.	
	Make explicit and public all public subsidies for credit, including guarantees	
Tax policy	Simplify the tax regime on production and profits for all firms.	Create special tax regimes based on sector or size of enterprises.
	Create positive incentives for formalization (i.e. credit, aid restricted to formal firms).	Give aid to informal firms
	Penalize tax evasion with increased effectiveness and credibility.	Tax financial transactions.
	Use self-control mechanisms to avoid evasion (such as VAT).	Tolerate tax evasion.
	Broaden the tax base to include microenterprises and the self-employed.	
Social protection policy	Cut the link between social security funding and employment.	Use the labor market to execute social policy.
	Guarantee that all workers are covered against common risks, irrespective of their labor situation.	Finance social protection programs for informal workers from payroll taxes.
	Finance universal social programs from general taxation.	Convert programs to combat poverty into a parallel social security system for informal workers.
	Guarantee an effective and broad-based social security network that protects workers in transition.	Confuse programs to invest in the human capital of the poor with programs to insure against risks.
	Promote mechanisms such as unemployment insurance that offer effective protection against dismissal.	
	Unify the pension and health systems.	
SME-support policies	Evaluate the impact of existing programs on productivity.	Grant tax breaks or relax compliance with social security regulations for SMEs over larger enterprises.
	Concentrate on the SMEs with the greatest possibility of success.	Give permanent or long-term support.
	Make any support conditional on achieving measurable targets and on formality status.	Include social objectives in SME policies.

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Table 1.1 Continued

	What to do	*What not to do*
Innovation policies	Link research to business activity.	Allocate resources to supply without evaluating the results.
	Grant financial stimulus or tax breaks to technology programs and services offered to enterprises.	Ignore demand from business and interactions with the rest of the innovation system.
	Strengthen intellectual property rights.	
	Correct the failures of coordination between the actors in innovation systems.	
	Promote competitive mechanisms as instruments for allocating resources to the supply side (professional and technical education, universities and technology centers) and evaluate results.	
Productive development policies	Stimulate development of sectors with positive externalities and the capacity to pull other sectors up.	Give preference to sectors simply because they are industrial or receive foreign investment.
	Identify failures of coordination and information and help solve them with persuasion, incentives, etc.	Support failed projects or enterprises.
	Promote joint exploration of opportunities between public and private sectors.	
	Let the losers go.	
Political reforms and strategies	Make productivity a central theme of public attention.	Fragment the design and discussion of productivity policies among multiple groups of agents and debate arenas.
	Disseminate the effects of policies on productivity.	Use subsidies and other harmful concessions for productivity as an instrument of political negotiation.
	Bring the business and labor sectors into the debate.	
	Invest in developing the capacity of the state.	
	Involve entities that guarantee credibility.	
	Anticipate the indirect consequences of the reforms on political actions.	

a tentative list because knowledge is limited, and because the conclusions must often be qualified in ways that are discussed in the rest of this volume. The list that follows is, therefore, an invitation to delve more deeply into the themes of greatest interest to each reader.

This chapter ends where it began: income per capita in the region has lagged behind the rest of the world not because the Latin American and Caribbean people invest less than others or work less, but because, in relative terms, the region's productivity has plummeted.

It is crucial to reverse this phenomenon. A country's standard of living can be raised by exploiting the fact that—for reasons of nature—some crop or mineral or energy source can be produced or extracted at very low cost in relation to the international price; it can also be raised for a time by borrowing. But the lag that Latin America and the Caribbean have suffered for decades in relation to the rest of the world shows prima facie that in the medium term, these strategies are not viable. In the end, there is no substitute for producing more effectively, innovating, training, adapting, changing, experimenting, reallocating, and using work, capital, and land with greater efficiency; in short, there is no substitute for higher productivity.

In the past 15 years, after many setbacks, Latin American societies have succeeded in building a social consensus in favor of macroeconomic stability. Thanks to this, the region has come through the worst international financial crisis since the Great Depression in relatively good shape. This is no minor achievement, and reflects the capacity of these societies to build consensus around fundamental issues. The challenge now is to build a politically feasible social consensus in favor of productivity so that this macroeconomic stability can lead to a development process stimulated by the growth of productivity, which is the real foundation of shared and lasting prosperity.

Notes

1. This figure and the rest of the figures in this paragraph are detrended with a Hodrick-Prescott filter to eliminate the effect of short-term fluctuations. See Chapter 2 for further details.
2. The term "small firms" in this book refers to the low end of the size distribution, and often, when data is available, it also encompasses microenterprises.
3. This term was coined by Hausmann and Rodrik (2006).

on their own, and that the actions adopted will have a similar impact. For example, if a firm has access to credit due to an SME program, it will benefit in a similar way to comparable firms that already have access to credit.

12. The inconsistent relationship between product innovation and productivity most likely reflects the fact that innovation takes time to produce an increase in productivity and its effect cannot be detected without panel data. For a discussion on this topic, see Hall and Maffioli (2008).
13. Although more pronounced in Latin America, the region is not alone its lack of systematic rigorous evaluations of SME policies. According to Storey (1998) and OECD (2005), few proper evaluations have been conducted in developed countries. Two examples of evaluations in developed countries are Roper and Hewitt-Dundas (2001) for Ireland and Motohashi (2001) for Japan. The former concludes that in Ireland, support to SMEs was successful in boosting employment but not productivity, while the latter concludes that in Japan, the new SME support model (that shifted from "lifting up the SME sector" toward more specific procompetition and innovation-inducing policies) had positive results; however, selection issues are still unresolved.
14. In Mexico, for example, more than 140 programs have identified working with SMEs as one of their objectives. Approximately US$3 billion has been spent on the largest 25 of these programs (see Soto 2009), about the same as the government spends on the conditional cash transfer program, *Oportunidades,* which reaches 5 million families.
15. See the 2007 process evaluations (Evaluación de Consistencia y Resultados) of the National Evaluation Council, CONEVAL.
16. See World Bank (2007). Also for Mexico, see OECD (2007a) and Storey (2008) for a review of the evaluation of SME support programs in Mexico.
17. See Lee (2006). However, the positive findings were measured in a pilot study and comprehensive evaluations are pending. This model, which includes training and technical assistance, was successfully implemented in Mexico (but was later abandoned) and has been tried in other countries, such as Panama.
18. This is parallel to the current trend in industrial policy of letting the losers *fail*: governments need to be ready to stop supporting those firms for which the program is not working.
19. Once a firm is able to establish credit, it could maintain it without government support. Or once it internalizes the benefits from training or innovation, it could continue those activities without receiving subsidies.

10

The Importance of Ideas: Innovation and Productivity in Latin America

The capacity of a society and its firms to generate and assimilate technological change is generally recognized as a key component of prosperity and growth. A long tradition of economic thinking that goes back at least to Schumpeter has identified a strong relationship between innovation and productivity growth. In developing growth theory, Solow (1956) attributed a vital role to technological change, and his vision of this issue remains a foundation of its understanding. Griliches (1986) formalized and specified the empirical content of these ideas by developing models aimed at measuring the impact of knowledge capital on productivity (Griliches proxied the research and development [R&D] stock for knowledge capital). Romer (1990) enriched the theory by modeling the determinants of knowledge creation, turning R&D into an endogenous variable in the understanding of growth instead of an external element. A considerable body of economic, sociological, and historic research has been accumulated in recent decades about the role of knowledge in economic development. This research is organized around the notion of innovation, understood as a concept that goes beyond R&D in the traditional sense—which implies that not all innovation has a technological origin (see Box 10.1).

The acquisition, adaptation, and creation of knowledge has become a major factor in economic development and is the common denominator in the successful development strategies followed by countries as diverse as Finland, Ireland, Singapore, South Korea, and Taiwan—and, more recently, China and India. Today's world economy is one in which innovation has become indispensable, even as the threshold for acquiring and disseminating knowledge is being lowered. This makes it possible, in

Box 10.1 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, in particular, presents the guidelines to follow in analyzing and measuring innovation activities in firms. The innovation survey is widely used in most OECD countries. The Manual de Bogotá (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 (OECD 2009).

theory, to implement strategies built on faster catch up by adapting knowledge that has originated in advanced economies.

This chapter, written against the backdrop of persistent stagnation in productivity in Latin America, seeks to address the following questions: how and how much innovation takes place in the region and who are the innovators? What are the links between innovation, as it takes place in the region, and productivity? What can be done to encourage innovation? The initial hypothesis is that the current stagnation of productivity in Latin America can be traced, in part, to an innovation deficit. This hypothesis is underscored by the contrast with the very fast growth that has occurred in economies that

not so long ago were poorer that those in Latin America—a growth process heavily leveraged by massive investments in innovation and technology.

Investment in Innovation and Research and Development in Latin American Firms

Innovation activities take different shapes, and go well beyond internal R&D, extending to expenditures on R&D external to the firm, capital goods that include embodied technology, hardware and software, licensing and purchasing of unembedded technology, technological training, engineering and consulting services, and industrial design, according to the Oslo Manual (OECD and Eurostat, 2005).

Despite this broad perspective of innovation, internal R&D efforts maintain a privileged role as part of the mechanism that leads to the creation and adaptation of new ideas and technological applications. R&D is commonly associated with the generation of new products and services capable of producing sustainable competitive advantages for firms. For a business that wants to engage in technology-based competition in a given market, having in-house technological infrastructure (Cohen and Levinthal 1989, 1990) provides several distinct advantages. Without such infrastructure, the use, identification, assimilation, adaptation, and exploitation of external know-how—embedded in the case of equipment or unembedded in the case of licenses or acquired patents—tend to be limited, and that diminishes the impact of innovation on productivity.

Table 10.1 focuses on a few select countries in Latin America and Europe and presents the main indicators of innovative effort in firms, the intensity of innovation, and information on human resources dedicated to innovative activities. As the first row shows, a high proportion of Latin American firms invest in innovation; the variation ranges from around 28 percent of firms in Uruguay to over 70 percent in Colombia.

However, Latin America exhibits some distinctive features regarding innovation. One is the low level of expenditure and intensity of effort on R&D. On average, firms' R&D intensity (as a percentage of sales) is less than 0.2 percent, far lower than the averages for Europe (1.6) and the OECD (1.9). The share of firms that invest in R&D exceeds 25 percent in Europe while in Colombia and Uruguay, the equivalent figure is about 6 percent.

A second distinctive feature of innovation in the region is the extent to which it centers on the purchase of capital goods and equipment. Expenditure on these items represents between 50 and 80 percent of total expenditure on innovation, while the corresponding share in OECD countries ranges from 10 to 30 percent.

Table 10.1 Inputs and Outputs of Innovation in the Manufacturing Industry, Selected Countries

	Argentina	*Brazil*	*Colombia*	*Paraguay*	*Uruguay*	*France*	*Germany*	*Belgium*
Innovation Investment								
Share of firms that invest in innovation activities (as a share of total companies)	61	65.7	77	63	27.8	n.d.	n.d.	n.d.
Innovation expenditure intensity (as a share of turnover)	0.9	2.8	0.8	n.d.	2.2	3.6	5.2	4.3
Share of firms that invest in R&D (as a share of total companies)	25	20.7	6	11[b]	6.2	27.7	27.9	35.2
R&D investment intensity (as a share of turnover)	0.2	0.58	0.12	n.d.	0.12	2.7	2.9	2.1
Innovation Expenditures Allocation								
R&D (as a share of total innovation expenditures)	16	21.8	0.8	13	3.9	68.8	47.7	30.5
Capital equipment (as a share of total innovation expenditures)	54	49.7	66.4	66	81.2	9.7	23.8	33.8
Human Resources								
Human resources in innovation activities (as a percentage of total employment)	3.3	n.d.	3.01	1.41[b]	2.3	n.d.	n.d.	n.d.
R&D personnel (as a percentage of total employment)	1.96	1	1.9	1.01[b]	1.1	n.d.	n.d.	n.d.
Innovation Outputs (as a share of total companies)								
Firms that innovated (any type)	51	33.4[a]	25.3	59[a]	26.9	35[a]	66[a]	54[a]
Firms that introduced product innovation	39	19.5	n.d.	48[b]	14	23.3	52.2	39.1
Firms that introduced process innovation	37	26.9	n.d.	41[b]	20	27.4	40.8	42.4
Firms that introduced organizational innovation	30[d]	37.2	7.9	33[b]	12	35.5	56	39.9
Firms that applied for patents	n.d.	6.7	3.12[c]	14[b]	1.7	12	24	7.9

Source: OECD (2009) for France, Germany, and Belgium and refers to manufacturing industry. Argentina: INDEC (2006); Brazil: IBGE (2005); Colombia: Colciencias, DANE, DNP (2004–2006); Paraguay: CONACYT (2004–2006); and Uruguay: ANII (2004–2006).

Notes: Indicators refer to the manufacturing industry and shares of companies in the total panel of companies, except when otherwise indicated.
[a] Refers to companies that introduced product or process innovation (share of total firms in manufacturing industry).
[b] These indicators refer to the total sample (including agriculture, mining, manufacturing, and services).
[c] Patents are filings at any patent office during 1996–2004.
[d] Refers to commercial and organizational innovation.
n.d. = no data.

This combination of low R&D effort and high investment in technology embedded in machinery could signal problems. Even though acquiring technology by buying equipment and sophisticated machines can be an important step in catching up and advancing toward the technological frontier, the impact of embedded technology at the firm level can be very limited if internal capabilities in R&D are absent. Such an absence—notably the weakness of the human capital dedicated to innovation—can lead to a technological gain to the economy as a whole that is not sustainable, even after intensive periods of modernizing the manufacturing base in a given country (Hanson 2007).

R&D is highly concentrated in a small number of firms. In Argentina, for instance, one firm accounts for one-third of the entire manufacturing sector's expenditures in R&D, according to the 1998–2001 innovation survey.

Large firms have a higher propensity to invest in innovation. Economies of scale explain this tendency; large businesses find it easier to distribute the high fixed costs of innovation across a larger volume of sales and have better access to financial services, technology, consulting, and specialized human-capital markets. On the other hand, small and medium enterprises commit themselves to innovation efforts that are more than proportional to their size. Econometric analysis of the propensity to invest in innovation and innovation intensity yields results that are not inconsistent with the descriptive statistics presented so far, but suggest that there are additional determinants of investing in innovation, as shown in Table 10.2, which was elaborated employing a variation of the model developed by Crepon, Duguet, and Mairesse (1998), hereafter referred to as the CDM models.

The propensity of a firm to become involved in innovation activities, as well as its level of innovation effort, are positively associated with the presence of public financing for innovation, formal protection of intellectual property, technological cooperation with other firms (suppliers and clients), and laboratories and universities. Firms that give importance to the intellectual property protection of innovation efforts tend to make a stronger innovation effort (the analysis is very clear on this matter for Argentina, Chile, and Colombia).

Foreign Capital, Export Intensity, and Innovation

Innovation efforts in Latin American economies are related only weakly to the participation of foreign capital. There is no significant difference between firms with foreign capital and domestic businesses regarding the propensity to innovate or innovation intensity. Only in Colombia do firms with foreign capital report higher innovation expenditures per employee.

Table 10.2 Determinants of the Probability of Investing in Innovation and its Intensity

	Argentina		*Chile*		*Colombia*		*Uruguay*	
	1	*2*	*1*	*2*	*1*	*2*	*1*	*2*
Human capital (engineers and hard sciences employees in employment)	+		−	−	+			
Cooperation with other companies or institutes	+	+	+					
Market share		+		−	+	−		
Intellectual property protection (appropriability)		+		+	+	+		
Public sources of finance		+		+	+		+	
Foreign ownership		−				+		
Export intensity					+			
Sources of information for innovation								
Internal			+					
External (other companies and externalities)	+							
Scientific (universities, institutes of technology)			+			+		
Obstacles to innovate								
Cost-related	−							
Related to national systems of innovation	+		−					
Controls								
Industries	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Company size (dummies)	+	+	+	+	+		+	
Periods	2 periods		4 periods (individual regressions)		3 periods available (last period used for regression)		3 periods (last period used for regression)	
Methods	Generalized Tobit		Generalized Tobit		Generalized Tobit		Generalized Tobit	

Source: Authors' compilation based on Arbeláez (2009); Arza and López (2009); Benavente and Bravo (2009); Cassoni and Ramada-Sarasola (2009).

Note: Model 1 refers to the probability of investing in innovation and Model 2 refers to the intensity of innovation expenditures (innovation expenditures relative to sales). The variables Sources of information for innovation and Obstacles to innovate are dummy variables that are equal to one if the company considers such source or factor with high or medium importance for innovation activities. The variables Intellectual property protection, Public sources of finance, and Cooperation with other companies or institutes are equal to one if the company was involved in such activity or had links with those actors in technological activities. The variable Foreign ownership is a dummy variable equal to one if the company has foreign ownership in capital. Only variables with statistical significance at 10 percent (or less) are reported.

The "+" and "−" symbols represent the sign of the coefficient obtained with the model. A "+" ("−") symbol indicates a positive (negative) relationship between the dependent variable and the independent variable.

It could well be that multinationals do not necessarily invest in innovation, given that their focus is on exploiting comparative advantages in terms of distribution costs or labor savings, for instance, and that they have a certain technological platform imported from their headquarters abroad.

The statistical models also show no connection between innovation propensity and export intensity. This relationship is not significant in Argentina, Chile, and Uruguay,[1] which suggests that export activity in Latin American businesses is not strongly linked to technology and innovation. This, in turn, could relate to the fact that the region's most important export items tend to be raw materials and low-tech products. A better understanding of this complex relationship, and the contrasting results for Latin America, would require taking a closer look at how and with what products economies participate in the international marketplace. Perhaps exporting certain types of products, or exporting to certain markets that are not particularly sophisticated, do not require considerable investment in technology.[2] A deeper understanding of this topic would require identifying the nature of the goods being exported (manufactured, mining, and agricultural products) and an assessment of their technological intensity, destination, and type of contracts involved. This is a necessary next step in research since the apparent disconnect between export activity and innovation in Latin America contrasts starkly with the experience in Asia where exports played a key role in learning and technology transfer processes undertaken through the interaction with global corporations (see, e.g., Gill and Karras 2007).

Sources of Financing

Access to financing sources external to the firm, including public subsidies, is correlated with investment in innovation activities in all countries for which information is available, in terms of both the propensity to become involved in innovation and the intensity of investment. These findings illustrate the importance of access to financing for innovators, who tend to engage in activities that have high fixed costs and considerable risk.

For those countries with available information, internal sources constitute the main source of financing for innovation, representing more than 70 percent of total financing (reinvestment represents 74 percent of total financing in Argentina and 76.5 percent in Uruguay), followed by commercial bank financing. As for public financing, 2 percent of Argentine firms and 2.5 percent of Uruguayan firms use public funding. The equivalent figure, according to the innovation survey, is 3.6 percent in Paraguay and 6 percent in Brazil: the highest in the region, but well below the benchmark of European countries.

Box 10.2 The Distinctive Contribution of Human Capital to Innovation and Productivity in Developing Countries

Since the seminal contribution of Nelson and Phelps (1966), it has been well established that a larger stock of human capital helps countries accelerate technological catch up. The propensity to innovate and the innovation intensity of an economy tend to be related to the quantity and quality of skills accumulated in the work force. Hanushek and Woessman (2009) have refined empirical models that point to a clear impact of cognitive skills on growth and have corroborated such a relationship for most Latin American countries.

Building on these and other precedents, López Boo (2009) analyzed the relationship between human capital, innovation, and productivity. She separated the effects of human capital on the two main channels through which such a relationship takes place: invention (radical innovations, or novelties for the worldwide market defined as those able to push forward the technological frontier) and adaptation (incremental innovation that moves products and processes closer to a preestablished technological frontier in the case of a particular firm or domestic market).

Using cross-country data for Latin America and other parts of the world, she finds that the connection between human capital and innovation in developing countries, and its corresponding impact on productivity, stem mainly from the contribution of skilled workers dedicated to adapting existing technologies: that is, from their contribution to moving closer to the technological frontier, rather than to expanding it. For this type of contribution to occur, the human resources must be located within firms or in close proximity to their operations. This is far from the case in Latin America.

The literature also points strongly to the need to invest not only in advanced scientific education but also in intermediate post-secondary technical degrees, such as those typical of community colleges or university technical colleges in the United States, Canada, and Europe. Aguion (2007) emphasizes precisely this point in his analysis of relationships between innovation and labor skills in the various states of the United States, as well as in several countries.

Human Capital

The CDM models tend to confirm what the economic literature has established regarding the importance of human capabilities in the decision to innovate and to spend on innovation (see Box 10.2). In Colombia, a

stronger profile of technical competencies (counted as the proportion of engineers in total employment in firms) is associated positively with both innovation variables. In Argentina, the presence of professional technical skills is also associated with a higher innovation propensity. While evidence is limited, there are indications that firms invest in training associated with the purchase of technology embedded in machinery. Most of these results are difficult to benchmark to OECD figures, since these indicators are not regularly included in the innovation surveys used in those countries.

Linkages with the National Innovation System

Links between industry and other actors in national innovation systems[3] occur mostly as a result of the attempts by firms to gain access to information and know-how. Technology-led collaboration seems to be associated with higher investments in R&D and innovation in general. In Argentina, where it was possible to analyze information partitioned by type of cooperation, collaboration with scientific institutions and other businesses were all positively associated with the probability of a firm engaging in innovation initially.

Statistics based on innovation surveys demonstrate that Latin American firms most often establish technological cooperation agreements with clients and suppliers (the results are very strong for Argentina, Colombia, and Uruguay). Universities have a relatively minor importance, with the exception of Argentina, where this kind of collaboration is on par with that in European countries.

Obstacles to Investment in Innovation

Although the factors inhibiting innovation activity in Latin America are many and complex, the main obstacles, as reported by business people themselves, are constraints in securing financing for innovation, the inability of firms to wait for long periods before recovering investments, or realizing a positive return, the small size of the market, and the shortage of qualified personnel.

The lack of financing and access to credit is a major barrier for investment in innovation in Latin America. This might partly reflect problems in the functioning of the financial markets at large; Latin America has the highest cost of capital in the world. Moreover, since particularly risky investments, such as those associated with innovation, are difficult to finance everywhere, lack of financing points directly at Latin America's

deficit in private financial intermediaries, such as venture capital or angel investors, as well as public financing directly aimed at encouraging private-sector innovation, particularly by small and medium businesses.

Problems linked to market structure and size suggest that the regional market is not integrated, meaning many businesses are confined to their domestic markets, which are often small by any measure. 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.

The reported lack of skilled personnel seems to reflect deficits in the supply of technological services and capabilities as well as communication and coordination issues among the different components of national innovation systems, such as universities and commercial firms. Statistics regarding the availability of human capital for innovation confirm the report by firms of an overall deficit of qualified technical and professional personnel with relevant skills for innovation activities. This holds true even for the larger economies in the region (details can be found in Duryea, Navarro, and Verdisco 2008).

Innovation Outcomes and the Novelty of Innovations

The lower section of Table 10.1 contains information about the percentage of firms that introduced innovations because they decided to invest in innovation inputs. Between 25 and 59 percent of firms that invested in innovation obtained innovation outputs. In comparison, countries such as Canada, Germany, Sweden, and Switzerland regularly report rates of 60 percent or more.

According to the results of an econometric analysis, firms that invested in innovation inputs in Argentina, Colombia, and Uruguay[4] have a significantly higher probability of obtaining innovation outputs, a result that highlights the value of knowledge when applied to technological change in firms. In terms of sectors, those that report more innovation intensity also produce more innovation outputs. Firms with foreign capital, however, do not show a significant difference in terms of innovation outcomes when compared to purely domestic businesses—although Argentina seems to present an exception in this regard.

Turning to the type of innovation firms engage in, process innovation is more frequent than product innovation in most countries. This seems to be related to the pattern of acquiring knowledge embedded in capital goods, since embedded technology should directly impact production processes for the better.

Table 10.3 Novelty of Product Innovation in the Manufacturing Industry, Selected Countries

Percentages of firms that introduced product innovation	*Argentina*	*Brazil*	*Colombia*[a]	*Paraguay*[b]	*Uruguay*
New to the global market	25	0.19	6.3	8.13	1.8
New to the local (or domestic) market	49	3.24	9.4	40	7.3
New to the firm	24	16.22	10.7	48	6

Sources: Argentina: INDEC (2006); Brazil: IBGE (2005); Colombia: Colciencias, DANE, DNP (2004–2006); Paraguay: CONACYT (2004–2006); and Uruguay: ANII (2004–2006).

[a] Refers to all innovation outcomes (product, process, and others).

[b] Shares in the total sample (including agriculture, mining, manufacturing, and services).

Still another interesting way of looking at innovation outputs is to focus on the dominance of adaptation over invention. Table 10.3 reports the percentage of innovative firms in the manufacturing sector according to the degree of novelty of product innovation in some countries. In Latin America, technological innovation is highly concentrated in adaptive and incremental innovations, which are not aimed at reaching international markets. This explains the reported dominance of innovations "new to the domestic market" or "new to the firm."

Innovation and Productivity in Latin America: An Overall Picture

The preceding attempt to characterize innovation inputs and outputs in Latin American firms has served mainly to lay the foundation for a better understanding of the contribution of innovative activity to productivity growth in the region. This section attempts to capture the impact of innovation on labor productivity at the firm level.

Available evidence for Argentina, Chile, Colombia, and Uruguay resists simple generalizations, but Table 10.4 points fairly clearly to the positive impact of innovation on productivity. This is particularly true of product innovation. Chile, however, represents an exception in this regard. Although innovation has had a positive impact on sales in Chile, the impact on productivity did not manifest itself until two years after the initial introduction of innovation inputs. In the case of Colombia, innovation's impact on productivity seems to be confined to the case of incremental innovation (the new-to-firm type).

Table 10.4 Impact of Innovation on Productivity

	Argentina	*Chile*[a]	*Colombia*	*Uruguay*
Dependent variable: Labor productivity	*Sales per employee*	*Sales per employee*	*Added value per employee*	*Production per employee*
Process innovation	n. s.[b] (reduced sample) + (total sample)	− (only in 2001)		+
Product innovation	+			+
Product innovation new to the firm		+ (only in 1998)	+	
Product innovation new to the market (local/global)				
Organizational innovation	−	− (in 1998) + (in 2001)	−	
Capital per employee	+	+		+

Source: Authors' compilation based on Arbeláez (2009); Arza and López (2009); Benavente and Bravo (2009); Cassoni and Ramada-Sarasola (2009).

Note: All regressions have employed instrumental variables (using predicted values from innovation production models [2nd stage equation]). Only variables with statistical significance at 10 percent (or less) are reported.

[a] Dependent variable in t+1 (regressions by period: 1995, 1998, and 2001).

[b] Not significant in the reduced sample (for which information on capital per employee was available), and statistically significant in the total sample (excluding the variable capital per employee).

The "+" and "−" represent the sign of the coefficient obtained with the model.

In contrast, process innovation seems to have no significant effect on productivity. Uruguay is the only country reporting a positive and significant effect. For Chile, some delayed positive effects are noted at least two years after the introduction of innovation.

One reasonable hypothesis is that the learning process implicit in adopting new processes takes time in Latin American economies. This, in turn, could be construed as a disincentive for investment in R&D and innovation among the region's firms, which seem to put a premium on quick returns on investment.

Previous studies report similar results pointing at a neutral—or even negative—relationship between process innovation and productivity. Firms that implemented process innovations in Belgium, Brazil, Canada, France, Germany, New Zealand, and the United Kingdom exhibited lower productivity per worker in a recent report (OECD 2009). Two plausible explanations have been suggested. First, process innovation brings about changes in production processes and results in learning and adjustment

costs that might temporarily reduce productivity. Second, firms seem better inclined to introduce process innovation in hard times when they are looking to compensate for a downturn by making production more efficient. In recessionary periods, however, gains from process innovation are potentially more important (opportunity costs are lower) and opposition to change tends to be weaker than usual. Some of this may be at work in Latin America.

As far as organizational innovation is concerned, there are negative effects in Colombia and Argentina. One possible explanation—built into the study that focused on Argentina (Arza and López 2009)—holds that this result may reflect inverse causality: less productive firms may be more inclined to introduce organizational innovation. Another possibility could be that organizational—and marketing—innovation imply short-term changes in the functioning of firms; thus, productivity declines in the short term.

Based on available analyses, the links between innovation and productivity in Latin American firms tend to mirror those of advanced economies. In those cases where variations can be detected, much of that difference can be explained by the constraints posed by limited data availability in Latin America. The most notorious limitation is the fact that all the analysis of Latin America remains based on cross-sectional data, as opposed to the far more desirable panel data.

Concerns about data notwithstanding, the analysis indicates several distinctive features of innovation in Latin American firms and differences in the way innovation and productivity interact in the region as opposed to advanced economies. The type of inputs is typically different; investment in R&D is lower in Latin America. The role of foreign investment does not seem to be the same. Innovations tend to be less radical and concentrated in nontechnology-based innovation. At the firm level, the time horizons seem to be longer for learning, for adjustments to lead to a visible effect on productivity, and to recover the investment in innovation. Human-capital and financing constraints seem to be larger obstacles for firms in Latin America.

These features suggest that Latin American firms are heavily involved in innovation, yet not necessarily in R&D; are moved by short-term concerns when making investing decisions—including investments in innovation; and invest in innovation mostly in the form of technology and know-how embedded in capital goods. This particular innovation strategy, as well as the dominance of new-to-firm and new-to-domestic-market innovation, clearly entails innovation activity based on adaptation of existing technology. Similarly, the preponderance of technology links with the supply chain rather than with universities, laboratories, or other technological institutions suggests that, for most firms, technological development is still

at an early stage—if it is occurring at all. Apparently, most Latin American businesses operate far from the technological frontier—far enough away that incentives for innovation are not particularly strong since the payoff on innovation investment could be hard to realize and highly uncertain. Moreover, the absence of adequate infrastructure for research and knowledge transfer creates barriers to absorptive capacity, severely reducing the benefits of innovation based on adaptation and probably slowing down catch-up processes.

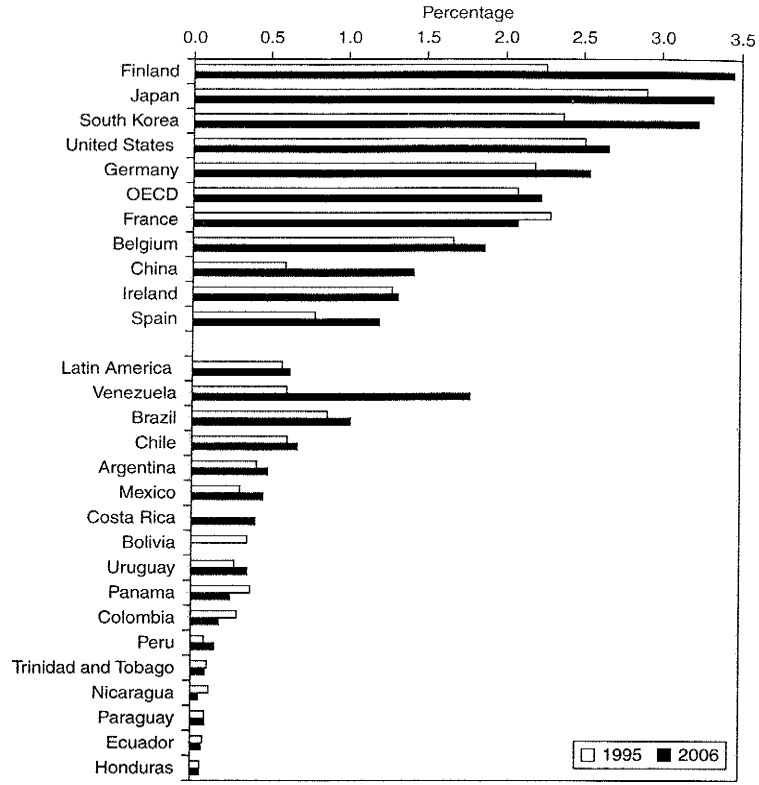
The balance of the discussion in this section suggests that even though innovation is fairly widespread among the region's firms, it seems to be failing to realize its potential as a major source of productivity growth. There are complex processes at play here, but some pieces of the problem stand out and are within the range of public policies for Latin American countries. A very important one is the low level of engagement with technology by most firms, even those that are innovative, which reveals a poor level of coordination between whatever R&D exists in a given country and productive activities. In other words, the main components of national innovation systems lack adequate articulation. This conclusion, in turn, invites a review of the current state of scientific and technological development in Latin American countries, so as to complement the firm-level perspective advanced thus far in this chapter with a macro perspective that provides information about the institutional and resource base—both human and financial—within which business innovation takes place.

R&D Activities in the Region

Almost every one of the relevant dimensions of the landscape of science and technology in Latin America differs greatly from the landscape of advanced economies. The difference in national investment on R&D is marked. While from 1995 to 2006, R&D expenditures as a share of GDP grew consistently in the advanced economies, they stagnated at a very low level in Latin America. On average, technological intensity in the region—measured not at the firm level, but in the national economy as a whole—is 0.6 percent, compared to 2.2 percent for OECD countries. In addition, investment in R&D is highly concentrated in the public sector, averaging 60 percent, compared to 36 percent for the OECD, regardless of whether the source of funding or the execution of expenditures is considered.

The differences regarding human capital are similarly great. While OECD countries average seven researchers per thousand in the population, Latin America does not reach even one per thousand. More importantly, the private sector employs relatively few researchers, in contrast with OECD

Figure 10.1 R&D Expenditure as a Percentage of GDP, 1995 and 2006

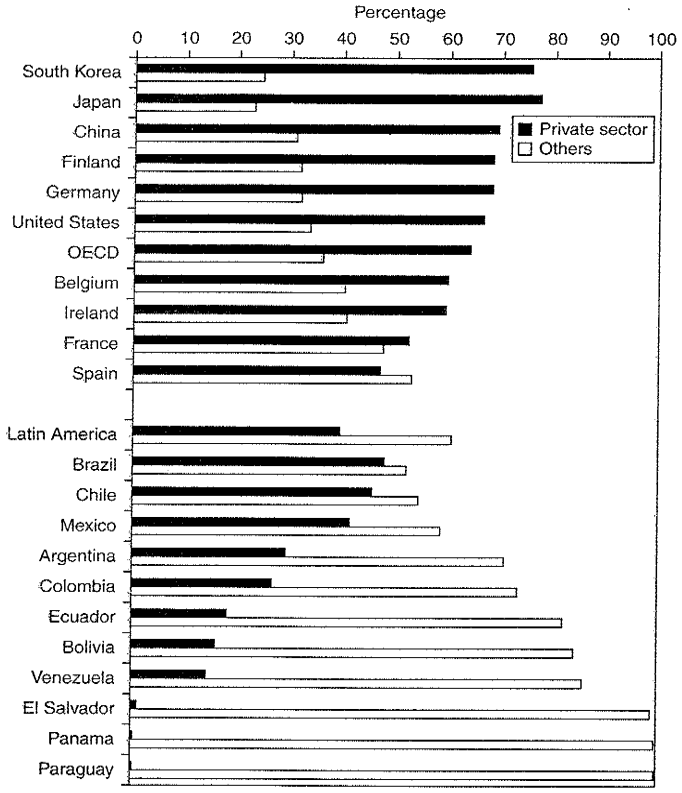


Sources: RICYT (2009) and OECD (2008).

businesses, which hire 64 percent of researchers in their economies (Figure 10.3). This fact echoes the previous finding that firms in Latin America invest sparsely in R&D development.

Figures 10.1 to 10.3 highlight not only the large differences between Latin America and OECD countries, but also the heterogeneity of the Latin American region itself, which makes some generalizations difficult. A closer look at the data indicates that Brazil—and to some extent Argentina, Chile, and Mexico—has evolved a technological profile closer to advanced economies, or at least to the less technologically intensive among them, such as Spain. Similarly, while the trend in several countries is to depend even more heavily on natural resources—corresponding, almost certainly, to being less technologically intensive—a few countries, such as Costa Rica and, arguably, Colombia, report a stronger participation of technology-intensive sectors in output and exports. Even

Figure 10.2 Composition of R&D Expenditure by Source of Financing, 2006



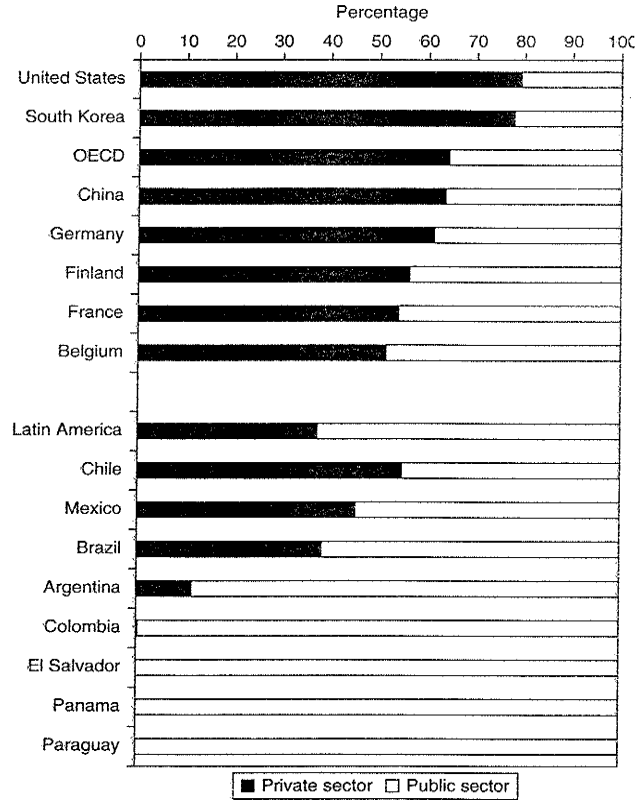
Sources: RICYT (2009) and OECD (2008).

Note: "Others" refers to government, higher education, and non-profit organizations.

for this group of countries, in which some build-up in technology has occurred over the past two decades, the relatively low investment in R&D and low share of researchers in the economy—especially in the private sector—remain serious concerns. An indirect indication of these problems is the relatively low level of foreign investment in R&D the region has received compared to other parts of the world.

The indicators are not particularly encouraging when shifting focus from inputs to the outcomes of innovation efforts either. Scientific performance continues to lag well behind developed countries: less than 50 publications per million population in Latin America, compared to over 300 in advanced economies (NSF 2008). Here again, the picture is more nuanced when considering the figures for Argentina, Brazil, and

Figure 10.3 Composition of Researchers by Sector of Employment, 2006

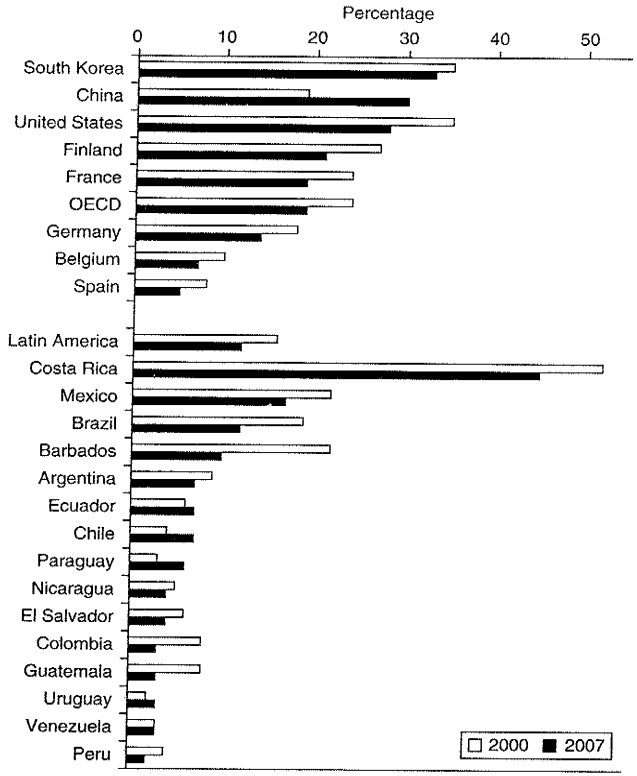


Sources: RICYT (2009) and OECD (2008).

Mexico, countries that have reached the top 50 in the world in terms of scientific publications. Moreover, the growth rate of publications from Latin America has tripled over the past decade and a half, outpacing other regions and consequently reducing the gap in this regard (OECD 2007b). These relatively positive trends contrast starkly with the relative scarcity of researchers in firms and prove that scientific and technological progress does not automatically solve the problem of developing effective national innovation systems. In other words, it is conceivable for a country to have an advanced scientific profile and still have few links between this considerable scientific knowledge and the economy.

Patents per capita continue to be relatively low. Patents per million population reached 150 for South Korea in 2005 (U.S. Patent Office), while they were less than one per million in Latin America. The low technological

Figure 10.4 High-Technology Exports as a Percentage of Exports in Manufacturing, 2000 and 2007



Source: World Bank (2009g).

intensity of Latin American economies is also evident in the relatively minor technological content of exports from all but a few countries in the region, as can be seen in Figure 10.4.

A Second Look at International Comparisons

Recent studies (see, most recently, Maloney and Rodríguez-Clare 2007) have suggested that international benchmarking exercises such as those presented above may distort the realities of innovation in Latin America. They argue that the comparison fails to adjust for the very different economic structures of developing and advanced economies. Thus, the argument goes, the optimal level of innovation in a given Latin American economy may be lower than the OECD average simply because of the low technological intensity of the natural resources and other sectors characteristic of the region and would be similarly low anywhere they are present. Instead of an "innovation shortfall," Latin America may be producing a natural response to a particular economic structure. This is a highly relevant argument that should be considered when comparing innovation data across countries.

However, the empirical evidence suggests that even after correcting for the industrial structure, the conclusion of low technological intensity holds, confirming the existence of an innovation shortfall—and a large one at that. Maloney and Rodríguez-Clare (2007) conclude that Chile is a case in point. Benavente and Bravo (2009), comparing Chile and Australia in the mining sector, and Chile and Finland in the paper-pulp sector, find that R&D investments are considerably lower in Chile; this explains much of the observed difference in productivity.[5]

Over the long term, the relationship of causality between technological effort and economic structure may very well be the opposite of what it seems in the short term. A commitment to technological change and more technology-intensive industries may very well steer economic structure toward knowledge- and innovation-intensive activities, raising productivity and living standards along the way.[6] There is little doubt that the more prosperous a given economy is, the more it tends to invest in R&D. Of course, a developing country has many urgent social needs that compete with innovation policy for attention and resources. The fact remains that the newly industrialized countries rapidly transformed their economies into knowledge-based and highly competitive ones as the consequence of intensive investments in technology and innovation that quite often were far above what their income per capita level would have predicted.

National Innovation Systems in Latin America Today

The stylized facts about the main dimensions of science, technology, and innovation in Latin America indicate that the economies of the region in the early twenty-first century tend not to be technology-intensive and perform weakly in terms of innovation outputs. This is especially remarkable given the recent emergence of a global knowledge-based economy in which the most dynamic sectors are precisely the most intensive in innovation and technology. A good share of the economic changes that have brought about sustainable growth in productivity in advanced economies and some emerging, mostly Asian, countries are closely related to successive technological revolutions. One in particular is the information and communications technology (ICT) revolution (see Box 10.3). The region

Box 10.3 ICT in Latin America, or How to Arrive Late to a Technological Revolution

Latin America's access to new information and communication technologies has been late and partial, as illustrated by all available indicators, such as the number of personal computers, access to the Internet, and access to broadband. This lag is particularly important in relation to the effects of innovation on productivity. The integration of ICT into firms' operations, combined with the accelerated growth in ICT industries, is one of the main factors—if not the main factor—that explains recent productivity growth in the U.S. economy (Draca, Sadun, and Van Reenen 2006; Jorgenson, Ho, and Stiroh 2008). The productivity gap between the United States and Europe in the late 1990s and earlier in this decade seems to be highly correlated with a slower diffusion of ICT among European firms (Van Ark, O'Mahoney, and Timmer 2008). Similarly, there seems to be a close relationship between the diffusion of ICT and the reversal of low productivity in the U.S. service sector before 1990.

The experience of advanced economies suggests that the adoption of ICT takes time to affect productivity, since for improvements to occur, the presence of hardware embedded with the new technology is far from sufficient. A vital part of the realization of the potential of ICT has been complementary investment in organization capital, understood as the reorganization of workplaces and the accumulation of skills in employees and managers (Samaniego 2005). Considerable investment in ICT has failed to deliver returns in the absence of such complementary conditions (McKinsey 2003). In the case of developing countries, these complementary conditions tend to be weak (Edwards 2002).

Some exceptions among large firms that have followed good overall approaches to adopting ICT show that it is possible for Latin American countries to exploit the potential of ICT (Alves de Mendonça, Freitas, and de Souza 2008). But, in general, a lack of infrastructure and relatively high costs of adoption are producing an unproductive mix. The level of only one ICT adoption indicator is excellent in Latin America: the market penetration of cell phones. This is precisely a sector that has benefited from relatively lower costs for users, thanks in part to radical marketing innovations, such as the use of prepaid phone time. The end result is that Latin American economies have been largely deprived of one of the main engines of productivity growth in the rest of the world. This is particularly the case compared to certain Asian economies, which undertook selective but highly significant early investments in ICT, including support for the local ICT industry, with enormous positive payoffs.

arrived late, and then only partially, to this revolution, leaving open the question of whether it is prepared to benefit from upcoming technological transformations based on nanotechnology, biotechnology, and materials science. A considerable build-up of technological capacity and innovation investment in the public and private sectors are required for Latin American economies to, at the very least, copy, adapt, and operate emerging technological applications, not to mention lead or make original contributions (RAND Corporation 2007; Pérez 2008).

The idiosyncratic features of business innovation in Latin America, the scientific and technological deficits characteristic of the region, and the lack of well-articulated national systems of innovation combine to present a formidable challenge to public policy that is aimed at improving innovation.

Evolution and Challenges of Innovation Policy in Latin America

Innovation policy has hardly been at the core of development concerns in Latin America for the past fifty years. Even though the region has a long history with industrial policy, the traditional emphasis was on tariff protection and subsidies to infant domestic industries. A group of insightful and prescient proponents advanced the idea of technological upgrade and the need to incorporate it into discussions about growth strategies, but policymakers rarely heeded their advice.[7]

Starting in the 1980s, and in line with the Washington Consensus, policy debate and policymaking itself became dominated by a framework based on policy neutrality, leaving the efficient allocation of resources among sectors to market forces and closing most of the room for any consideration of overall innovation strategy or selection of sectors. This is not to say that there was no innovation policy whatsoever; rather, it was peripheral to the mainstream of economic policy and growth strategies in Latin America.

The discussion that follows describes the evolution of science, technology, and innovation policy in an attempt to highlight the learning process underpinning the introduction of new instruments and decision makers' adoption of new priorities (called "approaches" or "generations" interchangeably here).

The First Generation of Innovation Policies

Starting in the mid-twentieth century in most countries of South America and Mexico and continuing to the present, the dominant public policy in

the sphere of science, technology, and innovation focused on expanding the human and physical resource base of these activities in each country. This approach focused largely on developing university institutions and research centers with the right infrastructure in scientific disciplines, as well as investing in advanced human-capital formation, mostly in natural sciences, math, and engineering. Much public support was channeled through university budgets, scholarship programs, and public research institutions.

The original versions of this approach offered few resources for competitive grant systems, innovation funds, or similar instruments; these would come later, in the context of the second generation of policy. This was in sync with the dominant understanding of worldwide innovation at the time, which viewed innovation as a linear process that started with basic scientific research, then moved to applied research and development, and finally focused on business processes and products.

Whatever scientific and specialized technological capabilities exist in the region can be traced to these initial efforts. In some countries, especially the larger ones, the scientific base has advanced to an internationally significant level—although in the region as a whole, the result is rather modest. In practice, this approach resulted in the growth of "curiosity-oriented research," the dominant role of scientific elites and very little input from the business sector to innovation policymaking.[8] To this date, innovation policy budgets reflect this original approach to a sometimes surprising degree, and the university-industry gap remains a key unresolved issue in the region.

A Second Generation of Policies

Around the mid-1980s, a new approach emerged that considered innovation a nonlinear process. According to this perspective, innovation is spurred not only by scientific discovery and basic research, but also by the search for solutions to practical problems in diverse industries. This systemic approach to innovation thus emphasizes the relationships among multiple public, private, and academic actors in the development of innovation. From these interrelationships arises the notion of national innovation systems.

Under the influence of this new approach, a whole set of new policy tools emerged, focused on filling the gap left by the former generation of policies in the key matter of business innovation. So-called innovation funds started to appear, conceived of as a response to market failures that hamper private investment in innovation, notably failures in the financial market.

While several countries in the region are just starting to use these policy tools, they have reached maturity in countries such as Argentina, Brazil, Chile, Mexico, and Uruguay, where they have proliferated as a family of instruments aimed at encouraging a wide range of innovative behavior among diverse groups of firms.

Thanks to this proliferation, a number of studies have appeared assessing the impact, costs, and benefits of innovation funds. A recent review of 13 program evaluations in six countries found that, in general, the economic results have been positive, as evidenced by the estimated rates of return and net present value. There is little evidence that justifies the main criticism of these funds (i.e., that they crowd out private investment). On the contrary, there is some evidence of a multiplier effect, meaning that public funds leverage private money for innovation—or, at the very least, accelerate private investments (López 2009). The use of these instruments remains confined to a very small share of businesses in each country, however, far from the level common in European economies.

In addition to innovation funds, some cross-cutting or horizontal policy instruments have been introduced, such as tax exemptions for business innovation expenditures, which often coexist with innovation funds in the same countries.[9]

Toward a Third Generation of Innovation Policy?

Starting in the mid-1990s, a new, third generation of policies rose in the region. This new approach aims at changing the emphasis of innovation policies in favor of a strategic perspective. The main concern has become coordination failures among the diverse actors of the innovation system. In this approach, innovation policy tends to position itself in the middle of the competitive strategy of a given country. It is concerned with business innovation and business-university relationships, but also with technological services, regulatory agencies, property rights regimes, and an expanded set of educational institutions beyond doctoral programs. It emphasizes the need to understand how these elements fit together and impact favorably on innovation. This approach is usually complemented by selectivity, whereby a few industries are targeted to receive special support and attention from innovation policy, since that policy envisions the creation of world-class economic niches as a result of the intensive use of knowledge and innovation.

This approach is in no way incompatible with the policy instruments of the two earlier approaches. It focuses rather on redirecting them to the chosen key sectors of the economy that have high potential for innovation.

A recent example of this policy evolution has been the launching of sector-specific innovation funds, a thrust made possible since the emphasis on sector-neutral economic policies began to recede in the late 1990s.[10] Programs organized around the notion of industrial clusters are also focusing on technology and innovation and are increasingly combined with efforts to strengthen regional and city-centered innovation systems. In addition, explicit instances of intersector coordination in innovation policy have been introduced, such as industry roundtables and dialogues on shared research agendas, as a deliberate attempt to improve coordination and encourage pooling of resources and sharing of priorities among the key actors of the innovation system (Avalos 2002).

Other traditional policy tools are undergoing a similar reorientation. Curiosity-oriented research is being replaced by research in the service of previously defined problems related to priority sectors. Scholarships are directed toward advanced degrees directly linked to those sectors, as well.[11]

The results of this type of policy are still not evident across the region. Some interesting precedents provide grounds for optimism. In a companion chapter in this book, Fernández-Arias describes how sector-specific policies have produced success stories in agricultural exports and mentions innovation and technology as key components of these successes. These efforts have placed particular importance on collaborative processes between public R&D institutions, producers, and technological transfer and extension services in Argentina and Brazil. A similar interaction among the public sector and private business, research, and national and local actors is also occurring in the production of radical innovations, such as the emerging agricultural machinery industry in Argentina (Lengyel 2009).

On the other hand, the trajectory of East Asian countries suggests that choosing priorities and engaging in strategic thinking can be important components of successful innovation policy. Whether to focus on developing brand-new high-technology sectors or turn around traditional, generally natural resource-based sectors through intensive technological upgrades is an issue several countries in Latin America are actively discussing. Given the risks of policy capture by vested interests in the domestic market and the uncertainties inherent in technological development and rapidly changing international markets, adopting a strategic and selective framework requires sustained attention to minimize such risks. In this regard, the idea of approaching innovation policymaking as a learning process is gaining ground in an effort to champion more flexibility (see the notion of self-discovery in Hausmann and Rodrik 2005).

Institutional Development and Policy Effectiveness

Each generation of innovation policy developed institutional vehicles in accordance with the most important policy objectives of each approach that constitute a singular contribution to building organizations, routines, and capabilities. Thus, the first approach relied mostly on universities and research centers, while policy was formulated from national councils for science and research (the traditional councils of science and technology—CONICITs—present in almost all countries). The second approach brought about agencies that were highly specialized in running innovation funds. The third approach has produced a surge of interest in "governance." The main goal is improving public-sector coordination and bringing innovation policy to the center of economic policymaking and development strategy. This is being tried through cabinet-level coordination and a variety of innovation and competitiveness councils around the region (akin to what the OECD has labeled the "whole government approach" to innovation). Information about these institutional developments and their affinity with certain policy instruments is presented in Table 10.5.

This table also provides an indication of the effectiveness of each policy instrument, as shown by the plus and minus signs. For many of the policy tools in the table, there is not enough information to validate their use. Notable exceptions include the innovation funds and scholarship programs. Beyond that, there is the pending task of improving program and policy evaluation in innovation policy. All in all, the arsenal of policy tools available to Latin American countries does not seem to be very different from the one available to OECD governments promoting innovation. The similarity, however, conceals some significant differences.

First, while advanced economies have a well-established institutional framework that is regularly financed and has considerable built-in management capabilities, such a framework is still in an early stage of development in most Latin America countries. A sudden economic or political crisis, or even the regular turnover of political appointees following an election, can leave innovation institutions weakened and scrambling to retain or recruit very scarce technical and managerial talent. Thus, there are frailties in innovation policy, which appear in different degrees across the region.

Second, Latin American countries must pay sustained attention and devote substantial resources to initiate and strengthen basic components of the national innovation system that developed economies can take for granted. A notable example is the difficulty that several countries in the

Table 10.5 Instruments, Institutions and Effectiveness of Innovation Policies in Latin America

	Human capital and investment in science	*Company innovation*	*Strategic selectivity*
Instruments and type of programs	Competitive funds for research projects in science and technology with low appropriability (+)	Company innovation funds, designed to adjust to different types of companies and different modes of innovation (+)	Sector innovation funds (+ −)
	Support for excellence centers, selected and specialized in technologies with universal application (ICTs, biotechnology, nanotechnology) (+ −)	Venture and seed capital, other financial instruments to support innovation (+ −)	Identification of priority areas or sectors (+ −)
	Scholarship programs for masters and doctorate abroad (+)	Tax and tariff exemptions (−)	Programs aiming to enhance production chains, technology poles, and business incubators (+ −)
	Reinforcing national postgraduates in science and engineering (+)	Technology extension services (+ −)	Instruments to reinforce regional innovation systems (+ −)
	Promotion programs for strengthening knowledge networks through repatriation of diaspora and attraction of global talent (+ −)		Dialogue mechanisms between actors of the national innovation systems
Institutional features	National Councils of Science and Technology specializing in human-capital issues	Agencies in charge of the management of funds for company innovation	National Councils of Science and Technology dedicated to coordination across sectors and the definition of the competitiveness strategy of the nation
	Agencies managing scholarship programs	Supervisory agencies for foreign investment	Creation of innovation tables
	Agencies managing competitive funds for research		In some cases, ministries of science, technology, and innovation

Source: Authors' compilation.

Note: (+): the evidence suggests positive results of these instruments; (−): the evidence suggests negative or limited results; (+ −): mixed evidence.

region have in securing adequate services and capacities in metrology, technical reviews of products, and quality certification.

Finally, Latin American countries are characterized by considerable social inequality and exclusion that are far more severe than anything that exists in advanced economies. In recognition of this fact, policymakers are paying increasing attention to the need to connect the innovation agenda to the social agenda, taking steps to ensure that innovation and technological development tackle poverty, education, and public health issues.

The maturity and development of institutions and policies for innovation in the region varies widely. Table 10.6 shows which main policy instruments discussed in this chapter—organized according to the policy approach—each country in a group of thirteen can count on. In the case of human capital for innovation, all countries have at least a few instruments. By contrast, countries have fewer instruments devoted to strategic and selective policies, even in some countries with the most developed innovation policy institutions. Instruments closely linked to the second approach, organized around the promotion of business innovation, are at an intermediate stage of development and consolidation.

Conclusion

This chapter has gathered the available evidence on the current status of science, technology, and innovation in Latin American countries, and has attempted to analyze its connection to the productivity stagnation that plagues the region. In spite of recent progress, mostly concentrated in the larger economies, a serious deficit of investment in R&D and innovation exists in the region. This conclusion becomes apparent once indicators from Latin America are benchmarked with international standards, and holds even if adjustments are made for the particular productive structure of the countries included in the analysis. The size of this deficit varies by country, but not a single economy in the region—not even Brazil or Mexico—can be complacent about its current level of investment on this front.

Even more serious than this deficit, particularly from the perspective of productivity growth, is the widespread failure to link R&D capacity with firms. Even countries that have achieved substantial progress in research capacity have not necessarily advanced well in building constructive and strong relationships between research capacity and business activity.

Many firms in Latin America are innovative. At the same time, it is very clear that innovation travels through peculiar paths in the region, and these paths reveal a series of problems and constraints that hamper growth in productivity.

Table 10.6 Innovation Policy Instruments in Latin America, Selected Countries, 2008

Instrument/Country	*Argentina*	*Brazil*	*Chile*	*Colombia*	*Costa Rica*	*Dominican Republic*	*El Salvador*	*Guatemala*	*Mexico*	*Panama*	*Paraguay*	*Peru*	*Uruguay*
First approach													
Scientific research and technology funds	■	■	■	■	■	■		■	■	■	■	■	■
Support for creation of centers of excellence	■	■	■	■					■				■
Scholarships for graduates and postgraduates	■	■	■	■					■	■		■	■
Support programs for national postgraduates in science and technology	■	■	■	■					■	■	■		■
Wage incentives for research in science and technology	■								■	■			■
Strengthening linkages with national researchers working abroad	■		■						■	■			■
Second approach													
Funds for the promotion of innovation and competitiveness of companies	▒	▒	▒	▒	▒		▒		▒	▒	▒	▒	
Venture capital, seed capital, and other financial instruments to support innovation	▒	▒	▒	▒									▒
R&D and innovation tax incentives	▒	▒	▒	▒					▒				
Mechanisms for the promotion of technology and knowledge transfer to non-agricultural industry (technology extension, etc.)	▒	▒	▒	▒					▒	▒	▒		
Third approach													
Sector innovation funds	■	■	■						■				■
Priority areas/sectors	■	■	■	■					■		■		■
Promotion of technology clusters, technology and business incubators	■	■	■			■							■
Other instruments to enhance regional innovation systems		■	■						■				
Dialogue mechanisms between actors of the national innovation systems (technology and innovation tables, etc.)	■	■	■						■				■

Source: Authors' compilation based on RICYT (2009) database complemented with information from experts.

There has been no shortage of public policies and programs aimed at these problems. A variety of tools has been put in place by governments. There are well-designed and effective public programs for innovation in many countries, although institutional development across them varies considerably and the size of these interventions is suboptimal. This conclusion can be easily illustrated by comparing the proportion of firms that receive public support for innovation in Europe to Latin America. Depending on which country is considered, between 10 and 50 percent of businesses receive public subsidies for innovative activities in Europe, while even Brazil, the country with the largest program in the region, ranks below that minimum.

Moreover, the relative emphasis on some policy instruments may not have been the best given the particular characteristics of innovation in Latin America. Most firms in the region operate far from the technological frontier. They are small, for the most part. The largest share of their investment in innovation takes the form of acquisition of technology embedded in machinery. The skills profile of their workers tends to be relatively less advanced than that of businesses in advanced economies, where the machinery was originally manufactured. The main channel for innovation and technological progress in the region is the adaptation of imported knowledge, while the absorptive capacity needed to take full advantage of technology transfer is often lacking.

What would a policy adapted to these conditions look like? It would emphasize technological services to business, whether they originate in laboratories, universities, or engineering and consulting firms, as well as technological extension programs directly aimed at facilitating access to relevant knowledge for firms. These kinds of programs should be far more common and significant in the Latin American innovation policy mix to improve firms' absorptive capacity. Another much-needed emphasis would be on programs aimed at developing human capital for technology and innovation. There is special need to correct the bias in human resource policies in favor of advanced degrees, and focus instead on training intermediate professionals in technical fields. This type of human resource constitutes a key link in the innovation systems in advanced economies but is extremely weak in Latin America, given the seemingly low prestige and visibility of this type of education.

Finally, the deficit in strategic vision must be addressed. Both dominant approaches to science, technology, and innovation policy over the past few decades are well-established in most countries, and rapidly maturing in others. Those approaches, however, are limited in their ability to support the key role that R&D and innovation should play in development strategies.

While innovation policies have focused on developing instruments to encourage private-sector innovation and technological upgrade in industrial firms, as well as on improving scientific capacity, the general economic strategy of the larger economies in the region—or, perhaps, inertia—has moved the region's economies in precisely the opposite direction, pushing them away from technology and knowledge-intensive industries toward natural resource processing activities and food production (Katz 2006).

Some countries have learned from this experience and are moving toward adopting a strategic approach to innovation policy: one that is proactive in identifying sectors and niches as priorities for public support, as well as in placing innovation at the core of industrial policy. This type of approach emphasizes a system perspective of innovation and highlights coordination failures that block innovation activity and impede communication and integration among key actors and aspects of the national innovation system in order to promote access to financing for innovative firms, conditions that favor dynamic entrepreneurship, provisions for the efficient start-up and closing of business ventures, management of intellectual property rights, university-industry links, and technological infrastructure and services.

Ever since the industrial revolution, R&D and innovation have been two of the main engines of economic growth and better living standards. Over the past three decades, that traditional role has grown, given the global trend toward a knowledge-based economy. The most dynamic economic sectors in the global marketplace are those that are technology-intensive, and they depend on the capacity to generate, adapt, and utilize knowledge as the foundation of productivity growth.

All advanced economies, to different degrees but without exception, are transforming themselves into economies with these characteristics. The success stories among emerging economies that have been able to leap forward in terms of productivity and welfare—most of them in Asia—share the common denominator of business innovation and technological development at the heart of their competitive strategies (Dahlman and Utz 2005).

In this context, Latin American economies face numerous and diverse challenges in building effective growth strategies. This book squarely identifies the region's stagnation in productivity as a key issue that must be tackled. It would be surprising if Latin American countries manage to jumpstart productivity growth without focusing on science, technology, and innovation in ways consistent with the characteristics of their economies, firms, and institutions, and within the framework of the global movement toward knowledge-based economies.

Notes

1. A similar result is reported for Brazil in an OECD analysis (2009). In a study of Argentine and Brazilian firms, however, de Negri, de Negri, and Freitas (2007) find a positive relationship between innovative effort and exports.
2. This analysis does not take into account the possibility of knowledge spillovers produced as a result of the operation of multinationals in developing countries. Mongue-González and Hewitt (2009) find solid evidence of knowledge externalities in a case study of the highly innovative information and communication technologies (ICT) industry in Costa Rica, registering positive impacts on productivity growth.
3. A national innovation system is the set of distinct institutions that jointly and individually contributes to the development and diffusion of new technologies and provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts that define new technologies (Metcalfe 1995).
4. See Arbeláez (2009); Arza and López (2009); and Cassoni and Ramada-Sarasola (2009).
5. Blyde et al. (2007) applied the same framework to Brazil and found that 18 OECD countries included in the analysis would invest far more than Brazil on R&D if they had the same pattern of sector specialization as the Brazilian economy. Anlló and Suárez (2009), in comparing innovative behavior in a series of industries in Argentina, Brazil, France, Germany, and Spain, concluded that significant differences exist in the technological intensity of firms working within the same industry across countries.
6. Cimmoli et al. (2005) analyzed structural change in the economic structure of Latin America between 1970 and 2000, and compared it to Finland, South Korea, and the United States. They find that growth in Finland and South Korea is clearly associated with a change in economic structure in favor of knowledge-intensive sectors, which have a role in disseminating technology throughout the whole economy. In contrast, in Latin American, there was a reduction in the participation of high technology sectors in favor of natural resource–intensive sectors. The behavior of productivity in both groups of countries could not be more different. Productivity growth accelerated in Finland and South Korea and stagnated in Latin America.
7. For an excellent sample of the type and depth of analysis on technology policy in the 1960s and 1970s in the region, see Sagasti and Araoz (1975).
8. A few exceptions can be found in scattered uses of public procurement policies in the service of investments in technology, such as the development of Empresa Brasileira de Aeronáutica (EMBRAER) in Brazil.
9. A recent review of innovation policy in the OECD indicates that 16 of 25 countries utilize fiscal incentives as a policy instrument (Sheehan 2007). There is evidence that such fiscal incentives yield benefits for innovation, ranging from neutral to favorable (Hall and Van Reenen 1999), to the point that they have come to dominate innovation policy in a few countries (e.g., Canada and the Netherlands). However, experts and analysts have criticized their use in developing countries, given their bias toward the largest firms—precisely the group that invests heavily in R&D anyway. For recent evidence, see Agapitova, Holm-Nielsen, and Vukmirovic (2002); Salazar (2007); and Mercer-Blackman (2008).
10. Brazil and Mexico were the first to introduce sector-specific innovation funds. See Ventura (2009) for a review.
11. Innovation policy in the area of human capital has also been evolving recently. More attention is being paid to the development of domestic graduate programs that will be able to accommodate the new cohorts of doctoral degree holders who are returning from abroad and consolidating domestic capabilities. More proactive steps are also being taken to manage talent flows across borders by designing specific policies directed at preventing brain drain and attracting the scientific diaspora of each nation.