CHAPTER

15

The Ability to Innovate and Use New Technologies

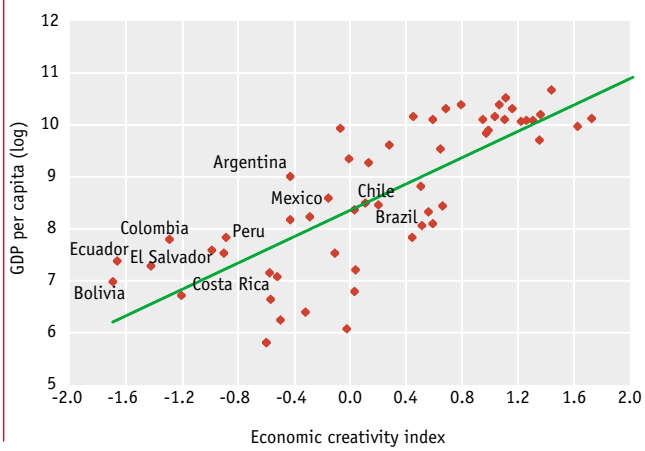
On one level, the spectacular growth of the Internet in recent years demonstrates its potential to increase productivity, which is the basis of economic growth. But even beyond that, the Internet and the new information technology in general demonstrate the importance of a more subtle but equally important growth factor: innovation and the ability to adapt. When all is said and done, the Internet is simply the latest expression of the ingenuity of human beings and the ongoing effort to improve social welfare and the ability of people and businesses to employ new technologies in the search for markets and profits.

How, then, can Latin America become more innovative? How can the region be more entrepreneurial, and how can it more readily adapt technologies?

The countries that are the most innovative and most able to successfully adapt technologies to domestic needs are also the ones that have higher income levels. Countries that are not very innovative, or that cannot adapt technologies efficiently, have lower GDPs. This relationship is clearly captured by the index of economic creativity developed by *The Global Competitiveness Report* (see Figure 15.1).[1] The index is based on a mix of indicators that reflect the ability of countries to renovate their technologies and firms (see Box 15.1). Most Latin American countries—Chile, Brazil and Mexico being the exceptions—rank low in terms of economic creativity.

Figure 15.2 shows that while the world's leading economies have high levels of innovation, the performance of Latin America is poor, with all countries displaying negative scores below the world average. Costa Rica and Chile are the Latin American leaders in terms of innovation, while Bolivia, El Salvador and Ecuador are the poorest performers. Unlike Latin America, not all the countries of East Asia register negative scores: Singapore and Taiwan have remarkable positions.

Figure 15.1 Economic Creativity Index and GDP Per Capita



Source: Warner (2000) and IDB calculations.

While innovation is the major force behind economic creativity in industrial countries, it is the transfer of technology that plays a more important role in the developing world and in Latin America in particular. Overall scores for Latin America are negative both for innovation *and* for technological transfer, reflecting the region's difficulties in renovating technologies, either

[1] As mentioned in Chapter 1, *The Global Competitiveness Report* for 2001 introduced a new methodology to construct its technology index, one of the components of the creativity index used here. In this chapter, we employ their previous index as the concept of creativity because it helps us to understand several of the key issues in Latin America related to the ability to innovate. The measure may be criticized, however, on the grounds of subjectiveness and endogeneity (Bertrand and Mullainathan, 2001).

Box 15.1 An Index of Creativity

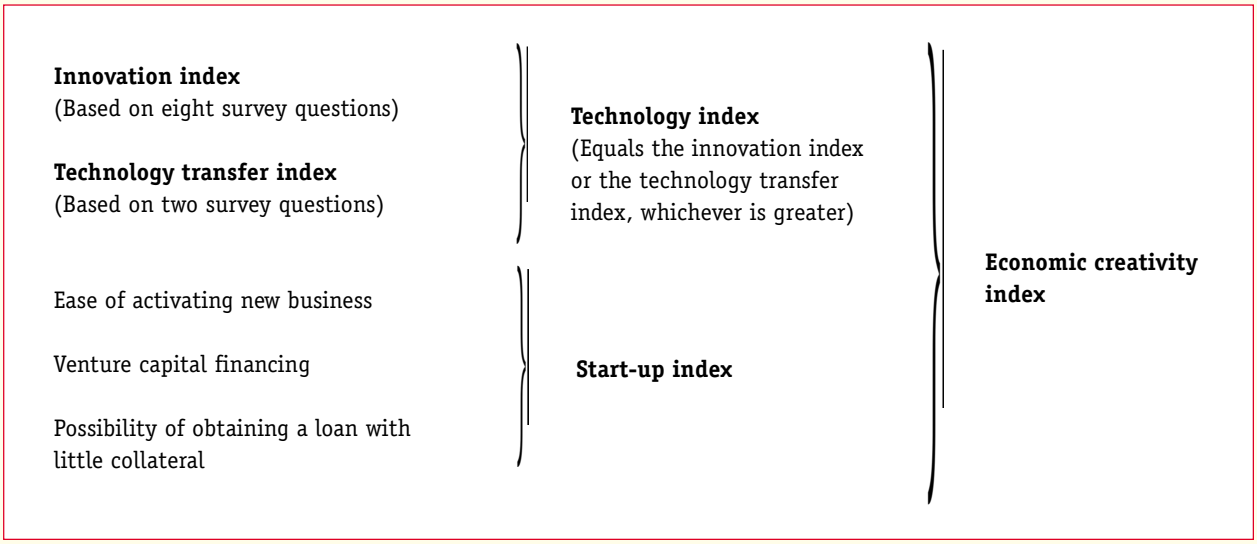
The Global Competitiveness Report for 2000 contains an index of economic creativity that captures the ability of countries to continuously renovate and improve their productive activities. This process requires renovating technologies as well as firms themselves.

The ability of a country to renovate technologies is measured through a technology index based on survey questions that capture a country's capability to innovate and adopt technology. Since countries can obtain technology either by producing or importing it, an overall technology index is measured by whichever of these components is largest. The idea is that the technology index rewards countries for either innovation or technology transfer. What is important is that the country participate in the newest technologies and innovations, not whether the country itself is the innovative pioneer. To raise GDP through technology-related activities, a country needs to achieve value-added at some stage of the process, but not necessarily at the inventive stage.

The ability to renovate firms is captured through a start-up index that is an average of whether financing is available, and the degree of difficulty in starting a new business. The former is measured by averaging responses to two questions: whether venture capital is available for risk-taking entrepreneurs, and whether it is easy to get a loan with a good business plan but with little collateral.

The final economic creativity index is an average of the technology and start-up indices. In a range that goes from -2 to +2, the average index of economic creativity for the developed countries is 0.92, whereas for developing economies it is -0.19. The gap occurs in all the categories of economic creativity, although it is more significant in the case of innovation (0.89 for developed countries vs. -0.57 for developing countries). The economic creativity index for East Asia is 0.32, whereas for Latin America it is -0.75. Although the economies of both regions have performed poorly in terms of innovation, the advantage clearly goes to East Asia.

Source: Warner (2000).



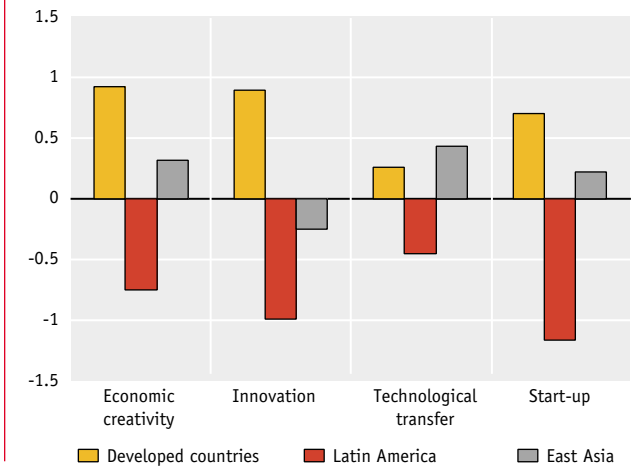
by developing them or by assimilating those developed by others. Compare this with East Asia, where the innovation index is negative, but less so, and where the technology transfer score is positive. This confirms the idea that in East Asia, adaptations of existing technologies have played a large role in the region's economic creativity process. In a world with international trade of goods and services, foreign direct investment, and international exchange of information and dissemination of knowledge, the role of economic creativity in a nation's productivity depends on both domestic and foreign research and development.[2]

Economic creativity also depends on the ability of firms to renovate themselves, which is captured by the start-up index in Figure 15.2.[3] In this respect, Latin

[2] See Coe and Helpman (1995).
[3] See Box 15.1.

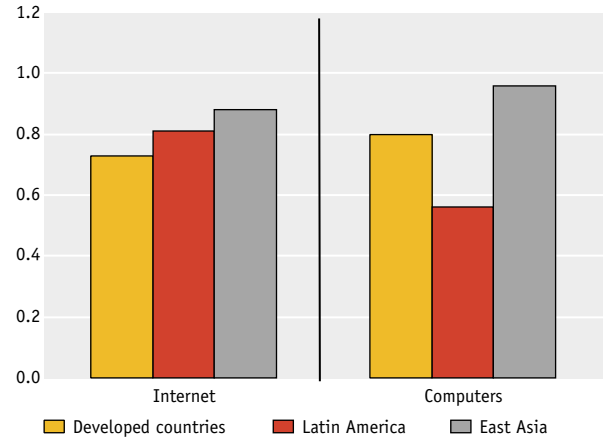
Figure 15.2 Economic Creativity and Its Components

(Average indices by region)



Source: World Economic Forum (2000).

Figure 15.3 Correlations between Economic Creativity and the Use of Information Technology



Source: World Economic Forum (2000) and World Bank (2000).

America fares even worse. This important source for improving productivity is severely constrained in many Latin American countries by lack of credit, shallowness of capital markets, and a gamut of hurdles to start businesses.

Economic Creativity, Innovativeness and Information Technology

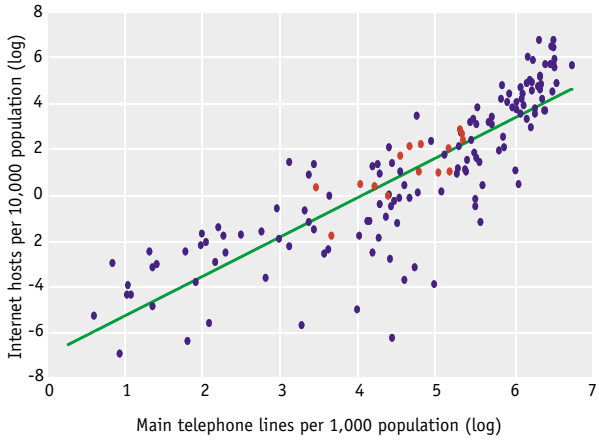
Although the measures of innovation and creativity in *The Global Competitiveness Report* are important, they are partly based on subjective surveys that are open to criticism for lack of comparability across countries and bias problems. Is there an objective measure of creativity and innovation in an economy? Given the fact that the new economy involves very recent technologies, its depth in a given country—that is, its economic creativity and innovative potential—can be measured in part by the number of Internet hosts or personal computers. In fact, the correlation between information technology and economic creativity is high, although it is higher for developed than for developing nations (0.73 vs. 0.54 for Internet hosts and 0.80 vs. 0.53 for personal computers). However, the lower correlation for developing countries is driven by the African countries, since for both Latin America and East Asia the correlation is higher (0.81 and 0.88, respectively, in the case of the Internet) (see Figure 15.3). In general, the Internet is highly correlated with innovation, start-up of new business, and even technological transfer. In other words, Internet is a useful proxy of economic creativity in the developing world in general, and in Latin America in particular.

In general, the higher the country on the economic creativity ladder, the more effective it will be in achieving technological development, as measured by the extent to which the Internet has penetrated the economy. At this point, an obvious constraint comes to mind: infrastructure (not a component of the creativity index). Does the use of the Internet reflect more the availability of telephone lines than the ability of people and businesses to adopt and use new technologies? Since almost all Internet users depend on telephone lines for connection, there is indeed a close relationship between the two variables (see Figure 15.4). Lack of telecommunications services is a serious problem in Latin America, especially in rural areas, so the digital divide is likely to persist in the future. However, lack of infrastructure is not insurmountable, as a number of imaginative solutions in Latin America have shown (see Box 15.2).

Although infrastructure may be important, it is far from being the whole story. In fact, the relationship between innovation and information technology as measured by Internet depth, to cite one example, holds tightly even when isolating for differences in telephone infrastructure among countries (see Figure 15.5).

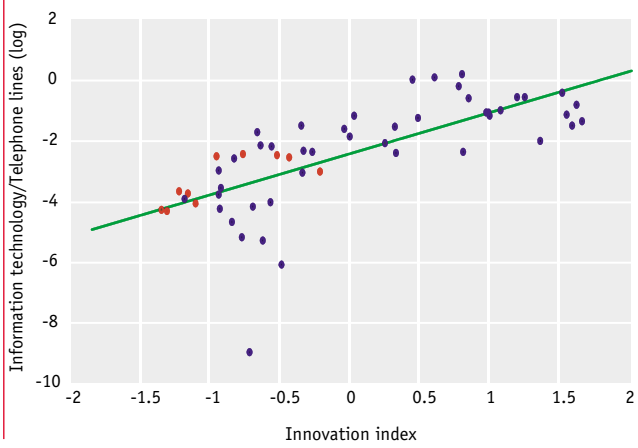
It is noteworthy that in Figure 15.5, the vertical axis measures the relationship between Internet hosts

Figure 15.4 **Telephones Lines and Internet Hosts**



Note: Each dot represents a country. Latin American countries are shown in red.
Source: World Economic Forum (2000) and World Bank (2000).

Figure 15.5 **Information Technology and Innovation Index**



Source: World Economic Forum (2000) and World Bank (2000).

and telephone lines, while the horizontal axis measures innovation as ranked by *The Global Competitiveness Report*. Clearly, the ability to assimilate new technologies is not just a matter of infrastructure.

Determinants of Innovativeness

What are the factors beyond infrastructure that can improve a country's ability to innovate and assimilate new technologies? As Edwards (2001) points out, before Latin American policymakers allow themselves to be seduced by the notion that information technology is the silver bullet for development, governments must take into account key factors that, if not addressed, will ensure that the money invested in new technologies will be wasted. The empirical exploration in Appendix Table 15.1 of the determinants of innovation makes clear that those key factors are education, access to credit, effective institutions, and economic openness.

Education and Training

Part III of this report showed that education is crucial to achieving productivity, since more educated workers are better able to devise more efficient ways to work. In other words, education enables workers to become innovative and to better absorb and adapt technologies. A skilled labor force plays a crucial role in exploiting the potential offered by the explosion of knowledge. Education is the basis for creating, acquiring, adapting, disseminating, sharing and using knowledge. Even though Latin America's labor force is not as unskilled as the conventional wisdom has it, the region still has a long way to go to bring its workers up to par.

The reality check comes from East Asia, a region with a highly educated population that, not surprisingly, has had the most success in adapting technologies from industrial countries, and later becoming an innovative powerhouse in its own right. In Latin America, it is becoming increasingly necessary to have a broader education that goes beyond just primary school and on to secondary and higher education. As was pointed out in Part III, in the absence of an adequate system of basic education, even the most well designed training systems have little chance of improving the skills of most workers. In Latin America, training systems tend to reinforce, rather than correct, basic education gaps, when in fact their role should be to help firms and workers assimilate technological developments. Toward that end, most training systems in the region need revamping if they are to become a functional contributor to the process of innovation.

Credit and Finance

As shown in Parts I and II of this report, business growth in Latin America is severely limited by lack of credit. The major problem firms face is the difficulty in accessing financial markets. This problem is exacerbated in

Box 15.2 Infrastructure and Telecom Centers in Latin America

Governments throughout the region have been promoting the establishment of telecom centers in low-income urban and rural areas. Provided that it would be difficult and expensive in the short run to attain universal domestic service in all countries of the region, governments are now focusing on providing widespread public access through the establishment of these centers, a goal that is attainable in a relatively small period of time.

A typical telecom center is a location where the public has access to the Internet and services like e-mail and chat rooms. Such facilities already exist in Brazil, Chile, Honduras, Panama and Peru, among other countries in the region. The first telecom center opened to the public in Peru in 1995, and some 700 centers were launched in the five years that followed. Most of these cabins are located in areas with adequate infrastructure to support the Internet connection. On average, the charge is 75 cents per hour, down from $1.40 in February 1999. This drop was the result of an increase in the number of people using the cabins. "El Encuentro," a private telecom center in an urban area in Chile, offers Internet access at $1 per hour and provides training on software packages such as spreadsheets and word processing programs for $16 a month. Information technology schools in Brazil's *favelas* offer spreadsheet courses at a monthly charge of $10. Most of these centers receive public as well as private funds.

The main obstacle to expanding the telecom centers in rural areas has been the infrastructure itself, which poses higher and sometimes unaffordable costs to governments in the region. To make the most of available infrastructure, Honduras has established rural centers that offer a broader range of services such as e-mail, end-user support and training and equipment rental. It is too early to assess the impact of telecom centers, but for the moment they would appear to be the most viable way to expand Internet access in areas of Latin America that lack infrastructure.

Source: Proenza, Bastidas-Buch and Montero (2001).

the case of information technology businesses, since their set-up costs are high, and because the firms interested in getting involved in information technologies are often microenterprises with little or no capital. This combination proves a formidable obstacle. In Latin America, innovation and the development of start-up companies is hindered by underdeveloped financial markets and an overall lack of creative financial instruments, and poor access to credit and its high cost.

Institutions and the Rule of Law

A functional bureaucracy, adequate property rights, control of corruption, and respect for the rule of law have a strong impact on economic performance. Simply put, institutions are crucial to increasing competitiveness, productivity and economic growth. An effective institutional setting proves particularly important in terms of information technology. The fast pace and rapidly changing environment associated with these technologies point to the need for an adequate institutional setting that can keep pace. A Website with a state-of-the-art and ultra-fast modem connection could well become obsolete in six months. A weak rule of law or an unnecessarily complex regulatory system are strong disincentives to innovation because, by their nature, they slow down the process of adaptation and change. Yet such scenarios are all too common in many Latin American countries, where registering a new business requires negotiating through a maze of red tape (see Box 15.3).

Clearly, there is a need for an institutional regime pertaining to information disclosure, transparency, accountability and the rule of law, as well as the structure and functioning of government, including issues of governance and the reduction of corruption. In some Latin American countries, particularly Brazil, Mexico and Argentina, the protection of intellectual property rights is becoming increasingly important. This is being driven by the mounting costs of research and development for new products or processes, and the shortening of the product life cycle. The incentive to develop knowledge is weakened if that knowledge is not protected.[4]

Economic Openness

Openness is another potentially significant factor in innovation and technological absorption. Imports of machinery and equipment, for example, are an important

[4] See World Bank (2000).

Box 15.3 Obstacles to Starting a Business

A worldwide study of 75 countries finds that some Latin American nations are among those that require the most procedures to start a business (see figure below). In Colombia, 17 steps are required, among the highest number in the world. Under the assumption that everything else goes right, it takes 55 days there on average and around $250 to start up a firm.

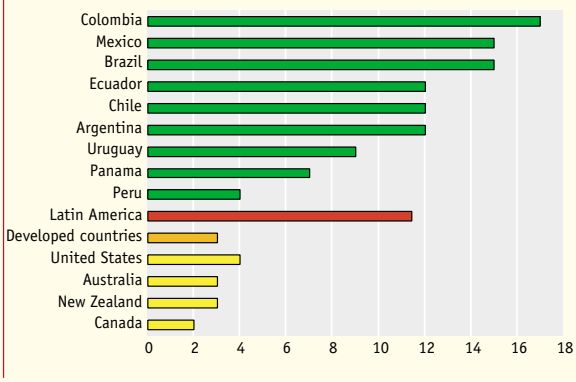
What is the purpose of all these steps? Theoretically, they guarantee that labor and tax rules are enforced, that consumer rights are protected, and that the environment is preserved. However, in practice, these requirements facilitate the opposite effect: they allow for additional rents to politicians and public officials, and they hinder innovation and competition.

This is not just the case in Colombia. Evidence across the world shows the same results. Countries with excessive regulations and procedures are among those with the highest levels of corruption. The myriad steps do not provide effective protection to consumers, do not control pollution, and in fact encourage tax evasion and larger underground economies.

Countries where the rule of law applies and corruption is minimal, such as Canada, Australia or New Zealand, do not hinder business start-ups. In Canada, starting a business involves undertaking two procedures for registry purposes. Operations can begin a few days after the company is registered. In turn, because firms can register easily and learn their obligations beforehand, rules are better enforced. Countries that make setting up a business difficult end up paying a high cost in terms of innovation and creativity. They impede the development of new entrepreneurship and give an implicit advantage to existing firms.

Source: Djankov et al. (2000).

Number of Procedures to Start a Business



Source: Djankov et al. (2000).

part of the process of channeling knowledge and transferring technology. Open economies have access to the latest technologies that can spur subsequent domestic innovation. Openness also allows the free flow of ideas among nations, which is particularly crucial in a knowledge-based economy that looks to take full advantage of new information technologies.

Pending Issues: Any Additional Government Role?

The analysis above shows that the diffusion of information technologies and the Internet requires investment in skills and infrastructure, a consistent and respected rule of law, the protection of property rights, financial depth, and economic openness. The development and adoption of new technologies, however, also presents its share of new challenges, questions and problems for governments. To the extent that the information technology revolution is relevant to Latin American development, what are some of the key pending issues?

For one, policies should support the creation and broad diffusion of new technologies and encourage competition in the information technology sector. A key issue is whether governments should subsidize the new economy. While it is true that some developed country governments have done so in a variety of ways, there is by no means a clear-cut answer for Latin America.[5] Edwards (2001) argues that subsidizing information technology carries the danger of creating costly and ineffective institutional conglomerates similar to the inefficient industrial complexes during Latin America's celebrated experiment with import substitution.

However, it is also true that most telecommunications technologies yield network externalities. That is, the private benefit for an individual to connect to the network is lower than the social one, since all agents who already are connected increase their benefit once the individual enters. If these externalities are big enough, a new technology that could improve social welfare might never be introduced. Thus, there may be a case for gov-

[5] For instance, recent U.S. budgets included relatively large funding for high-performance computing and communications. Similarly, the U.S. Congress has also passed legislation establishing programs that enable public schools and libraries to obtain subsidized Internet services (see Rivera Batiz, 2000).

Box 15.4 New Technologies and the Digital Divide

There is intense debate as to whether governments, international lending institutions and aid organizations should spend their limited development budgets on information technology. A number of development specialists and even some technology executives, such as Bill Gates, have questioned the wisdom of wiring the Third World at the expense of immunizing, educating and helping to feed the 1.2 billion people around the world who earn less than $1 a day. However, other development experts argue that devoting more money to setting up Internet connections in poor countries will, in the long run, provide people with a degree of self-sufficiency.

Efforts to wire the world have been energized by the production of increasingly low-cost computers, solar panels and satellite dishes. And efforts are underway to develop new types of technology that may be better suited to remote communities and Internet neophytes. Scientists in India, for instance, are testing a $200 hand-held computer with wireless Internet access and a picture-based operating system that even illiterate farmers can use. MIT researchers have assembled mobile Internet community centers inside metal shipping containers that have been transported to several villages in Costa Rica and the Dominican Republic.

One example of how the new information technology can bridge the digital divide is the rural village of Rovieng, Cambodia, where the Internet is transforming the economy. Several young women have revived the village's traditional silk weaving industry. The scarves are sold through the village's Website to customers around the world, but the profits from the new economy experiment are being plowed into the creation of something decidedly more old-fashioned: a pig farm. The farm has generated new employment and hopes for spin-off industries and profits that will go into a fund to pay for the villagers' medical care.

Of course, problems remain. The language barrier, for example, affects how the computers are used. Almost nobody in the village speaks or reads English, and there is very little on the Internet that is written in Khmer, the local language. In addition, although the price of computer hardware has fallen, the cost of satellite connections—the only way people in places such as Rovieng can tap into the Internet—remains prohibitively expensive. Rovieng was able to get around the obstacle by convincing a satellite company to donate a 64,000-bit-per-second link to the village. The connection is valued at about $18,000 a year.

Source: Chandrasekaran (2001).

ernments to provide subsidies so as to equalize the private benefit with the social benefit. This is a dangerous proposition, however, since the value of network externalities is difficult to determine, and subsidies are an easy avenue for corruption and for creating rather than correcting distortions.

There is a potentially safer way for governments to support the diffusion of new information technologies such as the Internet. The state is an important player in the economy, so the private benefit to adopt a new information technology is close to the social one. And the state is big enough to take advantage of network externalities, even though it is the only agent that adopts it. In addition, if the technology has important network externalities, once the government is in, the net benefit for private agents to enter into the network would be much larger, and therefore the technology would diffuse.[6]

Another important issue is the so-called "digital divide" problem, by which there is the risk that the rich will benefit proportionally more from the development of the new information technologies than the poor, thus exacerbating income inequality in the longer run (see Box 15.4).

This problem may be compounded by another factor. Since development costs are so high and variable costs are almost negligible, property right infractions abound, as a widespread underground economy is able to reproduce originals. Since both the producers and the users of these illegal copies are likely to be middle- or low-income groups, income distribution may suffer in the short run when property rights are enforced. This may prevent policymakers from taking decisions that in the long run will benefit the poor through better income and employment opportunities in the formal economy.

Another pending issue is whether governments

[6] It is important to remember that industries with large economies of scale tend to become monopolies, in which case, government intervention may be warranted. Information technologies can use many of the current networks, like telecommunications, TV cables and electric wires, so regulatory authorities must therefor have a global view of all these industries and prevent the concentration of these networks among a few players.

should apply a laissez-faire approach and let the market dictate whatever technology it wants, or whether governments should be proactive and settle, for example, on a lower-tech version of a given product. In principle, the latter appears to make some sense, especially when the inequalities within certain countries are taken into account, and given the fact that issues such as maintenance may be more expensive with more sophisticated technologies.

Finally, there is the issue of taxation of electronic commerce. There is a legitimate concern that the development of the Internet may shrink the tax base and hence reduce fiscal revenue. Taxation is inherently and inextricably linked with geographical jurisdiction. In order to assess the tax due, it is essential to determine where a certain transaction took place, or where value was added to a certain product.[7] To give a simple example, if a Peruvian citizen purchases the CD of an American pop singer from a local store, it is immediately clear that the transaction took place under Peruvian jurisdiction, hence that the applicable 18 percent value-added tax should be levied. However, if the Peruvian citizen downloads the music content of the CD directly from the pop singer's Website, it cannot be readily determined whether the transaction took place under the jurisdiction of the seller (located in the United States) or the consumer (located in Peru).

Conclusions

Governments should not pursue expensive policies to promote widespread use of computers as a means to accelerate growth. However, a hands-off approach is not necessarily the best strategy to take advantage of the possibilities offered by the new technologies, either. First and foremost, efforts should aim to improve the environment for innovation through better education, deeper and sounder financial sectors, and stronger institutions that facilitate investment. Second, obstacles to the extension of computer technologies should be removed, among them telecommunications infrastructure bottlenecks and monopolies. Governments should take the lead in adopting the Internet and be receptive to new solutions that facilitate the use of the information technologies by middle- and low-income groups. Finally, governments need be alert to the challenges presented by information technologies, such as the effects on tax collection, the digital divide, and the extent to which governments should be proactive.

[7] See OECD (1999).

Appendix 15.1

Data Sources and Definitions

Gross Domestic Product (GDP): Data for 1997 from *World Development Indicators,* World Bank (2000b).

Internet hosts: Data for 1997 from the database of the International Telecommunications Union (2000).

Main telephone lines (per 1,000 population): Data for 1997 from the database of the International Telecommunications Union (2000).

Personal computers (PCs): Data for 1997 from the database of the International Telecommunications Union (2000).

Private credit: Data for 1997 from *World Development Indicators,* World Bank (2000b).

Rule of law: The index used comes from *World Development Indicators,* World Bank (2000b).

Secondary schooling: Barro and Lee (1993).

Trade: Calculated as the sum of a country's exports and imports in 1997. Data on exports and imports from *World Development Indicators,* World Bank (2000b).

Total assets/GDP: Assets of the top 25 firms by country, including those of the real sector only. Data from WorldScope Database (2000).

Appendix Table 15.1 **Determinants of Internet Hosts: OLS Regression Results**

	Dependent variable: Internet hosts/Main telephone lines (log)			
Independent variables	**1**	**2**	**3**	**4**
Constant	-5.17 (-1.70)*	-5.36 (-1.81)*	-7.47 (-2.30)**	-7.19 (-2.23)**
Secondary school (%)	0.02 (3.47)***	0.02 (2.92)**	0.03 (4.00)***	0.02 (3.23)***
Private credit/GDP	0.13 (0.32)	0.27 (0.66)	0.28 (0.68)	0.33 (0.82)
Trade/GDP	0.13 (0.38)	0.06 (0.17)	0.33 (0.95)	0.24 (0.69)
Rule of law index	0.51 (2.09)**	0.18 (0.62)	0.51 (2.15)***	0.27 (0.91)
GDP (Log)	0.01 (0.06)	-0.07 (-0.50)	0.07 (0.52)	0.01 (0.05)
Total assets/GDP	3.42 (0.23)	2.78 (0.19)	4.50 (0.30)	3.93 (0.27)
Main telephone lines (per 1,000 pop.)		0.47 (1.89)*		0.34 (1.29)
Latin American dummy			0.87 (1.99)**	0.69 (1.52)
R^2	0.63	0.66	0.66	0.67
No. of observations	52	52	51	51

Notes: t-statistics in parentheses. The dependent variable is Internet hosts divided by telephone lines for 1992-98. For the sake of completeness, specifications (2) and (4) also control for telephone lines, As expected, such coefficients are not robustly significant. Notice that a Latin America dummy was included in the specifications (3) and (4), which replicate (1) and (2) respectively.

*** Significant at 1%.

** Significant at 5%.

* Significant at 10%.