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The Internet and the Ability to Innovate in Latin America

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Abstract[*]

In this paper we provide an overview of the situation of the Internet in Latin America and argue that, although latecomers, Latin American countries could in principle catch up at a faster pace and a lower cost. But that will depend on the environment for innovation in the countries; in that respect, the adoption of the Internet may prove to be no different than other technological changes. The paper also discusses how the degree of innovativeness in a country helps explain the extent to which new technologies may be more effectively absorbed. What is surprising about this relationship is that it is valid even when isolating the fact that countries with better telephone infrastructure are also the ones with more Internet hosts. We found that the capacity to innovate and assimilate new technologies is not just a matter of income or infrastructure endowment.

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1. Introduction

Information technologies, understood as those technologies that help produce, gather, distribute, consume and store information, have more than ever come to the fore. The reason is simple. They have become ubiquitous in everyday life in a relatively short period of time. This is particularly true of the Internet, access to which has increased by hundreds of times in recent years (Figure 1). Terms that were non-existent just a few years ago such as *world-wide-web*, *e-mail*, *Intranet*, and many others, are now part of people's everyday vocabulary. Consumers can now go online and comparison shop around the world, reviewing hundreds of vendors with little effort, as well as download music, photographs, and film from the web in a matter of minutes. Complex banking and other financial transactions can be made at home. People can listen to or watch the news from nearly anywhere in the world. And this is just the tip of the iceberg. Is this for real? Is the Internet just a somewhat different way to communicate, a technological curiosity not very different from traditional methods, such as the telephone, the fax, or "snail mail," or are we entering a new era—a global economy on steroids?

In fact, while the Internet does seem to be something more than just a fancy way to provide and receive information, the extent to which it contributes to an economy is unclear. To date, the question remains unresolved. Some commentators argue that the world is poised to enter a third industrial revolution that will transform the economy in such a way that the old laws of economics will no longer apply. Sooner or later, it has been claimed, the law of supply and demand will cease to exist. A more conservative view, shared by most economists, is that while the laws of economics are not the problem, specific characteristics of information technologies are. As much as information technologies "amplify brain power in the same way that the technologies of the industrial revolution amplified muscle power" (*The Economist*, 2000), the ultimate test of its benefit is the potential impact on productivity, either by creating new products or by making existing products more efficiently. After all, faster productivity growth is the key to higher living standards.

As Shapiro and Varian (1998) explain, the same well-known economic principles applied to the traditional economy are applicable to the new information technologies. The three key particularities of the information technologies era are related with (i) pricing information; (ii) lock-in problems and switching cost issues; and (iii) network externalities and standards.

Pricing Information. Information is costly to produce but cheap to reproduce. Books that cost hundreds of thousands of dollars to produce can be printed and bound for a dollar or two, and one hundred million-dollar movies can be copied on videotape for cents! Production of information goods involves high fixed costs but low marginal costs. The cost of producing the first copy of an information good may be substantial, but the cost of producing or reproducing additional copies is negligible. This cost structure leads to substantial economies of scale. The more someone produces information-related products, the lower the average cost of production. Moreover, fixed costs are primarily composed of sunk costs, while the marginal costs of additional copies of the product do not tend to increase as in other commodities.

Lock-In Problems. Sometimes new technologies are linked with "lock-in" effects so that once they are chosen the costs of switching become extremely high. Lock-in effects are not absolute, as new technologies do displace old ones, but their existence can affect a firm's strategy, options and ability to compete.[1]

Network Externalities. A third feature of many information technology-related products is the fact that they tend to exhibit network externalities. Telephones, electronic mail, and the Internet are good examples. Technologies subject to strong network effects tend to exhibit long lead times followed by explosive growth. The pattern results from positive feedback, as the installed base of users grows more and more users find adoption worthwhile. The key challenge is to obtain a critical mass so that the market can build itself.[2] The Internet exhibits this pattern. Internet technology was developed in the early 1970s but did not really take off until the late 1980s. When Internet traffic did finally start growing, though, it doubled every year from 1989 to 1995. After the Internet was privatized in April 1995, it started growing even faster.[3]

[1] The extreme historical example of a lock-in problem is the case of the layout of a computer keyboard, the so-called *QWERTY* arrangement. Why is this slower arrangement still in use, even when others, such as the Dvorak (1932) system, which was introduced in 1932, appear to be more efficient? The problem is that it is difficult for any individual to get out of this system because the return to each person depends on what everybody else is doing (David, 1990).

[2] A useful example is the fax machine. The basic technology was patented in 1843, and AT&T introduced it in the United States in 1925. However, faxes remained a niche product until the mid-1980s. During a five-year period, the demand for and supply of machines exploded. Before 1982, almost no one had a fax machine; after 1987, the majority of business had one or more (Shapiro and Varian, 1998)

[3] However, having the superior technology does not guarantee success, as agreeing upon standards is also important. See Shapiro and Varian (1998).

2. Where Does Latin America Stand?

Latin America is a latecomer to the information technology revolution. Despite rapid growth in Internet access in the last few years, it is estimated that only 0.5 percent of Latin Americans had access to the Internet in 1999, compared to 30 percent of the residents of the United States. Electronic commerce is also in its infancy in Latin America: $459 million in 1999 compared with a GDP of about $2 trillion.[4] The number of Internet hosts and the use of personal computers are two good indicators of new technology assimilation available for a large number of countries.[5] In both there is a big gap between Latin America and the industrial world. Whereas there are 407 Internet hosts per 10,000 people in industrial countries, the corresponding figure for Latin America is 9 per 10,000 people[6] (see Figure 2). A closer look at the numbers shows that there are wide disparities among Latin American countries. Today, Uruguay is the most "wired" economy of the region, with 38 Internet hosts per 10,000 people. Next on the list are Argentina, Chile, Mexico and Trinidad and Tobago, where the average number of Internet hosts per 10,000 residents is roughly 25. Poor countries such as Honduras and Bolivia have at most one Internet host per 10,000 people (see Figure 3).

The most common use of the Internet in Latin American countries is browsing for information. More than 50 per cent of individuals with Internet access surveyed by Latinobarómetro in Brazil, Peru, Uruguay and Colombia surf the web primarily searching for information, and around 15 per cent use it for sending e-mails. In other countries, such as Ecuador and Mexico, people browse the Internet mostly as part of their tasks at their office (see Figure 4). The Internet has also changed the way people spend time at their jobs, as well as their television viewing and newspaper reading habits. In fact, more than 15 per cent of the people surveyed in Mexico, Chile, Brazil, Paraguay, Argentina, Venezuela and Honduras report changes in the time they spend at their office because they now have access to the Internet. And in Uruguay and Peru around 15 per cent of the people say they have changed the time they spend watching television because they have now the alternative of browsing the web (see Figure 5).

[4] See World Bank (2000a, Chapter Four).

[5] Internet hosts are defined as any computer system with an Internet Protocol address connected to the network. The data do not provide a full count of users because surveys do not capture all computer systems connected to the Internet (e.g., computers behind firewalls) and thus provide an indicator of the minimum size of the Internet.

[6] However, unlike what the conventional wisdom would lead us to believe, the region is in the same range with respect to both East Asia (20) and Eastern Europe (18) in terms of Internet hosts. Numbers of personal computers in these three regions are also similar (44 in Latin America, 43 in East Asia, and 50 in Eastern Europe) The regions at

3. A Simple Model

Being a latecomer to the information technology dance, can the region still benefit from this revolution? In fact, there are reasons to be optimistic about Latin America's chances of taking advantage of the Internet revolution. For one, being a latecomer in Latin America may work to the region's advantage, as the dissemination of e-commerce and other uses of the Internet will likely be compressed into a shorter time frame, and the spillover benefits for efficiency improvements may be absorbed faster. A latecomer does not have to reinvent the wheel and by emulating the best practice or application of technology may thus be able to realize benefits in a relatively short time. Although the use of the Internet in Latin America lags with respect to other regions, the speed with which the new technology has spread has been nothing less than remarkable. In fact, it has been shown that information technology spending in developing economies has been growing more than twice as fast as in developed countries over the past decade, though admittedly from a low base.

In fact, related to this last idea, recent research shows that the use and impact of new technologies follows an S-shaped path. This kind of expansion resembles the way an infectious epidemic spreads among the population. In the first stage there is a slow rate of contagion and a small, relatively stable number of infected individuals. Once a critical number catch the infection, the rate of subsequent infection accelerates rapidly. In the third stage, there are so many victims that the number of cases tends to stabilize. Similarly, new technologies require an incubation period before they build a user base quickly, and often they have little impact on growth rates and output for some time, as adopting them might require additional training of the workforce, reorganization of the production process or company structure, replacement of obsolete machinery and so on. After this period, which can be very long, productivity and growth can skyrocket. In addition to the direct impact of the technology, there are often indirect spillovers into other industries. In the final stage, the technology will be fully exploited and growth will slow again.[7]

As described above, technological diffusion is analogous to the penetration of infectious epidemics in the population, which follows an S-shaped pattern. When a new technology is first introduced there may be a relatively long period in which no clear impact may be noticed. As the

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the bottom are the Middle East (6) and Africa (3).

[7] See Chong and Zanforlin (2001) and Coyle (1999).

group of users reaches a critical mass, the growth rate accelerates until the new technology reaches the middle range of the S-curve, and thus the growth rate tends to slow while the point change continues to increase. Once the penetration nears its saturation point (the steady state), both the percentage point change and the expansion rate begin to decrease.

Adoption rates depend on a number of factors, such as the affordability of the technology, potential adaptations to the technology to widen its potential market, and the appeal of the technology as its use becomes widespread. In fact, falling prices and more user-friendly products have spurred the adoption of information technology in recent years. Bass and Parsons (1969) first presented the theoretical model leading to empirical support for the existence of the S-shaped pattern to represent the diffusion of new technologies. The central proposition is that the probability of adoption, given that adoption has not occurred, depends on two main factors: first, the intrinsic tendency to adopt presented by agents, and second, the extent to which the hazard rate increases with the number of agents that already have adopted. This last factor captures some contagion among agents or only the fact that the benefit of adoption increases with the number of agent that already have adopted (network externality). In a closed economy:

$$\frac{d\,Tech}{d\,t} = \overline{Tech}\,(p + q\,Tech)(1 - Tech)$$

$\overline{Tech} :\equiv$ level of difusion in S.S.

p $:\equiv$ coef. of innovation (adoption w/o copy)

q $:\equiv$ coef. of imitation

Solving this differential equation we get:

$$Tech_t = \overline{Tech}\,\frac{1 - \exp(-(p+q)t)}{1 + \frac{q}{p}\exp(-(p+q)t)}$$

This model gives us several insights about the diffusion process of new technologies. If innovative agents characterize a country, the diffusion process would look like the one presented in Figure 6. In this scenario, the fraction of agents adopting the technology is more or less constant most of time and only starts to fall once the penetration nears its saturation point.

On the other extreme, in countries in which there are few innovative agents, most of firms adopt the technology because of imitation. In this case, the adoption process accelerates with the number of agents that already have adopted the new technology. In general, developing countries tend to have few innovative agents. Therefore we should expect the diffusion process to look like the one presented in Figure 7.

However, developing countries in general and Latin America in particular, tend to imitate and adopt the technology they observe in developed countries. Based on the simple model by Bass and Parsons (1969), let us assume that there are two countries in world, the leader (l) and the follower (f). The leader country is characterized by having several innovative agents (large p). The follower country is assumed to have few innovative agents (small p), but firms in developing countries are able to imitate the technology they observe at home (large q_f) and abroad (same, but with one lag). In formal terms, this idea can be represented by the following equations:

$$\frac{d\,Tech_t^l}{d\,t} = \overline{Tech}_t^{\,l}\left(p_l + q_l\,Tech_t^l\right)\left(1 - Tech_t^l\right)$$

$$\frac{d\,Tech_t^f}{d\,t} = \overline{Tech}_t^{\,f}\left(p_f + q_f Tech_t^f + \gamma_f Tech_{t-1}^f\right)\left(1 - Tech_t^f\right)$$

$$\gamma_f \coloneqq \text{Coefficient of imitation of foreign technology}$$

This set-up allows simulating the process of new technology diffusion in an integrated world in which there are innovative countries, such as the United States, and follower countries, such as those in Latin America. Figure 8 presents the case where the follower country does not have innovative agents at all, and both countries have the same number of adopters in steady state.

As soon as the new technology is discovered (t=0), innovative agents in the leader country begin adoption. Meanwhile, in the follower country agents do not have the capacity to adopt the technology by themselves, but imitate agents that have already adopted it. For this to occur, a critical mass of users in the leader country must be first reached. Once this occurs, an S-shaped pattern of technology diffusion is expected. Of course, this will actually depend on the degree of imitation and innovation in the follower country.

As seen in the model above, it becomes clear that the ability of countries to assimilate the new information technologies productively depends not just on the availability of computers or the number of Internet hosts, but on the presence of an environment conducive to innovation.

Achieving higher productivity may not depend on the Internet, but rather on some more fundamental factors that, among other things, make the Internet such an attractive tool.

4. Capacity to Innovate

The simple model presented above points not only to the importance of capacity to adapt but also to the importance of innovativeness. After all, the Internet is simply the latest expression of the ingenuity of human beings in the constant search for increased social welfare and the ability of firms and organizations to put new technologies to use in their search for markets and profits. In this context, the key question that remains is how can Latin America become more innovative, more entrepreneurial?

Warner (2000) has constructed an index of economic creativity that captures the ability of countries to continuously renovate and improve their productive activities. Not only does this imply renovating technologies, but also renovating firms. The ability of a country to do the former is measured through a technology index capability based on survey questions that try to capture innovation and technological adaptation in a country. Since countries can obtain technology either by producing it or importing it, he measures an overall technology index by whichever of these components is largest. In other words, countries get credit on the technology index for either innovation or technology transfer. What is important is that the country participates in the newest technologies and innovation, regardless of whether the country itself is engaged in innovation. The ability to renovate firms is captured through an index of startups, or ease of starting new enterprises. This index is an average of two parts: whether financing is available and whether it is easy overall to start 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 the startup indices. In a range that goes from –2 to +2 the average index of economic creativity for the industrial countries is 0.92, whereas the index for developing economies is -0.19. The gap is observed in all the categories involved in economic creativity, although it is more significant in the case of innovation (0.89 for industrial countries vs. -0.57 for developing countries). The economic creativity index for East Asia is 0.32, whereas the creativity index of Latin America is

-0.75. Although both regions display poor performance in innovation, the advantage clearly goes to East Asia (see Figure 9).

The countries that are the most innovative, the most able to successfully adapt technologies to domestic needs, are also the ones that have higher income levels. On the other hand, those countries that are not very innovative, or that cannot adapt technologies efficiently, tend to have lower gross domestic product (see Figure 10). Most Latin American countries, with the exceptions of only Chile, Brazil, and Mexico, rank low in terms of economic creativity. Innovation plays a major role in the economic creativity of the most developed economies (Figure 11 shows the scores of the different Global Competitiveness Report indices). While the top economies show high levels of innovation, the performance of Latin America is poor, with all countries displaying negative scores (i.e., below the world average). Costa Rica and Chile are the Latin American leaders in this category, whereas Bolivia, El Salvador and Ecuador are the poorest performers in terms of innovation. Unlike Latin America, not all the countries of East Asia register negative scores: Singapore and Taiwan, for instance, have remarkable positions. But while innovation is the major force behind economic creativity in industrial countries, technological transfer plays a more important role in the developing world and in Latin America in particular. However, the overall scores for Latin America are negative both for innovation and for technological transfer, implying a lack of ability to renovate technologies in the region, either by developing them or by assimilating those developed by others.[8]

In a world with international trade in goods and services, foreign direct investment, and international exchange of information and dissemination of knowledge, the productivity of a nation through economic creativity depends both on domestic and foreign research and development efforts (Coe and Helpman, 1995). But economic creativity depends not only on the ability to renovate technologies, but also on the ability of firms to renovate themselves, which is captured by the start-up index of Figure 11. In this respect, Latin America fares even worse. This important source of productivity improvements is severely constrained in many Latin American countries by lack of credit, shallowness of capital markets, and a gamut of hurdles to create firms.

[8] Compare this with East Asia, where the innovation index is negative but less so, and the technology transfer score is positive. This confirms the idea that in East Asia technological adaptations of existing technologies have played a large role in the economic creativity process in the region.

5. Innovativeness, and Information Technology

As relevant as the Global Competitiveness Report measures on innovation and creativity are, they are partly based on surveys which, being subjective, can be somewhat criticized for lack of comparability across countries and for bias problems. Is there an objective measure of the economic creativity and innovativeness in an economy? Given the fact that they are very recent technologies, the depth of the new economy as measured by the number of Internet hosts or personal computers can be linked with the economic creativity of nations in order to understand innovative potential. In fact, the correlation between information technology and economic creativity is high, although it is higher for industrial economies 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, as for both Latin America and East Asia it is quite high (0.81 and 0.88, respectively), in the case of the Internet (see Figure 12). In general, the Internet is highly correlated with innovation, start-up of new business, and even technological transfer. In other words, the 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 terms of 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, which is not a component of the creativity index. Does Internet use mainly reflect the availability of telephone lines, rather than the ability of individuals and firms to adopt and use new technologies? Since almost all Internet users have depended on telephone for their connection, there is indeed a close relationship between the two variables (see Figure 13). Problems with the availability and quality of telecommunications services are rampant in Latin America, especially in rural areas, which means the digital divide is likely to remain in the future. However, lack of infrastructure is not a totally insurmountable barrier, as a number of imaginative solutions in Latin America demonstrate. 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, for instance, holds tightly even when isolating for differences in telephone infrastructure among countries, as shown in Figure 14a. Notice that in this figure, the vertical axis measures the ratio between Internet hosts and telephone (fixed and

mobile), 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.

It is interesting to note that if we perform the same exercise with the index of technology transfer instead of innovation (as ranked by the Global Competitiveness Report) the relationship with Internet host is much weaker (Figure 14b). In other word, as predicted by the model presented before, at the beginning innovative countries are the ones that adopt the new technology. In the near future it should be the followers' turn.

6. Determinants of Innovativeness

What are those factors that can improve a country's ability to innovate and assimilate new technologies further than infrastructure? In fact, as Edwards (2001) points out, before Latin American policymakers let themselves be seduced by the notion of information technology as the silver bullet for development, governments have to take into account key factors that, if not addressed, will cause the money invested in new technologies to be wasted.

An empirical exploration of the determinants of innovativeness is shown in Table 1. Innovativeness is measured as the adoption of the Internet adjusted by a proxy of its steady state value (telephones). Consistent with what Edwards argues, we test the "crucial factors" that determine innovation and assimilation of technologies: education, access to credit, good institutions and openness. Our preliminary results show that the level of education is clearly one of the most important determinants of the adoption of Internet. Financial development and rule of law seem to play an important role as well, but unfortunately we do not get a final conclusion from the data because these variables are highly correlated both from a theoretical and empirical point of view. That explains why their coefficients are unstable across different specifications. Rule of Law is highly significant when Total Private Credit is used as a proxy for financial development, but this last variable turns out to be statistically insignificant in this specification. This result reverses when we use "Facility of Start Up" as a proxy of financial development. In this last case the financial variable is significant but rule of law loses its explanatory power.

In our preliminary results, openness does not seem to play an important role in the early introduction of the Internet. This could be explained by the fact that openness affects a country's ability to assimilate new technologies rather than its ability to innovate. Finally, it is interesting

to note that after controlling for the determinants of adoption of new technologies, Latin America does not seem to stand behind the rest of the world.

Education is a crucial factor in achieving productivity, as more educated workers are more able to better 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 taking advantage of 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 maintains, there is still a long way to go. The reality check comes from East Asia, a region with a highly educated population. Not surprisingly, this region has had the greatest success in first adapting technologies from industrial countries and later becoming an innovative powerhouse on its own right. It is thus increasingly necessary for Latin America to provide education that goes beyond primary schooling and to include secondary and higher education. An important point is that, in the absence of an adequate education system at the basic level, training systems, no matter how well designed, have little chance to raise the skills of most workers. As it happens in Latin America, training systems tend to reinforce, rather than correct, basic education gaps. Nonetheless, training systems do have the important role of allowing firms and workers to assimilate technological developments. To that end, most training systems in the region need revamping to really be part of the process of innovation.

Similarly, business growth in Latin America is severely limited by lack of credit. The major problem firms face is difficulty in accessing financial markets. This problem is exacerbated in the case of information technology-related firms. On the one hand, set-up costs are very high. On the other hand, firms interested in becoming involved in information technologies are usually micro-enterprises with little or no capital. This combination proves a formidable obstacle. Unlike in industrial countries—where financial markets are more developed, access to credit is easier and faster, and creative financial instruments exist—in Latin America financial development and access is quite limited. Poor access to and excessive cost of credit and the lack of sufficient stock markets hinder the development of start-up companies and innovation.

Abundant research in recent years shows the importance of institutions for economic growth. A good bureaucracy, adequate property rights, control of corruption, and a good rule of

law have a strong impact on economic performance. Simply put, institutions are crucial for achieving increased competitiveness, productivity, and economic growth. A good institutional setting proves particularly important in an information technology context, where the fast pace and extremely rapidly changing environment emphasize the need for an adequate institutional setting that can keep pace with such a situation. A website that allows a state-of-the-art ultra-fast modem connection today will become obsolete in six months. A mediocre rule of law or an unnecessarily complex regulatory system that slows down the process will result in a strong disincentive to innovate. Clearly, this is the case in many Latin American countries that impose a variety of red tape requirements to register a new firm. 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 countries of the region, mainly Brazil, Mexico and Argentina, the protection of intellectual property rights is becoming increasingly important. The mounting costs of research and development for new products or processes and the shortening of the product life cycle are driving this trend. The incentive to develop knowledge is weakened if that knowledge is not protected.[9] Lack of credit and weak institutions may be insurmountable hurdles to innovate.

Finally, openness could be another potentially important factor in technological absorption. Import of machinery and equipment is an important channel of knowledge absorption (Chong and Zanforlin, 2001). Open economies can have access to the latest technologies, which can spur domestic innovation later. Once again East Asia, as is well known, provides a good example. Openness also allows the free flow of ideas among nations, an element that proves particularly crucial in a knowledge-based economy, one that wants to take full advantage of the new information technology.

7. Conclusions and Agenda for Future Resarch

The analysis above suggests that in Latin America the diffusion of information technologies and the Internet necessitates investment in skills and infrastructure, a good, consistent, rule of law and protection of property rights, financial depth, and potentially openness for the diffusion of

[9] See World Bank (1999).

knowledge generated in developed countries. The development and adoption of new technologies, however, are also linked with a new share of challenges, questions, and problems to governments. To the extent that the information technology revolution is relevant to Latin American development, the question is, what are some of the key pending issues?

For one, policies that promote new technologies should support the creation and broad diffusion of new technologies, while competition policies should encourage competition in the information technology sector. A key issue is whether governments should subsidize the new economy. While it is true that some governments in industrial countries have supported the new economy in a variety of ways, there is by no means a clear-cut answer in the case of Latin America. Edwards (2001) for instance, argues that subsidizing information technology carries the danger of creating costly, ineffective monsters similar to the inefficient industrial complexes developed during the years of Latin America's famous experiment with import substitution. According to Edwards, though, as long as there are no substantial institutional changes information technology will have little effect on economic performance.

It is also true, however, that most telecommunication technologies yield network externalities. That is, the private benefit for an individual to connect to the network is lower than the social one: in effect, all agents who already are connected increase their benefit once the individual enters but she will not consider this effect in her private decision. If these externalities are large enough, a new technology that is welfare improving could never be introduced. Thus, there may be a case for governments to provide subsidies so as to equalize the private benefit and the social benefit. Since the value of network externalities is difficult to determine, and since subsidies are an easy avenue for corruption, creating rather than correcting distortions, this is a dangerous proposition.

But there is a potentially safer way in which government can help with the diffusion of new information technologies like the Internet. The state is an important player in the economy, therefore in its case the private benefit to adopt a new information technology is close to the social one. The state is big enough to take advantage of network externalities even though it is the only agent who adopts it. In addition, if the technology has important network externalities, once the government is in the network, the net benefit for private agents entering into the network would be much greater and therefore the technology will diffuse.[10]

[10] It is important to remember that industries with large economies of scale tend to become monopolies, in which

Another important issue is the so-called "digital divide" problem, whereby the rich may benefit proportionally more from the development of the new information technologies than the poor, thus exacerbating income inequality in the longer run. This problem may be compounded by another factor. As seen before, 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, enforcing property rights may worsen income distribution in the short run. This may prevent policymakers from implementing policy decisions that, in the long run, will also be beneficial for the poor through better income and employment opportunities in the formal economy.

Another pending issue is whether governments should apply a laissez-faire approach and let markets dictate whatever technology it brings or whether governments should act pro-actively and, perhaps, settle on a lower-tech version of a product. In principle, the latter appears to make some sense, especially when great inequalities inside 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 have the effect of shrinking the tax base and hence reducing fiscal revenue. Taxation is inherently and inextricably linked with geographical jurisdiction. In order to assess the tax due, it is essential to determine within which state borders a certain transaction took place or value was added to a certain product.[11] To give a simple example, if a Peruvian citizen purchases a music CD-ROM 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-ROM directly from the website of the pop singer, it cannot be readily determined whether the transaction took place under the jurisdiction of the seller (located in the United States) or under that of the consumer (located in Peru). The above

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case, government intervention may be warranted. Information technologies can use many of the current networks, like telecom, TV cables, electric wires, etc, therefore regulatory authorities must have a global view of all these industries and prevent the concentration of these networks in few players.

[11] See OECD (1999).

are pending issues with no definite answers, but where governments' attention should focus in search of solutions that help make the new technologies' promise a reality.

Table 1

Determinants of Internet Hosts

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Internet Hosts / Telephones (ln)							
Avrg. Schooling	0.336	0.313	0.272	0.338	0.317	0.181	0.301	0.186
	(4.21)***	(2.81)***	(2.83)***	(2.71)***	(4.96)***	(2.56)**	(4.49)***	(2.51)**
Total Priv. Credit / GDP	-0.084	-0.080	0.133	0.140				
	(0.18)	(0.17)	(0.27)	(0.28)				
Facility to Start Up					0.530	0.610	0.813	0.839
					(2.80)***	(3.53)***	(4.23)***	(4.69)***
Trade/GDP	0.003	0.003	0.002	0.003	-0.002	-0.003	-0.002	-0.003
	(0.83)	(0.78)	(0.57)	(0.74)	(0.92)	(1.45)	(0.97)	(1.50)
ruleoflaw 99	0.877	0.849	1.064	1.194	0.427	0.004	0.512	0.159
	(3.34)***	(3.05)***	(3.48)***	(3.47)***	(1.94)*	(0.02)	(2.42)**	(0.68)
Ln(GDP)	0.082	0.079	0.100	0.112	0.012	-0.036	0.016	-0.026
	(1.68)*	(1.60)	(1.87)*	(2.02)**	(0.33)	(0.99)	(0.46)	(0.74)
Fixed and Mobile phones (ln)		0.055		-0.181		0.595		0.479
		(0.31)		(0.83)		(3.39)***		(2.82)***
Latin-American Dummy			0.766	0.946			1.128	0.901
			(1.87)*	(2.04)**			(3.51)***	(2.91)***
Constant	-6.596	-6.623	-7.001	-7.019	-3.799	-4.353	-4.094	-4.346
	(4.50)***	(4.48)***	(4.17)***	(4.18)***	(2.89)***	(3.63)***	(3.18)***	(3.62)***
Observations	97	97	88	88	54	54	51	51
R-squared	0.60	0.60	0.61	0.61	0.78	0.82	0.83	0.86

Absolute value of t-statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Note: The dependent variable is Internet Hosts divided by Telephones (fixed and mobile) in logarithms for the period 1994-1999. For the sake of completeness, specification (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 specification (3), (4), (7) and (8), which replicate (1), (2), (5) and (6), respectively. Financial development (Total Priv. Cred. or Facility to Start Up), rule of law and infrastructure (Fixed and Mobile phones) are highly correlated both theoretically and empirically. That explains why their coefficients are unstable across specifications.

Data sources and definitions:

Trade: Data for 1994-1999, taken from the World Development Indicators, World Bank (2000).

Gross Domestic Product (GDP): Data for 1994, taken from the World Development Indicators, World Bank (2000).

Internet Hosts: Data for 1994-199, obtained from the database of the International Telecommunication Union (2001).

Main telephone lines and mobiles (per 1000): Data for 1994-199, obtained from the database of the International Telecommunication Union (2001).

Total Private Credit: Data for 1999, taken from Barth, Caprio and Levine (2000).

Rule of Law: The index used comes from Kaufman, Kraay and Zoido-Lobatón (1999).

Average Schooling: Barro andLee (2000).

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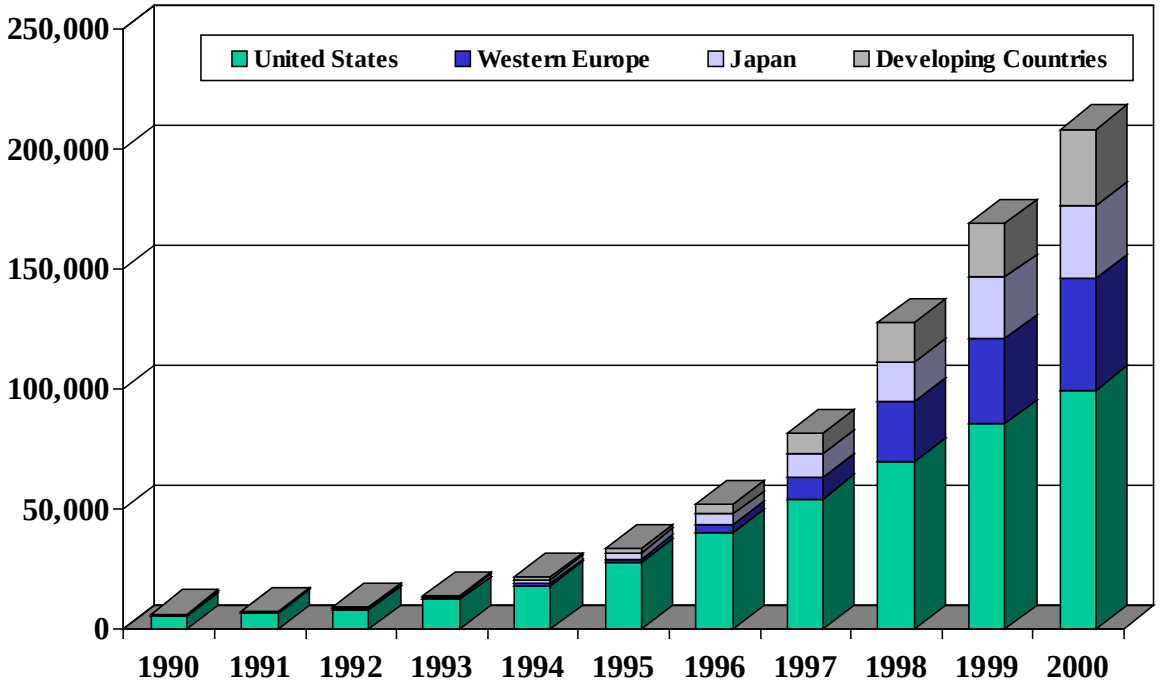
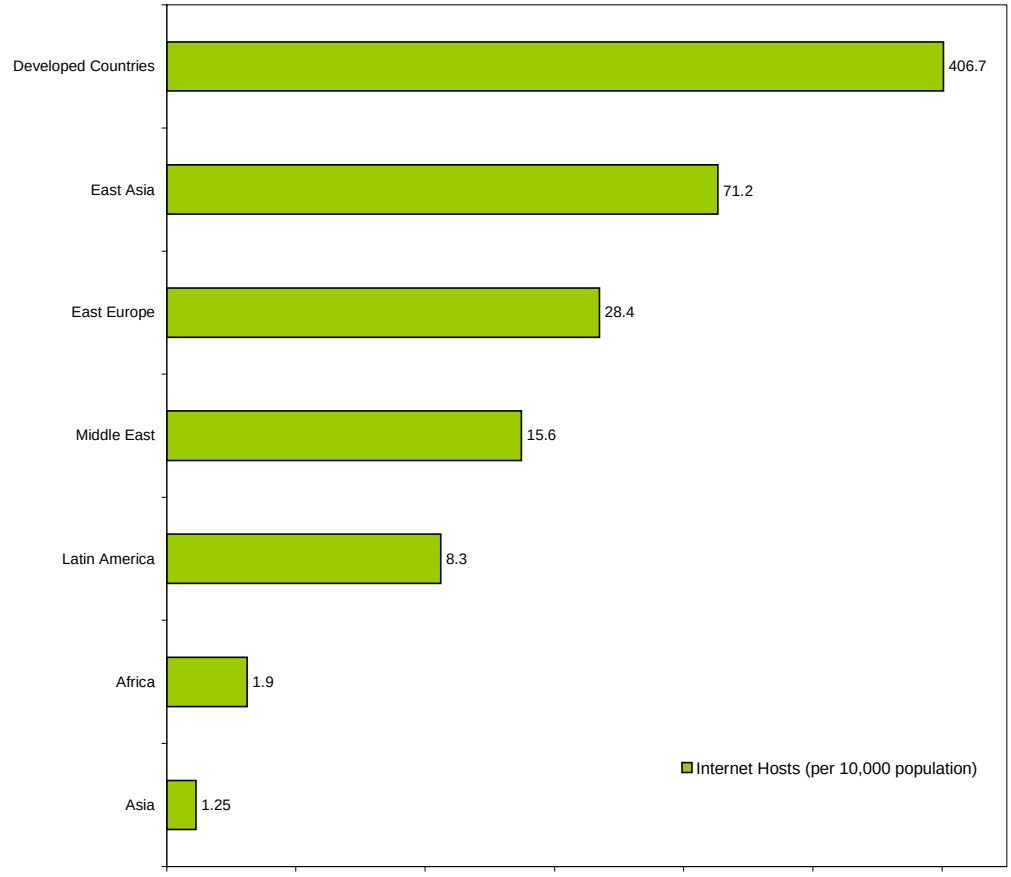
Figure 1
Estimates of internet access, 1990-2000
(Thousands of subscribers)



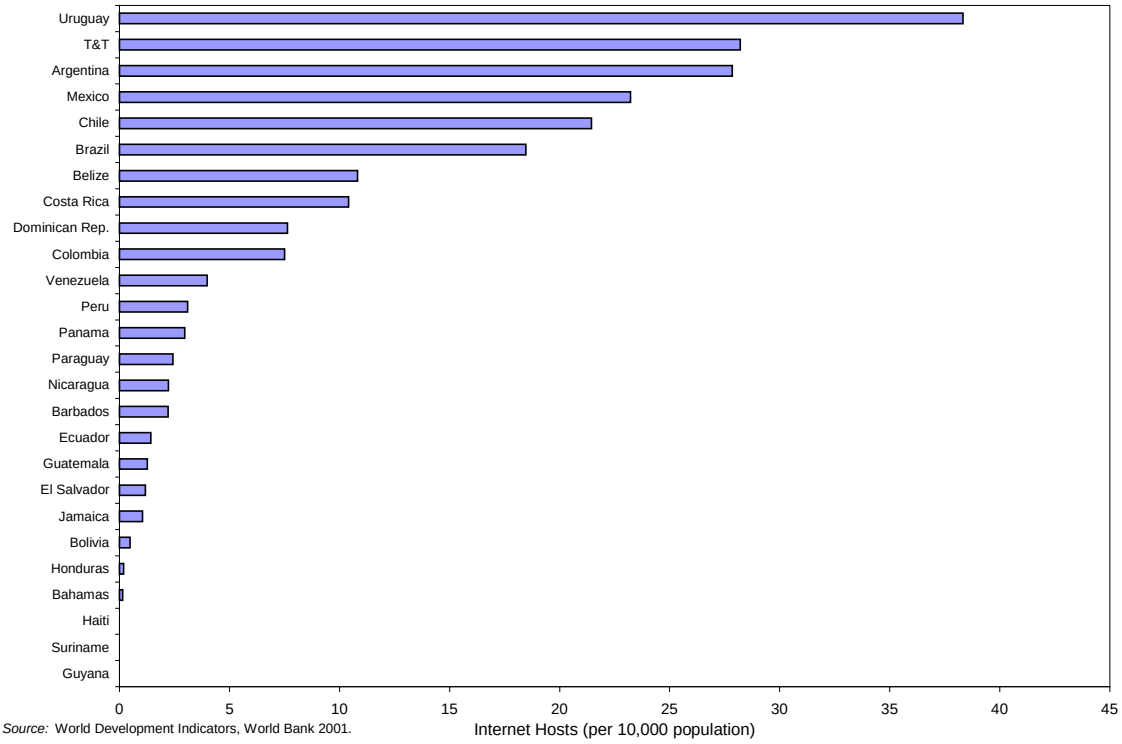
Source: ITU

Figure 2
Internet Hosts by Region, 1999



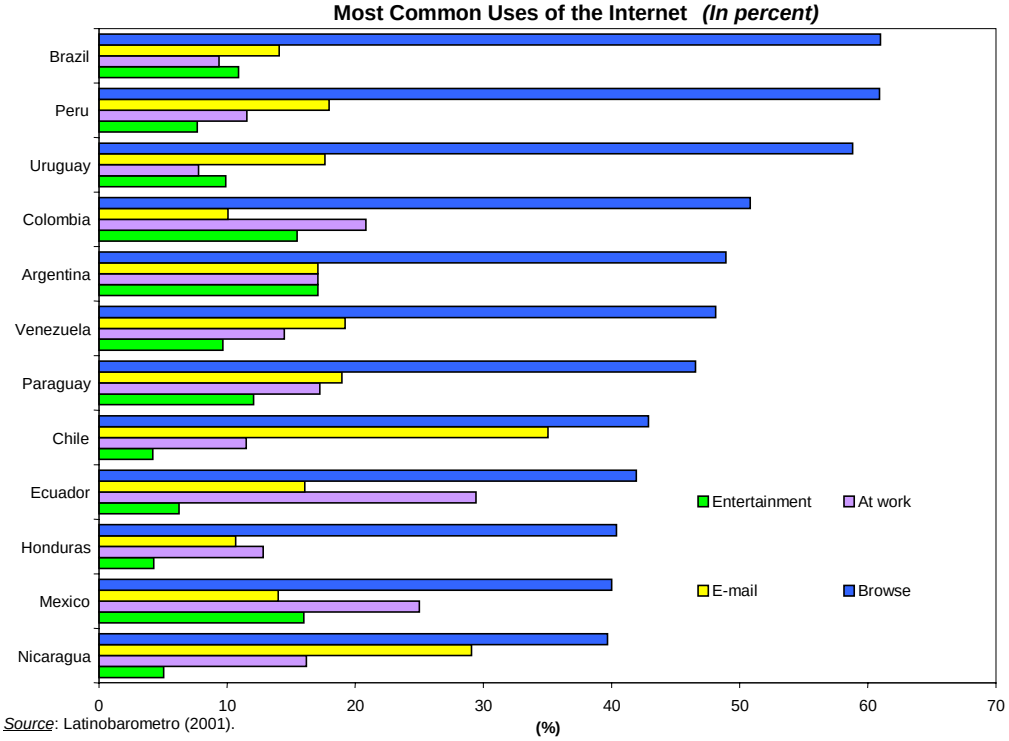
Source: World Development Indicators, World Bank 2001.

Figure 3 Internet Hosts in Latin America, 1999



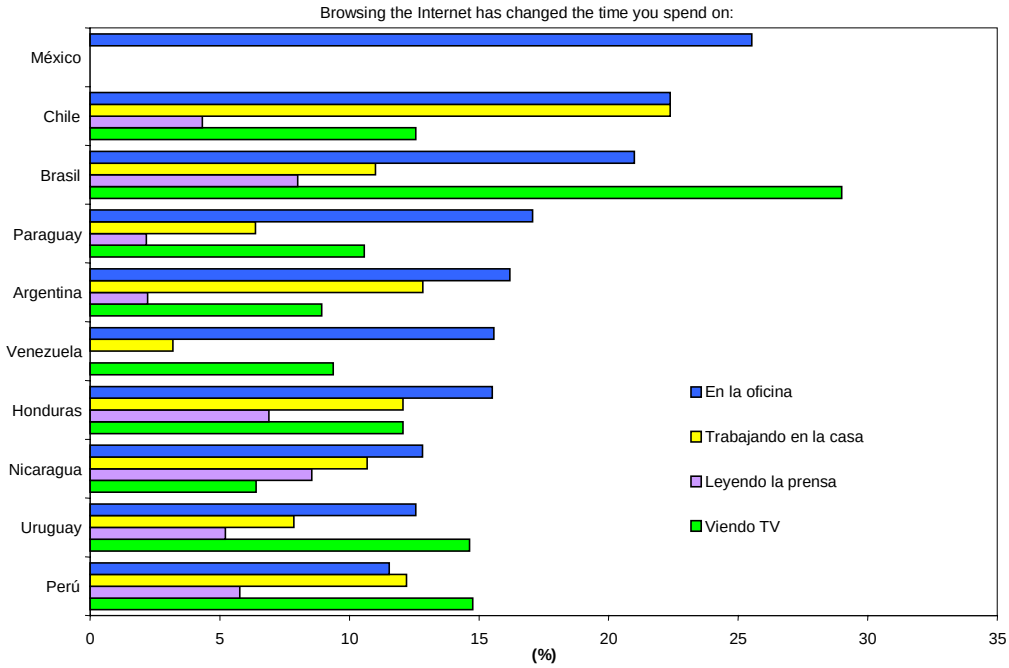
Source: World Development Indicators, World Bank 2001.

Figure 4
Most Common Uses of the Internet *(In percent)*



Source: Latinobarometro (2001).

Figure 5
Changes in Other Activities due to Browsing the Internet
(Percent of respondents)



Source: Latinobarometro (2001).

Figure 6

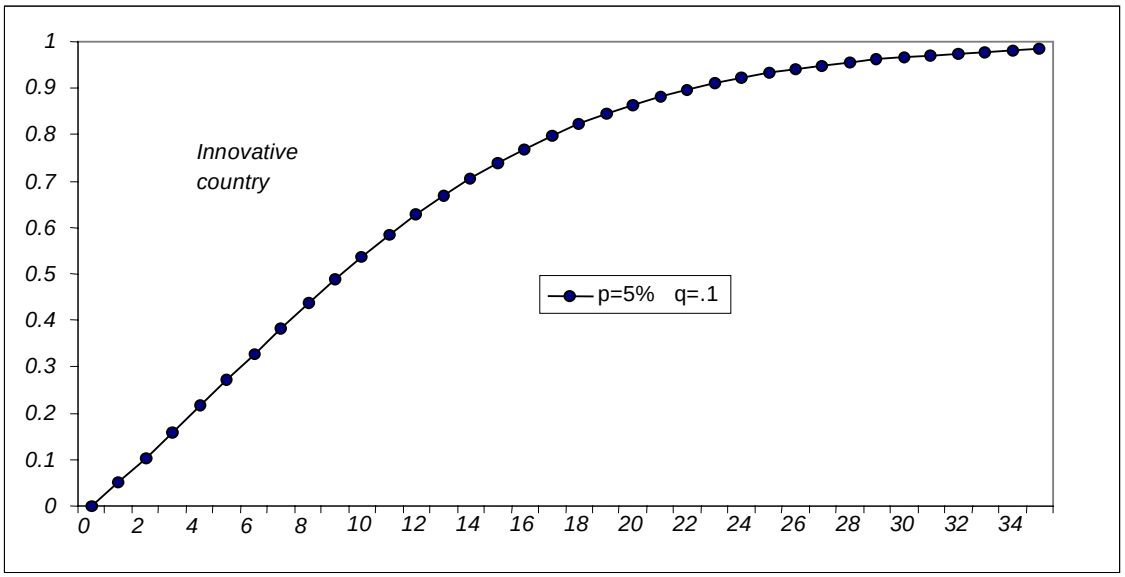

1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
Innovative country
p=5% q=.1

Figure 7

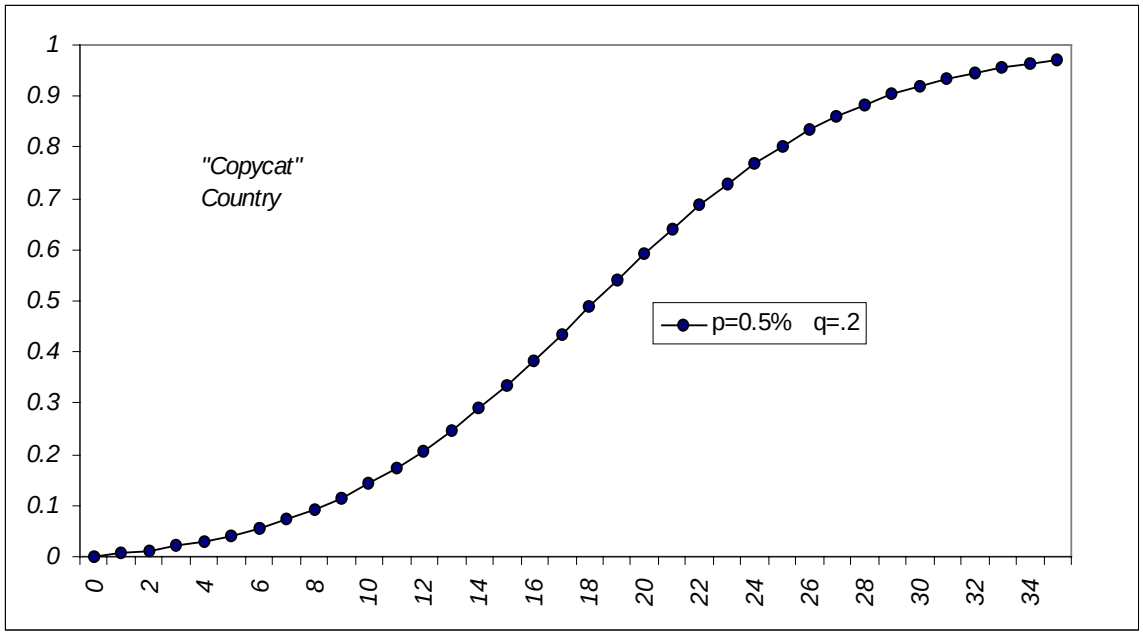

1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
"Copycat"
Country
p=0.5% q=.2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34

Figure 8

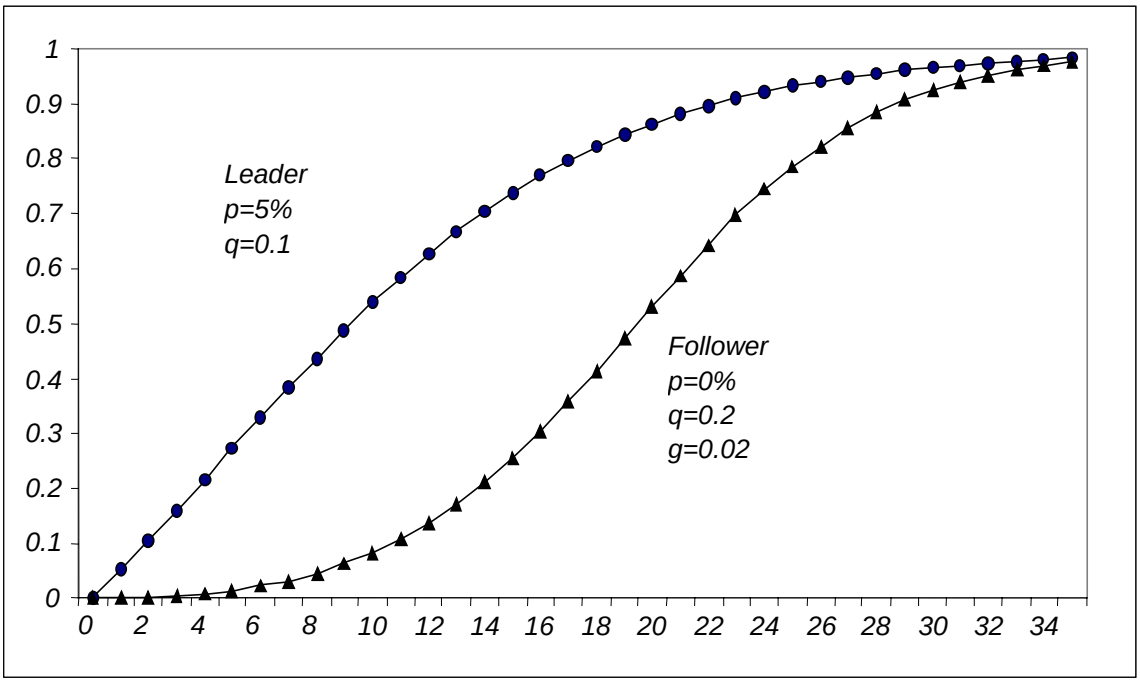
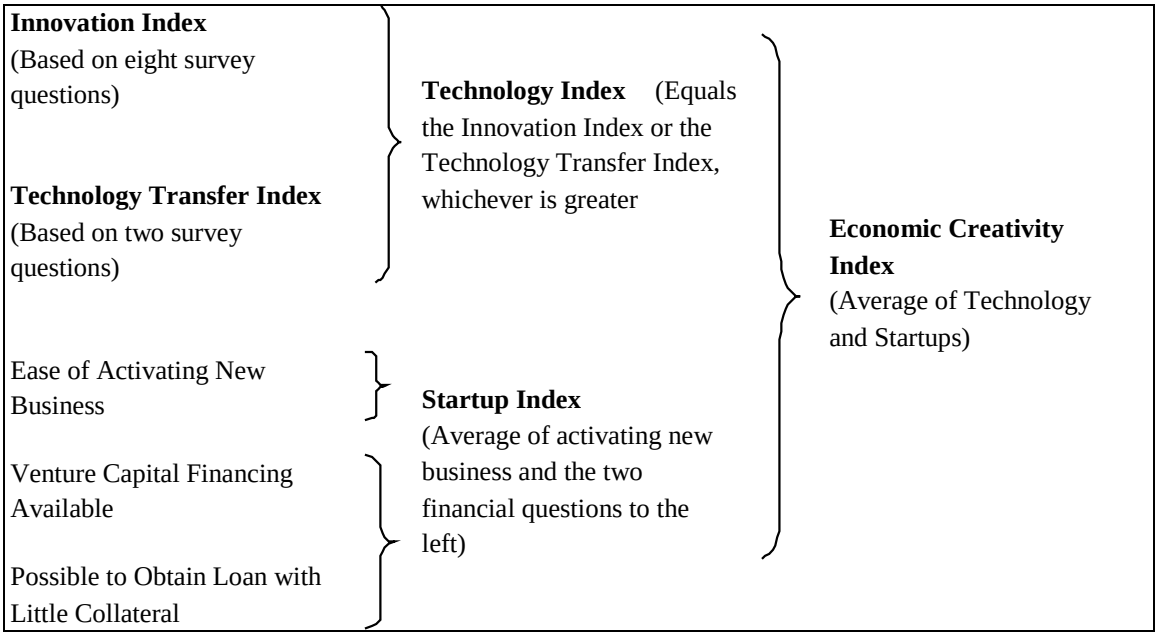

1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
Leader
p=5%
q=0.1
Follower
p=0%
q=0.2
g=0.02

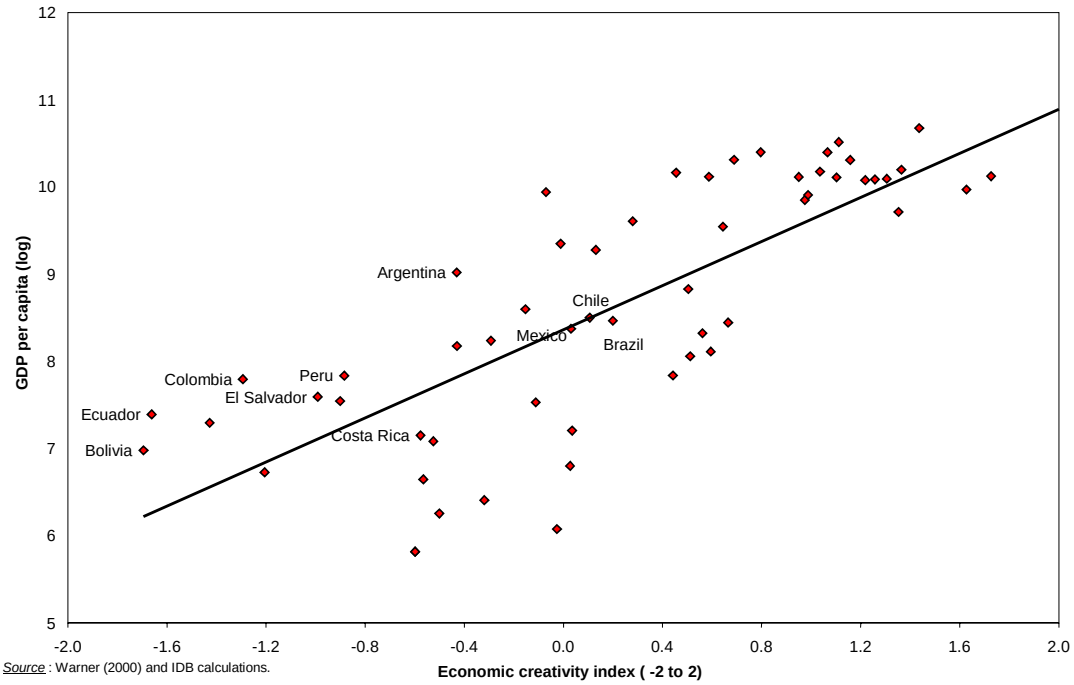
Figure 9

Economic Creativity Index



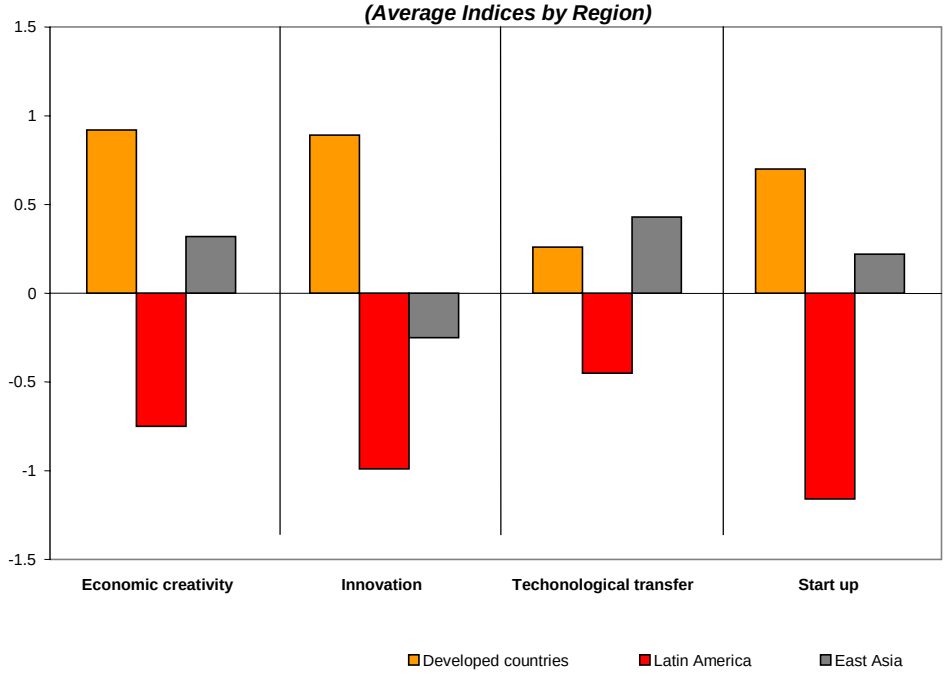
Source: Warner, 2000.

Figure 10
Economic Creativity Index and GDP per capita



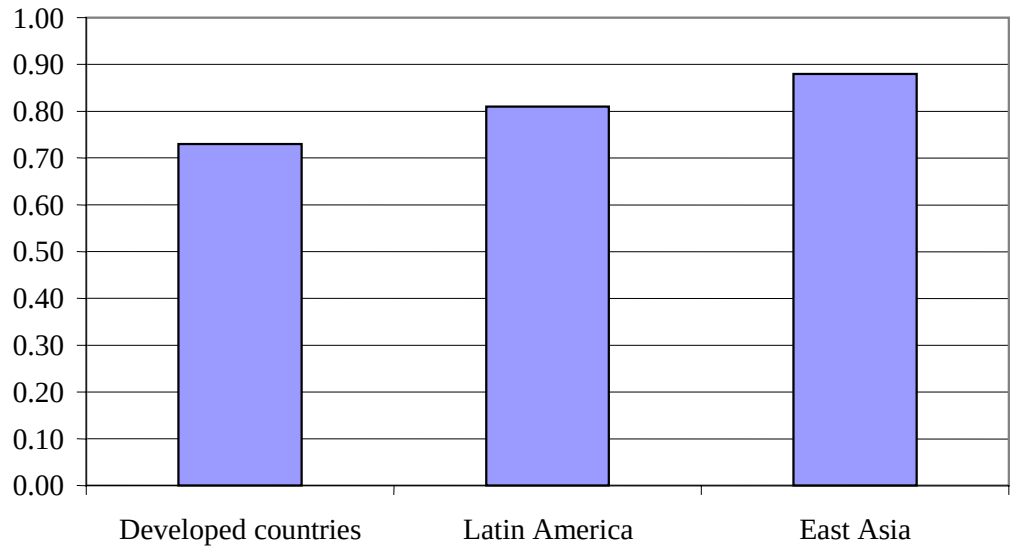
Source : Warner (2000) and IDB calculations.

Figure 11
Economic Creativity and Its Components
(Average Indices by Region)



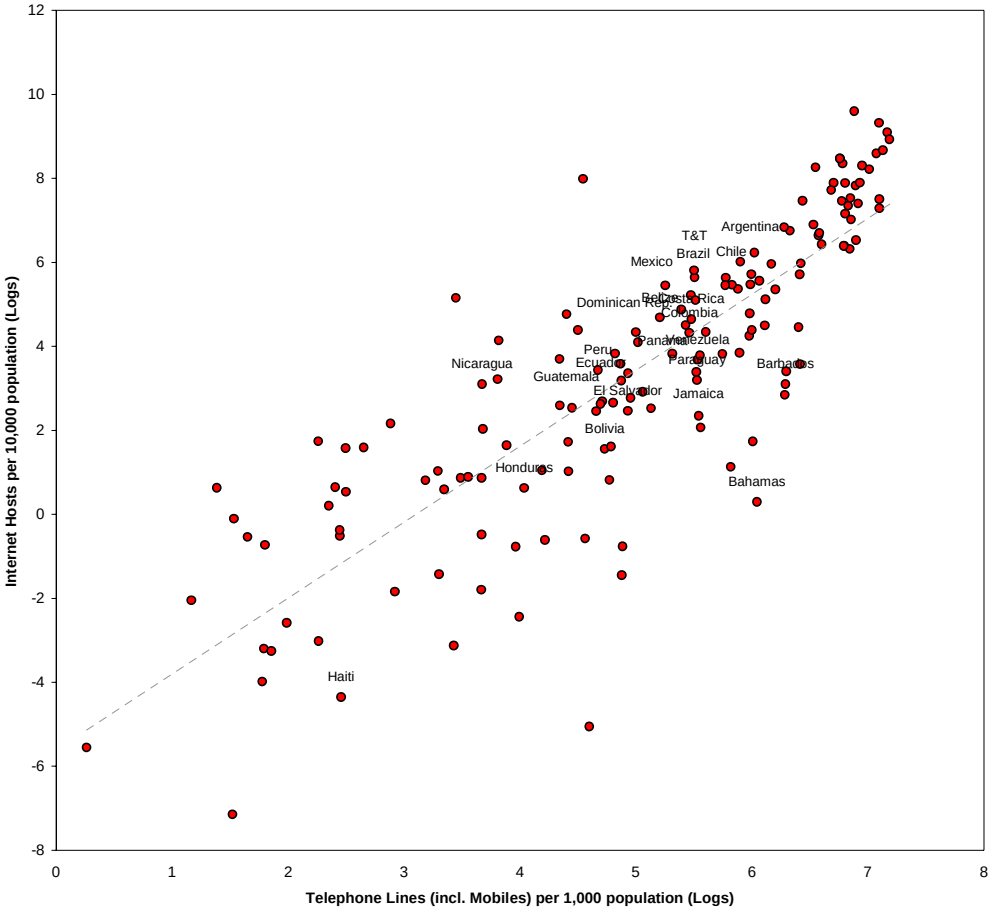
Source : GCR (2000).

Figure 12
Correlations between Economic Creativity and Use of Internet



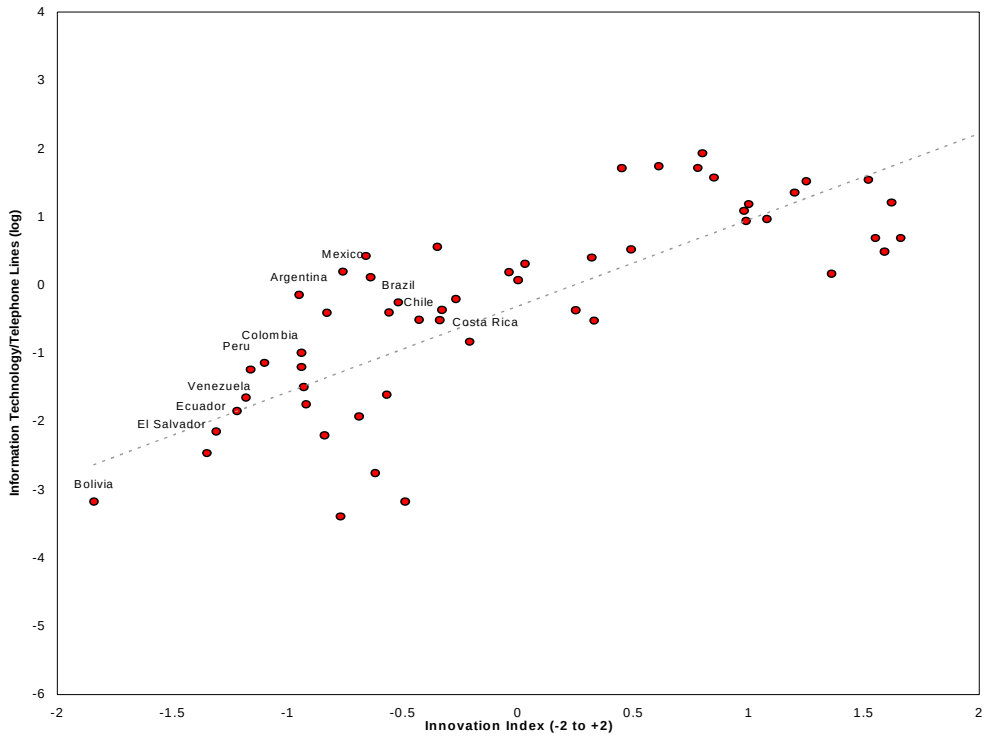
Source: GCR (2000) and World Bank (2000)

Figure 13
Internet Hosts and Telephone Lines



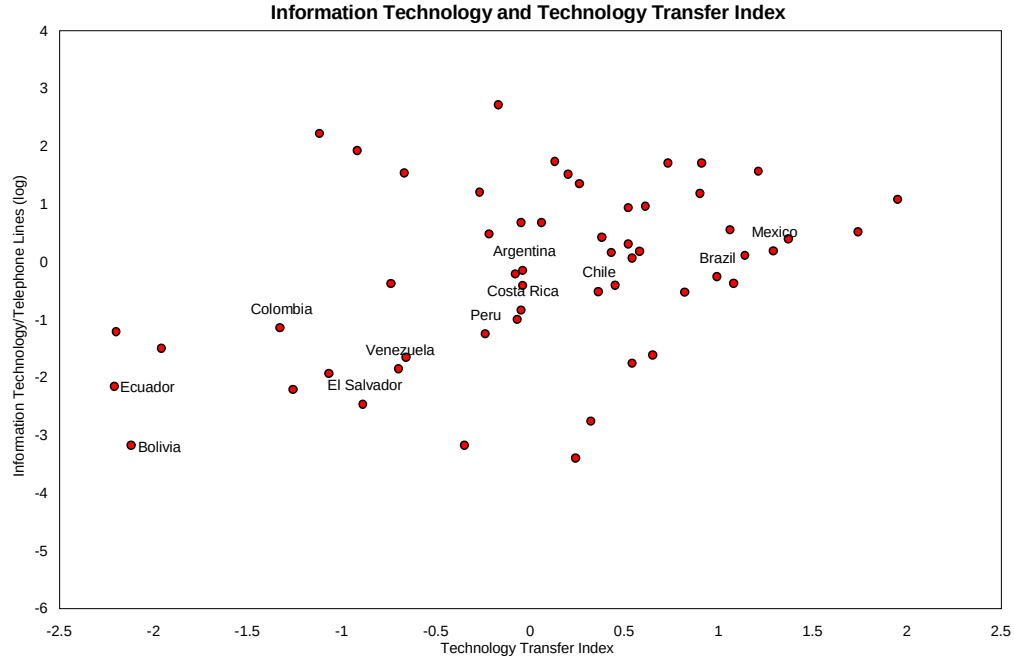
Source: World Development Indicators, World Bank 2001.

Figure 14a
Information Technology and Innovation index



Source: GCR World Economic Forum (2000) and World Development Indicators, World Bank 2001.

Figure 14b
Information Technology and Technology Transfer Index



Source: GCR World Economic Forum (2000) and World Development Indicators, World Bank 2001.