INFORMATION TECHNOLOGY AND ECONOMIC GROWTH IN THE EMERGING ECONOMIES

By

Sebastian Edwards
Henry Ford II Professor
University of California, Los Angeles

http://www.anderson.ucla.edu/faculty/sebastian.edwards/

September, 2001

ABSTRACT

In this paper I analyze the role of the internet, information technology (IT) and the "new" economy in Latin America. In particular, I discuss the channels through which the internet and information technology can help boost productivity growth and overall economic performance. I argue that in order to take full advantage of this new technology, the Latin American countries will need major investments in "complementary" areas, including research and development, education and infrastructure. Moreover, I argue that if the countries in the region do not implement major institutional and economic reforms, investment in information technology will have a small effect on growth.

___
I have benefited from discussions with Harald Beyer, Alejandra Cox Edwards, Guillermo Larraín, Ed Leamer and Jeff Sachs. Igal Magendzo provided excellent assistance.

"What saves us is efficiency –
the devotion to efficiency…"

Joseph Conrad
in
Heart of Darkness

I. Introduction

During the last decade economic performance in the emerging economies has been mediocre. Take, for example, the case of Latin America, where GDP grew at a rather disappointing 3.3% per year during 1990-2000. This is significantly lower than the World Bank's target for the region of 6% per annum. If this rate of growth is maintained in the years to come, Latin America will hardly make any progress in improving social conditions, and catching up with the more advanced nations.[1] Performance has also lagged behind in most of East Asia, Africa and Eastern Europe. In this paper I analyze the role of the internet, information technology (IT) and the "new" economy in Latin America.[2] In particular, I discuss the channels through which the internet and information technology can help boost productivity growth and overall economic performance.

At the center of Latin America's modest performance is an overall low rate of productivity growth. As Table 1 shows, with the exception of Chile, total factor productivity (TFP) growth has been very low during the last two decades. There is little doubt that an acceleration of the region's rate of economic growth will require a significant boost in productivity.

Chile and Mexico provide two interesting examples. In both countries the government authorities have set a target for GDP growth of 7% per year. In Chile this will mean exceeding the 2% rate of TFP growth attained during the 1990-2000 period. This will not be easy, as the sources of faster productivity growth that are associated with the first wave of market reforms have largely been exhausted. In the case of Mexico, achieving the 7% GDP growth proposed by President Vicente Fox will require turning the negative rate of productivity growth of the last decade into a healthy 2.5 % per year. Although during 1998-2000 Mexico's TFP growth improved remarkably, and averaged 1.2%, it is still significantly below what is required to meet President Fox's target.[3]

---

[1] Of course, behind these average figures hides a complex diversity of individual country experiences, going from Chile and Costa Rica's solid performances, to Nicaragua and Haiti's frustration and retrogression.

[2] In this paper I use the concepts "new" economy and IT interchangeably. IT is defined as the combination of computers hardware, computer software, and telecommunications equipment, including the internet and other networks.

[3] There are, of course, other factors that limit TFP growth in Latin America. These include the low degree of development of the financial sector and the low quality of public services.

In their quest for improving productivity growth, most countries in Latin America have placed their hopes in an expanding role of technology, the internet, and the "new" economy. Most countries look at Costa Rica, with its large *INTEL* plant, with admiration and a little bit of envy. And every Latin American leader wants to follow Chilean President Ricardo Lagos steps, and visit Silicon Valley and its star executives Bill Gates, Carly Fiorina, and Larry Ellison. President Ricardo Lagos, in fact, has been very explicit in arguing that the new economy and the internet should become Chile's new engine of growth, leading the country into prosperity and developed nation status. In his 2000 Message to Congress President Lagos said:

> *"Chile should become a leader among those countries that rely on information technology, and in particular on the internet, as an engine of growth and progress…"* [4]

In this paper I analyze the channels through which the internet and information technology can help boost productivity growth and overall economic performance in the emerging nations in general, and in Latin America in particular. I argue that in order to take full advantage of this new technology, the Latin American countries will have to make major investments in "complementary" areas, including research and development, education and infrastructure. Moreover, I argue that unless the countries in the region are able to implement major institutional and economic reforms, investment in information technology will have a small effect on growth. The reason for this is simple: information technology is a "general purpose technology," and its impact on growth depends not only on its own level, but also on the level of other complementary factors. In fact, I go as far as arguing that if these complementary investments and reforms are not undertaken, investments in information technology may, in some countries, end up having negative social productivity – see the appendix for an analytical formulation of this idea. It also argue that it is unclear whether merging countries will benefit from pursuing active public policies aimed at expanding the use of information technology in the business community.[5] There is, in fact, a danger that overly aggressive public policies aimed at subsidizing technology will generate massive distortions, not very different from the ones created throughout Latin America during the "import substitution industrialization" era.

It is important to notice that, although this paper concentrates on the Latin American nations, the analysis is quite general and applies to the vast majority of the emerging countries.

---

[4] Mensaje del 21 de mayo, 2000. In http://www.presidencia.cl/cuenta/index.htm.

[5] President Lagos announced a program along those lines in his 2000 annual address to Congress. He said: "..the *Banco del Estado* [a state-owned bank] will open credit lines in order to allow 100 thousand emerging firms to buy computers and obtain internet training."

II. The "New" Economy, Productivity and Growth: Empirical Evidence and a Conceptual Framework Based on Firm-Level Studies

For a number of years economists were skeptical regarding the effects of computer technology on aggregate productivity and economic growth. The statement attributed to Nobel Prize winner Robert Solow, "you can see computers everywhere, except in productivity figures," captures quite vividly this perspective.[6] In fact, early and detailed empirical studies on the U.S. business sector by Oliner and Sichel (1994), Brynjolfsson (1994), and Jorgesson and Stiroh (1995), among others, suggested that information technology had made a very small contribution to U.S. overall growth during the 1970s, 1980s and first part of the 1990s.

A number of new studies, however, have found that the surge in productivity in the U.S. during the second half of the 1990s has been largely the result of the adoption of new technologies. Oliner and Sichel (2000), for example, have concluded that information technology has contributed to approximately one half of the increase in U.S. productivity during 1996-1999. In a series of papers Bill Nordhaus (2001a,b.c) has used a new data set to investigate the role of information technology in productivity growth, and has concluded that for the U.S. business sector, information technology accounts for little over one third of recent productivity acceleration. In an update of their original study, Jorgenson and Stiroh (1999) and Jorgesson (2001), have found that information technology's contribution to U.S. output growth has increased significantly, reaching 1 percentage point per year on average in 1996-1999.

Most aggregate studies on information technology and economic performance have made a distinction between the contribution to growth of "computer *using"* and "computer *producing"* industries. An important conclusion from these analyses – and one with policy implications for Latin America – is that the contribution to U.S. growth of the computer *producing* industries has been significantly larger than that of the computer *using* industries.[7] These studies have also found that, at least until now, e-commerce has made a very small contribution to the U.S. rate of aggregate economic growth.

A limitation of studies that use economy-wide aggregate data is that they do not specify the exact mechanisms through which investment in information technology affects productivity and growth. It is possible, however, to draw economy-wide implications from a growing number of detailed firm and industry-level microeconomic studies.[8] Perhaps the most important insight from these micro studies is that investments in technology do not have a large *direct* effect on productivity. Their impact is indirect, and is mostly related to changes in other

---

[6] Solow's exact statement, made in the New York Times in 1987, is: "[Y]ou can see the computer age everywhere except in the productivity statistics."

[7] See the symposia in the Fall 2000 and Winter 2001 issues of the *Journal of Economic Perspectives.*

[8] See, for example, Brynjolfsson and Hitt (2000) and the essays in Greenan et al (2001).

aspects of the productive process. Investment in information technology plays the role of a "facilitator" that allows other innovations to take place. This point has been forcefully made by Brynjolfsson and Hitt (2000, p. 25):

> *"[I]nvestment in information technology complements the changes in other aspects of the organization…To be successful, firms typically need to adopt computers as part of a "system" or "cluster" of mutually reinforcing organizational changes."*

And from here the authors go on to make a very strong point regarding the determinants of success in the adoption of information technology:

> *"[M]aking computer investment without organizational change, or only partially implementing some organizational changes, can create significant productivity **losses**… " (Emphasis added).*

For information technology investment to be fully effective, it has to take advantage of "network externalities." This requires that a large enough number of people and organizations make the investment, and become connected to the network. But this is not enough. Network externalities are fully exploited only when those using information technology communicate among themselves effectively, rapidly and efficiently. This, in turn, requires that users share similar levels of technical, analytical, and "problem solving" skills.

Empirical analyses at the firm level suggest that companies that go through programs that combine information technology with organizational changes – including programs that change the firm's culture – are able to obtain significant increases in productivity. These studies indicate that, for these companies, the rate of return to investment in information technology exceeds by a wide margin the rental rate of computer capital. This new microeconomic research has identified a number of factors and "organizational changes" that determine the success of information technology investment:[9]

- In order to be fully productive, IT has to be accompanied with investments in human capital, especially at the technical level.
- The productivity impact of IT investment is higher in industries with high expenditure in R & D.
- IT investment has a greater impact in decentralized settings.

---

[9] See, for example, the fascinating review by Brynjolfsson and Hitt (2000), Lee et al (2000) and Bernhart et al (2000). See also Autor (2001).

- Effective IT investments take place where there is less vertical integration.

- Some of the most successful implementation of IT projects have taken place in new companies.

- IT investment thrives in organizations that introduce greater flexibility to labor relations.

Firm- and industry-level findings provide important insights on the potential effects of technology and the new economy at the national level. In Table 2 I summarize the most important lessons that have emerged from these industry level studies. In this table I consider four policy areas where microeconomic lessons appear to be particularly relevant for understanding the prospects of information technology at the national level. For each of these areas I briefly elaborate the way in which the microeconomic lessons are translated to the aggregate country sphere.[10]

III. Is Latin America Ready for the Information Technology Revolution?

In this section I analyze Latin America's preparedness for the information and computer revolution. The analysis is divided in two parts. First, I concentrate on technology proper, and I analyze the existing stock of IT capital in the region. In doing this I use comparative indexes that summarize data on the number of computers, phone lines, internet hosts and other information technology capital in Latin America and other parts of the world. Second, I investigate how well Latin America stands with respect to some of the key complementary areas identified in Table 2. In particular, I concentrate on three specific areas: (a) The costs of launching new ventures and companies. (b) The quality of human capital skills, with particular emphasis on science and mathematics training. (c) The extent to which labor legislation encourages the type of flexible and creative work relations required for the computer era. In Section IV I deal with the broader question of the prospects of major institutional reforms and cultural changes that could help leverage the technology revolution in Latin America.

III.1 The State of Technology in Latin America

According to *The Global Competitiveness Report, 2000*, Latin America is seriously lagging behind in information technology. A newly constructed ***Technology Index*** indicates that five out of the eleven Latin American countries

[10] Naturally, care should be made to avoid mechanical applications of micro phenomena to the more complex national arena.

in the study are in the bottom 15% of all countries included in the study.[11] Only Brazil and Mexico are ranked in the top half of the group of 59 advanced and emerging countries studied in detail.

The actual rankings for the Latin American countries are presented in Table 3. The data on personal computers per 1,000 inhabitants, also presented in this table, confirm the idea that there is a wide technological gap between Latin America and the advanced nations.

The *Competitiveness Report 2000* indicates quite clearly that in terms of technology, the Latin American region has major *competitive disadvantages.* This can be seen in Table 4, where data from the report and from the *International Telecommunication Union* have been summarized. As may be seen, the number of technological factors where the Latin America countries have technological *disadvantages* is twice as large as the number of factors where it has *advantages*. Brazil is the only Latin American country in the sample with a greater number of technological factors that exhibit advantages than disadvantages. Also, as Table 4 shows, the Latin American region does particularly badly in terms of number of personal computers per 100 people, and number of internet hosts per 10,000 inhabitants.

In a number of Latin American countries the low quality of the local telephone network, the structure of telephony rates, and the lack of progress in providing broadband services, conspire against the full exploitation of information technologies' "network externalities." On the positive side, some countries in the region do relatively well in terms of use of cell phones, and low costs of international telephone calls.

III.2 Regulations, Red Tape and Startup Costs

One of the most important findings of the microeconomic studies discussed above is that information technology is particularly effective in new companies that are unencumbered by traditional productive relations. This means that countries that facilitate the launching of new ventures and companies will have an advantage in attracting IT investment, and making an effective use of it.

Existing information suggests, however, that the Latin American countries continue to be overregulated and asphyxiated by red tape. More than a decade after Hernando de Soto (1989) exposed the bureaucratic nightmare of starting a small business in Peru, most of the region continues to be imprisoned by surreal volumes of paperwork and inefficiency. For instance, it takes over a year to

---

[11] These countries are Bolivia, Ecuador, Colombia, El Salvador and Venezuela. The Technology Index combines eight technological stock indicators, with two indicators of technological transfers.

obtain all the federal and local permits and licenses required to start a small business in Mexico City.[12]

In a recent paper, Djankov et al (2000) have analyzed the process of starting a new company in 75 countries. In particular, they have analyzed the number of steps required to obtain all the permits, the number of days this process takes on average, and the cost (as percentage of the country's GDP) implied by this process. Their results suggest that in most of the Latin American nations these costs are extremely high. For instance, and as depicted in Table 5, in Argentina it takes 71 business days to go through the process to a cost close to 25% of the country's income per capita. Compare this with New Zealand, where it takes only 3 days and costs less than 1% of GDP.

Data in the *Competitiveness Report 2000* also suggest that the difficulties to start a new company constitute a serious competitive disadvantage in 9 of the 11 Latin American countries in the sample of 59 nations. Worse yet, 9 of the 11 Latin countries in this study rank in the bottom 20% of the Report's ***Startup Index*** (Table 6). Figure 1 plots the Latin American countries' overall ranking in the Competitiveness Index against their ranking in the Startup Index. Countries that are ranked higher in the Startup than in the Overall index are above the diagonal line, and are said to have a "competitive advantage" in the startup category.[13]

But startup competitive disadvantages in Latin America go beyond red tape and bureaucratic regulation. The absence of venture capital, the lack of protection of minority share holders' rights, and poor corporate governance are all elements that hold Latin America behind in the quest for innovation and change.

III.3 Human Capital, Education, and Support for Science and Research

Firm level studies have shown that investment in information technology is more effective in settings that have a greater investment in human capital. Recent data – both from surveys as well as from formal standardized tests -- indicate that education deficiencies in Latin America are substantial. Indeed, studies that have focused on the quality of education – as opposed to its coverage – show that the Latin American region is seriously lagging behind other nations. For instance, recent survey results on the quality of math and science education place every Latin nation, with the exception of Costa Rica, in the bottom third of a sample of 59 countries.[14] See the data in Table 6. Figure 2 summarizes information on Latin America's competitive advantages and

---

[12] This point was made by Mexico's Secretary of Finance Francisco Gil Diaz at the World Economic Forum Mexico Meeting (Cancun), March 2001.

[13] See the Global Competitiveness Report 2000, for details on the competitive advantage and competitive disadvantage concepts.

[14] The Global Competitiveness Report, 2000.

disadvantages in education. As may be seen, the majority of the Latin American countries are in the disadvantage area (that is, below the diagonal).

Results from comparable standardized tests are not better, however. Indeed, Chile, the only Latin American country that participated in the ***Third TIMSS*** project on mathematics and science for eighth graders, did extremely poorly. The results from these standarized tests, which were taken by more than 150 thousand students in 38 industrial and emerging countries, are strictly comparable across nations. In mathematics, Chile placed 35th out of 38 countries, with a score 20% below the average for all nations. In science it also placed 35th; this time, however, Chile's score was *only* 14% below the average for all countries. [15]

A possible objection to these results is that they refer to *unconditional* test scores. However, econometric analyses suggest that even after conditioning by a number of factors – including GDP per capita, education coverage, class size and expenditure in education – Chile's test scores are among the lowest in the sample.[16] When these findings are projected to the rest of Latin America, the picture that emerges is one of a region where children are not being adequately trained for a technologically oriented future.

Data on private and public sectors' expenditures on R & D, on collaboration between industry and research universities, and on the number of patent applications confirm the point made above. Latin America is not currently developing a "human resource" base that is complimentary with information technology and the new economy.

The relationship between human capital, education and information technology is complex and runs both ways. A better technological base – including access to computers in the classroom – is likely to increase students' abilities to tackle math and science problems. And a better-trained labor force is likely to allow the country to take full advantage of new technological developments, including the internet. This suggests that Latin American would benefit from efforts to move into the "computer age" at the school level. To the extent that "problem solving" skills increase, a broader investment in information technology is more likely to be translated into a productivity boost.

However, improving the quality of education is not only – and not even mostly – about introducing computers into the classroom. Improving the quality of education requires teachers' accountability, curriculum reform, a greater degree of decentralization, and reducing bureaucracy in schools administration.

Recent experiences in a number of Latin American countries indicate that implementing education reform can be politically very difficult. This, indeed, has

---

[15] The complete TIMSS results can be found in: http://timss.bc.edu

[16] The regression results are available from the author on request.

been the recent case of Argentina, where former education minister Juan Llach's launched a very creative reform initiative. The reform program was both simple and ingenious. It relied on decentralization, de-bureaucratization, choice, merit-based compensation to teachers, accountability of school principals, and greater parent involvement. But it was strongly opposed by the powerful teachers' unions, and by politicians from within the president's own political party. At the end President Fernando De la Rua balked under teacher union pressure, and left his education minister standing alone without political or financial support. As time went by, it became increasingly clear that the president was unwilling to use any political capital to bankroll the reform program. In September 2000, frustrated by political opposition, the Minister of Education resigned his post.[17]

III.4 Labor Relations in the Internet Age

Information technology in general, and the internet in particular, are about freedom, creativity and dynamism. As pointed out above, there is abundant microeconomic empirical evidence suggesting that the effects of the internet are greater when labor relations are flexible and dynamic. Labor legislation in Latin America, however, is generally rigid and does not facilitate the rapid redeployment of workers across companies and sectors. Moreover, in many countries collective bargaining still takes place at the industry-level. These centralized labor negotiation practices tend to ignore the peculiarities of specific firms, that in the midst of technological change may face very particular circumstances.

In a recent paper, Nobel Laureate James Heckman and Carmen Pages, from the Interamerican Development Bank, analyzed labor legislation in Latin America and concluded that it restricts labor mobility significantly. Moreover, these authors compared employment protection under labor legislation in Latin America, several European countries and the U.S. They found that, contrary to popular belief, employment protection in Latin America is, in general, significantly higher than in the European nations and higher than in the U.S., which is the most unregulated of all. The authors also find evidence that more restrictive labor legislation has resulted in slower job creation and a larger "informal" labor market. A labor market flexibility ranking constructed from their data is presented in Table 7.

Efforts to reform labor legislation, and introduce greater flexibility while enhancing workers' rights, have been largely unsuccessful. Argentina's recent labor reform was clearly insufficient and retained many features of the old legislation, and Chile is currently considering a labor reform that could introduce new rigidities into labor markets. And in Brazil and Mexico – as in much of the rest of the region – currently there is no talk about labor market reform.

---

[17] For details see Edwards (2000).

IV. Concluding Remarks

Economic historian David Landes has recently stated that when it comes to explaining cross-country differentials in growth and performance, "culture makes almost all the difference" (2000, p. 2).

The notion that culture affects economic performance is, of course, not new. Max Weber made the point forcefully in his analysis of the origins of capitalism. More recently, the idea that culture, and in particular institutions, play a key role in development has been emphasized by scholars such as Douglas North, Francis Fukuyama and Robert Putnam. Nobel Laureate Douglass North has argued that countries that are able to develop strong institutions that protect property rights, and help solve disputes, have low "t*ransaction costs*" and can devote themselves fully to productive activities. Robert Putnam, has focused on the role of "social" capital, and has argued that different cultures treat this important form of capital differently. Francis Fukuyama has emphasized the role of trust. Building on this notion Ronald Inglehart (2000) has recently presented evidence suggesting that some cultures have a greater degree of trust than others. Those "high trust" cultures, in turn, have done better in terms of economic performance. Column 2 in Table 7 contains, for selected Latin American nations an index of "trust."

This emphasis on culture helps put technology in perspective. In particular, it stresses the point made in this paper: Unless it is accompanied by "cultural" changes – and by this I mean institutional, value, and deep economic changes –, information technology will have little effect of aggregate growth and performance. In terms of cliches, it is possible to state that *"the information technology revolution requires a cultural revolution!"*

In the real world, economic and social relations are seldom one way. This means that while an effective adaptation of information technology requires a cultural revolution, information technology can itself help catalyze cultural and institutional change. Information technology can help increase transparency and reduce corruption. This is the case, for instance, in countries where government procurement has gone on line. Also, by reducing the costs of communications, information technology can reduce "economic distance" across countries. "Closeness," in turn, increases international trade and helps blur cultural differences. Leamer and Storper (2001) have recently argued that, although the internet will not replace the basic mechanisms through which "trust-based" business relations are established, it will reduce the maintenance costs of this relations. This is likely to reduce transaction costs and will make economic relations more effective and productive. And to the extent that information technology helps improve the quality of education – through the use of computers in the classroom and the implementation of international TIMSS type standardized tests – it will also help introduce cultural changes among the young.

An important conclusion of this paper is that there are costs of taking "shortcuts." Implementing major technology programs at the national level, without making changes in the complementary areas identified in this paper, may backfire and result in important social costs. More specifically public policies aimed at subsidizing the adoption or use of information technology may be very costly, yielding meager results. Beginning the effort at the educational level seems to be the correct strategy. If the information technology effort is indeed undertaken as a part of "system" of mutually reinforcing changes, it may indeed become a powerful tool in Latin America's effort to move towards growth, development and prosperity.

This paper has concentrated on the relation between technology and performance in the Latin American nations. Most of the conclusions, however, are applicable to other emerging regions. In particular, the notion that investment in complementary areas will be required to take full advantage of the new technologies, has general applicability. An analysis of the factors emphasized in this paper –education, new firms, labor legislation and culture – suggest that other regions also face important shortcomings in many of these areas.

APPENDIX

Information Technology and Aggregate Economic Growth: A Simple Analytical Representation

From an analytical point of view, the points made in this paper can be captured by an aggregate production function of the following type:

(A.1) $$q = A\, L^{\eta} K^{\alpha} T^{\psi} H^{(\beta + \gamma T - \delta T^{**}2)} .$$

(A.2) $$A = A_0^{(\varphi + \lambda T - \theta T^{**}2)} .$$

Where q is aggregate output (GDP), A is the country's stock of organizational and knowledge capital, K is physical capital, H is human capital, and L is labor. T is the stock of information technology capital, and α, β, γ, δ, η, φ, λ, and θ are parameters assumed to be ≥ 0.

This formulation is, of course, a variation of the traditional Cobb-Douglas production function, which has been used profusely in aggregate cross-country growth studies. In most traditional analyses it is assumed that β, γ, δ, φ, λ, and θ are equal to zero. Under those traditional assumptions, investment in information technology has no independent effect on the growth process.

According to equations (A.1) and (A.2) investment in information technology will affect aggregate growth through two channels. First, a higher stock of information technology (T) will make investment in human capital (H) and in "organizational" capital (A) more productive. Take, for example, the case of human capital. It is easy to see from (A.1) and (A.2) that the effect of higher human capital on GDP growth is given by:

(A.3) $$(d \log q)/(d \log H) = \beta + \gamma T - \delta T^2 .$$

Where log q is the natural logarithm of q, and (d log q) is the rate of growth of GDP. Equation (A.3) says that the effect of higher human capital (d log H > 0) on GDP (q) will depend on the level of information technology capital (T). The higher T, the stronger will be the effect of human capital accumulation on growth. According to (A.3) the effect of T on (d log q)/(d log H) is positive, at a decreasing rate. Notice that in traditional models of growth (A.3) collapses to a constant: $(d \log q)/(d \log H) = \beta$.

Second, investment in information technology will have a direct effect on growth. This will be given by:

(A.4) $$(d \log q/d \log T) = \psi + T(\log H)\{\gamma - 2\, \delta T\} + T(\log A_0)\{\lambda - 2\, \theta T\}.$$

As may be seen, the effect of investment on information technology on GDP growth will depend on the levels of both human capital and organizational capital. Also, and as discussed in the paper, it is possible that investments in IT that are not accompanied by other policies will result in a decline in total growth. A necessary (but not sufficient) condition for this to happen is that $\{ \gamma - 2 \delta T \} < 0$, or that $\{ \lambda - 2 \theta T \} < 0$.

References

Autor, David (2001), “Wiring the Labor Market,” *The Journal of Economic Perspectives*, 15(1).

Autor, D., L.F. Katz and A.B. Krueger (1998). “Computing Inequality: Have Computers Changed the Labor Market?” *Quarterly Journal of Economics*, 113(4).

Berndt, E.R., C.J. Morrison and L.S. Resenblum (1992). “High-Tech Capital, Economic Performance and Labor Compensation in U.S. Manufacturing Industries: An Exploratory Analysis.” *MIT Working Paper*, 3414EFA.

Branstetter, Lee G. and Mariko Sakakibara “When Do Research Consortia Work Well and Why? Evidence from Japanese Panel Data.” *NBER Working Paper*, 7972.

Brynjolfsson, Erik (1993). “The Productivity Paradox of Information Technology.” *Communications of the ACM*, 35(12).

Brynjolfsson, Erik, A. Renshaw and M. Van Alstyne (1997). “The Matrix of Change.” *Sloan Management Review*, Winter.

Brynjolfsson, Erik and Lorin M. Hitt (2000). “Beyond Computation: Information Technology, Organizational Transformation and Business Performance.” *The Journal of Economic Perspectives*, 14(4).

Cappelli, Peter (2000). “Computers, Work Organization, and Wage Outcomes.” *NBER Working Paper,* 7987.

De Soto, Hernando (1989). *The Other Path,* Harper and Row.

Doms, Mark, Timothy Dunne and Kenneth R. Troske (1997). “Workers, Weges and Technology.” *The Quarterly Journal of Economics*, 112(1).

Djankov S., R. la Porta, F. Lopez de Silanes and A. Shleifer (2000), “The regulation of Entry,” National Bureau of Economic Research Working Paper 7892.

Edwards, Sebastian (2000). “Argentina’s De la Rua Flunks Education Reform 101,” *The Wall Street Journal*, October, 10, P. A-19.

Greenan, Nathalie, Yannick Lhorthy and Jacques Mairesse (2001). *The Puzzling Relations Between Computer and the Economy*. MIT Press.

Heckman, James and Carmen Pages-Serra (2000) “The Cost of Job Security Regulation: Evidence From Latin American Labor Markets.” *Journal of the Latin American and Caribbean Economic Association*, 1(1).

Inglehart, Ronald (2000). “ Culture and Democracy,” in *Culture Matters*, Edited by L.E. Harrisona and S.P. Huntington, Basic Books

Jorgenson, Dale W. and Kevin Stiroh (1995). “Computers and Growth.” *Journal of Economics of Innovation and New Technology*, 3.

Jorgenson, Dale W. and Kevin Stiroh (1999). “Information Technology and Growth.” *American Economic Review*, 89(2).

Jorgesson , Dale W (2001). “Information Technology and the U.S. Economy,” *American Economic Review*, 90(1).

Landes, David (2000). “Culture Makes Almost All of the Difference,” in *Culture Matters*, Edited by L.E. Harrisona and S.P. Huntington, Basic Books

Leamer, Edward and Michael Storper (2001), “The Economic Geography of the Internet Age,” Anderson Graduate School of Management, UCLA, April

Mairesse, Jacques, Nathalie Greenan and Agnes Topiol-Bensaid (2001). “Information Technology and Research and Development Impacts on Productivity and Skills: Looking for Correlations on French Firm Level Data.” *NBER Working Paper*, 8075.

Murnane, Richard J., Frank Levy and David Autor (1999). “Technologycal Change, Computers and Skill Demands: Evidence from the Back Office Operations of a Large Bank.” *Mimeo NBER.*

Oliner, Stephen D. and Daniel E. Sichel (1994). “Computers and Output Growth Revisited: How Big is the Puzzle?” *Brooking Papers on Economic Activity*, 2.

Oliner, Stephen D. and Daniel E. Sichel (2000). “The Resurgence of Growth in the Late 1990s: Is Information Technology the Story.” *The Journal of Economic Perspectives*, 14(4).

William D. Nordhaus (2001a). “Alternative Methods for Measuring Productivity Growth.” *NBER Working Paper*, 8095.

William D. Nordhaus (2001b). “Productivity Growth and the New Economy.” *NBER Working Paper*, 8096.

William D. Nordhaus (2001c). “New Data and Output Concepts for Understanding Productivity Trends.” *NBER Working Paper*, 8097.

World Economic Forum (2000). *The Global Competitiveness Report 2000*. Oxford University Press.

Yang, Shinkyu (2000). “Productivity Measurement in the Information Economy: A Revised Estimate of the Total Factor Productivity.” *Mimeo, New York University.*

TABLE 1

Total Factor Productivity Growth in Selected Latin America Countries During the 1980s and 1990s

COUNTY	ESTIMATED TFP GROWTH (%) 1980-90	ESTIMATED TFP GROWTH (%) 1990-2000
Argentina	-2.4	1.1
Brazil	-1.5	0.7
Chile	1.0	2.0
Colombia	0	-1.6
Ecuador	-1.3	-0.6
Mexico	-2.4	-1.5
Panama	-2.9	-1.1
Peru	-3.3	3.9
MEAN	-1.6	0.4
MEDIAN	-2.0	0.1

Source: Goldman-Sachs for the period 1980-1997; own calculations for 1998-2000.

TABLE 2

Information Technology, Productivity and Growth: Lessons from Firm and Industry Level Studies

POLICY AREA	Findings from Industry and Firm Level Studies	Policy Implications for the National Level
1. New Companies	▪ Information technology has been particularly effective in new companies that are unencumbered by traditional productive relations.	▪ Reduce red tape required to form new businesses ▪ Financial market with an active venture capital funding
2. Human Capital, Workers Skills and R&D	▪ Successful adoption of information technology tends to take place in "organizations that have a greater investment in human capital." ▪ Industries that emphasized R & D have been more successful in adopting informational technology projects.	▪ National educational systems should be reformed ▪ Improve training in mathematics and sciences ▪ National R & D policies that encourage the collaboration between universities and private sector
3. Labor Relations	▪ There is a strong empirical connection between successful information technology projects and a highly flexible workplace. ▪ Labor flexibility encourages freedom and creativity, complementing IT.	▪ Labor legislation should be reformed ▪ Collective bargaining should be at firm level ▪ Labor contracts should be flexible ▪ Workers' protection should not interfere with job creation
4. Organizational Structure	▪ In order for "technology" to be fully productive, major organizational change is required. ▪ Partial or incomplete organizational change may result in a decline in productivity. ▪ Industries with a low level of "trust" have serious difficulties in effectively implementing IT.	▪ Institutional and cultural changes will be necessary to leverage the effects of information technology. These changes should increase the level of "trust". ▪ Judiciary should be reformed ▪ Corruption should be reduced, and transparency in economic relations should increase. ▪ Reform of the state, including decentralization

Sources: Brynjolfsson and Hitt (2000), Brynjolfsson, Renshaw and Van Alstyne (1997), Financial Times, March 6, 2001, Murnane, Levy and Autor (2000), Brynjolfsson , Hitt (2000) and Yang (2000), Doms, Dunne and Troske (2000), Berndt, Morrison and Rosenblum (1992), Autor, Katz and Krueger (1998), Brynjolfsson and Hitt (2000), Mairess, Greenan andd Topiol (2001), Capelli (2000), Autor (2001).

TABLE 3
Technology Indicators for Selected Latin American Countries, 2000

	Ranking of TECHNOLOGY PREPAREDNESS (Out of 59; 1 is best)[a]	NUMBER OF PERSONAL COMPUTERS PER 100 PEOPLE[b]	NUMBER OF INTERNET HOSTS PER 10,000 PEOPLE[b]
Argentina	41	5.1	73
Bolivia	59	1.2	2
Brazil	22	4.4	52
Chile	36	8.6	49
Colombia	57	3.4	11
Costa Rica	42	10.2	19
Ecuador	58	2.1	1
El Salvador	54	1.6	1
Mexico	12	5.1	57
Peru	45	3.6	4
Venezuela	52	4.6	7
USA	1	58.5	2,928
Canada	14	39.0	769
New Zealand	27	36.0	901
Israel	8	25.4	288
Korea	25	19.0	288

[a] This index captures the assessment of private sector executives in each of the countries. ***The Global Competitiveness Report, 2000***; [b] International Telecommunication Union.

TABLE 4
Technology Advantages and Disadvantages in Selected Latin American Countries

	TECHNOLOGICAL COMPETITIVE ADVANTAGES (Number of determinants where the country exhibits advantages)	TECHNOLOGICAL COMPETITIVE DISADVANTAGES (Number of determinants where the country exhibits disadvantages)
Argentina	2	6
Bolivia	5	9
Brazil	6	3
Chile	3	11
Colombia	2	9
Costa Rica	8	9
Ecuador	1	10
El Salvador	4	12
Mexico	5	6
Peru	1	10
Venezuela	4	6
TOTAL	**41**	**93**

Source: Elaborated from raw data obtained from the Global Competitiveness Report, 2000.

Table 5: Costs of Starting a New Company: An International Comparison

Country	Cost (Share of GNP/ capita)	# of Steps	Time
New Zealand	0.4%	3	17
United States	1%	4	7
Canada	1%	2	2
Chile	12%	12	78
Colombia	12%	17	55
Peru	21%	14	171
Argentina	23%	12	71
Mexico	57%	15	112
Brazil	67%	15	67
Bolivia	236%	20	82

Source: Djankov and associates (2000)

TABLE 6
Startup and Quality of Education Indicators for Selected Latin American Countries

	STARTUP INDEX (Difference from the overall average, rank in parenthesis)	MATH AND SCIENCE IN EDUCATION (Score, rank in parenthesis)
Argentina	-0.82 (48)	4.0 (49)
Bolivia	-1.55 (57)	4.2 (43)
Brazil	-0.59 (43)	3.6 (55)
Chile	-0.15 (31)	4.1 (47)
Colombia	-1.49 (54)	4.0 (50)
Costa Rica	-1.10 (50)	5.0 (23)
Ecuador	-2.01 (59)	4.4 (38)
El Salvador	-1.09 (49)	4.1 (48)
Mexico	-1.23 (51)	3.5 (56)
Peru	-1.53 (56)	3.0 (59)
Venezuela	-1.52 (55)	3.8 (54)
Average Advanced Countries	**0.76 (19)**	**5.0 (24)**

Sources: The Global Competitiveness Report, 2000; the University of Michigan World Values Survey.

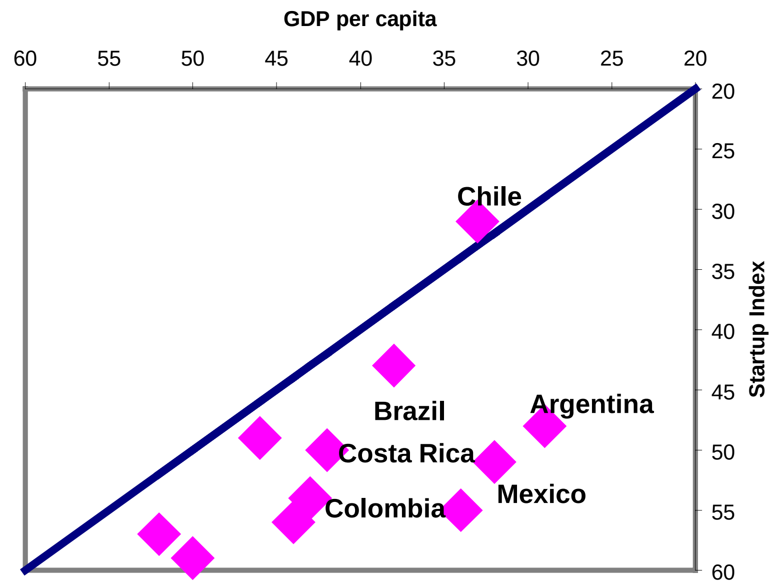
TABLE 7
Labor Flexibility and Trust Indicators for Selected Latin American Countries

	Ranking of LABOR MARKET FLEXIBILITY (Out of 36; 1 is best)	Ranking of TRUST (Out of 48; 1 is best)
Argentina	24	40
Bolivia	36	n.a.
Brazil	13	48
Chile	29	42
Colombia	30	n.a.
Costa Rica	25	12
Ecuador	34	n.a.
El Salvador	27	22
Mexico	26	38
Peru	32	n.a.
Venezuela	23	n.a.

Sorce: Heckman and Pages-Serra (2000).

Figure 1

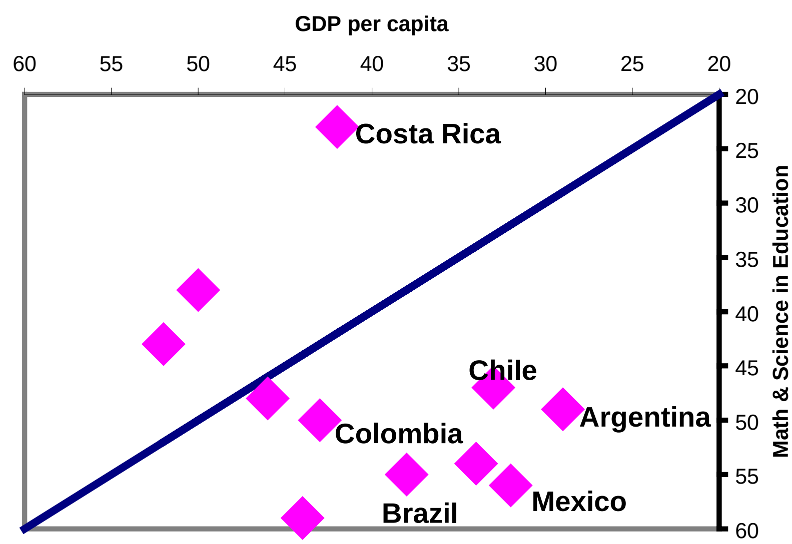
Startup Index: Competitive Advantages and Disadvantages in Selected Latin American Countries



Source: World Competitiveness Report, 2000. Countries below the diagonal line have a "competitive disadvantage." Countries above the diagonal line have a "competitive advantage."

Figure 2

Math and Science in Education: Competitive Advantages and Disadvantages in Selected Latin American Countries



Source: See Figure1

Request PDF | INFORMATION TECHNOLOGY AND ECONOMIC GROWTH IN THE EMERGING ECONOMIES | In this paper I analyze the role of the internet, information technology (IT) and the "new" economy in Latin America. In particular, I discuss the | Find, read and cite all the research you need on ResearchGate.Â Baily, Katz and West (2011) suggest that investment of ICT innovation as a key factor in the economy, so we can say that the oximeter is a technology that can help economic growth regardless of health satisfier. [2][3], [4], [5]. Design of Pulse Oximeter with WiFi Connectivity and Interoperability with Standard HL7 and IEEE 11073-10404:2008. Emerging and growth-leading economies (EAGLEs) are a grouping of key emerging markets developed by BBVA Research. The EAGLE economies are expected to lead global growth in the next 10 years, and to provide important opportunities for investors. EAGLEs is a grouping acronym created in late 2010 by BBVA Research to identify all emerging economies, whose contribution to world economic growth in the next ten years is expected to be larger than the average of the G6 economies (G7 excluding the U.S.). This The share of the digital economy involving digital skills and digital capital now accounts for about 22.5% of the world economy, and it still has a huge potential to further intertwine with the traditional economy and expand. By applying digital skills and technology, the world economy is expected to generate $2 trillion of additional economic output by the year 2020 [Knickrehm, Ber-thon, Daugherty, 2016].Â The ministers also noted that the role of digital technology in the global economy remains largely unknown, and it may create challenges to inclusive-ness, employment, etc. According to the document, special attention should be paid to the underrepresented and disadvantaged groups that still lack access to the Internet [G20, 2017a].