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GLOBALIZATION AND TECHNOLOGY: YOU CAN'T PUT THE GENIE BACK IN THE BOTTLE AGAIN

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Globalization and Technology: You Can't Put the Genie Back in the Bottle Again

Carlos A. Primo Braga, John A. Daly, Riva Eskinazi, Carsten Fink[1]

INTRODUCTION

It is broadly recognized that powerful technological and economic forces are increasing the interdependence of the world economy. Relationships between North and South and between the rich and the poor become every day more intense and complex. As the events of September 11 underscore, however, the effects of this growing interconnectedness – the hallmark of globalization – go well beyond the field of economics, affecting power relations, political and cultural interactions, and the balance of peace.

In this paper, we discuss the role of technology in the process of economic globalization, with an emphasis on its implications for developing countries. For Latin American and Caribbean (LAC) countries, the current phase in the process of economic globalization opens some new development opportunities. Many countries in the region invested heavily in laying the foundations of a networked economy in the 1990s. This occurred in parallel with a significant wave of economic liberalization that has promoted deeper economic integration with the world economy. As the title of this paper suggests, the scope for turning back the clock, as far as economic integration is concerned, is limited. Inward-oriented strategies are unlikely to be sustainable in spite of their short-term appeal in situations of macroeconomic stress. At the same time, the challenges for LAC countries to spread the benefits from the globalization process in an equitable manner are as daunting today as they were a decade ago.

THE EMERGENCE OF THE NETWORKED ECONOMY

Many books, theses, and articles have been written over the last ten years, describing the transition from industrialism to the "new economy," which is also often referred to as the "knowledge economy" and/or identified with the emergence of the "information society" or the "networked economy."[2] A common thread in this literature is the proposition that the world economy is becoming more knowledge-intensive.

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[2] See, for example, the three volumes by Manuel Castells on The Information Age: Economy, Society and Culture (1996, 1997 and 1998).

Growth in science and technology inputs in the post-World War II period has been impressive. OECD countries, for example, now spend more than $520 billion per year on research and development (more than the combined output of the world's 30 poorest countries).[3] Nearly half a million research papers are published a year, each adding to the stock of scientific and technological knowledge. Moreover, not only is the body of scientific and technical knowledge increasing, but the increase is accelerating; the world's scientific and technological publications per year increased by 19 percent in just fifteen years from 369 thousand in 1981 to 439 thousand in 1995.[4] Similarly the rate of accumulation of technological innovations is accelerating; the number of patents granted by the U.S. Patent and Trademark Office rose from 49,971 in 1963 to 175,983 in the year 2000.[5]

This accumulation of knowledge is having significant effects. Technological innovation underlies product innovations and increasing efficiency in production. Long-term economic growth is substantially based on the accumulation of new technological knowledge. At the same time, economic growth has lead to an increase in the importance of service sectors in the economy as well as structural changes in the service sector.[6]

Globalization has also been associated with the increase in trade in high technology goods; from 1990 to 1999, OECD trade in high technology manufactured goods more than doubled, and high-tech trade has grown much faster than trade in general [7] Globalization is also accompanied by other structural changes. U.S. "trade in easily transported manufactures grows while trade in (expensively shipped) commodities shrinks. The same pattern occurs worldwide."[8] "Trade in manufactured goods grew much more rapidly (27-fold) than either agriculture (5-fold) or mining (7-fold) products."[9]

These transformations have increased the demand for knowledge inputs in the world economy. The proposition that knowledge is at the very core of the "new economy," however, does not help much our understanding of the phenomenon. After all, throughout history, knowledge has been a critical variable in the structure of power of nations, and technological mastery a major determinant of economic success.

What *is* new is the technological revolution that has occurred in information and communication technologies (ICT). Technological innovations and growth of the information infrastructure have generated a growing influence of ICT in *all* aspects of economic and social life. This new technological paradigm affects our capacity to create and disseminate information and – more substantively – to foster the transformation of information into knowledge. It is also influencing social structures around the globe – as economies become increasingly services-oriented, companies shift from hierarchical

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[3] UNDP (2001).
[4] National Science Foundation, Science and Engineering Indicators, Appendix Table 5-49.
[5] US Patent Statistics http://www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.pdf
[6] cf. Liberalizing International Transactions in Services: A Handbook, United Nations Conference on Trade and Development and The World Bank, 1994.
[7] OECD, Science, Technology and Industry Outlook, 2001.
[8] Hummels, David, "Have International Transportation Costs Declined?", Unpublished.
[9] Ibid.

structures to networked modes of production, and the "knowledge worker" emerges as a critical actor in the economies of many countries.

The process of economic globalization of industrialized economies in the period 1870 to 1914 was driven by technological progress in the transportation of goods; the service economies of the 21st century, in turn, are also globalizing via advances in the transport of information. The telecommunications and financial services industries are prime examples of industries that are benefiting from these advances.

ICT also has been responsible for efficiency improvement in the transportation of goods, with applications ranging from computer aided design of aircraft and air traffic control improvements, to GPS based computerized scheduling of trucking. Thus in the United States "ten to 15 years ago, the percentage of loaded to unloaded trucks in a long-distance fleet might average 85%; today, it's typically more than 90%. Route optimization shaved another 10-15 % of costs. Optimization programs have also brought fuel costs down maybe $600 to $1,000 a year for a typical truck. The result has been a cut in fixed costs by nearly 25%".[10]

This is an example of a revolution in management that has been made possible by ICT. Indeed, there is a strong link between the increased management demands made by the globalized economy and the increasingly powerful coordination mechanisms that have evolved. Thus, the revolution in techniques for economic coordination, ranging from Internet mediated markets for intermediate goods, to improved scheduling techniques related to just-in-time procurement, to project management techniques created for the aerospace industry are a critically important, if largely unrecognized contributing factor to globalization.

The shifts in communications have also profound implications for the fields of research, education, and culture, and indeed for democracy. At a functional level, ICT opens the doors for new ways to conduct research and education, enhancing productivity in these fields and allowing for much more dynamic cross-border interactions. In the same vein, the "digitization" of everything allows for new forms of dissemination and projection of cultural values. Moreover, ICT can empower the disenfranchised and their intermediaries (as illustrated by the growing influence of non-governmental organizations), while promoting transparency of governmental actions and market outcomes.

These developments challenge the status quo and elicit economic and social frictions, as illustrated by the cycles of wealth generation and destruction in financial markets, the "dot com" phenomenon, the impact of new entrants in the media business, and the emergence of anti-globalization networks. They may also become forces of exclusion as those not properly equipped to take part in these transformations are left behind. This, in turn, is often identified as the problem of the "digital divide."

In analyzing if modern networks will become a force for inclusion or exclusion, it is useful to organize the debate in terms of their impact on knowledge dissemination and innovation. The potential for a positive impact dominates the intrinsic dangers of the

[10] Murphy (2001).

emergence of the network society. At the same time, the dangers are real and may affect not only those on the wrong side of the digital divide, but also those who are riding the digital wave to the extent that the power of networks can be used by a few to disrupt the lives of the many.

ICT AND KNOWLEDGE DISSEMINATION

The word "knowledge" elicits many interpretations. In communications theory, it is often identified as the factual and conceptual contexts that enable social actors to interpret and extract meaning from information and data.[11] In the 1998/99 World Development Report, published by the World Bank, knowledge is distinguished between "knowledge about technology" and "knowledge about attributes." The latter category refers mainly to the knowledge required for agents to make efficient decisions in the marketplace. This latter category of knowledge may include, for example, that related to choices about distinct diets (implicitly balancing nutritional and economic considerations) or the capacity to recognize employment opportunities. "Knowledge about technology," in turn, is typically associated with the efforts of the academic communities and of "proprietary research communities."

ICT tends to affect the conduct of these efforts along the following lines:

- **First**, ICT facilitates the process of codification and transmission of knowledge about technology;
- **Second**, ICT enhances the positive learning externalities of knowledge generation by magnifying the possibilities for recombination of ideas and information;
- **Third,** ICT dilutes the "tyranny" of geography by providing new ways for researchers to escape national boundaries. The rate of international co-authorship of scientific and technical papers, for example, has increased significantly over the last decade.
- **Fourth**, ICT increases the "distribution power" of innovation systems, diminishing the time to market of new products and services, while enhancing the dissemination, application, and use of "mature" technologies.

Developed countries dominate the global distribution of research and development activities. Thus the United States is responsible for about one-third of all publications in major scientific and technological journals, Western Europe for another one-quarter, and Japan for about one-twelfth, while Latin America, Africa and the Near East, and the countries of Asia excepting China and the Asian tigers each produce about two percent of publications.[12] Still there is an increasing amount of international cooperation. In the production of scientific and technological papers, international co-authorships have increased in all parts of the world, and the increase has been most notable in developing countries.[13] "Industrial firms increasingly have sought global research partnerships as a means of strengthening their core competencies and expanding into technology fields

[11] For further details see David and Foray (1995).
[12] National Science Foundation, 1998, Chapter 5.
[13] Daly (1999).

considered critical for maintaining market share. Such international strategic technology alliances increased sharply throughout the industrialized world in the early 1980s and accelerated as the decade continued."[14]

Networked environments also open new opportunities to enhance the transparency and effectiveness of markets for knowledge. Individual, companies, nations can easily benchmark themselves against competitors, learn from best practices and access an incredible amount of information on the web. As it is often pointed out, however, to use the Internet for "knowledge-mining" is like trying to "drink water from a hydrant." In this context, efforts to catalog and to assure the credibility of available information are a priority area for action.[15]

NETWORKS AND POLICY MAKERS[16]

The promise of modern information networks poses some significant challenges to policy makers around the world. The role of intellectual property rights in a networked environment, the issue of extra-territoriality and the difficulties to control unlawful behavior illustrate some of these challenges.

Intellectual Property Rights

Intellectual property rights (IPRs) play an important role in the process of innovation (generation of new knowledge) in market economies. Over the last fifteen years there has been a clear trend toward the strengthening of IPRs around the world, a process closely associated with multilateral negotiations.[17] Although recent developments – as illustrated by the outcome of the WTO Ministerial Conference in Doha – suggest that this trend may be reversed, most owners of intellectual property will continue to press for higher standards of protection at national and international levels.

Ironically, the explosion of creativity and innovation associated with the Internet has occurred in a setting that had at its core a non-proprietary approach to the protocols and, in part, to the content on the network.[18] At the same time, the rise of the Internet gave new relevance to the issue of extra-territoriality, increasing the demand for convergence among national intellectual property rights regimes.

At its content layer, the Internet not only opened new possibilities for dissemination of information, but also expanded the scope for activities that may infringe on someone's IPRs. With a few computer strokes, one can download copyrighted material in bulletin boards around the world in an anonymous fashion. It can be argued that this is simply

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[14] NSF, Science and Engineering Indicators, 1998, National Science Foundation, Chapter 5, 1998. http://www.nsf.gov/sbe/srs/seind98/frames.htm

[15] In the field of knowledge about development, for example, a major initiative to promote access to relevant information is the Development Gateway, a portal based on partnerships between development agencies, private companies and civil society organizations. For details, visit: www.developmentgateway.org

[16] This sections relies Primo Braga and Fink (1997).

[17] For details see, for example, Primo Braga (1996).

[18] See Lessig (2001).

another chapter in the history of technological progress and that as in the case of photocopying, audio, and videotape capabilities, the law will adapt – as time goes by – to face these new challenges. A more fundamental question, however, is the following: is there anything intrinsic to a networked environment that requires a rethinking about the role of IPRs protection in promoting innovation?

There are some analysts who believe that to be the case. Barlow, for example, argues that encryption, rather than laws, provides the only effective way to protect intellectual property in "cyberspace."[19] The gist of his arguments can be captured by the following propositions: (i) "all information wants to be free"; (ii) the economics of information in a networked economy will increasingly be associated with relationships (for example, selling ancillary services) rather than property; and (iii) the transaction costs to enforce IPRs in a networked environment are too high.

Some aspects of propositions (i) and (iii) can be addressed by the supporters of IPRs orthodoxy without major problems. After all, IPRs do not protect information in the abstract. In the case of copyright, for example, the requirement of creativity allows one to argue that the protection of intellectual property promotes the production of knowledge and works of art without hampering the possibilities of dissemination if information *stricto sensu.*[20] In the same vein, the issue of transaction costs is not a new phenomenon and IPRs laws have been flexible enough to cope with this problem, as illustrated by the special treatment given to private use of copyrighted works in most countries. From this perspective, laws will adapt as experience with the economics of a digital environments accumulates.

Proposition (ii), however, poses a new challenge to IPRs orthodoxy. If the economics of networks evolves in such a way that the business model of content providers in cyberspace increasingly relies on the free distribution of intellectual property, while charging for ancillary services and products, then attempts to strengthen IPRs enforcement in this environment may become counterproductive.

More fundamentally, attempts to strengthen protection – as illustrated by the drive toward the application of patents to software and business processes in the United States, and the *sui-generis* approach to database protection in the European Union – may chill innovation by fostering rent-seeking and restricting experimentation in the "commons" under which cyberspace has prospered.

Extra-territoriality and law enforcement

Cyberspace does not recognize national borders. In this context, policy makers are often told that the "Internet is too international to be controlled."[21] This, in turn, raises concerns about the ability of governments to enforce their laws and to regulate electronic markets. In reality, the scope for off-shore activities to by-pass national laws (e.g., copyright protection) is constrained by the quality of the infrastructure in the hosting site. Typically, jurisdictions with lower legal standards are also characterized by poor connectivity and, as a consequence, their capacity to play a major economic role in a

[19] See Barlow (1994): 84 and 129.
[20] For more information, see Lehman & Brown (1995).
[21] For a detailed discussion see Mann (2001).

networked environment is limited. On the other hand, an off-shore site that is well connected and has fully developed broadband infrastructure is unlikely to be immune to economic pressures to respect international standards.

Law enforcement in a networked environment does require, however, substantial sophistication from governmental authorities. Identification of the critical nodes of the network – particularly, in the context of peer-to-peer networks – becomes a critical variable in controlling the transaction costs of law enforcement. Needless to say, most governments in the developing world are not well positioned to address these challenges at present.

NETWORKS, S&T AND GLOBALIZATION

Globalization

The process of economic integration across borders of markets for labor, capital, goods and services- has been an ongoing journey that can be traced back centuries. By the end of the nineteenth century the process became sufficiently large in geographic and economic scale to be justly termed "globalization". Globalization, however, has not been continuous over the past 150 years; rather it has been marked by waves of integration and retrenchment.

Historically, the first major wave of globalization took place from 1870 to 1914. Technological advancements in transportation allowed the transport costs to fall, and this fostered negotiations for reductions in trade barriers while facilitating the movement of capital and labor. The result was a dramatic increase in the flow of goods, labor and capital. The total labor flow reached 10 percent of world's population in the first wave of globalization.[22] World wars, increased protectionism, and the global depression of the 1930s reversed this trend. By the late 1940s, trade as a share of income was back to its level of 1870s (see figure 1); not only growth of per capita income fell by one third, but economic inequality continued to increase and the number of poor people augmented.[23]

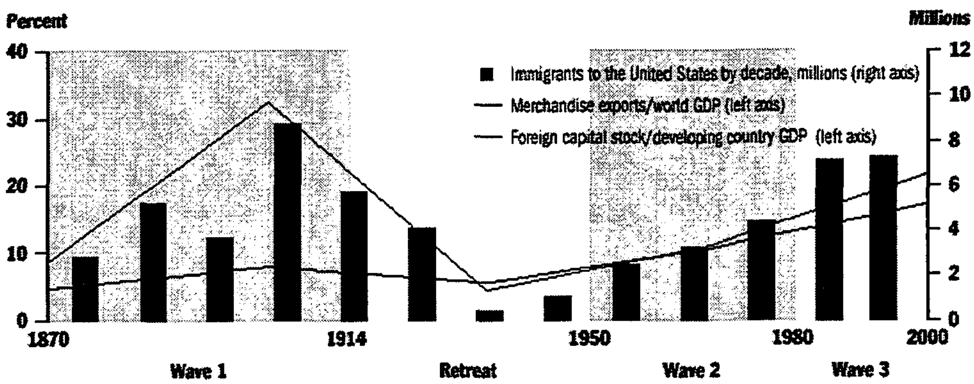
A second wave of globalization occurred between 1945 and 1980, and the economic integration was much more concentrated among rich countries who agreed on a series of multilateral trade liberalizations under the General Agreement on Tariffs and Trade (GATT). As for developing countries, trade was mainly focused on primary commodity exporting and capital flows were limited. During this period, the gap between developed and developing countries widened further.

However, since 1980, a new wave of globalization driven by technological advance in transport and communication technologies improved the investment climate in developing countries and fostered foreign direct investment.[24] Manufactured goods rose from one quarter of poor-country exports in 1980 to more than 80 percent in 1998.[25] This integration cycle was particularly strong for roughly two dozen countries -- including China and India -- that are home to 3 billion people. Over the past two decades, these

[22]World Bank (2001).
[23] Ibid.
[24] Ibid.
[25] Ibid.

countries have doubled their ratio of trade to national income. In the 1990s their GDP per head grew by an annual average of 5 percent and life expectancy and schooling levels increased significantly.

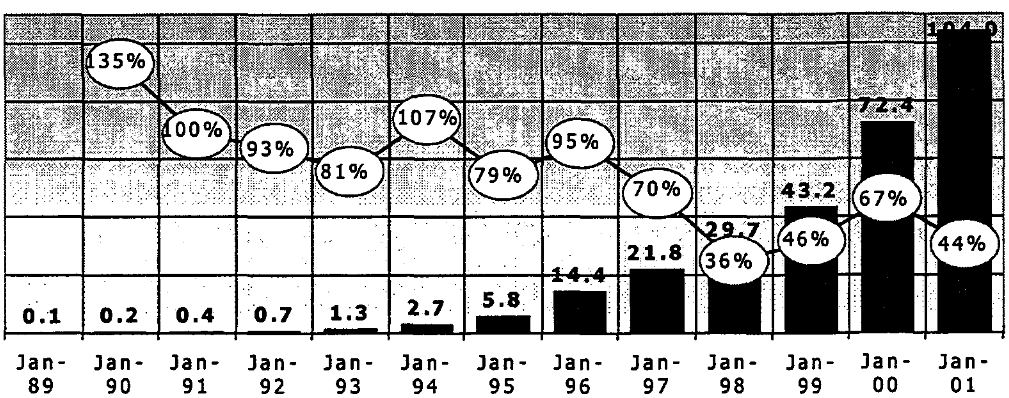
Figure 1 - Waves of globalization



Source: Reproduced from Globalization, Growth, and Poverty, the World Bank (2001).

An important new dimension of the globalization process over the last two decades has been the expansion of computer-mediated networks. As illustrated in Figure 2, the expansion of the Internet has been dramatic with the number of Internet hosts typically growing at more than 50 per cent per year over the 1989-2001 period. By the end of 2001, the network had roughly 522 million users.[26]

Figure 2 - Number of Internet Host Computers in millions, and annual growth in %



Source: Reproduced from ITU, 2001. Adapted from Internet Software Consortium, www.isc.org

Empirical Estimates

Are countries with greater S&T and IT capacity more globalized? To explore this proposition empirically, we regress the latest Globalization Index developed by A.T. Kearny and the Foreign Policy Magazine against alternative measures of technology development.[27] As a proxy for technology development, we employ four alternative

[26] WITSA (2001).

[27] We only focus on the "economic integration" dimension of the A.T. Kearny/Foreign Policy Globalization Index. This index is computed by first assembling data on the following variables: foreign direct investment (FDI) inflows and outflows; portfolio capital inflows and outflows; income payments and

measures: the Technology Achievement Index published in the 2001 UN Human Development Report; R&D expenditure as a share of GDP a "Connectivity Index" derived from information on Internet hosts, Internet users and international telecommunications traffic; and the "E-Readiness" Index published in the Global Information Technology Report, 2001-2001.[28]

To control for possible "size" influences on the Globalization Index, we collected countries' GDP, total population, and estimate a multivariate regression using ordinary least squares (OLS).[29] All data are for the year 2000, except the Technology Achievement Index, R&D measure and E-Readiness Index, which broadly refer to the late 1990s.

The estimation results are presented in Table 1. The coefficients on all four proxies for technological capacities show a positive sign and are statistically significant at the 10 percent level. Surprisingly, the coefficient on the "size" controls are mostly statistically not significant—except land area, which is statistically significant at the 10 percent level in two regressions.[30]

While these simple regressions suggest that greater S&T and ICT capacity are associated with more globalized economies, the findings should be regarded as preliminary and interpreted with due caution. The estimation results are based on a relatively small sample of observations and are likely to be sensitive to the construction of the Globalization Index. Moreover, the empirical correlations identified do not necessarily imply that more advanced levels of technology development are a causal driver of the globalization process. Indeed, one might suggest that the process of globalization encourages countries to increase their scientific and technological activities. Alternatively, both factors may well be driven by third influences not considered here.

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receipts; and exports and imports of goods and services. All variables are expressed as a share of GDP and then "normalized" through a process that values the single lowest data point at zero, the highest at one, and the remaining observations falling in between (in proportion to the single and highest data points). The four individual scores are then summed for each country, whereby FDI and portfolio capital flows receive double weighting, due to their particular importance. For further details see Foreign Policy, January/February, 2002.

[28] The connectivity index is also based on data by A.T. Kearny/Foreign Policy. The number of Internet hosts, the number of Internet users, and minutes of international telephone traffic are first expressed as a share of a country's total population and then mapped on a scale from zero to one. The three individual rankings, all weighted equally, are then simply summed up.

[29] The data for the controls were taken from the World Bank's World Development Indicators.

[30] We estimated an alternative model, whereby population was omitted and GDP was replaced with GDP per capita. This specification of size controls allows for a direct impact of per capita income and avoids estimating a model with both population and area as dependent variables, which are likely to be correlated with each other. The results yielded a significantly negative coefficient on land area (at the 1 percent level) in all four alternative regressions. While the coefficients on the technology variables had the correct positive sign, only the coefficient with respect to the connectivity variables was statistically significant (at the 5 percent level). Per-capita GDP was positive, as expected, but statistically not significant. The latter result is consistent with both GDP and population not being significant in the reported results in Table 1. We chose to present the results using all three size controls, as the separate inclusion of GDP and population allows for a more flexible functional form in which these two variables affect globalization.

More research is necessary to confirm and strengthen the results presented here, but there does appear to be a statistical correlation between technological capacity, and especially information technology capacity and globalization..

Table 1: OLS Estimation results

Dependent variable: Economic Globalization	(1)	(2)	(3)	(4)
Intercept	3.218	4.497**	1.696	1.023
	(1.18)	(2.00)	(0.97)	(0.61)
GDP	0.042	0.003	0.071	-0.063
	(0.22)	(0.02)	(0.47)	(-0.29)
Population	-0.168	-0.216*	-0.145	-0.085
	(-0.89)	(-1.39)	(-0.80)	(-0.39)
Land area	-0.089	-0.088*	-0.098*	-0.071
	(-1.29)	(-1.32)	(-1.64)	(-1.09)
S&T Achievement	0.855*			
	(1.40)			
R&D as a share of GDP		0.285*		
		(1.42)		
Connectivity index			0.189*	
			(1.49)	
E-Readiness				1.799*
				(1.41)
Observations	49	41	60	51
R-Square	0.502	0.472	0.512	0.461

Note: t-statistics are in parentheses. * indicates statistical significance at the 10 percent level and ** indicates statistical significance at the 5 percent level.

NETWORKS AND DEVELOPING COUNTRIES[31]

Polar views seem to dominate the debate about the welfare implications of the information revolution for those who live in the developing world. Some stress ICT as mechanisms for developing countries to "leapfrog" stages of development, and others see the emerging global information infrastructure as contributing to even more economic divergence.

It is broadly recognized that countries are better positioned to thrive in the new economy when they have: (i) widespread access to communication networks for its companies and citizens; (ii) an educated labor-force and consumers; and (iii) strong institutions that promote knowledge creation and dissemination.

Against this background, developing countries seem to be at a significant disadvantage vis-à-vis industrialized countries.

Relative to population, the information infrastructures in developing and transition economies are, on average, only about one-seventh the size of that in OECD countries. With 81 percent of the world's population in 1999, non-OECD countries had only 43 percent of all phones (fixed plus mobile) and 27 percent of related revenues. On the

[31] This section relies on Primo Braga (1998).

positive side, there is clearly a narrowing of some dimensions of the digital divide in terms of basic telecoms. Compared with 40 percent of all phones in 1999, developing and transition economies had eleven percent in 1988, and only seven percent in 1981.[32] The improvement partly resulted from the addition in the last decade of 170 million mobile customers outside the OECD. Seventy percent of this expansion occurred in China, Brazil, and India.

The advent of the Internet, however, has resulted in a new development gap. For example, Africa is lagging behind in Internet connectivity. Africa has only 0.25 percent of all Internet hosts and it share has been decreasing[33]. But as pointed out by ITU, there is direct correlation between access to telecommunications, economic wealth, and social development. Even when the infrastructure problem such as high speed Internet connection is solved, there are several barriers that are less related to telecoms such as advanced education, language, social structures etc. Therefore to spread the benefits of the network economy, we must identify that the digital divide is as much a "knowledge divide as an infrastructure divide".[34]

The quality and coverage of schooling at all levels, including vocational training, are characterized by significant gaps between industrialized and low- and middle-income countries. These gaps reinforce income inequality, not only internationally, but also within nations. The gaps are even more dramatic when one looks at the area of computer literacy.

In a nutshell, the communications and education gaps threaten a social transformation that will *increase* rather than *diminish* economic divergence at the international level. Developing economies might well be condemned to fall further behind in the international economic race because of their lack of connectivity and ability to transform the information explosion into a knowledge revolution. Indeed, this danger is present not only in the North-South framework, but also among OECD countries. A recent OECD report points out that the long term convergence between the most advanced and other OECD economies was reversed in the 1990's.[35]

Technological developments, however, are rapidly eroding economic and technical barriers to entry into communication networks. Developing countries can, for example, leapfrog stages of development by investing in fully digitized networks rather than continuing to expand their outdated analog-based infrastructure. The opportunities for latecomers – for example, not having to cope with the technological obsolescence of wireline networks – are illustrated by the fact that low-income economies presented a higher share of digital telephone lines than high-income economies by the end of the last century. ICT is also creating new development opportunities to address some of the handicaps of developing countries noted above.

First, by developing a modern information infrastructure countries can reduce isolation and exclusion. Many countries are experiencing fast expansion of cellular telephony as an

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[32] Figures come from Wellenius, Primo Braga, Qiang (2000).
[33] OECD (2001b).
[34] ITU (2002).
[35] OECD (2001a), p. 15.

alternative to inefficient conventional network services. Wireless technology can also provide affordable connectivity to rural areas in a fraction of the time that was previously required to expand conventional telephone networks. Moreover, community information centers with access to value-added services can be customized to the needs of the poor. In many places such centers are being used to provide access to the Internet and to help answer questions concerning health, employment, and human rights issues.

Second, countries can benefit from distance education. The costs and effectiveness of such programs are improving significantly, although many challenges still remain in the development and adaptation of educational software to the needs of developing countries. Teacher training is one of the most promising areas for developing countries as ICT helps to address a serious bottleneck – the availability of qualified teachers. ICT is also being used for lifelong learning, opening opportunities for new players in education systems. In developing economies, the dynamism of these new entrants – from courses dedicated to computer training to virtual schools in the Internet – can challenge conventional educational systems, playing a catalytic role in the transformation of educational systems.

Third, a modern information infrastructure can also be a powerful force for better governance. It can, for example, enhance tax administration, auditing, and control or increase the transparency of government transactions via e-procurement.

THE IMPLICATIONS FOR LATIN AMERICA AND THE CARIBBEAN

It is clear that there has been considerable social and economic development in Latin America in the last several decades. Yet this progress has been slower than most would have desired. For Latin America as a whole, growth in per capita GDP was only 1.5 percent per year in the 1990's, following a net reduction in the previous decade.[36] The overall economic climate of the region is clearly central to concerns for technology and globalization, but prognostication as to the political and economic future of the region is far beyond the scope of this paper.

We will rather focus on technology policy, suggesting the importance of a "no regrets" technology policy. Adequate technology policy and institutions will be a necessary enabling factor if economic progress is to take place in the next decades. However, even if the more general environment is not conducive to economic growth, improvements in technology policy and institutions will do no harm, and indeed may help ameliorate the situation. The appropriate technology policies will differ greatly from country to country. The smaller nations of Central American and the Caribbean will face quite different technological challenges than Brazil and Mexico, for example. The poorest nations in the region, in turn, face different challenges than the more affluent.

Globalization, in the sense of increased mobility of technologically trained people represents an increasing challenge for the region: these workers will have to be given occupational opportunities or they will leave their countries and go to places where they can work productively in their chosen fields. Similarly, it seems clear that capital moves more quickly in the globalized world -- not to where it is most needed but rather to where the risks and likely return are most attractive. To maintain high levels of investment to

[36] IDB (2001).

support innovation and technological deepening, appropriate economic climates are more necessary than ever.

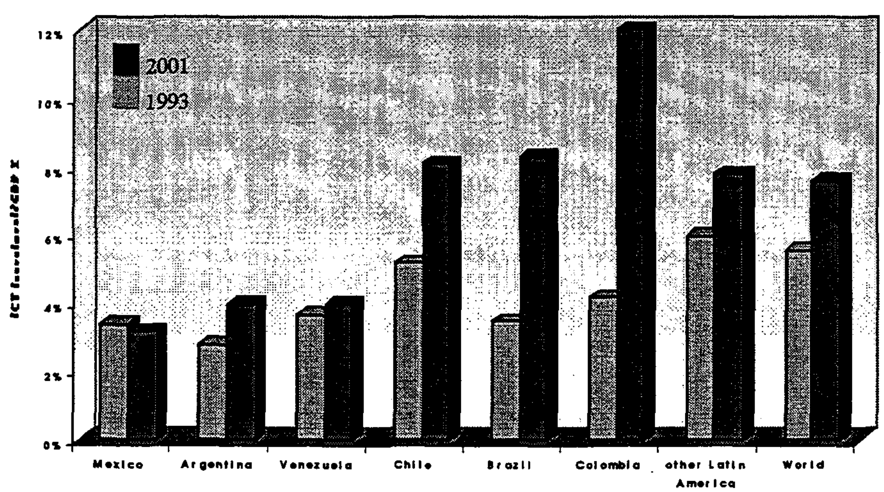
The primary technological challenge for Latin America and the Caribbean is and will remain increasing economic productivity in order to reduce poverty and improve standards of living. Increased international trade will provide opportunities and challenges in that effort. In the hemisphere, globalization may well be most importantly reflected by increases of international trade within the region. Mexico, already deeply affected by the North American Free Trade Agreement, finds itself in quite a different situation from most other countries in the region.

According to the Inter-American Development Bank,

> 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 with 30 percent of U.S.residents. Electronic commerce is also in its infancy in Latin America, representing $459 million of the region 's GDP of $2 trillion in 1999. The number of Internet hosts and the use of personal computers are two effective indicators of how well new technology is being assimilated. Both these indicators show an enormous gap between Latin America and the developed countries. Whereas the number of Internet hosts is 811 per 10,000 people for developed countries, the corresponding figure for Latin America is 23.Similarly,the number of personal computers per 1,000 people in developed countries is 353,compared to 44 in Latin America.[37]

However, assuming reasonable policy domains, we project that Latin America and the Caribbean will continue to experience a major build-up of its information infrastructure. As illustrated in Figure 3, the region has increased its investments in ICT in a significant manner over the 1993-2001 period. Moreover, key LAC countries are investing a greater share of GDP than the world average.

Figure 3 - ICT Investment in Latin American Countries

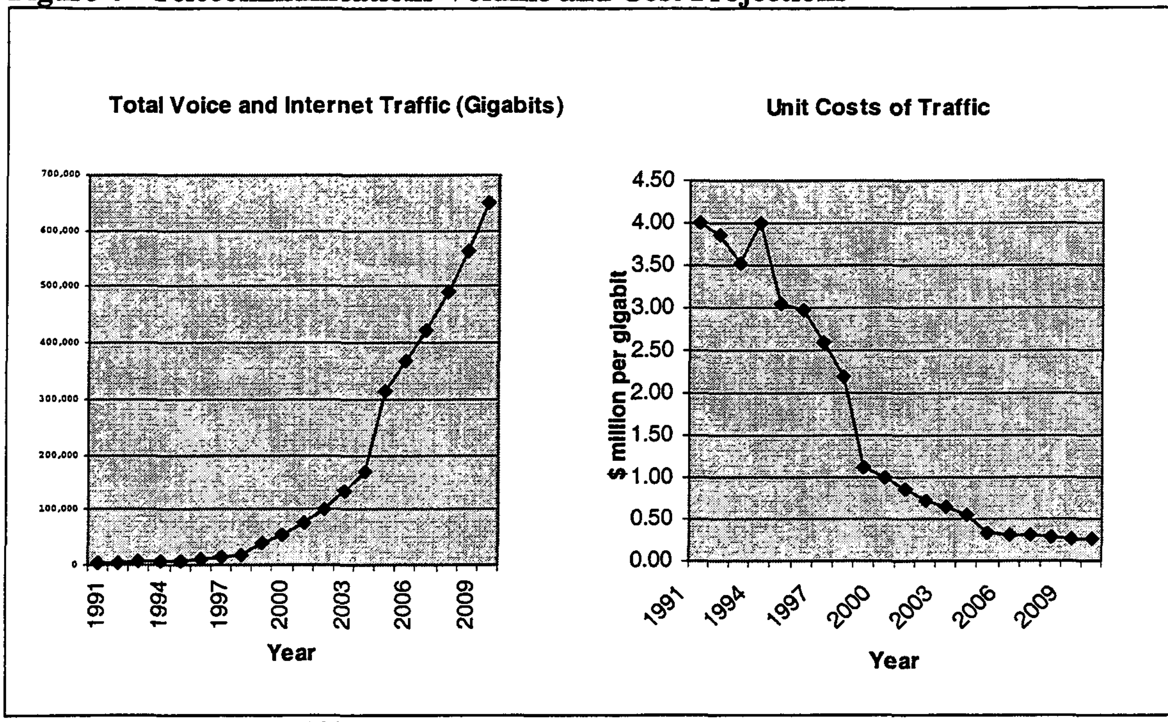


Source: WITSA (2002)

[37] Ibid., p. 205.

The growth of total voice and Internet traffic in Latin America, and the unit costs of that traffic are shown in Figure 4. A recent report projected that the number of Internet connections in South America will grow from an estimated 6.8 million in January 2000, to almost 18 million by the end of 2005.[38] Wireless telephony is expected to continue to rapidly expand telephone connectivity. The communications explosion, in conjunction with the evolving liberalizing policy environment, seem likely to engender significant increases in trade within the region as well as between Latin America and other continents.

Figure 4 - Telecommunications Volume and Cost Projections

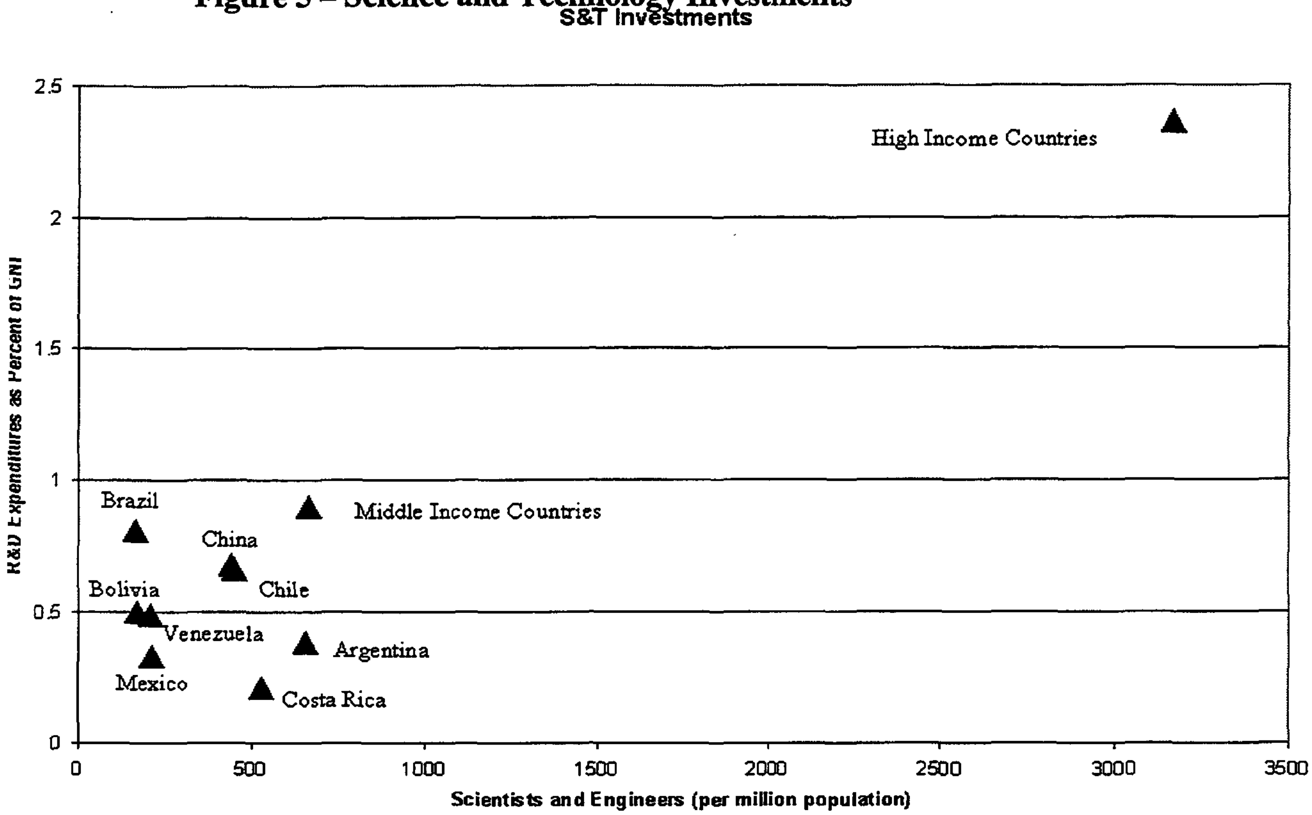


Source: Pyramid Research (2000)

In order to take advantage of this opportunity, Latin America will be well advised to exploit those areas in which it holds comparative advantage. However, comparative advantage seems likely to shift more quickly than in the past. These trends, in turn, suggest a need to increase scientific and technological capacity especially in support of those industries which will be growing or which may be developed. Applied research and technology development capabilities will have to be strengthened, as well as the training of professionals and paraprofessionals in key technological areas. As is shown in Figure 5, Latin America countries lag considerably behind not only the average developed country, but also the average middle-income country in expenditures on research and development (R&D) and scientific and engineering manpower engaged in R&D.

[38] Alan Mosher of Probe Research, http://www.newsbytes.com/news/02/174687.html

Figure 5 – Science and Technology Investments

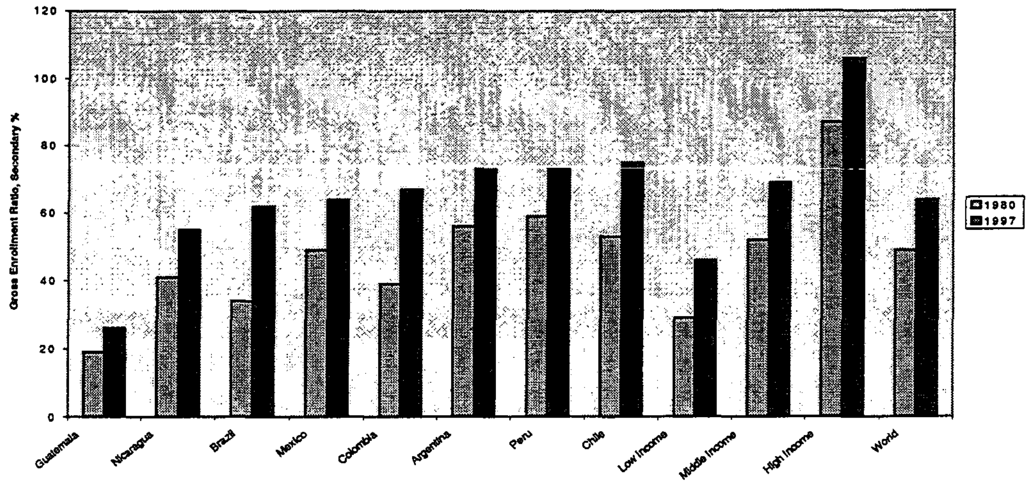


Source: World Development Indicators, 2000/2001.

Perhaps the most critical factor for success in the Networked Economy is human capital. Latin America needs a highly trained workforce. This includes not only scientists and engineers, but a wide range of university and secondary school graduates. Figures 6 shows that secondary school enrollments have generally increased in Latin America, as they have worldwide, but remain lower than those of high income countries. The differences among countries in the region are notable. Of course, a large portion of the workforces in Latin American nations belongs to generations who reached working age before the increase of secondary school enrollments, and even were the region to achieve an enrollment ratio equal to that of high-income countries there would be a lag until the average educational level or the workforce caught up.

Figure 7 shows tertiary enrollments, and again the differences among countries are notable. Chile stands out due to the high levels of enrollment it has achieved.

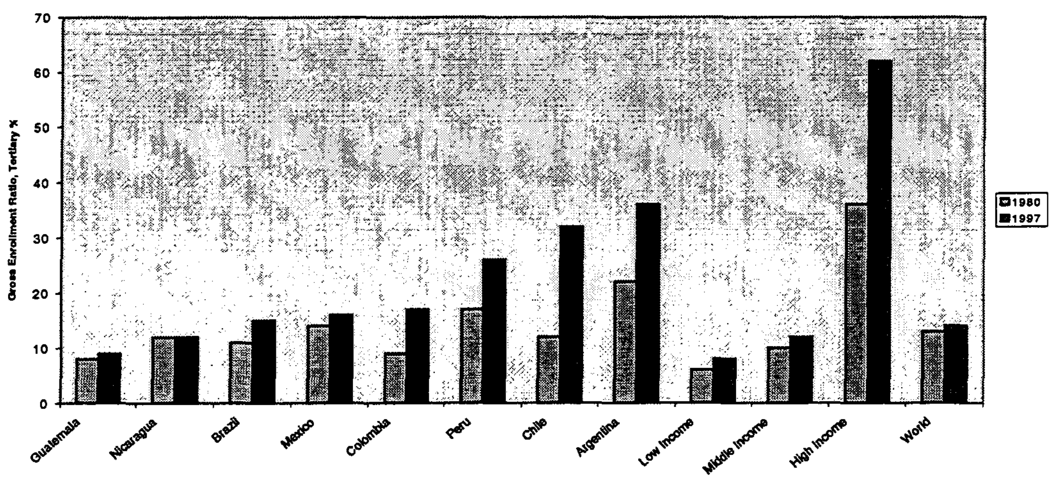
Figure 6 - Secondary school enrollment in selected Latin American countries



Source: World Development Indicators, 2000/2001

Latin America also will have to further develop a number of key institutions if it is fully to participate in the Networked Economy, including those for higher education, research and development, intellectual property protection, standards, mensuration, and quality control. Clearly there has been significant progress in this effort in the last decade, especially in some countries (Mexico, Brazil, Chile come to mind.) However, sustained institution building over a period of decades is required.

Figure 7 - Tertiary school enrollment in selected Latin American countries



Source: World Development Indicators, 2000/2001

As the transportation revolution in the 19^{th} century required an invention of new technologies of coordination and control,[39] so too has the information revolution engendered a massive effort to expand these technologies. Computers and the Internet are

[39] Chandler (1980).

fundamental to this movement, and Latin America will need to adapt and harness these technologies to its management systems and markets.

CONCLUDING REMARKS

This paper makes the following points: first, even though historically economic integration has been largely determined by policy rather than by technology, the importance of technological factors -- particularly, ICT -- in influencing this process has increased over the last two decades. Second, the process of globalization and the quality of a country's information infrastructure are positively correlated. Third, globalization does not eliminate the capacity of the nation state in regulating and influencing the way that economic agents operate, but it does change the effectiveness of certain policy tools, particularly with respect to the innovation process.

In the case of LAC countries, trends established in the 1990s are unlikely to be reversed. The significant investments made in modern communication networks in the region are expected to create feedback loops that reinforce the push toward economic integration. The challenges faced by governments trying to strengthen national innovation systems and to address shortcomings in their educational systems remain, however, significant.

Summing up, the logic of the networked economy can be one of *inclusion* rather than one of *exclusion*. As technological progress continues to push down the costs of ICT, opportunities for development-oriented applications will multiply. These considerations point toward a positive scenario for broad participation in the emerging knowledge economy. Needless to say, the realization of such a scenario requires governments to engage pro-actively in exploring these opportunities while promoting the expansion of modern networks in a pro-competitive environment.

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Annex: Data used in the analysis

Country	Globalization	Technology Achievement Index	R&D Expenditure as a Share of GDP	Connectivity Index	E-Readiness Index
Argentina	0.370	0.381	0.380	0.177	4.010
Australia	0.437	0.587	1.680	1.046	5.220
Austria	1.153	0.544	1.520	1.080	5.320
Bangladesh	0.124	na	na	0.001	2.530
Botswana	0.552	na	na	0.084	na
Brazil	0.415	0.311	0.760	0.077	3.790
Canada	1.318	0.589	1.600	1.491	5.230
Chile	0.806	0.357	0.640	0.264	4.000
China	0.386	0.299	0.650	0.034	3.100
Colombia	0.309	0.274	0.410	0.078	3.290
Croatia	0.634	0.391	na	0.404	na
Czech Republic	1.181	0.465	1.190	0.332	4.380
Denmark	1.552	na	2.030	1.219	5.560
Egypt, Arab Rep.	0.186	0.236	na	0.023	3.200
Finland	2.242	0.744	2.780	1.220	5.910
France	1.460	0.535	2.230	0.546	4.710
Germany	1.192	0.583	2.310	0.822	5.110
Greece	0.259	0.437	0.480	0.418	4.130
Hungary	0.822	0.464	0.730	0.253	4.140
India	0.277	0.201	na	0.010	3.320
Indonesia	0.370	0.211	0.500	0.013	3.240
Iran, Islamic Rep.	0.162	0.260	na	0.013	na
Ireland	5.011	0.566	1.430	1.401	4.890
Israel	0.815	0.514	2.300	0.829	4.840
Italy	0.497	0.471	1.080	0.379	4.700
Japan	0.126	0.698	2.920	0.796	4.860
Kenya	0.142	0.129	na	0.017	na
Korea, Rep.	0.444	0.666	0.690	0.758	4.860
Malaysia	1.216	0.396	0.340	0.422	3.820
Mexico	0.366	0.389	0.420	0.157	3.580
Morocco	0.223	na	na	0.045	na
Netherlands	3.110	0.630	2.090	1.135	5.680
New Zealand	0.641	0.548	1.100	1.096	5.230
Nigeria	0.675	na	na	0.003	2.100
Norway	1.097	0.579	1.680	1.480	5.680
Pakistan	0.122	0.167	na	0.008	na
Panama	1.193	0.321	0.380	0.128	3.420
Peru	0.193	0.271	na	0.048	3.380
Philippines	0.559	0.300	0.210	0.078	3.270
Poland	0.546	0.407	0.760	0.229	3.850
Portugal	0.959	0.419	0.650	1.233	4.570
Romania	0.369	0.371	na	0.112	3.100
Russian Federation	0.426	na	0.950	0.070	3.170
Saudi Arabia	0.317	na	na	0.113	na
Senegal	0.462	0.158	na	0.031	na
Singapore	2.494	0.585	1.470	1.652	5.470
Slovak Republic	1.210	0.447	1.180	0.338	4.010
Slovenia	0.496	0.458	na	0.488	4.240
South Africa	0.303	0.340	na	0.139	3.710
Spain	1.446	0.481	0.860	0.434	4.620
Sri Lanka	0.353	0.203	na	0.026	3.150
Sweden	1.766	0.703	3.850	1.426	5.760
Switzerland	2.590	na	2.740	1.487	5.170
Taiwan	0.605	na	1.920	0.772	5.180
Thailand	0.566	0.337	0.120	0.050	3.580
Tunisia	0.563	0.255	na	0.065	na
Turkey	0.230	na	0.450	0.096	3.670
Uganda	0.366	na	na	0.001	na
Ukraine	0.500	na	na	0.036	3.050
United Kingdom	1.404	0.606	1.870	0.878	5.310
United States	0.365	0.733	2.600	1.817	6.050
Venezuela, RB	0.377	na	0.890	0.101	3.410