SCIENCE AND ECONOMIC DEVELOPMENT[1]

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The role of science or technology in economic development is discussed in the context of the world economy. Two myths that have dominated thinking about technology in Latin America are examined. The role of the firm in the formulation of strategies for technological change and the requisite of macroeconomic stability to achieve competitiveness are emphasized.

I do not believe that it is possible to discuss the role of science or technology in economic development without first examining the changing context of the world economy in which future economic development will, inevitably, take place. I therefore propose to begin with a few broad observations.

The role that most less-developed countries (LDCs) played in the world economy in the past was dominated by their commitment to the extraction and sale of primary products. But the economic returns from such specialized role have declined sharply in recent decades partly, but not entirely, because of technological changes. The technological ingenuity of the industrial world has long generated substitutes for the primary products upon which LDCs have been heavily dependent: synthetic fibers for cotton and wool, plastics for leather and for some non-ferrous metals, synthetic for natural rubber, synthetic detergents for vegetable oils in the manufacture of soap, optical fibbers for copper wires, etc.

The productivity improvements that have been associated with these substitutions have, in some cases, been truly awesome. Consider the following facts: The best transatlantic telephone cable in 1966 could carry simultaneously only 138 conversations between Europe and North America. The first fibber optic cable, installed in 1988, could carry 40,000. The fibber optic cables being installed in the early 1990s could carry nearly 1.5 million, an increase of more than four orders of magnitude.

The electronic age that has recently emerged is one that depends upon fibber optics and silicon chips, inputs that can be transported around the world at very low cost, unlike timber, rubber, copper, iron ore or bauxite.

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Furthermore, as a result of new or improved transportation technologies, geographic proximity to rich raw material deposits has also lost the importance that it possessed in the first half of the 20th century.

The improvements in computer technology associated with the transistor, integrated circuits and the microprocessor, have transformed the computer into a remarkably efficient device for communicating – so much so that the term "computer" itself has now become a misnomer. The computer has become a key instrument for world-wide communication and networking, in the form of the internet, e-mail and the World Wide Web.

Furthermore, the immense growth in service employment in industrial economies is one of the most profound economic changes that is transforming the nature of affluent societies. This is a big subject that I do not have the time to deal with, but I should point out that the service sectors are far less dependent than industry or agriculture upon access to cheap raw material inputs. Let me leave this huge subject with just two simple observations:

1) Well over 70% of the American labor force is currently engaged in service activities, as compared to a mere 171/6 in traditional manufacturing, and

2) more than 30% of American exports currently consist of the export of services (business consultants such as McKinsey and Arthur Anderson, financial services, transportation, tourism, etc.). The service sectors will inevitably come to dominate the lives of successful economies in the 21st century.

But the arrival of the global economy is not entirely due to technological changes. One of the immensely-important, ongoing changes of the second half of the twentieth century has been the dramatic decline in politically-imposed barriers to the international flow of goods and of capital. A succession of international agreements, beginning with GATT, have recently culminated in the formation of a World Trade Organization. Regional free trade agreements, such as NAFTA, Andean Pact, MERCOSUR and the European Union, have also contributed to the decline of tariff and nontariff barriers to the flow of goods across national borders. And electronic innovations have, of course, played a key role in creating a truly global capital market in which immense amounts of capital now flow into and out of countries in response to even slight change in interest rates or in profitable market opportunities. It is fair to say that the economic benefits of trade liberalization are now accepted as overwhelming [World trade is now growing three times as fast as world GNP].

1 THE CENTRALITY OF EXPORTS IN ECONOMIC DEVELOPMENT

The increasing openness of world markets offers remarkable opportunities for countries that know how to exploit these markets. In a way this is a very old story. Some of the world's richest countries have been very small, but were able to exploit access to international markets to offset limitations imposed by small size. Switzerland, The Netherlands, and Sweden are among the world's richest countries. The population of Sweden is just over 8 million people – far smaller than the city of Los Angeles, or about half the size of Mexico City. Hong Kong, still a British colony, and perhaps the freest trader in the world, now has a higher per capita income than Britain, the imperial power. This may soon change. The prospect of becoming a Chinese rather than a British colony gives rise to the reflection that, although all forms of colonialism are reprehensible, some forms of colonialism may be more reprehensible than others.

Recent experience in some parts of the world clearly indicates that exporting is a skill than can be learned. Indeed, the continuing liberalization of world trade is making export orientation an increasingly attractive option – in fact, an increasingly necessary option for LDCs that want to achieve rapid growth. The most successful developing countries today, especially those in east Asia, have all succeeded by economic policies that involve a strong export orientation.

South Korea today is the home of the largest steel mill in the world The Pohang Steel Corporation), as well as the largest cement plant in the world, in addition to some of the world's most efficient and highly competitive shipbuilding yards. These are achievements of the last thirty years, and would obviously have been inconceivable if South Korea had been producing these products only for her own internal consumption. And, it is worth pointing out that, according to World Bank data, South, Korea had the same level of per capita income as Ghana only 35 years ago. Today South Korea's *per capita* income is a full order of magnitude larger than that of Ghana.

I cite these figures as a useful index of what may be achieved through a determined policy of export orientation. But it must quickly be added that the export achievements of South Korea and other rapidly-growing economies of east Asia required climbing up the ladder of technological sophistication. That is why I regard drastic changes in the attitude toward technological change as being an essential prerequisite to a policy of export-oriented economic development.

But an export-oriented policy is valuable not just because it enables a country with, a small internal market to enjoy the benefits of economies of scale, although that is a powerful reason. In addition, having meet foreign competition in international markets is a powerful form of economic discipline. Success in international markets provides an unambiguous, objective measure of a firm's economic efficiency. This is extremely important, in its own right, but it is also valuable as a guide to economic policy making. Government policies that offer subsidies to manufacturing firms are provided with a clear measure of whether or not those policies are successful if that success is measured by export performance.

Furthermore, in the most basic sense, freer trade provides a powerful stimulus to growth by strengthening the forces of competition. There is overwhelming evidence that tariff barriers by themselves promote inefficiency by eliminating the pressure that foreign competition provides toward cost reduction and quality improvement. When firms can generate huge profits in a closed economy they are not likely to search for means of reducing costs, improving quality or seeking out new technologies. Latin America's experience with Import-Substituting Industrialization provides abundant evidence in support of that statement. In this sense, the case against protectionism is precisely the same as the case against monopoly. Protectionism tends to favor the growth of local monopolies, with all their attendant evils.

But there is a still further reason why an industrial policy that includes export orientation provides a powerful thrust toward improved productivity and therefore more rapid economic development. Exporting forces a firm to keep up to date with what is going on in the outside world. It forces firms to find out, in a variety of ways, about new technologies – new manufacturing technologies as well as new products. It forces firms to commit themselves to a continual learning process, which is what climbing up the ladder of technological sophistication is all about. Open economies absorb new technologies far more rapidly than closed economies, and the ability to acquire more productive technologies through technology transfer is the key strategic opportunity for LDCs.

And finally, there is still another crucial reason why climbing up the technological ladder and learning to export is essential. For countries that are determined to achieve rapid economic development, foreign borrowing can quickly become an unsustainable burden without an increase in foreign exchange earnings to service those external debts. Recent Latin American history provides a sad litany of macroeconomic instability, not because the servicing of foreign debt rose to a high percentage of ONP, but because the servicing of foreign debt rose to a very high percentage of a country's export earnings. Indeed, when this situation was combined with overvalued exchange rates (as was frequently the case), foreign borrowing served merely to finance the overseas flight of capital. That is to foreign borrowing served to finance the private sector's accumulation of foreign assets, rather than an increase in the country's productive capabilities. And, of course, overvalued exchange rates are the most powerful of all deterrents to exports.

I propose now to examine the role of technological change in economic development, with special reference to Latin American history. I have decided that a useful way to proceed is to deal with two myths that I at have dominated thinking about technology in this region.

2 THE FIRST MYTH

For many years, the advocates of industrialization in Latin American countries worried about the effects of American exports upon their own domestic economies. A widely-held common denominator was the: view that large-scale American manufactured imports seriously hindered the possibility of developing an indigenous industrial capability. An immediate result of that concern throughout Latin America was the adoption of policies of import substitution.

But I would like to suggest that America also exported something that may have had a far more damaging effect on Latin American industrialization than its manufactured products. This export was, for the most part, not the result of a conscious or deliberate act. It was not even a tangible thing. It was, rather, a concept, a way of thinking about technology – what it is and, closely connected, where it comes from.

The myth that was exported by America stated, in brief, that technological change is a process that has its origins at the very forefront of present-day scientific research. Technological change is regarded as a process whose beginnings can be traced directly back to some piece of laboratory research in which scientists succeeded in prying out some vital new piece of knowledge about the physical universe. The myth that I have in mind, in other words, is the myth that equates technology with high technology (Really with very high technology). This myth is sometimes known as the Linear Model, in which causality runs from (1) Basic research to (2) Applied research) to (3) Development, to (4) Production to (5) Marketing.

Like many myths, this one has retained much of its vitality and persistence because it is not 100% myth. It certainly contains elements of truth, especially in the long run. There is no difficulty in identifying a number of important new technologies that have had readily recognizable antecedents in prior scientific research. In the 19th century the fundamental researches of Faraday on electromagnetic induction: led directly to the electricity-based technologies, although it is important to remember that a full half-century elapsed between Faraday's great discovery (1831) and the use of a dynamo to generate electric power (The Pearl Street Station in lower Manhattan, which opened in 1882). In the twentieth century, scientific -research in quantum mechanics laid the basis for the transistor and the extensive electronic innovations that have been built upon it.

Similarly, the revolutionary scientific breakthroughs in molecular biology, beginning with the discovery of the double-helical structure of the DNA molecule and culminating in the discovery of recombinant DNA in the 1970s, laid the basis for the new biotechnology products that, are just beginning to emerge. The biotech industry is one that is certain to play a dominating role in the 21st century. But the very fact that more than forty years have elapsed between the scientific breakthrough and the new industry that is being built upon that breakthrough, provides an important clue to the true nature of technology development.

A consequence of this myth, of the tight, intimate dependence of technology upon fundamental breakthroughs in science, is that it is fundamentally misleading in the way it encourages us to think about technology. It misrepresents something that does occasionally occur for something that is representative or typical. But, more deeply, even in those cases where it can be shown that a new technology did indeed owe its origins to some scientific breakthrough, the subsequent train of technological improvements will often have very little, if anything, to do with research at the frontiers of science. It will, much more likely, involve intensive scientific research of an applied nature, directed at more modest, short-term goals. And the conversion of scientific insights into a new or improved technology will involve a heavy and prolonged reliance upon the patient and prosaic work of product designers, production engineers, marketing specialists and, far from least, workers on the factory floor. The fact that a new technology had its origins in a major scientific breakthrough very quickly becomes a matter of interest only for historians of science, and not for businessmen.

Thus, the "high tech" view of the Innovation process leads to what logicians sometimes call the fallacy of misplaced emphasis. It calls our attention to the wrong factors, if our concern is with improved economic performance rather than the history of science. [And I cannot resist pointing out, if only parenthetically, that the high tech view is popular among my scientific colleagues in American universities because, it provides a strong argument for increasing federal budgetary commitments to the support of basic research].

The central point for present purposes, then, is that, even in those cases where a new technology depended upon research at the scientific frontier, success in the market place need not have any close connection with frontier scientific research. The remarkable economic performances of Japan and other east Asian countries is strong testimony to the fact that a distinguished research capability in science is not a sufficient condition for commercial success. Indeed, very often it is not even a necessary condition – and I say this with some trepidation because such a statement would be regarded as nothing less than heresy at any major American university, including my own.

This mythology of the universal importance of basic research has very serious consequences. Belief in this myth is likely to bias the search for technological improvement, and thus to lead to overlooking potentially rich sources of such improvement. It is likely to discourage less-developed countries from searching for technological improvements that are well within their capabilities, even if such countries have very limited capabilities for major breakthroughs at the scientific frontiers. It is likely to lead to government policies and, perhaps even more importantly, to managerial practices, that fail to encourage and to stimulate technological improvements from a variety of sources – suggestions from workers on the factory floor.

The Japanese, of course, have understood this. They have not been taken in by what I might call the mystique of pure science. American academics and industrialists for a long time dismissed Japanese industrial efforts as "unsophisticated" the work of "mere imitators". One hears less of such language in recent years. Those "mere imitators" became virtually the sole source of every VCR and tax machine in America, as well as the suppliers of much, if not most, consumer electronics. In the absence of a so-called "voluntary" quota, Japanese firms would have captured far more than their present 25% of the American automobile market (an American "voluntary" quota, of course, is a quota that is not voluntary). The Japanese have developed organizational and managerial systems that draw upon multiple sources of human ingenuity and inventiveness that lie virtually untapped in America or Britain, Although the ways in which they have done this are numerous, one important element is their understanding that the potential sources of innovation are much more diverse than they have been made out to be in the mythology of the dominant role of frontier science.

The preoccupation with the dominant role of frontier science in generating technological innovation has another dangerous consequence: it leads to an exclusive focus on hardware as the source of a firm's productivity improvement, and therefore to a neglect of organizational improvements. And yet, as the experience of Japan has convincingly shown, changes in organization and management can have at least as great an effect on productivity as new hardware technologies. Or, to put the point somewhat differently, Japanese industrial firms have, time and again, produced much greater volumes of output than their American counterparts while using essentially the same manufacturing technology (indeed, often achieving such results while using machinery imported from America).

Consider "Just in time" inventory control methods (Actually, just in time is a way of eliminating inventories, not controlling them). This is a way of organizing the flow of work through the factory. The huge productivity improvement associated with it is organizational and managerial, not technological. Similarly, Japanese firms have pioneered in methods of maintaining high standards of quality control – *e.g.*, quality control circles, Japan's extraordinary successes in semiconductor technology owe a great deal to the higher yield that her semiconductor firms have been able to maintain, an achievement that has been largely a matter of quality control (total quality control).

More generally, Japanese firms have managed, in a multitude of ways, to enlist the enthusiastic cooperation of factory workers in raising productivity. In many ways the Japanese firm is much less hierarchical than its western counterparts. Far more decision making is left to workers on the factory floor. The organization of work is less constrained by the rigid job descriptions that prevail, *e.g.*, in the US or the UK industrial relations. Are, in general, less confrontational and more consensual than is the case in the west.

These differences are often dismissed as differences that are deeply rooted in Japanese culture and history, and are therefore not readily transferable to other countries. I believe that this is simply a mistaken view. Unfortunately, I do not have the time to discuss these issues in any detail. Lot me simply point out that many of the features of the Japanese firm and factory that correctly elicit so much admiration are essentially organizational innovations that did not exist before World War II. They are, for the most part, postwar organizational innovations.

3 THE SECOND MYTH

I turn now to a second myth. This myth emerged, as I see it, out of two historical episodes:

1) The long period of Latin American dependence upon foreign sources for their industrial technology, often of course upon multinational firms.
2) The attempt of Latin American countries, beginning shortly after the end of the Second World War, to accelerate their industrial development through policies of import substitution – ISI.

As a result of these two overarching forces, there was a strong tendency for firms and businessmen in Latin America to look upon technology as some kind of remote force that was forever treated in an arms length way. Technology itself came to be regarded as something that was imported from a foreign supplier, who shipped it from some far away place, together with an instruction manual. These instructions were to be followed in a mechanical way, often with not very satisfactory results, and almost always without the growth of an indigenous capability for doing anything much with the technology beyond following the instructions of some invisible foreign manual writer. Indeed, frequently the contractual relationship with the foreign supplier required that there be no deviation from those printed instructions, or the warranty that came with the equipment would not be valid.

I am tempted to use a well-known Marxian term here to describe what happened in Latin America. Marx, as you may recall, wrote at length, and often with great eloquence, about how the introduction of industrial technology in the first half of the 19th century resulted in the alienation of the worker because the use of machines led to the suppression of worker skills and creative expression. But what happened in Latin America was somewhat different from the British experience, about which Marx was writing. In Latin America the industrial worker was not alienated in the same way, because the Latin American worker was never as thoroughly immersed in that technology, in the first place, as his northern counterpart. The labor force in the north always at least retained a class of highly skilled workers, who were intimately familiar with machine design, modification and maintenance. Marx himself paid a great deal of attention to the importance of these workers in the vital capital goods sectors. He well understood that, without them, capitalism's technological dynamism would soon grind to a halt.

In the Latin American case, then, alienation took a very different form, because the labor force came to perceive new technologies as some kind of totally alien intrusion, a threatening intrusion that in no way emerged out of a recognizable social process in which Latin Americans themselves participated. In my view, the effects of this alienation persist to this day. The dominating tendency in Latin America is to continue to see technology as something that arrives, literally, in a package. It is something that is already incorporated in a product – a machine – and simply purchased from a remote foreign supplier and unpacked. It is not something that is regarded as an outcome of a process in which the Latin American worker has, himself, been an integral part.

Thus, Latin American industrial history, including both the dependence upon the North and the import substitution regimes that were intended to reduce that dependence, has had some very insidious effects. But the most insidious effect of all may well have been the attitude that it bred toward technology, Latin Americans saw themselves, not as potentially active participants in technology development and improvement, but as passive recipients of foreign technologies that came to them from afar in various forms: assembly kits, turnkey plants, or boxes of machinery for which they had instruction manuals, but no true understanding. The contrast with the east Asian economies is striking. Countries like South Korea and Taiwan, and of course Japan, devote enormous energy to monitoring technological developments all over the world. I know of nothing even remotely comparable to this world-wide monitoring in Latin America.

This passivity toward technology in Latin American countries was further reinforced by central elements of import substitution policies. In particular, high tariff protection and other nontariff restrictions on competition, combined with an extensive system of subsidies to certain favored domestic producers, all conspired to create profitable opportunities for those who knew how to gain favorable treatment from government officials. The way to attain high profits was, often, to influence (*i.e.*, to bribe) government officials, and not to improve efficiency, I know that I do not have to belabor this point to a Latin American audience. A broadly similar story could be told of other LDCs that adopted highly protectionist policies, such as India.

Thus, the incentive to Pursue the goals normally achieved through the use of superior technologies – productivity improvement, cost reduction and higher quality – was blunted or even totally eroded. The availability of a captive local market vastly weakened the normal incentive to establish a more advantageous position in the market through technological change. Firms did not come to regard the improvement of their technologies as central to their competitive success.

Indeed, the protectionist policies left a further debilitating legacy. Inside the protectionist wails, they created strongly hostile attitudes toward the firms that had been the beneficiaries of protection. As a result, it rendered even more difficult the later prospects for more collaborative relationships between domestic buyers and sellers, when these Countries began to seriously consider entering into competitive international markets. As Carlota Perez has said of countries that had employed the Import Substitution approach,

> *"... there is an additional hurdle which is not present in developed nations: the truly antagonistic relationship with suppliers resulting from import substitution policies. After having been forced for decades to buy what they often saw as low quality, high price, low diversity inputs from local producers, the last thing a user will want to do, if imports*

> *are fully open, is to collaborate with suppliers. In the ISI case, supplier relations were not at arm's length but at gun-point"* (Perez, 1991, p. 161).

This hostility and distrust is likely to become a particularly serious problem as Latin American countries attempt to participate in the world-wide trend toward networking relationships and strategic alliances. A main port of entry into world markets in the future is likely to take the form of alliances with other firms, both foreign and domestic. In these alliances, individual partners become specialized suppliers, subcontractors or assemblers in networks involving other firms. But such networking presupposes some minimum relationship of trust and confidence among the participants. Networking relationships are not likely to emerge readily in an environment that has been shaped by decades of pointed guns and mutual distrust. Building such trust and confidence is an indispensable, high priority goal.

4 THE STRATEGIC ROLE OF THE FIRM

It is important to emphasize that the formulation of strategies for technological change and productivity improvement need to take place at the level of the private firm, and not the government. Governments may, and do, formulate goals and targets for countries, but these seldom amount to more than empty rhetoric unless the appropriate incentives exist, or can be made to exist, at the level of the individual firm. I believe that the evidence of the 20th century is simply compelling on this score: Governments may complement the initiatives of private industry, but they cannot effectively serve as substitutes for the lack of initiative in the private sector. I believe that the evidence is similarly compelling that research that takes place inside government laboratories cannot provide a substitute for R&D carried out inside private industrial laboratories. Research workers in government labs are never sufficiently sensitive to, or responsive to, the requirements of the commercial world. They do not know enough, or care enough, about the specific needs of numerous classes of ultimate buyers, and government agencies hardly ever promote the incentives that are required for the development or for the design of products that can be sold at low cost.

Why is it so important that the research capability should reside primarily inside the private firm? A fame part of the answer goes back to the first myth that I dealt with earlier, the myth of the centrality of basic science. The private firm is not, usually, an appropriate place for the conduct of fundamental research. However, it is important to realize that only a small fraction of total R&D, even in the advanced industrial economies, is devoted to basic research. In the US, such research has constituted only about one-twelfth of total R&D. R&D is, in the US as well as in other industrial countries, overwhelmingly D, not R. And D is primarily the domain of the engineer, product designers, production engineers, and technical specialists of all sorts. And while the R of R&D is indeed the domain of the scientist, these are primarily scientists doing applied research of a kind that offers the prospect of a financial payoff within some relatively near-term future.

This raises a basic paint that is not widely appreciated in the US, where academic scientists tend to equate greater government support for R&D as a platform for the performance of the sort of research that occasionally wins Nobel Prizes: Most R&D expenditures are devoted to the prosaic but economically vital activity of improving on old products, not inventing new ones – and much less supporting basic research. According to McGraw-Hill annual surveys conducted over a number of years, the great bulk of R&D in the US, around 80%, is devoted to improving products that already exist, rather than to the invention of new products.

Thus, it is incorrect, even in the US, to think of R&D expenditures as committed to the search for breakthrough innovations. On the contrary, the great bulk of these expenditures need to be thought of as exhibiting strongly path-dependent characteristics. Their main goal is to improve upon the performance of technologies that a firm has inherited from the past. A moment's reflection suggests that this should not be surprising. The telephone has been around for a hundred and twenty years, but only recently has its, performance been significantly enhanced by improvements built upon the infrastructure of that old technology: FAX, electronic mail (e-mail), internet, World Wide Web, voice mail, data transfer, on-line services, mobile phones, conference calls, and "800" numbers (the last a very important innovation in commercial terms). The automobile and the airplane are one hundred years old and more than ninety years old, respectively, the camera is 150 years old, and the Fourdrinier machine, which is the mainstay of the papermaking industry today, was patented during the Napoleonic Wars, almost precisely two hundred years ago. But these technologies continue to absorb a very large percentage of all current R&D expenditures.

Thus, R&D activities need to be understood as activities that make economic sense only in the context of industries in which individual firms are competing for economic advantage, and in which they do so by developing strategies in which technological improvements are expected to strengthen their competitive position *vis-à-vis* domestic competitors and, ultimately, foreign producers in global markets. It should be obvious that these kinds of activities can only be effectively carried out in an organizational context that is very close to the market place, and where, therefore, technological considerations are never divorced from their financial and commercial implications. In particular, firms that hope to compete in high tech markets need to establish an internal research capability that will link future product and process development to a well-informed vision of its market opportunities.

But there is an additional reason that supports my insistence on the urgency of developing an internal research capability. It is a reason that is especially important for firms in LDCs. I have called attention so far to an "Internal" reason for a research capability, a reason connected to the ongoing improvement process that must go on inside a firm that aspires to climb the technological ladder in global markets. But there is also a crucial "external" reason. An internal research capability is essential to allow a firm to monitor what goes on in the external world, the world outside the firm and, even more important, outside the country.

Modern information technology now allows everyone, everywhere, to literally plug into a vast international network of information being generated by universities, a variety of nonprofit research institutions, government agencies (which in the US, generate research findings in fields such as energy, health, agriculture and food processing, environment, safety and other fields and, not least, other firms. And, although it is now a relatively simple matter to plug into this information network, provided one has the necessary electronic hardware, making effective use of this information is another matter entirely. That requires a sophisticated level of scientific comprehension, not only to read and understand the huge literature to which one now has access, but also to understand possibly relevant implications, and to form judgements about potential applications to a firm's present product line, as well as potential enlargements of the firm's future capabilities.

Doing these things in ways that offer the prospect of being commercially useful requires not only a sophisticated internal scientific capability, but a capability that is directly attached to an intimate familiarity with the firm's present activities as well as its longer-term strategic plans. In this sense, a firm's internal research capability may be thought of as a "ticket of admission" to a vast information network.

5 A CLOSING OBSERVATION

I would like to close with a strong caveat. I am anxious not to leave the impression that either science or technology is some, sort of magic bullet. Neither is anything of the sort. Technology is, potentially, an immensely powerful tool for economic development. But it can serve as such a tool only in an economic environment that offers strong incentives to private industry. This implies, at a minimum, a reasonable degree of macroeconomic stability. Inflationary expectations generate a high degree of uncertainty and short time horizons; they also create numerous opportunities for earning profits through speculative ventures and other kinds of socially unproductive activities. Moreover, prices and wages must be allowed to reflect economic conditions in reasonably unregulated markets in order for managers to be able to make intelligent decisions with respect to technology.

Latin American history already offers too many episodes in which political popularity was pursued through continuous expansion of employment in the public sector, through controlling prices at unrealistically low levels, and through subsidizing inefficient and unprofitable enterprises. The notion that such policies can be made compatible with improved competitiveness in international markets is surely one of the most frequently-discredited myths of the late twentieth century. I am tempted to label it the third myth of my talk. No amount of technological sophistication can create competitiveness, or stable economic growth, in that kind of environment.

6 REFERENCES

PEREZ, C. *National systems of innovation, competitiveness and technology*. Caracas, p. 161, 1991. (unpublished manuscript).