VERSÃO PRELIMINAR
MARKET-ORIENTED STRUCTURAL REFORMS, GLOBALIZATION AND THE TRANSFORMATION OF LATIN AMERICAN INNOVATION SYSTEMS.¹

Jorge Katz

1. INTRODUCTION.

As a result of macroeconomic stabilization policies and market-oriented structural reforms, on the one hand, and of the rapid process of globalization experimented by the world economy throughout the 1990's, on the other, Latin American countries are currently undergoing major economic and institutional changes. As part of said changes, national innovation systems are also experimenting a profound transformation throughout the region. In this paper we examine how national innovation systems – and technological behaviour – are changing in Latin America as a consequence of the transition to a more open, de-regulated and privatized macro-policy regime. Major economic, institutional and technological forces deriving from said transition are currently affecting the ‘sources’ of productivity growth of different sectors in the economy, the rate and direction of domestic innovation activities and the development of domestic technological capabilities. ‘Old’ patterns of technological behaviour, ‘old’ institutions – such as high and ‘tailor-made’ rates of tariff protection related to the ‘inward-oriented’ process of industrialization, are being phased out while ‘new’ forms of production organization and technological behaviour are being gradually adopted.

Are these new forms of production organization and technological behaviour inducing faster productivity growth and/or a better pattern of insertion of Latin American economies in world markets?. Unfortunately, the available evidence indicates that they are not. A more open, de-regulated and privatized economic regime has not so far derived in a higher average rate of productivity growth than in the past, nor has it induced a significant reduction of the productivity gap Latin American countries exhibit vis a vis more developed industrial countries.

As a result of the above there is an increasing feeling in the region that a better long term growth and innovation performance requires a much stronger, pro-active and ‘hands-on’ strategy on the technology-cum-innovation front than the one Latin American countries have so far deemed necessary to adopt. However, how to reconcile prevailing orthodox views of ‘horizontal’ policies and neutrality with those of selectivity and ‘pro-active’ government intervention aiming at the ‘construction’ of dynamic comparative advantages based on knowledge and innovation, still constitutes a major unresolved policy dilemma that most Latin American governments have not been able to resolve. The Latin American and East Asian attitudes toward these

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matters differs widely as research by L. Westphal (1978), L. Kim (1997) and others has shown. We submit that it is probably in the ‘hand-on’ and ‘proactivity’ of policy making on the technology-cum-innovation front that East Asian countries owe much of the long term differences in economic performance they have been able to attain vis a vis Latin American ones.

Market-oriented structural reforms were implemented in Latin America under the expectation that the transition from an ‘inward-oriented’ ‘state-led’ growth strategy to one which was ‘outward-oriented’ and more responsive to market signals was going to be rewarded with significant long term improvements in technological performance and growth. The competitive discipline imposed by a more open and de-regulated economic regime was expected to induce firms and individuals to undertake technological ‘deepening’ efforts which, in due time, were to derive in a gradual but steady ‘convergence’ to international ‘best-practice’ forms of production organization and levels of productivity.

A global look at the region’s performance over the last two decades tells us that such a priori expectation was far too optimistic. It is true that macroeconomic stabilization programs and market-oriented reforms have helped to bring under control various critical cases of macroeconomic mismanagement and dis-equilibrim – even running off episodes of hyper-inflation - which resulted from the two Oil Shocks of the 1970’s and from the massive capital flight and the Debt Crisis of the early 1980’s. It is also true that said reforms have been successful in making the economies in the region more open to trade inducing them to re-structure into a new pattern of production specialization and insertion in world markets which is more respectful of ‘natural’ comparative advantages and relative factor endowments. But, with very few exceptions, it can not be said that market-oriented reforms have been successful in making Latin American countries grow faster than in the past, nor that they have induced a higher rate of innovation and total factor productivity growth than in the 1960’s and 1970’s. Furthermore, and given that a minority of the firms in any given country – mostly, domestic subsidiaries of large transnational corporations and locally-owned conglomerates – have managed to react to the new macro-policy regime modernizing their production facilities and gradually ‘catching-up’ with international best-practices, while the large majority of firms – mostly family-owned SMEs – has not been able to do so, structural heterogeneity has increased in almost every other country in the region during the course of the last two decades. In a nutshell, not only have most countries in the region not been able to grow faster, or significantly reduce the productivity gap they exhibit vis a vis more mature industrial societies, but they have now become more unequal than in the past. Few notable exceptions can be singled out, but unfortunately they confirm the general rule.

In addition to market-oriented reforms domestic innovation systems and technological behaviour have also been affected in recent years by the increasing pace of globalization taken by the world economy in the 1990’s, particularly so during the first half of the decade. The rapid expansion of direct foreign investment, the acquisition of numerous domestic companies by foreign-owned enterprises, the privatization of large public firms involved in the production of telecommunication, water sanitation, transport or energy services, and a stronger propensity of local firms
to operate under licensing contracts with foreign corporations, resulted in a major process of ‘externalization’ of the ‘sources’ of productivity growth as well as in a profound change in the rate and direction of domestic technological and innovation efforts.

Finally, and pari passu with the above, the world’s technological frontier has been changing at a very dramatic pace in recent years in areas such as biotechnology and genetics, information and communication technologies, etc. affecting a wide spectrum of scientific and technological fields and production activities and strongly influencing the way in which firms and individuals organize themselves for the production of goods and services. Many new forms of ‘real time’ production organization, involving the use of digital technologies, of ‘networking’ with customers and subcontractors, of accessing through the Internet to the world of e-commerce, e-government, e-education, etc. are gradually finding their way into Latin America transforming the economic, institutional and technological environment of the countries in the region. The same could be said of recent advances in biotechnology or genetics now being adopted in natural resource processing areas such as fisheries, mining or agricultural production.

Thus, market-oriented reforms, the rapid globalization of the world economy and the international diffusion of major new technologies, are inducing significant changes in structure and behavior of Latin American innovation systems. This is the topic we want to examine in the present paper.

We argue here that many aspects of said changes, and their relationship with productivity growth and international competitiveness, have not been so far well understood by mainstream economists and policy makers in the region. A different conceptual approach to these issues and a much more pro-active and ‘hands-on’ policy perspective seems to be needed in the years ahead if Latin American countries are to achieve faster productivity growth and a steady process of ‘convergence’ to international productivity standards. Science, technology and innovation appears as an area in which the public policy agenda of Latin American countries is still far off from the policy agenda of the more developed nations in the world.

Why is it in the first place that Latin American politicians and economists consider market-oriented mechanisms as sufficient for the countries in the region to attain a faster rate of economic growth and a better technological performance?. In our view the answer to this question lies in the massive support Washington Consensus ideas received in Latin America since the late 1970’s from the part of mainstream academic economists and policy makers that took for granted that the free functioning of markets was all that was needed for the countries in the region to enhance their long term performance, including that associated to innovation and productivity growth.. So strong was the ideological stand upon which the above mentioned ideas were predicated in the region that both government officials and academia failed to perceive that conventional neoclassical ideas are simply not good enough when we come to explain the dynamics of markets where uncertainty, asymmetry of information, ‘public goods’, non-rivalry in consumption, imperfectly defined property rights and other such ‘abnormal’ features of the real world of production organization constitute the norm rather than the exception. Knowledge-generation activities, innovation and the
development of domestic technological capabilities clearly belong in this set of ‘abnormal’ fields where neoclassical lens give us a highly ‘miopic’ perspective as to the required incentive regime for socially optimal long term functioning. A fortiori, they also give us a highly inadequate policy advice as to what should be done in order to enhance the economy’s long term performance.

It is our believe that the lack of an adequate theory of innovation is what has induced Latin American economists and policy makers to take for granted that the discipline of markets was all that was needed for the countries in the region to enhance their technological and innovative performance and their long term competitive insertion in the world economy. Unfortunately, things have not worked as expected and after two decades of structural reforms, of de-regulation of factor markets and of major privatization efforts, Latin American countries continue to exhibit rather low levels of average labor productivity – say, one third to one half of world standards in many areas of the economy – and an enormous variance across firms and sectors as far as rates of productivity growth are concerned. Moreover, recent changes in production structure have induced exports to concentrate in the low value added end of the commodity spectrum, forcing most companies in the region to act as ‘price-takers’ in highly competitive world markets for natural resource processing industries and/or for low domestic value added ‘maquila-type’ assembly activities. Concomitantly with the above, technology-generation expenditure has continued to be dramatically small in the region – just a small fraction of what firms and governments of more developed industrial countries spent on this front – and institutions and public policies related to innovation and technical progress continue to play an almost negligible role.

Market-oriented neoclassical ideas derive from a very simple model in which the ‘representative’ firm constitutes the central analytical tool upon which the formal edifice is erected. Alongside with the notion of the ‘representative’ firm neoclassical growth theory is also specified in terms of a highly ‘stylized’ institutional-free scenario, in which no uncertainty prevails and agents are endowed with perfect knowledge and understanding as to their future opportunities. Under such conditions markets perform an adequate resource allocation job, attaining Pareto optimality. Knowledge-generation activities and technology markets are thought to behave just as any other activity and market in the economy and no room is made for the fact that innovation and technical change demand Schumpeterian quasi-rents, well above the ‘normal’ rate of return on capital, if they are to be emerge at all. How big such quasi-rents need to be, what is the more appropriate institutional environment for them to emerge, what is the role of public/private alliances, of ‘collective action’ and of public coordination of activities supplementing the role of markets in order to induce the right amount of knowledge-generation and diffusion efforts in the economy, and how all of the above differs across countries and sectors of economic activity as result of differences in institutional environment, do not really constitute questions in which ‘market-oriented’ neoclassical economists are particularly interested. Adequate macro ‘fundamentals’ and a well-functioning intellectual property rights regime is all what they deem necessary for the right amount of R&D efforts and innovative activities to obtain in the economy.

Moreover, the neoclassical firm operates on the basis of a well-behaved ‘generic’ production function where there is no room for ‘tacit’ and ‘firm-specific’ ‘non-formalized’
knowledge, that needs to be accessed by trial and error and through search under conditions of uncertainty and imperfect understanding as to where and how one should be searching for. When “learning” is introduced into modern growth theory it is usually done so in a ritualistic way that leaves on the side the institutional complexities and imperfections of technology markets, the essentially non-predictable character of future technological ‘states-of-the-world’. Learning is introduced into a formal structure which continues to operate under equilibrium principles.

Given the above, the actual functioning of technology markets often remains as a ‘black box’ for main stream economics. The analyst is normally more interested in the behaviour of macro variables – the exchange and interest rate, real wages – than with questions of asymmetry of information, inappropiabilities, insufficient ‘initial technological capabilitiesd’, ‘clustering’ and coordination efforts, or increasing returns to scale, which are the normal conditions under which learning takes place in the economy.

In our view, this is why Washington Consensus oriented government officials and ‘main stream’ economists did not a priori think that structural reforms could fail in their capability of inducing a better overall innovation-cum-productivity growth performance. The likelihood that inadequate ‘initial endowments’ a la A. Sen (i.e. low initial technology absorption capabilities in particular areas of the economy, family-owned SMEs, for example)\(^2\), or the lack of institutions and ‘public goods' inducing higher domestic R&D and engineering efforts from the part of individuals and firms, or a longlasting macro climate of turbulence, uncertainty and disequilibrium inducing economic agents to become extremely ‘overdefensive’ and unwilling to undertake long term innovation efforts, was simply not taken into consideration. And yet, all of the above features – inadequate ‘initial endowments’, lack of institutions and of an appropriate incentive regime inducing firms and individuals to undertake innovation efforts and a highly uncertain macro environment – have been present in Latin America all through the period in which market-oriented structural reforms were undertaken. We believe that such forces have seriously affected the long term innovation and productivity growth performance of Latin American economies. Moreover, we also believe that a poor long term productivity growth performance has negatively affected the sustainability of the macro ‘fundamentals' of the economy, closing down the micro-to-macro loop of casual forces.

If the above ideas are correct, a new look into these issues – both conceptually and policy-wise - seems to be needed in the years ahead if the countries in the region are to improve on their long term growth and innovation performance. In our view the rate of technical progress of any given economy and its process of modernization is influenced not just by the macro ‘fundamentals’ in the economy but also by a host of sectoral and firm-specific forces that need to be taken into consideration if we are rightly to ‘explain’ why some countries, regions, industries or firms actually ‘forge-ahead’ while others ‘stumble-back’ or ‘stay-behind’ (Amsdem, 1994). Also, if we want to design policy instruments capable of enhancing global growth performance. The role of macroeconomic prices and of ‘macro’ institutions such as intellectual property

rights, adherence to rule of law or even a well functioning judiciary system, have been correctly identified as influencing forces in recent neoclassical writings (Kuczynski and Williamson, 2003; Lora and Panizza, 2003). Much less attention has been paid, however, to the role meso and microeconomic forces play in this field, influencing sectoral and individual firm technological and innovative strategy and behavior. Such meso and micro forces have to do with what we call here the "competitive and technological regime" in which specific industries operate and with the micro circumstances influencing individual firm technological strategy and behavior. Firms and industries tend to be very different from each other, even within narrowly defined fields of economic activity. The role of intellectual property rights is different in, say, pharmaceuticals or textiles. Property rights on natural resources do not play a similar role in resource-processing industries or in metalworking activities. In other words, sector-specific technological and regulatory institutions play a crucial role at the 'meso' level. (Winter, 1996; Malerva 1999), while 'micro' forces – what we sometimes call ‘business culture’ – play an active role influencing firm-specific strategies explaining inter-firm behavioral differences as far as innovation and productivity growth are concerned, even within a given industry. (R.Nelson, 1999) Such differences are important if we are correctly to explain why some firms and industries succeed, while others fail, even under similar macro and meso circumstances. Also if we are successfully to understand macro-to-micro interdependencies in any given economy.

As mentioned before, conventional neoclassical growth theory does not help us either to understand the long term relationship between the macro 'fundamentals' of the economy and its long term productivity growth performance. It seems clear, however, that a poor long term innovation performance militates against international competitiveness, particularly so in the more dynamic fields of international trade – which do not necessarily have to be 'high-tech' fields - and the attainment of export-based synergies in the economy as a whole. If the long term pattern of production specialization and trade remain trapped in low-domestic value-added activities it is unrealistic to expect that any given country will be able to pay high wages to its citizens, nor that it will be able to capture significant benefits from international trade. The Mexican example of the last two decades is a very vivid example of the above. Multiplying by three its export penetration in world markets with 'maquila-type' assembly industries has not resulted in Mexico’s significantly improving its long term productivity performance nor in paying higher real wages. As different from Chile, the export-lead growth strategy has had a much smaller impact in the case of Mexico. (Cimoli et. Al. 2002).

The present paper is divided in three sections. We begin by examining how Latin American National Innovation Systems behaved during the ‘inward-oriented’ period of industrialization, i.e. during the four decades spanning 1940-1980. We then continue – in Section 2 – with a brief description of the major changes that innovation systems and technological behaviour experimented in recent times as a result of ‘market-oriented’ policy reforms and of the rapid process of globalization of the world’s economy in the 1990’s. In this section we proceed in terms of a short list of ‘stylized facts’ representing major recent changes in Latin American innovation systems. We wrap up – in Section 3 – with a brief discussion of a few major policy issues which, in
our opinion, Latin American countries need urgently to address if they are to attain a better long term innovation and productivity growth performance, allowing for a gradual reduction of the income and productivity gap they presently exhibit vis à vis developed countries.

2. **Technological behavior during the years of ‘inward-oriented’ industrialization.**

In previous papers of mine I have examined some of the more salient features of the production organization model of the ISI period (Katz, 1987, 1997). I will therefore not spend much time here discussing that part of the story. Instead, I shall concentrate on some of the more relevant features of the innovation system that emerged during that period, pari passu with the process of industrialization. This will permit us later on to compare with the current scenario, as far as structure and performance of the innovation system is concerned.

Let us begin by looking at aggregate R&D spending and at the structure of knowledge-generation activities during the ISI period, before examining the more general issue of the innovation ‘culture’ - centered around public R&D agencies - that emerged in the immediate Post-War years throughout Latin America.

R&D expenditure, measured as a percentage of GDP, has always been low in Latin America, particularly if we compare with OECD countries and with the economies of South-East Asia. The ISI years were by no means different in this respect. As a rule, R&D expenditure was never much more than, say, half a percentage point of GDP, even in the larger countries of the region. Public funds accounted for 80-90% of the total. Most R&D activities were conducted by public laboratories and technological institutes, in public universities and in the R&D and engineering departments of public enterprises. Nearly all of the training of human resources was also undertaken by the public sector, whether in Government-funded primary, secondary and vocational schools or in national universities. Around 20% of S&T expenditure was funded and performed in the private sector of the economy, whether by firms or private universities. Let us now look in some more detail the underlying pattern of behaviour of these different actors.

The 1940’s and 1950’s describe a period in which economic protectionism was at its height throughout the world. Following Keynesian ideas governments played a leading role as an "engine" of growth both in developed and developing countries. Latin America was by no means an exception. The region copied and assimilated – within its own idiosyncratic political climate, in which military rule was the norm rather than the exception – the new institutions associated to the Welfare State that were being erected elsewhere in the world. Accordingly, the public sector undertook responsibility for establishing R&D institutes and laboratories, supplying them with equipment, human capital and research budgets, as much as it took responsibility for building up hospitals or telephone companies. As mentioned before, the armed forces played a significant role in many Latin American countries at that point in time strongly influencing the technological strategy followed by these countries during and at the end of World-War II. This was specially so in Argentina and Brazil, where atomic energy research (Argentina) and aeronautics research (Brazil) was carried out in the
R&D department of public firms closely connected with each country’s army and geopolitical strategy of the time.

Many State-owned companies found it necessary to create their own technical and R&D departments adequately to fulfill their role. These engineering departments played a vital part in designing, maintaining and upgrading new production facilities run by the public sector. Examples of this can be found in large State-owned oil companies (YPF, Pemex, Petrobras), in the Iron and Steel sector (Usiminas in Brazil, Somisa in Argentina, Lázaro Cárdenas in Mexico), in Petrochemicals, Aluminum and so forth.

As a result of the above, and within a short period of time, a large number of public R&D centers emerged, constituting the back bone of the National Innovation System of the time. This is where the bulk of S&T efforts were carried out, and where human capital was trained during the war and immediate post-war years.

Together with the above a large number of public development banks were created (BANADE, BNDE, NAFINSA, CORFO, etc.) taking responsibility for the funding of large-scale investment projects. These agencies also acted as technological focal points for the importation, generation and adaptation of ‘blue-prints and engineering know how in various spheres of economic activity, including the production of capital goods and machinery. Thus, it was the State which, in conjunction with public banks and development agencies, designed and brought ‘on stream’ large-scale production facilities which were then operated as public-sector enterprises or transferred to the private sector of the economy once the initial risks related to engineering design and start up had been absorbed by the State.

Numerous studies document the important technological role the public sector played during those years creating the scientific and technological infrastructure, training human resources, and designing and financing large-scale production facilities in different areas of the economy. Far from telling a story of failure, many of these studies show that a large number of these projects resulted in successful technological and production programs and in major forms of technological modernization. Domestic technological capabilities improved quite significantly as a result of these efforts.

We also find a similar success story when we look at the performance of State-run institutes related to the agricultural sector of the economy (INTA in Argentina, EMBRAPA in Brazil, INIA in Chile, etc.), which did a great deal to induce technological change in the rural sector, designing and testing agricultural equipment, providing free agricultural extension services, etc. (E. Obstchatko, 1996; ECLAC, 1998).

Pari pasu with the above a massive arrival of foreign companies obtained, as from the mid-1950’s onwards. Such arrival also exerted a major impact upon the nature and functioning of local innovation systems. Most of these firms brought with them new product designs, new process technologies and organizational routines that were often unknown in the domestic environment. Local engineering capabilities changed quite significantly as a result of their arrival.

The great majority of these firms did not come to the region with the idea of developing a local technological infrastructure, but many of them found that they actually needed one in order to operate in a highly idiosyncratic production and institutional environment. Given the firm-specific nature of much industrial technology,
many of these enterprises had to ‘adapt’ to local conditions production routines and organizational know how that was originally created in their headquarters to be utilized in a very different physical and human environment. As a result of that many of these firms found it necessary to create "localized" engineering departments and supplier development programs that were geared to the needs, operational scale and organizational ‘culture’ of the time. This was especially so in the case in Argentina, Brazil and Mexico and, to a lesser extent, in Colombia, Chile or Peru. The impact of transnational corporations in this respect was quite significant, and their engineering departments became an important part of the incremental flow of technological knowledge flowing throughout the local production fabric during the ISI years. Many of these firms acted as training ground for hundreds of local engineers and technicians. R&D expenditure was not necessarily high but significant engineering efforts were undertaken as part of the daily routine. The exposure of their technical and professional staff to the technological and business "culture" of their respective headquarters had a major impact upon the local production organization environment.

Their technological efforts were generally aimed at "adapting" product designs, process technologies, organizational routines to local conditions. They were also aimed at making use of domestically-available raw materials. The idea was therefore not so much to create products or processes that were 'new' world-wide but rather to "adapt" to the local conditions production knowledge brought from their respective corporate headquarters. Their technological efforts could therefore be regarded as "minor", although on more than a few occasions they demanded the utilization of experimental facilities, i.e. pilot plants, prototypes, etc. and involved a significant amount of new knowledge creation within the firm. As a result of these efforts many subsidiaries of transnational corporations behaved as national ‘focal points’ for the diffusion of technology in the domestic environment setting up the local quality control and efficiency standards thereafter copied by domestic firms. (Katz, 1987). In quite a few instances these local engineering efforts played a valuable role in the gradual expansion of exports to other Latin American markets and in the transfer of engineering services within the corporation. (Katz and Ablin, 1978; Gatto, et al., 1977).

Family-owned SMEs constituted a third and quite distinct segment of national innovation systems. SMEs account for 80% or more of the total number of firms in the economy in the typical Latin American scenario. Their economic and technological behaviour is not, therefore, marginal to the overall picture. As far as innovation and knowledge-generation activities are concerned local SMEs belong in a quite distinct category, which we now examine.

A large number of locally-owned SMEs were created in Latin America during the 1940’s and 1950’s under the stimulus of high tariff protection and subsidized government financing. Many of these firms engaged themselves in the production of foodstuffs, textiles, garment, footwear, machine tools, furniture, farm machinery, etc. for domestic consumption

Even though many of these firms often started out as repair shops with an ad hoc plant layout, second-hand machinery, and scarce production organization know how, it is to be noted that many of them grew quite rapidly during the 1950’s and 1960’s
catering for the internal market. They also managed to put together their own technical and engineering departments, developing new products and production processes, training their labour force and making significant progress along a highly idiosyncratic long-term learning path. Unlike the subsidiaries of foreign corporations which we examined before, local SMEs were forced to develop their new products and process technologies from scratch, without much external collaboration. They normally copied old product designs on the basis of the owner's technical expertise. Production processes were ad hoc and based on second hand machinery. Many of these firms were erected by former immigrants that brought with them basic forms of engineering training from their respective home countries. It can therefore be assumed that the development of domestic technological capabilities in this part of the domestic production fabric was more of the 'learning-by-doing' type, and involved a greater degree of self-organization than in the previously examined cases of public enterprises and of local subsidiaries of transnational corporations. SMEs opened up and developed many previously non-existing industries substituting imports which could not be obtained in international markets as a result of the war and of the disruption of normal trade flows. For such purpose they often started by copying products that were previously imported and which normally were several years behind the international technological frontier (Katz, 1987).

The available empirical evidence indicates that it was well after their original start-up – one or even two decades after – that many of these firms ventured into the development of new process technologies or introduced new organizational practices. This frequently happened when new production facilities were erected, once the company was already well established in the local environment and its size came to be augmented. Under the conditions of excess demand and lack of imported substitutes that prevailed during the 1950's their prime objective was that of producing local versions of previously imported commodities, paying little attention to questions of quality, production efficiency or costs. As local markets were not contested by foreign firms, local companies lived for a rather long time in "seller's markets" where long waiting lists prevailed and consumers had little bargaining power. Under such circumstances it is not hard to understand why family enterprises focused first on copying foreign product designs, paying much less attention to process technologies or production organization routines.

Latin American SMEs were not particularly interested in expanding exports either. It was not until the mid-1960's that domestic markets returned to normality and imported substitutes began to appear. It is as a result of the above local technological efforts begun to be performed in order to develop more sophisticated product designs and to introduce better production organization routines. It was then that firms began to pay more attention to production planning as well as to the strengthening of their process engineering capabilities. It is important to understand that manufacturing exports of an increasing degree of technological sophistication, as well as exports of 'pure' technology under the form of 'complete' plants delivered on a 'turn-key' basis in third countries of the region emerged during those years – particularly in the case of SMEs from Argentina, Brazil and Mexico. (Ablin and Katz, 1984; Dahlman and Cortes, 1984; Sercovich, 1984, etc.) indicating that local learning capabilities were growing
rapidly. Bolivia, Cuba, Central American countries, a few African countries and Spain, appear on the receiving end of these increasingly sophisticated exports.

Our previous discussion can now be summarized as follows: a. R&D and engineering efforts were low in Latin America during the ‘inward-oriented’ industrialization period, never much more than half of a percentage point of GDP, i.e. a fraction of what such efforts were in more developed industrial countries or in the south-east Asian economies; b. Close to 80% of said efforts were financed and carried out by public sector enterprises, producing telecommunication, transport, energy and water sanitation services as well as by public sector agencies concerned with agriculture, nuclear energy, mining, aeronautics, and so forth; c. Together with the above, but on a much smaller scale, the national innovation systems of the time also exhibits the participation of the engineering departments of local subsidiaries of transnational corporations as well as of many small family-owned SMEs.

High tariff protection, excess domestic demand and waiting lists in most industrial markets militated against an export orientation from the part of local firms. Latin American firms grew accustomed to operate in “seller’s markets” in which no strong incentives prevailed inducing them to attempt far-reaching innovative efforts.

All of the above probably explains why the national innovation system Latin American countries developed during the ‘inward-oriented’ process of industrialization was not strong enough, or sufficiently motivated, to search for ‘world-class’ new technologies. As A.Amsedm puts it in her recent book on ‘The rise of the Rest’ (Amsedm 2001), “‘Late industrialization’ was a case of pure learning, meaning a total initial dependence on other countries’ commercialized technology to establish modern industries...without (involving) proprietary innovations”. And further adds: “This dependence lent catching up its distinctive norms”. It should be noticed, though, that in many countries of the region, a skilled man-power base and a technological infrastructure gradually developed pari passu with the above mentioned process of inward-oriented industrialization. Such a skill base and technological infrastructure – part of what M.Abramovitz calls ‘social capabilities’ – played a paramount role as a ‘source’ of productivity growth in those early phases of inward-oriented industrialization. It continued to play an important role in more recent times when countries opened up to external competition and had to evolve to a new industrial organization regime, more respectful of market-oriented principles. The available evidence indicates that firms with a larger and more mature stock of ‘core technological capabilities’ (Nelson, 1991) have managed better to adapt themselves to the complexities of the new competitive environment, successfully re-structuring their production organization routines under the pressure of a more open and de-regulated market environment. Although part of the ‘old’ technological infrastructure was probably already obsolete and had to be overhauled, it is nonetheless true that mechanical engineering skills and production organization capabilities are extremely malleable forms of ‘social capital’ capable of being redeployed in very different areas of economic activity.

Having looked at the structure and performance of local innovation systems in the early years of the ‘inward-oriented’ industrialization process let us now turn to the
examination of how such system has been changing in recent times as a result of market-oriented structural reforms cum globalization trends.

3. **The recent transformation of Latin American innovation systems. A brief review of major ‘stylized’ facts.**

Structural reforms, on the one hand, and the rapid process of globalization affecting the world economy during the 1990’s, on the other, are significantly changing the structure and behaviour of Latin American innovation systems. In this section we briefly summarize some of the major changes identified by various recent country studies undertaken in the region on this subject. (Cimoli and Katz, 2003; Aboites and Dutrenit, 2003; etc). The list of ‘stylized’ facts that follows is of a ‘generic’ nature. The studies undertaken in Argentina, Brazil, Chile, Colombia and Mexico illuminate the ‘localized’ and highly idiosyncratic nature of each country’s situation as far as the following ‘generic’ issues is concerned.

1. Tariff protection on imported capital goods has been sharply reduced. Less expensive and more easily accessible pieces of machinery and equipment have become available facilitating their substitution for locally-produced capital goods, as well as for engineering manpower and unskilled labor.

1. ‘In house’ R&D efforts and engineering activities have been reduced by many firm in recent years. This has been the case in most of the privatized companies producing telecommunication, energy, transport and water sanitation services which now operate on the basis of technology and engineering services brought from their respective headquarters and capital goods supplied by their international suppliers. It is also the case of domestic subsidiaries of large MNCs which have now ‘de-verticalized’ their production organization routines becoming part of Internationally Integrated Production Systems (IIPS) coordinated by their respective headquarters. Many of them now assemble vehicles, computers, videocassette recorders and many other consumer durable on the basis of parts and components which they import from all over the world. As in the case of privatized public utilities these firms have significantly reduced their domestic R&D and engineering efforts and now operate ‘on line’ with other firms in the system producing a wide variety of products which have themselves become highly standardized commodities.

2. New computer-based production technologies are rapidly diffusing in the economy making ‘real-time’ production organization a growing feature of the local production environment, at least among domestic subsidiaries of transnational corporations and large local conglomerates. Such a transition demanded a rapid professionalization of management staff as well as the absorption of international quality control norms and standards. A significant proportion of large domestic companies are now familiar with the use of SCM (supply chain management) and CRM (customer relationship management) production organization routines. A small but rapidly expanding area of e-commerce and e-government activities appears as a salient feature of the
current situation in countries such as Brazil, Chile, Argentina, Costa Rica, Mexico, Colombia or Uruguay. (Hilbert and Katz, 2003).

3. The above mentioned transition to computer-based production organization routines has not so far been successfully undertaken by the large majority of family-owned SMEs. A mixture of lack of ‘initial entitlements’ – i.e. technological capabilities to undertake the required transition to digitized technologies - access to long term financing, and insufficient supply of ‘public goods’ in the economy – such as, for example, industrial ‘extensionism’ of the sort supplied by the Small Business Administration in the US - seem to be the major explanation of this major structural weakness.

4. The privatization of State-owned public companies resulted in a significant upgrading and modernization of telecommunications, water and sanitation, energy and transport services. Such process of modernization derived in a significant reduction of the technological gap Latin American countries exhibited in the above mentioned fields vis a vis more mature industrial societies. Although such reduction is also acting as a ‘systemic’ growth force, facilitating productivity improvements in many other areas of the economy, it is somewhat paradoxical that it has been obtained at the cost of a much smaller utilization of locally-available technological capabilities, as the new owners – themselves public companies from more developed industrial countries – have opted for reorganizing their local operation on the basis of technology and engineering services brought from their respective headquarters or from international subcontractors.

5. Firms have become less vertically integrated, cutting down on the number of parts and components they manufacture internally and outsourcing abroad production services and intermediate inputs. As a result of these changes domestic production chains have become much ‘thinner’ – less ‘locally-rooted’ – than before. Many local suppliers of parts and components –mostly family-owned SMEs – have been substituted by foreign firms.(Katz, 2001 and 2002).

6. Public R&D institutes and laboratories have been subject to a major change in incentive regime as their access to public funding has been considerably reduced. As a result of the above many of them have significantly changed in structure and performance. Many public sector R&D institutes and laboratories have been forced to search for funding in the private sector of the economy for as much as two thirds of their operating budget. In many cases their response to such change in public policy has been to downgrade their research efforts, concentrating on metrology, quality control routines and other standardized technical services to production, more easy to be sold to private firms in the economy.

7. In various countries of the region governments have turned to demand-side subsidies for the allocation of R&D funds. Major public universities in the region have now been transformed in quasi-private organizations charging
tuition fees to their students much in the way private universities have always
done.

8. Intellectual property rights have been significantly increased extending
patentability to fields such as pharmaceuticals, computer software,
microorganisms, etc. and gradually incorporating WTO disciplines.

9. The private sector is rapidly gaining participation in human capital creation
expanding its role in secondary and tertiary education, as well as in the
 provision of training services to the labor force. It can not be said, however,
that it has equally so expanded its commitment to R&D activities, which
continue mostly to be carried out by the public sector and on the basis of
public funding.

From the above list of ‘stylized facts’ – obviously incomplete, but useful for a first
‘appreciative’ identification of recent changes in the structure and performance of Latin
American innovation systems – we can derive a few general propositions:

a. Latin American National Innovation Systems are gradually loosing some of
the deeply-rooted features they acquired during the ‘inward-oriented’ period
of industrialization. On the one hand, they are becoming much more
‘externally-conditioned’ than in the past, as imports of capital goods, foreign
licensing and ‘on line’ overseas technical assistance acquired a more
fundamental role in the ‘new’ production organization environment.
Technology is now more ‘embodied’ in imported capital goods than in the
past. ‘Adaptive’ domestic engineering efforts of the ‘learning by doing’ type
have now become less significant in the economy.

b. In addition to the above, national innovation systems are also loosing part of
their original format as a new incentive regime based on public tenders,
demand subsidies and ‘internal’ market principles is gradually being adopted
by public sector R&D labs and knowledge-generation organizations and as
private sector efforts in secondary and tertiary education become more
significant.

c. Market forces have induced the re-structuring of Latin American economies
in the direction of ‘static’ comparative advantages, i.e. sectors making use of
unskilled labour and natural resources, and against ‘knowledge-intensive’
activities involving the use of domestic engineering capabilities and more
basic R&D efforts. In fact, Latin American countries appear as increasingly
specialized in low domestic value added commodities, having now become
‘price takers’ in extremely competitive international markets for products such
as pulp and paper, fishmeal, vegetable oil, steel, aluminum, etc. Their
external sector presents a major long term fragility as a result of the above
and of the low demanded elasticity such commodities exhibit in world
markets. Contrarily, they have become avid importers of engineering-intensive
capital goods and machinery.

d. Very little of the ‘public-good’ nature of technology and of the need for a
‘national strategy’ in the field of knowledge-generation and know-how
dissemination activities normally to be found in more mature industrial
societies has actually permeated to Latin American government spheres. Orthodox policy making still regards technology as a pure private matter and the macro ‘fundamentals’ of the economy as the only set of forces government should be involved with. There is very little debate in the region as to the complex institutional fabric underlying knowledge-generation and technological diffusion activities.

We now close the present paper with a short policy discussion related to innovation and productivity growth. We shall not spent much time on equilibrium macro ‘fundamentals’. We regard them as a necessary, but not as a sufficient condition, for an adequate global performance of the economy, particularly when we come to productivity growth and innovation. Instead, we shall examine three topics in which we think both horizontal and selective policy interventions are required in the years ahead if Latin American countries are to enhance their long term productivity growth performance and their international competitiveness. It should be noted that there are no universal recipies in this field and that what works and does not work in any given country or region will closely depend upon such country’s or region’s institutional framework and prior accumulated ‘technological absorption capabilities’.
4. A BRIEF LOOK INTO POLICY ISSUES.

Market oriented structural reforms have not succeeded in making Latin American countries grow faster, neither have they done so in inducing a faster rate of productivity growth and innovation. In our view such failure derives from the fact that markets do not perform well when inadequate initial technological capabilities, lack of ‘public goods’, uncertainty and asymmetries of information play a major role, inducing a less than optimal commitment from the part of firms and individuals. It is quite clear that technology-generation and diffusion activities belong in such sphere. Given the above we argue here that market forces need to be complemented with active government intervention if countries are to improve on their long term productivity growth and innovative performance. Selectivity and a certain amount of ‘hands-on’ from the part of government have to be accepted in a pragmatic way - as they clearly are in the policy environment of more developed industrial countries – if Latin America is to make headway in the right direction in the years to come.

This being so, we consider now: 1. Size and nature of domestic R&D spending and technology-generation efforts; 2. The role of MNCs within national production activities and innovation systems; and 3. The incentive regime under which local R&D and technology-generation efforts are performed. To a brief discussion of these three topics we now turn. (Cimoli and Katz, 2003).

4.1. R&D expenditure and national (sectoral) ‘technological regimes’.

Our previous discussion brings to light the fact that Latin American technology generation and dissemination efforts have always been small by international standards. They continue to be so today. Government officials and local entrepreneurs seem to believe that countries can do without a stronger commitment to domestic knowledge generation and diffusion activities and that markets can adequately handle questions of access to technology and know-how. Technology is regarded as an input that can easily be obtained from abroad when needed would be and therefore local resources should not be used in funding a domestic S&T infrastructure.

And yet, we know that there are many reasons on account of which this is a highly ‘miopic’ way of looking at what growth is all about, and at how production organization actually works. Many years ago K.Polanyi argued that ‘technology’ is partly ‘codified’ and partly ‘tacit’. More recently W.Baumol et al made the same point by saying that: “technology is partly in books and mind, partly in the fingers and organization. The information part is largely a ‘public good’ for those with the requisite training and experience. But the later part involves significant firm-specific investment and learning.” (W.Baumol, 2001). Similarly, M. Abramovitz has argued many years ago that the growth of nations is strongly related to their ‘technological absorption capabilities’. As a factor of production ‘technology’ is, indeed, far from being an ordinary ‘commodity’ which can be easily purchased ready made from abroad. Local adaptation efforts, trial and error and ‘in house’ R&D activities are needed. There are ‘tacit’ components to ‘know-how’, as well as ‘local-specificities’ of natural resources and of production organization routines that make it next to impossible to operate exclusively on the basis of imported product designs and pieces of machinery.
Furthermore, in many areas of the economy – health, education, environmental protection, – no country in the world can operate on the basis of imported know how. Local solutions need to be found to local problems and there seems to be no alternative but to carry out ‘in situ’ R&D efforts if we are adequately to deal with domestic needs. This is certainly true when we consider the sustainable exploitation of natural resources – fisheries, forestry, mining – an area to which many countries in the region have now become heavily specialized. A new technological frontier seems to be opening up in many of these fields as a result of recent advances in molecular biology, genetics, immunology, mineralogy, etc. and there is urgent need to undertake local scientific and technological efforts in many of these fields if we are to exploit local resources in a sustainable manner in the years to come.

The development of domestic technological capabilities in the above mentioned fields demands not only a major increase in local R&D spending but also a new set of institutions strengthening domestic educational systems, intellectual property rights, and the links between firms, universities and government agencies. Technological parks, incubators and other forms of collaboration between public sector R&D labs, universities and firms should be explored. In most Latin American countries lack of ‘initial technological absorption capabilities, constitutes a salient feature of the present situation, particularly so among many small and medium size family enterprises. This calls for major efforts in the re-training and upgrading of new generations of local entrepreneurs. Technological ‘extensionism’ as well as different incentives such as the granting of patents, fiscal subsidies, leasing of public funds in open, competitive, tenders for technology-intensive ‘start-ups’ etc. have to be tried out in support of knowledge-generation and diffusion activities as well as in support of knowledge-intensive start-ups. The general idea is gradually to induce domestic firms into technological ‘deepening’ efforts accepting that innovative quasi-rents are a sine qua non condition for technology-generation efforts and for innovations capable of enhancing international competitiveness. The international experience does not tell us otherwise.

4.2. Foreign firms, local technological capabilities and dynamic comparative advantages.

Many transnational corporations have recently reorganized themselves as internationally integrated production systems (IIPS). As part of this process, they have phased out local production of parts and components, outsourcing them from external sources. They have thus globally gained in economies of scale. At the same time the products they produce have gradually become ‘world-class’ commodities. The above has been facilitated by recent trade liberalization measures, as well as by the diffusion of computer-based technologies, which increased the feasibility of real-time production planning and organization. As a result, many domestic subsidiaries of multinational corporations are more in the nature of ‘enclaves’ today than what they were in the past. One of the consequences of the above transformation in production organization is that many of them now carry out less domestic R&D and engineering efforts than what they did in the past, during the ‘inward-oriented’ industrialization period, when they operated full-fledged manufacturing facilities. In a certain sense we could say that the current model of production organization involves their ‘de-linking’
from the local production structure and innovation system. (Cimoli and Di Maio, 2003). MNCs are now able to capture the advantages of specialization and economies of scale through intra-company trade, but (from the national point of view) at the expense of a ‘thinner’ and less sophisticated commitment with the local production structure and innovation system.

Such phenomena opens up a major new policy dilemma for Latin America governments. Maquila-type operations (assembly of ‘in-bond’ parts and components) provide for a rapid expansion of exports, but do not provide for a similarly rapid expansion of domestic productivity, neither for a significant expansion of domestic technological capabilities. Low domestic wages are the main and almost exclusive reason for the existence of maquila-type operations. As real wages increase they tend to move away toward less advanced environments. How to proceed in order to induce foreign subsidiaries to become more ‘rooted’ in the local production and innovation environment appears as a major question of the current policy agenda. In the new WTO world governments can not impose higher domestic content requirements to foreign firms, as they did in the past. The same is true as far as local R&D and engineering efforts and the creation of domestic technological capabilities are concerned. How to handle such a dilemma and benefit further from the local operation of large MNCs and from their global access to markets, but coaching them to play a stronger role in the ‘construction’ of a more sophisticated production fabric and innovation system appears as a major question demanding creative new ideas from the part of governments. How to lure foreign companies into new forms of partnership with domestic SMEs. How to induce them to make use of their local production platform as the basis for the production and ‘world-wide’ marketing of ‘world-class’ new products?. Which quid pro quo could be bargained, with whom and for what, needs to be explored in the years ahead. The recent Costa Rican experience with Intel, as well as ongoing Chilean negotiations in Palo Alto in relation to the software industry, or of Argentina’s dealings with Motorola in the Cordoba region as well as Brazil’s recent experience with VW, Fiat and General Motors (but not with Ford) in connection with the selection of the local subsidiary as a ‘center of competence’ for particular technologies and/or products to be produced for world wide marketing (R. Quadros and S. Quieroz, 2001), suggest that actions of this sort could be successfully attempted in the future. Imagination, trial and error and a large doses of heterodoxy seem to be needed, though, as all of the above is way off from conventional market principles.

4.3. A new incentive regime underlying the functioning of local innovation activities.

Latin American innovation systems seem to be currently loosing some of the idiosyncratic nature they acquired during the ‘inward-oriented’ period of industrialization. They are also loosing part of their strong original Public Sector imprint. On the other hand, an pari pasu with the above, the incentive regime underlying the functioning of public R&D agencies is changing quite significantly. Public R&D organizations are becoming more autonomous and de-centralized from the central government and increasingly able to handle their own research budgets, recruitment programs and human capital upgrading efforts, together with the introduction of performance-related pay systems. ‘Internal’ markets and more competitive rules for the allocation of R&D funds are becoming more common today in
the region, pari pasu with an increasing use of ‘demand subsidies’. On the other hand, public R&D agencies are increasingly involved in selling technology and engineering services to the private sector in the economy, searching for extra-budgetary resources. All of the above is strongly affecting the behaviour of public S&T organizations and their role in the economy. A more explicit public sector strategy in this field, signaling country-wide priorities, allowing for private patenting of research results attained with public funding (like in the case of the 1984 Bayh-Dole Act in the United States), allocating funds in competitive tenders for the opening up of new fields of exploration responding to national priorities, might be use in order to strengthen knowledge generation and diffusion activities.

In conclusion, more and better-oriented public R&D efforts and their coordination with the private sector of the economy, new patterns of negotiation with multinational corporations in relation to their ‘re-linking’ with the domestic production structure and innovation system and the design and implementation of a new incentive regime in order to turn public R&D organizations more competitive in domestic and international technology markets can be identified as major policy topics in which Latin American governments should probably engage themselves in the near future if they want to induce Latin American innovation systems to play a more dynamic role in support of productivity growth and a better pattern of insertion in world markets.

**Bibliography:**


