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Science and technology policies in open economies: The case of Latin America and the Caribbean

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CEPAL

Promotion of Productive Development Project, Regional Program on Modernization of the State, Public Administration, and Local and Regional Economic Development, ECLAC-GTZ

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Santiago de Chile, October 2005

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This document has been prepared as part of the Promotion of Productive Development Project, Regional Program on Modernization of the State, Public Administration, and Local and Regional Economic Development, ECLAC-GTZ.

A first draft of this paper has been presented at the First Meeting of Ministers and High Authorities on Science and Technology (CIDI), Lima, Peru, November 11th and 12th, 2004.

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United Nations Publication
ISSN printed version: 1020-5179
ISSN online version: 1680-8754

ISBN: 92-1-121563-8
LC/L.2404-P
Sales No.: E.05.II.G.151

Printed in United Nations, Santiago, Chile

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Abstract

Technical change and economic development are unequivocally related. But it still is a matter of debate how to close this loop and, even more, how to design proper policies to stimulate knowledge accumulation and diffusion.

Evolutionarists and institutionalists demonstrate —to paraphrase Richard Nelson— that a network of formal and informal threads, embodied in what is called the National Innovation System, links the transformation of industrial structure, the accumulation of technological capabilities and the evolution of innovation policies (Cimoli and Dosi, 1995).

Taking an evolutionary perspective, the focus of this paper is on technology policy in Latin America and the Caribbean. Two main issues are addressed. The first is to identify changes in the industrial structure, institutions and technology policies in the context of open economies. The second is to analyze market and non-market mechanisms, and supply-side and demand-side incentives responsible, for technical change and innovation, in order to identify technology policy opportunities for the region.

The paper ends calling for pragmatism and coordination in technology policy. The need to go beyond a linear logic in innovation policy models the importance of recognizing the complex nature of knowledge and the "*quasi* club good" character it assumes in open economies and the crucial role of institutional building and restructuring are the three key pillars of this reality tailored model of technology policy. Actually, effectiveness of technology policies largely depends on the co-ordination and the co-evolution of its objectives, strategies and instruments with the transformation of production and organizational structures.

Introduction

Technical change and economic development are unequivocally related. But it still is a matter of debate how to close this loop and, even more, how to design proper policies to stimulate knowledge accumulation and diffusion. For example, it is quite intuitive that improvements in the efficiency of production techniques or in product performances are a binding precondition for growth in per capita income and consumption. But, for instance, there is no consensus on the extent to which modernization of production technologies is sufficient to create and diffuse endogenously knowledge nor on the extent to which free markets foster technological catch up and exploration of novel innovative opportunities and even less on the room for active public policies to improve technological capabilities. Evolutionary economics offers an interesting non-orthodox perspective to deal with these issues. Evolutionarists or institutionalists demonstrate —to paraphrase Richard Nelson— that a network of formal and informal threads, embodied in what is called the National Innovation System, links the evolution of industrial structure, the accumulation of technological capabilities and innovation policies (Cimoli and Dosi, 1995).

Taking an evolutionary perspective, the focus of this paper is on technology policy in Latin America and the Caribbean. The first section presents a panorama of the evolution of regional specialization patterns, focusing on technological intensity, modernization processes and changes in ownership. The second section focuses on the evolution of technology policy models, stressing the transition from a linear supply-side scheme to a linear-demand scheme. Policy instruments, with a special attention to technology funds, resources dedicated to S&T and a taxonomy of Intellectual Property regimes in the region are presented. The third section calls for pragmatism and coordination in technology policy design and implementation. In this respect three key spots are identified: the need to go beyond the "linear logic" in designing incentive schemes, the importance of recognizing that knowledge in many cases behaves like a "club good", and hence proper mechanisms are needed to guarantee access to it, and the crucial role of institutional capabilities in the process of technological change and catch up.

Section fourth concludes, presenting a co-evolutionary policy model, where the evolution of technology policy is synchronized with the transformation of the production structure.

I. Industrial structure and technological incentives

1. Patterns of specialization and technological intensity

During the last decade economic liberalization and increased participation in international trade modified production incentives and specialization patterns in Latin America and the Caribbean. Two different specialization patterns emerged in the post-reform period, the one based on natural resources, basically in the Southern Cone, and the other on labor-intensive activities, especially in Central America and the Caribbean. But, beyond sub-regional differences, there are commonalities among Latin American and Caribbean countries: the scant pervasiveness and diffusion of knowledge and intangibles in regional production systems. In the present context of open economies regional countries are persistently specialized in low technology intensive industries or production stages (ECLAC, 2004).

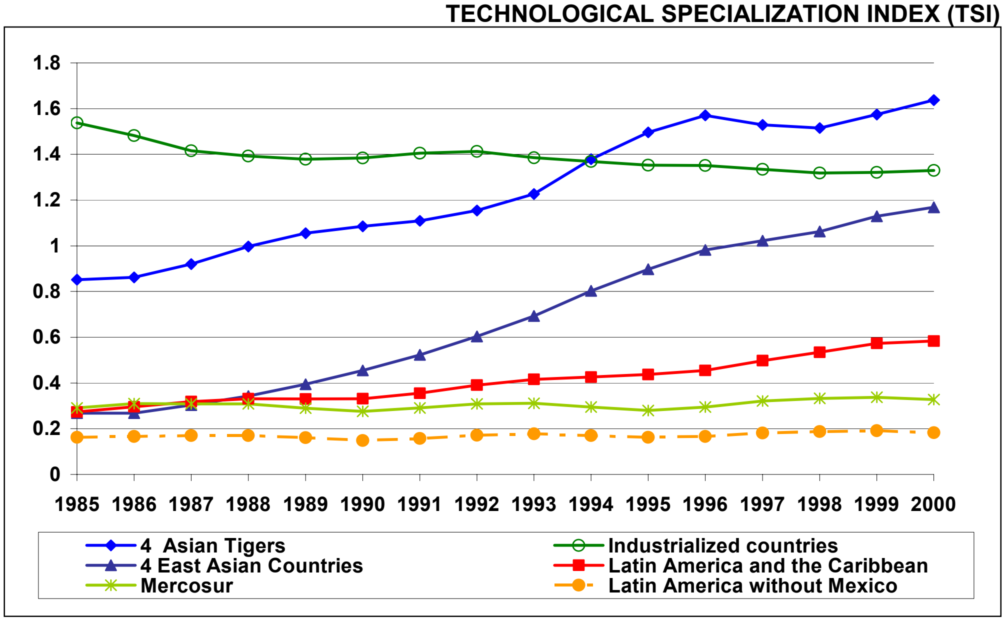
The opening up process and consequent growing exposure to external competition induced some Latin American and Caribbean countries to further specialize their production structures according to static comparative advantages. Argentina and Chile, for example, reoriented production structures towards raw materials and natural resources processing activities, while Mexico and many Central American countries moved towards *maquila* type industries.

These changes in the regional specialization patterns favored the generation of an industrial structure that, *"per se"*, limited endogenous technological capabilities and expresses a scant demand for knowledge, thus implicitly limiting the potential positive stimuli effect towards technological catch up of liberalization and increased competition. In contrast, the Asian economies like Korea and Taiwan, followed by Malaysia, Thailand and Indonesia, were successful in entering and expanding technology intensive industries or production stages, combining selective import substitution policies with aggressive, but gradual, export oriented strategies (Amsden, 1989; Jomo, K. S. 1997; Wade, 1990).

Figure 1 shows these different specialization patterns, through a proxy of technological dynamism with respect to world trends of different geographical areas, i.e. the technological specialization index –TSI. The TSI is obtained by dividing the market share of technology intensive exports (of a given area) by the market share of low technology exports. Thus the index increases as an area evolves towards more technology intensive exports. Figure 1 shows that Asian economies experienced a monotonically increasing value of the TSI since 1985. Latin America and the Caribbean, however, register only a modest increment in the index value. Furthermore, excluding Mexico, the pattern of the Latin American TSI turns out to be a flat curve. When looking at the technological intensity of Mexican exports it is to b noted that, actually, most of these exports derive from *maquila* operations where it is known that, until recently, activities are mostly of assembly nature, without significant local innovation and linkage effects (Capdevielle, 2004). Thus, the persistent technological gap of Latin American exports with respect to industrialized and Asian economies, and the fact that domestic knowledge content of regional exports did not remarkably increase, depict a problematic scenario for the region (Reinhardt and Peres, 2000; Mortimore and Peres, 2001).

Figure 1

TECHNOLOGICAL SPECIALIZATION INDEX (TSI)



Source: based on Alcorta and Peres (1997).

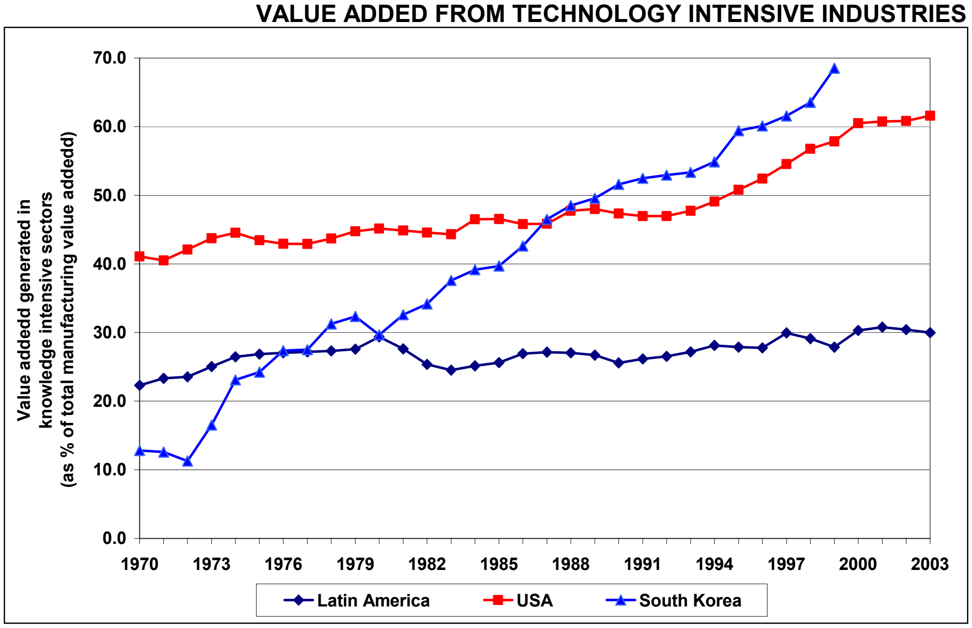
Note:

$$TSI_i = \frac{MS_i^H}{MS_i^L} \qquad MS_i^H = \frac{\sum_{j \in H} X_{ij}}{\sum_{j \in H} X_j} \qquad MS_i^L = \frac{\sum_{j \in L} X_{ij}}{\sum_{j \in L} X_j}$$

Where MS stands for market share, H for high technology intensive, L for low technology intensive. and X_{ij} stands exports of i country in the j product group to the rest of the world, while X_i is total export in the j products group to the rest of the world.

It is worth mentioning that TSI only measures the degree of technological specialization of exports, but in the long run it is reasonable to assume that the technological expertise and capacities of a country will be embodied in its exports. Hence, the index could be regarded as a good proxy for the technological intensity of the whole production structure as well. Indeed, the analysis of the structural composition of manufacturing value added according to technological intensity leads to similar conclusions. Actually, figure 2 shows the asymmetry in the dynamism of the share of technology intensive industries in total manufacturing value added between Latin America, United States and South Korea. In Latin America during the 1970s an improvement can be observed but since 1982 scarcely any change can be noted. The opening up process favored the modernization of regional production structure and the reorientation of regional specialization patterns, but technological intensive activities still represent only around 30% of total manufacturing value added, approximately 60% of which is due to transport equipment industry. On the contrary, South Korea managed to catch up and even forge ahead. During the nineties both in USA and South Korea more than 60% of manufacturing value added was generated in technology intensive industries.

Figure 2
VALUE ADDED FROM TECHNOLOGY INTENSIVE INDUSTRIES



Source: UN-ECLAC PADI and OECD STAN databases, own elaboration.

2. Ownership, network hierarchies and modernization

In open economies, agents face worldwide opportunities and constraints. Globalization modifies economic agents' incentive schemes, widening up the potential spatial domain of economic decisions. Actually, in open economies, domestic and foreign companies do not merely act on the basis of the logic defined by a given national boundary.

In fact, the recent reorganization of international production chains and the last upswing of international mergers and acquisitions during the nineties led to relevant changes in the ownership landscape of the region. That is, foreign firms, already dominant in many economic sectors, especially in durable and capital goods, expanded their presence towards other economic sectors (Mendes de Paula, Ferraz and Iootty, 2002). By the turn of the decade, around 40% of the 500 largest Latin American corporations where foreign owned, compared to around 30% at the beginning of the nineties (ECLAC 2004). Structural debilities of local economies and competitive pressures originating from liberalization and structural reforms imposed a dilemma for large size, locally owned companies: either to further expand abroad or to sell or transfer ownership to foreign companies. Privatization of utilities and commodities also played a major role in reshaping ownership patterns, from a dominant role for State corporations to a leading position for North American and European companies (especially the Spanish ones) and even for new comers like recently risen Latin American companies. (Bonelli, 2000; Cantwell and Santangelo, 2003).

Regional firms that managed to integrate into international production chains positioned themselves in low technology activities, while transnational companies kept the lead of production networks, mastering the generation, promoting the diffusion and appropriating the benefits accrued from accumulation of technology and innovation. These companies control and determine the specialization pattern of Latin American owned enterprises through their outsourcing and networking strategies. In effect, regional firms participate in global production systems mainly performing at the lowest hierarchical levels, generally far away from control positions, and, in general, carrying out raw materials processing or basic assembling activities. Indeed, competitive pressures in global markets, where strong actors benefit from increasing returns led international network hierarchies' leaders, which are mainly located in developed economies, to profit from international trade outsourcing, subcontracting or re-localizing production activities according to static comparative advantages (Cimoli and Katz, 2003).

In parallel, as competitive pressures increased most firms, or those of larger size, underwent modernization processes, strongly biased towards rationalization. Rationalization included: expansion of components imports, outsourcing of non-core activities, adoption of new organizational techniques, like quality systems controls and just in time management, and the localized introduction of new equipment, especially those of microelectronics base. As mentioned above, larger and leading firms were more capable of entering modernization thus widening the efficiency gap in each sector relatively to those of smaller size. But, besides the increase in regional heterogeneity among economic agents, the rationalization of regional production processes resulted in a "truncated" modernization because the leapfrog towards effective domestic technological upgrading is still to be done. In effect, technological upgrading entails the development of endogenous capabilities through a complex, dynamic and collective trial and error process. To develop capacities of technology assimilation, reverse engineering and to build up the structural and institutional capability of mastering and adapting foreign technology could be a crucial asset for countries that want to catch up in open economies.

In a landscape dominated by foreign companies and weak scientific and technological infrastructure, most incentives are for companies to increasingly rely on foreign sources of knowledge and, what is even more important, the few results of innovation and technological upgrading in the region are not appropriated locally but tend to be transferred abroad thus hardly contributing to the development of innovative capacity of Latin American and Caribbean countries. In overall, very little was done in terms of expanding investments in R&D.

In fact, many Latin American and Caribbean research centers and laboratories of domestic enterprises were closed up during the last decade due to the change in the logic of innovation investments in open economies. In effect, controlling companies, mainly located in advanced economies, benefit from comparative advantages in technology and innovation. Keeping their control over research and development is one of their major concerns (Patel and Pavitt, 1991; Chesnais, 1995; Cimoli, 2000). Indeed, multinational companies concentrate the bulk of research and development activities in their countries of origin or, as recent tendencies suggest, in strongly dynamic economies that are specialized in highly technological intensive industries and that represent huge potential markets for technological produce, like China.

The emergence of new economic powers in the international setting, and China above all, is transforming current global patterns of technology generation and control. Multinationals outsourcing strategies are no longer merely based on existing comparative advantages of host countries. Alongside outsourcing of pure assembling activities, following the *maquiladora* pattern, multinationals are growingly expanding and internationalizing research and development activities in order to keep up with boosting demand for new technologies of emerging and dynamic future markets where adequate scientific and technological infrastructure, including the supply of qualified human resources exist. Market size and active policies also play a catalytic role in inducing firms to invest in innovation centers away from home. Hence, the current global evolving scenario presents a twofold dilemma for Latin America and the Caribbean. On the one hand rising China has the potential to wipe out the bulk of Mexican and Central America manufacturing exporting activities, i.e. the *maquila* industries (as it is currently happening), and on the other hand, the increasing tendency to outsource research and development to emerging markets may generate adverse incentives to carry out science and technology activities in the region, thus further underpinning regional backwardness in terms of technological upgrading potentialities.[1]

Albeit the establishment of research and development laboratories by multinational companies could be a risky business for host countries and considering that it does not automatically increase local innovation capacities, it could offer new sources of advantages to recipient emerging economies. If properly managed this new trend could represent a new form of “center-periphery” relationship built up on dynamic comparative advantages. Indeed, to fully grasp the benefits of this new type of knowledge-based correlation and outsourcing of headquarters localized in advanced economies and remote research centers hosted in emerging economies, host countries need effective national innovation systems that enable recipient economy to retain potential emerging benefits, to promote high level human capital formation on a continuum basis, to strategically manage intellectual property rights systems and to own capabilities of mastering physical and cultural distances with headquarters.

After more than a decade of economic liberalization, Latin America and the Caribbean came up with a simple production structure, increasingly fragmented and disarticulated in terms of local capabilities and progressively more outward linked and dependent that absorbs more and more knowledge and technology from abroad thus undermining its endogenous capacity of innovation and knowledge generation and diffusion.

Latin American integration to global trade is thus occurring on asymmetric basis. Domestic agents participate in international production processes but they are marginal actors in the globalization of scientific and technological activities. The transition from global trades to global players is still a quite distant goal for regional countries. Hence, it could be observed that the persistency of a low level of complexity of domestic production structures is the current counterweight for the increasing complexity of international production systems. The density of linkages and technological transfers, which determines the degree of complexity of the production structure and which affects competitive capacity and facility to react to exogenous shocks, depend upon specialization patterns and, in open economies, upon the positioning in global networks.

To sum up, economic liberalization imposes new challenges for development processes in the region. Among other determinants, history teaches that sustained development is based on innovation capabilities. If specialization in natural resources and labor intensive activities prevail, if local firms are placed in low value niches in international production chains, how to increase their “density” by extending and strengthening linkages to knowledge, services and products suppliers? If inward internationalization means a dominant role for foreign companies in economic activities for the years to come: how to induce them to localize innovation efforts in the region? If the

[1] In recent years hundreds of multinational companies started to look at China as a location for research and development investment. Microsoft recently set up a research center in the Chinese technological district of Haidian in Beijing, where a cluster of 40 universities, 138 technological institutes and 810000 scientist and research engineers interact. Nokia outsourced to China the development and production of software codes. Starting 2005, one thousand two hundred researchers are supposed to be at work in the recently established General Motors Shanghai research center. Laboratories and research centers set up by transnational companies in China are augmenting, in number, by 200 per year.

modernization process has been strongly biased towards rationalization, how to further advance this process by turning its directions towards process, product and organizational innovations? Actually, the full addressing to these questions is not an easy task. To pave the way for it the issues of coordination and synchronization between transformations in the structure of production and industrial and technology policies must be brought into discussion. And this is the framework within which upcoming sections will deal with technology policy and institutional mechanisms in the region.

II. Policy and institutional changes

1. From supply-side to demand-side: persistent linearity in technology policies

Alongside economic liberalization changes in technology policy formulation, design and implementation occurred in Latin America and the Caribbean, as shown in Table 1. Along the lines of structural adjustments, transformations in regional science and technology policies took place, pushing Latin America and the Caribbean toward a linear demand-side model of technology and innovation policies where the private sector is supposed to act as the main science and technology bargain hunter. (ECLAC, 2004; Cimoli and Primi, 2004). The focus on few and large endeavors is replaced by a horizontal perspective and incentive based mechanisms rather than command and control are put into practice. Nonetheless, both models persist in conceiving innovation as a linear process; the former inducing to an overlap of the concepts of innovation and information accessibility, and the latter supposing that technological dynamism is merely confined in the private and business sector domain. Policy makers and national innovation systems' agents persistently face the challenge of combining the strengths of supply-push with demand-pull initiatives in an interactive and feedback intensive process, always taking into account and departing from the constraints and opportunities imposed by the real economy.

During the import substitution phase a linear supply model of technology policy prevailed. The public sector played a major role in identifying priorities and direct intervening in S&T activities. The aim of technology policies was the expansion of local production capacity and the creation of some sort of autonomous domestic technological capability and infrastructure. Hence, technology policy was mainly oriented to the creation of S&T basic institutional infrastructure and to the promotion of human capital formation on the basis of government priorities (Bisang and Malte, 2000; Capdevielle, Casalet and Cimoli, 2000; Crespi and Katz, 2000; Tigre, Cassiolato, De Souza Szapiro, Ferraz, 2000). During the import substitution period many technology agencies were instituted, like the National Council for Scientific and Technical Research (CONICET) in Argentina in 1958; the National Council for Scientific and Technical Development (CNPq) in Brazil in 1951 and the National Council for Science and Technology (CONACYT) in Mexico in 1970.

Table 1

CHANGES IN TECHNOLOGY POLICY MODELS

Basic characteristics	Linear supply model	Linear demand model
Main perspective	Public sector as main S&T provider	Private sector as main S&T bargain hunter
Pattern of knowledge diffusion	Hierarchical	Non-hierarchical
Policy proposals	Selective and centralized supply S&T policies	Horizontal and demand boosting S&T policies
Management criteria of S&T institutions	Predominance of public sector and academies	Predominance of private sector and market mechanisms

Source: own elaboration.

Knowledge and innovation were supposed to flow from government and public institutions (supply-side) to the productive apparatus (demand-side). The theoretical background of these science and technology policies derived from the assumption that knowledge was a public good, i.e. non rival and non excludable in consumption. From this perspective, government and public agencies were natural knowledge providers. Knowledge was supposed to naturally flow and circulate among economic agents once it had been slotted in the economic system by public institutions. In other words, there was a strong belief that scientific progress would automatically turn into technological innovation.

During those years research and development activities were mainly carried out by big public enterprises operating in strategic sectors like telecommunications and transport and by public research institutes and universities working in the areas of agriculture, energy, mining, forestry and aeronautical, among others, thus manifestly following an selective industrial approach (ECLAC, 2004). According to governmental priorities Latin American countries, especially the larger ones, started to build up research institutes and commissions in strategic sectors. In Argentina the National Atomic Energy Commission (CNEA) in was set up1954, followed by the National Institute of Industrial Technology (INTI) and the National Institute of Agricultural Technology (INTA) in 1957. Both were responsible for the provision of technology services (Yoguel, 2003). Correspondingly, in Mexico the National Institute for Nuclear Research (ININ), the Electrical Research Institute (IIE), the Mexican Institute of Water Technology (IMTA) and the Mexican Petroleum Institute (IMP) were set up to promote technological innovation and development in the respective industries (Casalet, 2003; ECLAC, 2004). Consistently with a selective industrial focus, Brazil created a series of sectoral institutions. In the early fifties was established the Aerospace Technology Centre (CTA), while almost twenty years later, in 1973, was set up the Agricultural Research Enterprise (EMBRAPA). According to the predominant logic of state intervention as an engine of growth, many public enterprises established their own research centres, like ELETROBRAS' Electrical Energy Research Centre (CEPEL) and the Leopoldo Américo M. de Mello Research and Development Centre (CENPES) run by PETROBRAS (ECLAC, 2004; Pacheco, 2003).

Public funds were the major source of science and technology (S&T) financing; by then 80% of regional expenditure on S&T was financed by the State (ECLAC, 2002). In this setting the public sector and the scientific world, i.e. academies, commanded priority setting and resource allocation. Their influence went beyond orientating the expansion of research and development activities. The public sector logic of institutional management ruled the administration of S&T institutions, which were run under hierarchical, non-flexible and pyramidal managing style that made difficult, if not impossible, coping with and responding to the dynamics of private sector knowledge and technological requirements.

The linear supply model contributed to the creation of a S&T infrastructure, thus seeding into the basis for future technological upgrading. At the same time, the model was weak in coordinating different sectoral agencies leading to overlapping initiatives and consequent waste of resources (Capdevielle, Casalet and Cimoli, 2000; ECLAC, 2004; Yoguel, 2003).

The linear supply model of science and technology policy came to an end with the structural reforms and a new and different model slowly emerged. Indeed, in the first years of the structural reforms the room for science and technology policy interventions shrank. During the initial years of reforms, S&T policy was simply marginalized in the management of economic policy. Slowly a change in perspective emerged and market mechanisms became the basic reference behind priority setting and resource allocation. S&T policies became neutral and horizontal in nature thus losing their previous selective makeup.

The science and technology policy model of the nineties emphasized the role of markets incentives and of demand side in priority setting. The support for technological upgrading and private sector innovation focused on areas where market failures occurred; i.e. public policies priority was merely correcting information asymmetries between economic agents. This stance towards public policies meant placing knowledge and innovation on an equal footing with information accessibility. In effect, a conceptual linearity associated with the process of knowledge generation and technology diffusion persisted. Knowledge was supposed to follow bottom-up non-hierarchical pattern, in a setting where the key engine for innovation and knowledge generation is the autonomous initiative of the private sector expressing demands as a major technology booster (Cimoli and Primi, 2003).

Starting from the nineties, the demand for technology became the main criteria in the definition of policy priorities and allocation of resources. The faith in market mechanisms resulted in neutral and horizontal policies planned to minimize state interference with market behavior. Main concerns were favoring of technology transfers, investments in quality and efficiency and the provision of technological services following a logic of "commercialization" of knowledge and technology (ECLAC; 2004; Casalet, 2003; Jaramillo, 2003; Pacheco, 2003; Vargas Alfaro and Segura Bonilla, 2003; Yoguel, 2003).

The shift towards the linear demand model of technology policy entailed institutional and organizational changes. The reorganization of the S&T institutional architecture brought about modification of domain areas and management styles of existing institutions as well as the creation of new institutional bodies. In Argentina the restructuring of S&T institutional infrastructure led to an increase in coordination among different bodies, partly overcoming what represented a structural limit of the previous period. In Mexico the priority was the decentralization of S&T institutional management, according to the different technological and specialization patterns of various Mexican regions. In Colombia the restructuring privileged the regionalization of the S&T system and greater emphasis on cooperation between universities and enterprises in technological upgrading. In Costa Rica the reorganization of S&T institutions focused on human capital formation.

Beyond countries' peculiarities, the reorganization of institutions generally brought about: i) increments in resources and in the relevance of those S&T agencies dedicated to capture private sector demand for technology and knowledge, ii) an incipient interest towards greater articulation and coordination between private and public sector, resulting in cross-countries augmented interest in universities-enterprises connections and, iii) changes in competencies and objectives of agencies. S&T priorities shifted from basic research to the provision and commercialization of technological services, mainly oriented to support production process management and quality control. Reward systems and management styles of S&T institutions changed as well, moving towards practices that are more in line with market mechanisms and incentive schemes, privileging performance based models of evaluation and allocation of priorities. Accordingly, the role of international financial institutions as source of financing for S&T augmented.

The changes and transformations in the policy model and in corresponding institutional infrastructure engendered a radical shift in S&T priorities to information accessibility from learning dynamics. Innovation related institutions became to be regarded as "markets" for trading or exchanging information more than as part of an articulated and flexible system through which know-how, codified and non-codified knowledge embodied in routines, production processes or research results are transferred (Dosi, Sylos Labini and Orsenigo, 2004; Nelson, 2003).

After the structural reforms liberalization and increased participation to international trade became to be considered the sources of modernization. In such a context, active technology policies were to play a minor role. More than any active set of policies, imported components, capital goods and technology licensing were seen as the basic sources of technological upgrading. Indeed modernization of industries effectively happened through these channels, even though it remained circumscribed to leading and larger firms not diffusing to the remaining of the production apparatus (ECLAC, 2004). Colombia and Costa Rica are two additional, slightly different examples of the reduced autonomy of technology policy in the region. In these countries technology policies were basically linked to trade policies and especially to the export promoting strategy (ECLAC, 2004; Jaramillo, 2003; Vargas Alfaro and Segura Bonilla, 2003).

2. Policy instruments

Besides the changes in technology policies and the introduction of a new model scheme oriented to stimulate the demand for knowledge and innovation, Latin America is still a backward area in terms of technological upgrading and knowledge diffusion (ECLAC, 2004). In effect, a production structure characterized by a scant dynamism in technological innovation and intensity faces adverse stimuli for wide technological change in a context where incentives for innovation and technological upgrading are mostly mastered under demand- pull mechanisms.

In general, National Science and Technology Councils, Agencies and Programs foster and sustain research and development priorities and science and technology activities in Latin America and the Caribbean. However, there are considerable differences among countries in terms of origins of funds, magnitude of administered budgets, objectives and horizontality or selectivity of priorities. Each country establishes its own science and technology policy, which is more or less formalized and contextualized according to institutional development and complexity of production apparatus and articulation of national innovation system.

Within priority areas in regional science and technology there is an almost homogeneous cross-country interest in fostering post graduate and doctoral human capital formation. Brazil with its articulated system of grants and loans for financing university postgraduate studies forms around 7000 PhDs per year and scores the highest in domestically formed PhDs in the region (accounting for more than 70% of total Latin American PhDs according to RICYT's estimates). The 2004 Argentine National Plan for Technology and Production Innovation put in its forefront the strengthening of national scientific and technological base through supporting PhDs formation, as well. In Chile the National Commission for Scientific and Technological Research (CONICYT) supports postgraduate training through a series of articulated pad-hoc programs oriented to assist PhDs formation within the country and through international networking. The Bolivian National Secretary for Science, Technology and Innovation, the Colombian National Program for Industrial and Technological Development 2000-2010 and the Uruguayan National Service for C&T (SENACYT) and FUNDACYT support post graduate and doctoral human capital formation through credit and grants systems. In Costa Rica support to graduate and post-graduate studies is mainly coming from private universities, while in Mexico National Council for Science and Technology (CONACYT) allocates public funds for sustaining high level human capital formation and the Public Research Centres (CPI) directly intervene in human capital formation and subsidize it through grants which are financed by specific CPI's funds. According to a selective intervention strategy, in Peru the Genome Program finance post-graduate formation in genetics, while the Paraguayan 2002 National C&T policy prioritize formation in the engineering and mining sectors.

Another common feature of regional science and technology policies is the increasing concern in fostering interaction and coordination between public sector (mainly universities and research laboratories) and private sector (essentially enterprises) efforts in research and development and technological upgrading. Most technology supporting schemes and financing mechanisms in the region emphasize articulation and co-participation of supply and demand side in technological upgrading establishing incentive schemes to foster cooperation between them. An example is the Innovation Law of Brazil, in course of approval, in which greater degree of freedom is given to university researchers to undertake temporary research at private sector institutions. But these initiatives yet to gain strength and economic significance as budgets remain low and practices are still not in accordance with contemporaneous needs. In effect, partly of the scanty results of these regional S&T supporting mechanisms, alongside reduced budgets, could be due to the asymmetry between this attention to coordination and the characteristics of regional production specialization. In effect, as it was previously underlined, Latin American and Caribbean production patterns on the one hand induce private sector and enterprises to express a meagre demand for knowledge and on the other hand lead domestic agents to mostly seek outward oriented linkages and coordination, basically privileging foreign companies and research laboratories that already have sound reputation and worldwide widely recognized experience in effective and efficient science and technology efforts. Thus a mismatch ensues between demand side needs and supply side offering, hampering policies' impact.

In terms of instruments, resources to finance S&T activities are channelled for the most part through technology funds. While, traditional fiscal incentives schemes and risk capital are residual policy instruments to support innovation, with the latter being the less widespread regional form of financing. Within all of these categories, at country level, deep differences and heterogeneity emerge in terms of prospective beneficiaries (research centres, enterprises, and special treatment given in certain cases to SMEs), source of financial resources dedicated to S&T, i.e. national (private or public) and international and in terms of access mechanisms to these resources (basically supply or demand-side mechanisms or a coordination mechanisms between the two).

First of all, with respect to regional technology funds it is worth mentioning that they all tend to prioritize the creation and strengthening of technological service markets. In effect, since the structural reforms technology funds in the region have been fostering the promotion of consultancies and technical assistance services basically aiming to reinforce research and development capacities of universities, research centres and enterprises in order to sustain innovative capacity of the domestic production structure. Two basic models emerge in the region: one that could be labelled the demand-subsidy scheme, the other that places emphasis in coordination between demand and supply of S&T.

The demand subsidy scheme, to which the Argentine, Chilean, Costa Rican and Mexican funds' models belong to, channel public funds, or loans from international organizations, to S&T activities subsidizing the demand by following a horizontal logic based on the evaluation of proposals and applications directly presented by prospective recipients (enterprises or research centres). This kind of system, where access to incentives for innovation depends upon a direct initiative of potential beneficiaries, may lead to increasing heterogeneity in technological behaviours because it could ingenerate adverse selection mechanisms among recipients. In the demand subsidy scheme incentives to recur to financial assistance for innovation are biased. More pro-active agents which perhaps have a comparative advantage in technological upgrading and that could probably master technological innovation without recurring to public funds will be more prone to submit projects for evaluation, while more technological backward actors will face higher barriers to participate to this scheme. A further weakness of the demand subsidy model is that a proper information dissemination policy is needed in order to allow beneficiaries to be aware of the possibility offered by the financing schemes. Actually, most of the sub-utilization of technological funds mastered under a demand-oriented mechanism is that potential beneficiaries lack information on it (Casalet, 2003; Jaramillo, 2003; Pacheco, 2003; Vargas Alfaro and Segura Bonilla, 2003; Yoguel, 2003).

For instance, the Argentine Technological Fund (FONTAR) prioritize 5 areas in S&T development: i) technological development of new products, services or production processes, ii) technological modernization, i.e. improvement of products and processes, training, iii) promotion of the technological services market, supporting research laboratories and business research centres activities, iv) training and technical assistance and v) technological advisory assistance programmes especially to strengthen small and medium-sized enterprises' technological performance. The fund, which allocate resources on the basis of a demand-pull mechanism, is made up of national financial resources originating from national budget, fiscal credit law, credit lines of public banks and of resources originating from international loans (IADB loans according to the Argentine Modernization Plan). The FONTAR assigns financial resources to demanding beneficiaries principally in the form of non-repayable contributions, loans, subsidies and fiscal credit according to specific objectives and prospective beneficiaries.

In contrast, a system based on coordination between knowledge and innovation demand and supply exists in Brazil since the late nineties. The Brazilian system of industry-related funds overcomes the limits of an incentive scheme purely demand-pull or technology-push and establishes a new form of mastering technological and innovation incentives in open economies. It represents a step forward in regional technology policy design and implementation on two accounts: on S&T financing mechanisms and on the technology funds'operational management.

On the one hand, the system builds up a complex and articulated mechanism. It assigns private resources to S&T activities following an industry specific logic. 12 industrial technological funds are set up through 12 corresponding sector's law that identify the amount of the income generated in each industrial sector that should be devoted to support science and technology upgrading in the corresponding industry. Then, these 12 industrial funds collectively contribute to sustain S&T and R&D in 3 priority non industry-specific areas for which 3 respective fund are built up, like cooperation among universities, research centres and enterprises, maintenance and improvement of R&D infrastructure and development of S&T activities in the Amazonian region.

On the other hand, the Brazilian scheme entails a strategic collective management approach. Representatives of academies and research centres, industrial ministries, members of the Minister for Science and Technology, the business sector and regulatory bodies constitute a mixed management committee that run each technological fund according to a coordinated and consensual strategy. This mechanism, which has the great advantage of promoting coordination and stimulating interaction between private and public sector in technological management, is complicated to administer and could originate serious governance troubles which could lead to a sub-utilization of its potentialities.

In Latin America and the Caribbean fiscal incentive schemes essentially take the form of i) tax credits and deductions for different types of R&D activities according to the categories of involved actors, ii) public development bank loans. Both mechanisms are marginal financing sources in the region, even though information on fiscal incentive laws is quite easily accessible in many cases, such as Colombia, Mexico and Venezuela. Fiscal incentives are powerful tools to foster selective development of S&T activities because they allow prioritising in a simple way; in effect they are being used to foster institutional infrastructure development and maintenance, as in the case of Mexico, and to promote patenting related activities as it is happening in Brazil since the year 2002, when tax deductions for enterprises that carry out R&D activities were doubled if the business units are granted the patent for which they applied for.

Risk capital is an indirect form fostering of science and technology development. Public institutions act as a convoy for private financial resources that flow, through risk capital operations, to risky business activities consenting to convert technologically advanced projects into operating production entities. Risk capital industries are based on private capitals but need public policies to create a favourable environment, to foster liquidity in financial markets, to promote adequate regulatory and incentive systems and to encourage pubic and private agents involvement in innovation and technological upgrading. Albeit its worldwide-recognized role in favouring technological development in key areas of developed economies, risk capital businesses are hardly found in Latin America and the Caribbean.[2] Scant development of financial markets and institutions and strong uncertainty and volatility of regional macro setting could partly account for the residual presence of risk capital operations in Latin America, due to the strict linkage existing between this form innovative and risky business support and financial markets.

3. Resources allocated to S&T

World expenditure on research and development substantially increased over the past decade, reaching the amount of almost 700 billion of current US dollars in 2002. However, above and beyond Latin American' efforts in increasing domestic technological capabilities the region is still a residual actor in global R&D activities.

The amount of regional expenditure on R&D accounts only for 1.6% of 2002 world expenditure, thus scantling incrementing regional share in world expenditure which at the beginning of the decade was 1.4% and exceeding only Africa and Oceania whose share in global R&D spending are respectively 0.2% and 1.1%. The USA lead the scene making up almost 40% of global expenses followed by Asia and Europe whose share in R&D is around 30% each. Needless to say Latin American R&D spending is not homogeneously spread among regional countries. More proactive countries in terms of R&D spending are Brazil, Mexico, Argentina, Chile and Cuba, which as a whole account for almost 80% of regional spending.

[2] The Argentine Program to support technology base enterprises and risk capital, the Brazilian INOVAR Project and the Risk Capital Portal, the Colombian fund for risk capital investments, the risk capital initiative of the multisectoral investment bank in Salvador and the Mexican capital risk fund for technological development are some regional initiatives in terms of risk capital financing.

Table 2

EXPENDITURE ON RESEARCH AND DEVELOPMENT, 2002

Countries	Million of current US$
Latin America and the Caribbean	10 763
Argentina	361
Bolivia	23
Brazil (2000)	6 239
Chile	360
Colombia	81
Costa Rica (2000)	62
Cuba	190
Ecuador (1998)	15
El Salvador	10
Honduras (2000)	3
Jamaica	5
Mexico (2001)	2 453
Nicaragua (1997)	3
Panama (2001)	45
Paraguay	5
Peru	58
Trinidad and Tobago (2001)	9
Uruguay	32
World	700 000
USA	281 767

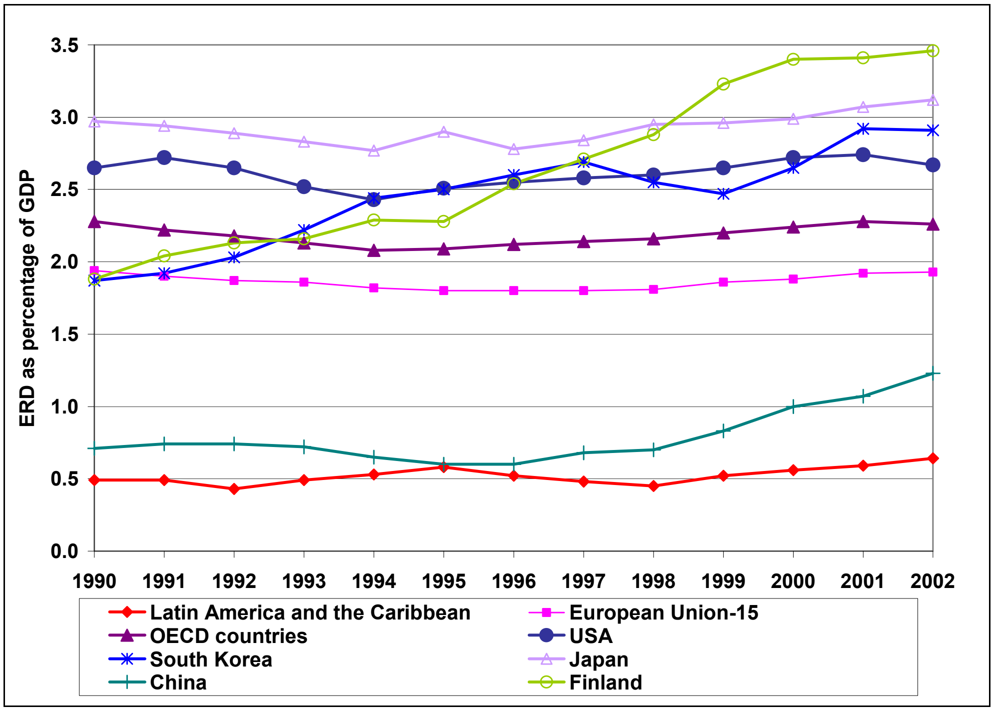
Source: RICYT, 2004.

Latin America and the Caribbean increased efforts in science and technology by elaborating articulated S&T plans and programs and placing knowledge and innovation at the central core of national strategies. Nonetheless, domestic efforts did not let Latin America and the Caribbean to considerably increase domestic R&D share in GDP. In effect, even now the region is a backward area in terms of gross domestic expenditure on research and development with respect to GDP when compared to international benchmarks. The region's backwardness in science and technology activities emerges when compared to industrialized countries and to catching up and emerging economies (see figure 3).

There is a persistent gap in R&D expenditure share in GDP between Latin America and the rest of the world across the decade of the nineties to present time. While regional share of R&D spending in GDP steadily accounted for half of a point, technologically mature countries like OECD ones, the USA and Japan spent, on average, respectively 2.3%, 2.7% and 3% of GDP in R&D.

Within the country sample presented in figure 1 Finland and South Korea are the most dynamic countries having amplified the gap respect to the region. At the beginning of the nineties Finland R&D expenditure share in GDP was equal to the average share of European countries, but throughout the following 12 years Finland increased the share of R&D spending in GDP to 3.5%. During the nineties South Korea strengthened technological capabilities as well increasing R&D efforts from 1.9% to almost 3% share in GDP, due to effective technology policies combined with a technology oriented specialization pattern.

Figure 3
EXPENDITURE ON RESEARCH AND DEVELOPMENT AS PERCENTAGE OF GDP: A COMPARATIVE PERSPECTIVE 1990-2002



Source: RICYT 2004, OECD MSTI (Main Science and Technology Indicators) 2004 and Korean Ministry of Science and Technology, 2004.

Latin America as a whole persistently devote no more than 0.6 of GDP to R&D expenditure being one of the most stragglers areas in the world. While, for example, China, who in 1995 spent 0.6% of GDP in R&D just as like Latin America, embarked on a rising and virtuous pattern overcoming the ceiling of 1% of GDP share devoted to R&D in 2000. Furthermore, it is to be remarked that the slight increase in R&D spending recorded between 1990 and 2002 is mostly due to the Brazilian efforts.

Latin America records different patterns with respect to more industrialized economies and catching up countries both in terms of source of finance and of sector of performance of S&T activities.

In Latin America governments are the major financing source for R&D spending, accounting for 57% of gross domestic expenditure, while in more developed areas public sector make up less than 30% of total R&D spending; only the Russian Federation displays a pattern similar to the Latin American one with enterprises financing only 33% of total expenditures and government accounting for almost 60% of total R&D disbursement.

The foreign sector scantly contributes to R&D financing in advanced economies and in most Latin American countries as well, wit the exception of Panama, El Salvador and Paraguay where 55%, 22% and 23% of total R&D spending is respectively financed by foreign financing sources.

Differences between the region and more advanced economies also exist in terms of R&D spending by sector of performance. The business sector is still a residual actor in R&D performance in Latin America, where it accounts for 41% of total expenditure, even though it augmented its share from the 20% of the 80s. On the other hand, at least 70% of R&D spending is carried out by enterprises in OECD countries, USA, Japan, South Korea, Singapore, China and in the Russian

Federation. Furthermore, deep heterogeneity emerges within regional countries. Uruguay, Brazil and Mexico are the countries where enterprises carry out more than 30% of total R&D spending, while Nicaragua, Panama and Paraguay represent the opposite extreme cases with an almost null business sector participation in R&D performing.

Table 3

EXPENDITURE ON RESEARCH AND DEVELOPMENT (AS PERCENTAGE OF GDP) BY COUNTRIES

Countries	1990	1995	1998	1999	2000	2001	2002
Latin America	0.49	0.58	0.45	0.52	0.56	0.59	0.64
Argentina	0.36 [1]	0.42	0.41	0.45	0.44	0.42	0.39
Bolivia	..	0.36	0.29	0.29	0.28	0.27	0.26
Brazil	0.76	0.87	..	0.86	1.04	..	..
Chile	0.51	0.62	0.54	0.55	0.56	0.54	0.58
Colombia	..	0.29	0.21	0.20	0.18	0.17	0.10
Costa Rica	..	0.21	0.21	0.20	..	..	0.21
Cuba	0.70	0.47	0.54	0.50	0.52	0.61	0.62
Ecuador	..	0.08	0.09	..	..	..	0.10
El Salvador			0.09				
Honduras	..	..	..	..	0.06	..	..
Jamaica	..	..	..	..	..	0.06	0.08
Mexico		0.31	0.38	0.43	0.37	0.31	0.34
Nicaragua	..	..	..		..	..	0.07
Panama	0.38	0.38	0.34	0.35	0.40	0.40	
Paraguay	..	..	..	..	..	0.08	0.10
Peru	..	..	0.10	0.10	0.11	0.11	0.10
Trinidad and Tobago	..	..	0.13	0.12	0.11	0.10	0.14
Uruguay	0.25	0.28	0.23	0.26	0.24		0.22
Venezuela	..	..	0.35	0.33	0.34	0.44	0.29
World	..	2.06	2.12	2.19	2.30	2.46	2.06
Finland	1.88	2.28	2.88	3.23	3.40	3.41	3.46
Israel	..	2.96	3.42	3.96	4.88	4.96	..
Japan	2.97	2.90	2.95	2.96	2.99	3.07	3.12
South Korea	1.87	2.50	2.55	2.47	2.65	2.92	2.91
USA	2.65	2.51	2.60	2.65	2.72	2.74	2.67
Russian Federation	..	0.90	0.92	1.01	1.05	1.16	..

Source: RICyT, UNESCO and WDI 2004.

[1] Data in 1993, source SECyT.

Divergences in terms of type of carried out R&D activities mirror the aforementioned asymmetrical patterns between the region and more advanced economies. Most regional R&D activities concentrate on applied and basic research, while experimental development is scantly diffused in Latin America. In contrast, in the USA, one of the world's leaders in S&T, experimental development accounts for more than 50% of total expenditure.

Table 4

RESEARCH AND DEVELOPMENT EXPENDITURE BY FINANCING SECTOR, 2002

(percentages)

	Government	Enterprises	Higher Education	Non-profit organizations	Foreign
Latin America and the Caribbean	**56.9**	**37.2**	**4.4**	**0.4**	**1.1**
Argentina	41.8	22.5	32.2	2.2	1.2
Bolivia	20.0	16.0	31.0	19.0	14.0
Brazil (2000)	60.2	38.2	1.6	0.0	0.0
Chile (2001)	68.9	24.9	0.0	2.1	4.1
Colombia (2001)	13.2	46.9	38.3	1.7	0.0
Cuba	60.0	35.0	0.0	0.0	5.0
Ecuador (1998)	90.6	0.0	0.0	0.5	8.9
El Salvador (1998)	51.9	1.2	13.2	10.4	23.4
Mexico (2001)	59.1	29.8	9.1	0.8	1.3
Panama (2001)	32.8	10.2	0.6	1.2	55.1
Paraguay	63.1	0.0	12.7	2.3	21.8
Uruguay	17.1	46.7	31.4	0.1	4.7
Trinidad and Tobago	48.2	34.5	17.3	0.0	0.0
	Government	**Enterprises**	**Other sectors**		**Foreign**
United States	30.2	64.4		5.4	..
Total OECD	29.9	62.3		4.8	3
EU-15 (2001)	34.1	56		2.2	7.7
Finland	26.1	69.6		1.2	3.1
Japan	18.1	73.9		7.6	0.4
Korea	25.4	72.2		2	0.4
Russian Federation	58.4	33.2		0.4	8

Source: RICYT, UNESCO and OECD MSTI 2004.

Table 5

RESEARCH AND DEVELOPMENT EXPENDITURE BY SECTOR OF PERFORMANCE, 2002

(percentages)

		Enterprises	Higher Education	Private non-profit
Latin America and the Caribbean	**19.8**	**40.9**	**38.1**	**1.2**
Argentina	39.3	27.1	30.4	3.2

Bolivia	21.0	25.0	41.0	13.0
Brazil (2000)	18.4	37.4	43.6	0.6
Chile (2001)	40.4	14.9	43.8	0.9
Colombia (2001)	8.0	18.0	60.0	14.0
Costa Rica (2000)	19.5	23.3	36.2	21.0
Ecuador (1998)	61.9	4.8	16.1	17.2
Mexico (2001)	39.1	30.3	30.4	0.2
Nicaragua	0.0	0.0	0.0	0.0
Panama (2001)	67.1	0.0	9.2	23.7
Paraguay	35.9	0.0	40.7	23.4
Peru	30.2	10.7	47.7	11.4
Trinidad and Tobago (2001)	64.3	13.3	22.4	0.0
Uruguay	19.4	49.0	31.6	0.0
United States	8.8	70.2	15.9	5.1
Total OECD	11.0	68.0	18.1	2.9
EU-15	13.0	64.4	21.8	0.8
Finland	10.4	69.9	19.2	0.5
Japan	9.5	74.4	13.9	2.2
Korea	13.4	74.9	10.4	1.3
China	28.7	61.2	10.1	0.0
Singapore	13.2	61.4	25.4	0.0
Israel	5.8	72.9	17.5	3.8
Russian Federation	24.5	69.9	5.4	0.2

Source: RICYT and OECD MSTI 2004.

Table 6

EXPENDITURE ON RESEARCH AND DEVELOPMENT BY TYPE OF ACTIVITY, 2002

(percentages)

	Basic Research	Applied Research	Experimental Development
Argentina	26.2	47.2	26.6
Bolivia	47.0	40.0	13.0
Chile (2001)	55.3	32.1	12.6
Colombia (2001)	24.0	47.0	29.0

Cuba	11.0	50.0	39.0
Honduras (2001)	34.5	40.2	25.2
Mexico (2001)	34.5	40.2	25.2
Panama (2001)	25.4	45.7	29.0
Paraguay	12.0	68.6	19.5
Uruguay	18.8	53.5	27.8
USA	18.4	23.7	57.9

Source: RICYT.

4. Intellectual property systems management

In open economies intellectual property (IP) becomes a key issue in knowledge generation and technology diffusion. In such a context, effective intellectual property systems management should be the natural counterpart of any industrial, technology and global development strategy. And this is mostly true for developing economies like Latin America and the Caribbean for which effectual handling of IP systems could represent a way to protect and develop scientific and applied research, especially, for example, in the areas of genetic bio-diversity provided by their natural recourses, traditional knowledge and cultural industries.

Two main changes occurred at the global level in recent times. The one related with the management of scientific discoveries and applications' appropriation through patenting mechanisms; the other being the leading role played by the USA patenting office, the USPTO, in world IP related activities.

On the one hand, the 1980 Bayh-Dole law fostered the patenting of basic research's results more than applied research ones, inducing universities to become one of the major patenting agent and modifying academy-enterprises network relationships in knowledge generation and diffusion. From 1991 to 2000 universities' patents application grew about 240% and research and development employment took off. One of the main consequences of this stance is the so-called "privatization of scientific activities", which entails increased access costs to basic research results, augmented patenting overheads and amplified risks and costs of patent related legal controversies (Correa, 2003). In reality, the "public nature" of knowledge is definitively shifting towards the private and club goods domain, where access is ruled by given market mechanisms, thus incrementing access barriers to basic research's results.

On the other hand, USA leads IP activities, mastering in qualitative and in quantitative terms world-patenting system. The natural counterweight of the USA leadership had been the weaknesses of developing economies in the IP global arena and the consequent centering of Latin American countries in domestic patenting systems. This trend is in turn reinforcing regional marginal participation in the North American and in the European patenting offices, USPTO and EPO, respectively.

Since the conclusion of the Uruguay Round in 1994 and the adoption of the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) most Latin American and Caribbean countries introduced substantial changes in Intellectual Property Regimes and laws, thus beginning to reduce the pre-Uruguay Round regional heterogeneity in Intellectual Property Systems. Recent modifications of regional regimes entailed the spreading out of Intellectual Property Rights (IPR) domain in Latin America and the Caribbean, which now includes new fields. The expansion of the IPRs resulted in the introduction of minimum standards, in the increasing number of patentable products and processes and in the licence to import already patented products by means of including this activity under the umbrella of "sufficient exploitation" (ECLAC, 2002).

Above and beyond the evolution towards more homogeneous systems of IP management, Latin American and Caribbean countries recently saw the coming out of disadvantages related with current running patterns of IP rights and systems, mostly due to deep asymmetries between the region and the more advanced economies in terms of capacities of mastering IP related aspects. Actually, prices of patented products and processes are augmenting, inducing vicious effects in the region; furthermore, the increasing barriers posed to reverse engineering and imitative practices, which had been a key pillar of South East Asian technological catch up, limit and hinder domestic learning processes (IPRC, 2002).

The peculiarities of Latin American and Caribbean countries in terms of IPRs management emerge also from a regional comparative perspective. According to WIPO, the region show diverse patenting patterns with respect to developed economies and recently catching up countries. For instance, in South East Asia the number of residents' patents is growing at a higher rate than those of non-residents, while in Latin America and the Caribbean non-residents patenting leads the scene. In this scenario patenting systems are a powerful tool in the hands of foreign companies: commercialization of foreign produce is facilitated, while, in most of the cases, local technological capabilities are damaged. More recently, changes in the strategy of governing intellectual property rights included in the multilateral agreements and in the way in which international organizations behave have been requested by an increasing number of developing countries.[3]

The region is a minor actor in the most relevant patenting office, the USPTO. Latin America and Caribbean applications for patents represent only the 20% of Korean ones, and, moreover regional patenting pattern is deeply asymmetrical with respect to those of advanced or catching up economies. Latin America and the Caribbean mostly patent in traditional sectors (mechanics and chemicals) while those related to new technological paradigms (like telecommunications, biotechnology, genetics and electronics) are at the hub of developed and catching up countries patenting patterns (Aboites and Cimoli, 2001).

The parallelism between the divergence in the patenting patterns and the asymmetry of industrial specialization patterns and structures between the region and the technological frontier is self-evident. In Latin America and the Caribbean local innovation processes are basically adaptive in nature and rarely encompass inventions and scientific discoveries. Moreover, regional R&D expenditure is modest and current patenting systems are not yet adapted to local production structures' necessities. Therefore, tailoring Intellectual Property Systems to Latin American and Caribbean production structures potentialities would benefit regional growth and development. In this field traditional knowledge and the genetic and natural resource regional heritage are major exploitable and profitable assets.

Hence, in the current scenario where bilateral, regional and multilateral agreements are core elements of international negotiations, institutional asymmetries in Intellectual Property Systems' management, ensuing from monopolistic positions of multinational enterprises in IP rights and regimes' utilization concur to explain the backward position Latin America and Caribbean in the international negotiating arena.

Intellectual Property systems are a complex governing arena whose running mechanisms are not easily manageable. Effective IP management requires proper infrastructure and institutions and actors' preparedness, as well as suitable legal architecture and enforcing mechanisms. In the current open economies setting there are three main areas that are of strategic importance for intellectual property management. The first topic regards modes and manners of managing intellectual property systems. The second issue has to do with the boundaries of intellectual property rights and regimes' domains, while the third one connects with the existence of dominant and monopolistic positions in

[3] The document signed up by Argentina and Brazil and recently presented at the WIPO assembly is a clear example of this emerging voices (see: http://www.wipo.int/documents/en/document/govbody/wo_gb_ga/pdf/wo_ga_31_11.pdf)

global and domestic markets. And in all of these three areas the characteristics of Latin American and Caribbean pattern lead the region to face serious constraints, mostly because of persistent, if not growing, asymmetries that exist among domestic countries and more advanced economies.

First of all, regarding intellectual property systems managing modes, Latin America and the Caribbean lack strong negotiation capacities and specific skills for making up regionally coordinated policy proposals (Drahos, 2002). In most cases countries depend upon external assistance for designing intellectual property legal frameworks, thus ingenerating a wired situation where regional counterparts in negotiations are the very same regional policy advisors. Furthermore, the increasing proliferation of bilateral agreements, which breaks to pieces regional attempt to develop a common position and constrains countries' degrees of freedom in decision making, keeps a tight rein on Latin American and Caribbean countries capabilities of profiting from existing policy spaces of TRIPS agreements. For instance, developing countries make scanty use of the Bolar exception, which is actually allowed within the TRIPS agreement and which consents firms to carry out experimental research and development to produce generic products without incurring in patent's violation.[4] Others windows of opportunities residually used by regional economies are: i) compulsory licensing,[5] which plays a marginal role in regional intellectual property activities due to the lack of suitable institutional infrastructure and trained personnel, which make compulsory licensing costs to exceed potential benefits, ii) parallel imports[6] that allows a reduction in prices and a higher integration at the regional level and, iii) utility models,[7] a patenting mechanism more adaptable to the idiosyncrasy of the innovation activity in the region.

Apart from asymmetrical bargain powers in international negotiations and the fact that international agreements are, in most cases, tailored to fit developed economies needs, it is worth calling attention Latin American and Caribbean institutional weaknesses which is mostly reflected in deficiencies in autonomy and topic-specificity of government councils and commissions and lack of autonomous advisory capabilities.

Secondly, it is worth dealing with regional capacities and capabilities in terms of managing intellectual property rights and regimes' domains. The whole set of institutions dealing with intellectual property in the region is short of effective management capabilities (IPRC, 2002; Lopez, 2003). Moreover, most research and development centers, universities and enterprises lack specific departments or professional teams to deal whit intellectual property rights and protection of R&D results, thus ingenerating vicious effects on the incentive structure of researching activities. The less opportunities to protect and to guarantee the ownership of an innovation or of a technological upgrading, the less are the incentives to invest and to effectively engage in its development. In Chile, for instance, according to a recent case study, less than 5% of enterprises and less than 12% of institutions hold a team to deal with intellectual property affairs and protection of R&D results; and the outsourcing of R&D outcomes protection to specialists is far more marginal, only 3.2% of Chilean enterprises and 6.5% of universities make use of it (Santibanez, 2003).

Lastly, the existence of foreign owned dominant and monopolistic positions in global and domestic markets poses serious threats to regional IP managing capabilities. Patents are increasingly used to foster products or services commercialization and to regulate access to markets, thus being

4 *The Bolar Exception*. This clause, also known as "early working", allows generic producers to import, manufacture and experiment on patented products before the patent expires, thus making possible scientific and technological progress in the countries of the region.

5 *Compulsory licenses*. Through this instrument, a license for the use of a patented technology may be granted by the government of the country where the patent is registered if the user has unsuccessfully tried to obtain such a license on the terms laid down in article 31 of the TRIPS agreements. The use of compulsory licenses, however, comes up against some conditions which are difficult to fulfill, and it often happens that the potential producer lacks the know-how to carry out reverse engineering and does not have access to a market big enough to enable him to get back his investment.

6 *Parallel imports*. Before a patent runs out, countries can take advantage of products manufactured under license in other countries or for other markets, thus making possible their importation at a lower price.

7 *Utility models*. This is a mechanism —also known as "little patent"— which permits the patenting of incremental innovations or improvements in designs, products and production processes.

converted into "pure objectives" rather than strategic tools. Actually, patents, which in nature are supposed to guarantee innovation appropriation, are mostly used as barriers to control competitors' entrance in the market arena and to maintain dominant monopolistic positions thus creating incentives for moral hazard and anticompetitive behaviors. In this respect, another structural weakness emerges: in the region prevails a "traditional" usage of competition policy that basically acts as a tool for protecting consumers' interests. In contrast, in the open economies context competition policy is a crucial collateral instrument for promoting regional upgrading in international network hierarchies and for managing IP rights in order to avoid restrictive practices and improper use of rights. Actually, mergers and acquisitions transactions are explained to a great extent by willing of patenting control and above all point to gain dominant position in international markets (De Janvry, Graff, Sadoulet and Zilberman, 2000). In the biotechnology field, for instance, less than 10% of obtained patents effectively circulate in markets (Platt, 2001).

To sum up, weak institutional and personnel capabilities in intellectual property systems' management, reduced negotiation capacities and the existence of monopolistic markets where regional enterprises and economic agents perform at the lowest levels of international hierarchies, depict an displeasing scenario where Latin American and Caribbean countries have weak negotiation powers in terms of intellectual property, scantly use the windows of opportunities that current agreements offer and suffer of structural weakness in terms of capacities of proposing regionally-tailored changes in the rules' games in order to support domestic technological and innovation capabilities.

Table 7

REGIONAL INTELLECTUAL PROPERTY SYSTEMS: TAXONOMY OF WEAKNESSES

Strategic areas for IP management	Present weaknesses (persistent, if not growing asymmetry with catching up and more advanced economies)
IP Systems management	Weak negotiation capabilities and poor evaluation capacities of opportunities and constraints of existing agreements
	Poor domestic capacity of profiting from potential flexibilities of TRIPS and scanty capability of adapting them to local needs
	Scanty coordination among actors which are affected by IP agreements (Scanty articulation and poor coordination of IP policies with broader national development policies and strategies)
	Lack of well trained human resources and infrastructure to assist governments, politicians and policy makers involved in negotiations and domestic enterprises
	Lack of financial resources dedicated to institutions and domestic departments involved in IP management
	Scanty use of compulsory licensing, parallel imports, utility models and Bolar exception due to lack of information and management capacities
IP rights domains	Neither enterprises nor universities master IP management capabilities and most of them lack training in how to protect R&D findings through IPR and on IP enforcing regimes
	High costs and complexity of patenting and maintenance of IP systems
	Enforcement mechanisms and trials are extremely costly and bureaucratic requirements exceed domestic enterprises and actors capacities and capabilities
	Patenting costs offset benefits in most cases
Dominant and Monopolistic positions	Imposition of harmonized IP regimes standards reinforced moral hazard conducts
	Monopolistic market domain and strategic use of IP systems of more advanced economies companies create entry barriers to markets and limit imitation opportunities
	IP rights are mostly used to favour product commercialization thus limiting compulsory licensing use
	Competition policy lacks instruments and capacities of managing IP rights in order to avoid restrictive practices and improper use of IP rights

(continued)

Table 7 (concluded)

Source: authors' elaboration.

III. Pragmatism and coordination in technology policy

1. Going beyond pure supply and demand incentives

According to the literature on national innovation systems, innovation is an interactive process that ensues in given environments where agents, responding to different incentives schemes, interact and cooperate (Freeman, 1987; Lundvall, 1992; Nelson, 1993; Cimoli and Dosi, 1995). To be precise, innovation and technological upgrade arise when enterprises, which act by reason of market mechanisms, and institutions, whose behavior is determined by non-market incentives, end up networking in a domain regulated by suitable norms and lows. Indeed, technological capacity derives from interactions between demand-pull and technology-push incentives.

Framework conditions are crucial in determining firms' technological behavior; actually enterprises never act alone and perform in an setting where they are expected to interact and maintain channel of communications on a continuum basis with other economic and non-economic agents like enterprises, which could be partners or competitors, universities, public institutions and non governmental and civil society organizations. Firms mold and determine their technological behavior and strategy also according to the manifold pressures that originate from this set of interlinks. Interactions between enterprises, institutions, organizations and legal systems, i.e. the national innovation system dynamics, determine knowledge generation and diffusion paths. And the codified or non-codified network between those actors shapes, according to the density and specificity of linkages, a more or less favorable environment for knowledge and innovation generation, diffusion and accumulation.

In the more industrialized countries the debate on technology and innovation policies had been focused on the importance of networks, linkages and interactions between agents as major stimuli for innovation and technology transfer since the decade of the eighties. In Latin America it is only recently that there is a pressing need to take these issues into consideration in technology policy planning and implementation. (Teece, 1989; Metcalfe, 1995)

Pure supply-side or demand-side oriented technology policies are clearly not enough to stimulate innovation, knowledge generation and accumulation in economies where production processes and management are increasingly carried out within networks. Indeed, technological upgrading is a systemic process of network interaction that goes beyond pure demand and supply side incentives. Collective interaction favors scope economies in knowledge accumulation and innovation through technological interrelations and complementarities between firms and institutions devoted to science and technology (Arthur, 1989; Dosi, 1998). And networks, through links and interactions foster externalities and increasing returns in production processes and industrial organization (Cimoli and Dosi, 1995; Dosi, 1998).

2. Handling knowledge as a "club good"

In open economies the relevance of networks increased. On the one hand, the opening up process and the consequential changes in specialization patterns and production structures led domestic enterprises to growingly participate to international production chains and to increase their degree of outward orientation. On the other hand, networks boundaries go beyond domestic borders and enterprises, institutions and legal frameworks, i.e. the national innovation systems, face global incentives and pressures in the development of local organization and production processes.

But access to networks does not automatically guarantee the possibility of profiting from potential technological spillovers. Positioning in international value chains and in international network hierarchies determines economic agents' capacity of retaining technology and innovation and of profiting from technological interactions. Positioning in international networks affects knowledge accessibility and appropriation capabilities of economic actors and, hence, deeply influences domestic enterprises and institutions innovation capacities. A dominant position in production networks guarantees the control of knowledge de-codification mechanisms. Hence, in this setting, innovation dynamics and access to codified and no-codified knowledge strictly depend on the positioning in international network hierarchies and on the stage of production process mastered by domestic agents in global production arrangements.

In abstract terms, in open economies knowledge is less identifiable with a public good that is freely accessible and usable once it is slotted in the economic system. On the contrary, increased relevance of networks and changes in production organization lead, in certain cases, knowledge to be more and more similar to a club good, i.e. an asset non rival in consumption but excludable in use (Cimoli, 2002; Yoguel, 2003). In this setting a more suitable and pragmatic technology policy model would overcome pure supply or demand perspectives and should promote coordination and articulation between the two, fostering the design and the implementation of a coordinated set of horizontal, vertical, selective and competition policies, having domestic repositioning in global networks as a major concern.

Horizontal policies deal with market failures and sort out information asymmetries; they foster human capital formation and facilitate widespread diffusion and assimilation of foreign generated knowledge in domestic realm thus creating the basic conditions for technological development. Vertical and selective policies encourage cooperation and articulation among universities, research centers and enterprises and are able to prioritize production activities, thus fostering technological accumulation and innovation through the creation of dynamic market failures. Competition policies promote domestic agents' upgrading in international hierarchies and thus fostering regional control over knowledge de-codification mechanisms and increasing potential benefits of networking in terms of knowledge and technology (Cimoli and Primi, 2004; ECLAC; 2004).

3. Building up institutional capabilities

Policy formulation and implementation and knowledge generation and diffusion are complex processes involving continuous learning and trial and error processes. The best evolution paradigm should synchronize the strengthening of domestic institutional capacities in policy making with the upgrading in production specialization patterns. As countries improve institutional capacities and develop more complex and articulated production structures they face different incentives for technological upgrading and policy articulation. The re-composition of domestic production structure toward a more technologically intensive vector leads the private sector (the demand side) to prioritize knowledge and innovation and to consequently increase the demand for it. The evolution of the institutional settings increases capabilities for supporting innovation and technological upgrading thus fostering the supply of it. Hence, reinforced knowledge and innovation demand and supply patterns could induce countries to extend the scope of policies and to design and implement vertical and selective policies amid horizontal ones while strengthening mechanisms for policy coordination and articulation.

It must be recognized that there are no generic blue prints for an optimal technology policy. Policy goals, instruments and capabilities must be tailored to country specific context and time requirements and coping with relevant financial constraints. However, historical experiences of successful economies may help the region to develop technology policy models in order to enable Latin American and Caribbean countries to cope with the emerging challenges imposed by the open economies context.

A production structure with low levels of complexity and internal linkages, poor endogenous technological capacity, a demand-pull model of technology policies and meagre resources allocated to innovation and knowledge diffusion concur to depict a vicious circle and an adverse scenario for technological catch up. Policies are needed to revert this set of adverse self-reinforcing forces and to push regional economies towards technological upgrading. But the bundle of suitable policies should take into account regional specificities and should be designed on the basis of a renewed and more pragmatic technology policy model that considers the necessity of going beyond a purely supply or demand-side linear perspective.

IV. Science and technology for development: a co-evolutionary model

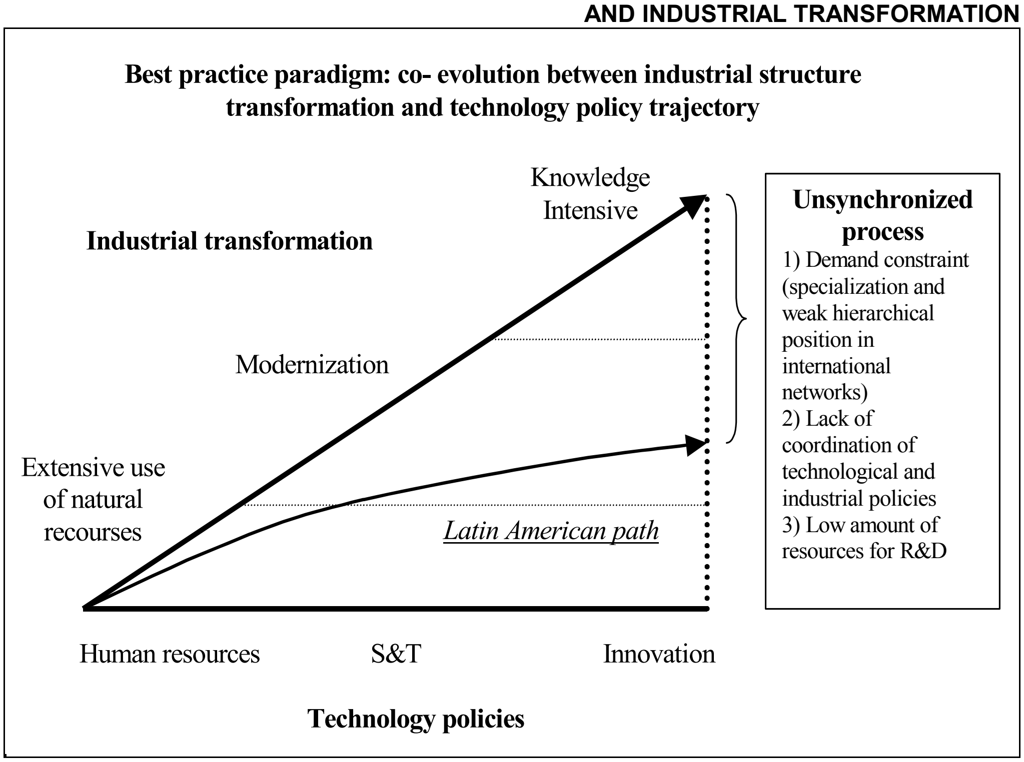
To come to the point, open economies call for a pragmatic and coordinated technology policy model that takes into account the need for stimulating market mechanisms of which demand for S&T stems from and institutions and research centers activities of which knowledge generation and diffusion is a result of.

However, merely disposing of a well designed and pragmatic technology policy is not a sufficient guarantee of effectiveness in innovation and technological capabilities upgrading. In effect, above and beyond fostering innovation through introducing public and private sector coordination mechanisms, a key factor of success for any technology policy is the matching of its goals with production structure needs and effective demand. That is the co-evolution and synchronization between industrial transformation and progression in innovation policy's goals and technological capabilities should be constantly searched for.

In effect, on the one hand, the natural evolution of technology policy seems to occur along a pattern which moves from supporting human capital formation and infrastructure building to propping up innovation through leaning private and public sector agents' efforts in S&T and passing through an intermediate phase mainly oriented to shore up basic research and experimental development.

On the other hand, policy action takes place in an evolving structural environment, where industrial and trade policy measures, the relative positioning in global value chains and technology policies lead economic agents and production structure to go through industrial transformation, whose extent varies according to the effectiveness and the relative weight of the set of the aforementioned factors. Economies generally go through deep structural transformation in their manufacturing articulation along their historical development pattern. Mature and catching up countries changed specialization patterns. They shifted from an extensive specialization pattern, where countries industrialized mostly exploiting abundant factors, like natural resources and labor. Those economies specialized in low technological content produce and performed as price takers in global markets. Then, those countries shifted to more knowledge intensive specialization patterns where private and public sectors are collectively engaged in carrying out S&T activities and R&D expenditures thus moving towards more technological intensive paradigms and increasingly dynamic sectors. Between the tangible resource extensive pattern to the knowledge intensive one, the modernization phase occurs, where enterprises start to extensively adopt more capital intensive processes and increase efficiency in production processes mostly through incremental innovations and products and processes imitative practices.

Figure 4
A CHALLENGE FOR LATIN AMERICA AND THE CARIBBEAN: CLOSING THE GAP WITH TECHNOLOGY POLICY AND INDUSTRIAL TRANSFORMATION



Source: authors' elaboration.

Production structure's demand for knowledge and enterprises' needs for technological upgrading naturally co-evolve with structural transformation of specialization patterns. And, in effect, the demand for knowledge and technology jointly determine the effectiveness of the technology policies. The more synchronization exists between production structure demand for knowledge and the kind of knowledge-supply fostered by technology policy, the more the actual policy paradigm will move toward the best practice paradigm where technology policy targets are synchronized with production structure's needs. Latin America and the Caribbean are not following this so-called best-practice paradigm. In effect the characteristics of regional production structures and the attributes of technology policies that emerge from the analyses carried out in the previous sections, depict a scenario where production structure and technology policy evolved following divergent and unsynchronised patterns.

On the one hand technology policy moved from being mostly focused on human capital formation support and institutional infrastructure building of the import substitution phase to the current attention paid to interaction between public and private sector in knowledge generation and experimental development. On the other hand most countries' specialization patterns remained anchored to natural resources and labour intensive activities that *"per se"* express a scant demand for knowledge, interrupting their industrial transformation and thus truncating their modernization process.

Hence, above and beyond strengthening regional capabilities of designing and implementing technology and innovation policies and increasing domestic efforts in S&T activities, there is an emerging and crucial need for increasing coordination between industrial and technology policies' priorities in order to move toward a more synchronized evolution pattern of regional production structure and technology policies. In effect, synchronizing technology policy within the framework of industrial policies, and other economic measures in general, like trade negotiations, is definitively a key asset to foster industrial transformation that could have a positive multiplier effect on regional development and catch up.

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Appendix

Appendix 1

A DEMAND BASED MODEL (I): THE TECHNOLOGY FUND IN ARGENTINA (FONTAR)

FONTAR programs	Instrument used	Objectives	Beneficiaries	Form of allocation and financial contribution
Technological development (new products, services or production processes)	Non-repayable contributions	Increased competitiveness through innovation in products, services and processes	Micro-, small and medium-sized enterprises and brooder enterprises certified by IBEROEKA	By public competition. Up to 50% of project cost
	Loans for technological development projects	Finance for middle-income technology production projects	Micro-, small and medium-sized enterprises with research and development departments or teams, collaboration groups, and UVTs (Unidades de Vinculación Tecnológica - Technical Linkage Units) underwritten by the enterprise	Compulsorily repayable loans. Up to 80% of the total cost, allocated on an open window basis, with a maximum of 200,000 pesos for three years
Technological modernization (improvement of products and processes, training)	Fiscal credit programme	Assistance for the execution of research and development activities	Physical or juridical persons who own enterprises producing goods and services	Subsidies through Fiscal Credit Certificates obtained through public competition. Up to 50% of the total cost of the project
	Loans for modernization projects	Technological adaptation and improvement of products and processes with a low level of technical and economic risk	Enterprises with research and development department or groups. Collaboration groups, and UVTs underwritten by the enterprise	Special compulsorily repayable loans allocated on an open window basis. Up to 80% of the total cost of the project, with a maximum of 300,000 pesos for three years
	Loans to enterprises	To finance projects for the development of new production processes, products and modifications thereto	Enterprises, without any restrictions as regards size or sector. No finance provided for projects with a rate of return of less than 12%	Compulsorily repayable loans allocated on an open window basis. Up to 80% of the total cost of the project, with a maximum of 1 million pesos
Promotion of the technological services market (research centres and business research centres)	Subsidies for projects to develop business plans	Finance for business development projects based on research and development	Micro-, small and medium-sized enterprises whose projects are executed by UVTs	Subsidies allocated on an open window basis. Up to 50% of the total cost of the project, with a maximum of 20,000 pesos, for up to one year
	Loans to institutions	To promote the establishment and strengthening of structures for the provision of technological services to research and development enterprises and institutions	Public or private institutions providing services to the private production sector. The projects may be presented on an individual or associated basis	Obligatorily repayable subsidies allocated on an open window basis, up to a maximum of 2 million pesos
Training and technical assistance	Subsidies for training and retraining projects	Subsidies to support activities for the training and retraining of human resources in new technologies	Micro-, small and medium-sized enterprises whose projects are executed by UVTs	Subsidies allocated on an open window basis. Up to a maximum of 50% of the total cost of the project, or 20,000 pesos for up to six months
	Subsidies for project formulation	Support for the formulation of research and development projects, technology transfer or technical assistance	Micro-, small and medium-sized enterprises whose projects are executed by UVTs	Subsidies allocated on an open window basis. Up to a maximum of 50% of the total cost of the project, or 20,000 pesos for up to six months

(continued)

Appendix 1 (concluded)

Technological advisory assistance programmes. Strengthening the performance of technical small and medium-sized enterprises	Technological advisory assistance programme	Support for entrepreneurs in the diagnosis of technological problems through technological advisory assistance. Identification of suppliers of technological services	Micro-, small and medium-sized enterprises producing goods and services which incorporate technological added value	Subsidies allocated on an open window basis, individually or for groups, with a maximum of 50% of the total cost of the project or 110,000 pesos and a maximum of 20,000 pesos per participating enterprise

Source: ECLAC, 2004.

Appendix 2

A DEMAND BASED MODEL (II): THE CASE OF TECHNOLOGY FUNDS IN CHILE

Fund and administering body	Objectives	Beneficiaries	Origin and destination of financial resources
National Fund for Scientific and Technological Development (FONDECYT). Administered by CONICYT	To promote the development of fundamental scientific and technological research in order to create or improve methods and means of production of goods and services	Natural persons or research institutes using various financing programmes	Contributions allocated under the National Budget Law, legacies, and domestic and international donations that do not have any other specific purpose. The beneficiaries are selected by public competition
Fund for the Promotion of Scientific and Technological Development (FONDEF). Administered by CONICYT	To strengthen the scientific and technological capacity of universities and research centres in order to increase the competitiveness of enterprises. The fund finances projects in priority areas (natural resources, promising areas for the creation of added value, and others of high social impact)	Non-profit-making institutions, individually or in association, which carry on R&D activities and have legally existed for at least 5 years. The fund requires the participation of enterprises, especially those working in the area of technology	The fund finances up to 60% of the cost of projects, with a ceiling of 450 million pesos. Institutions and enterprises must contribute at least 20% themselves. The beneficiaries are selected by competition, by R&D projects, and on an open window basis for technology transfer projects
Development and Innovation Fund (FDI). Administered by CORFO	To promote technological innovation in areas with strategic impacts in terms of economic and social development	Non-profit-making institutions and technology centres engaged in R&D activities, technology transfer and related services. Technological-entrepreneurial consortia made up of at least 3 enterprises not related in ownership before the date of application, associated with one or more technology centres	Project competitions; tenders for the execution of specific lines of work; and open window arrangements (new form of allocation). The fund finances expenditure on operations, administration, human resources, subcontracts, and any other areas needed for the project

(continued)

Appendix 2 (cocluded)

Associative Development Projects (PROFOs). Administered by CORFO	To improve the competitiveness of a group of enterprises which seek to solve management and marketing problems on a joint basis	Small and medium-sized enterprises with annual sales of between 2,400 and 100,000 UF. Minimum sales are 1,200 UF for agricultural enterprises, while the maximum sales rise to 200,000 UF in the case of manufacturing enterprises which are associated in groups of at least 5 enterprises	Open window basis: the enterprises must contact intermediaries of CORFO who will provide application forms and designate professionals to diagnose the stage of preparation of the project
Technical Assistance Fund (FAT). Administered by CORFO	Through consultants, to incorporate management techniques into the operations of enterprises or new technologies into their production processes	Chilean companies that require specialized outside support and have net annual sales of not more than 100,000 UF. The consultants are designated on an individual or collective basis (at least 3 companies in the latter case)	Open window basis (both cases): Individual FAT assistance: for the initial diagnosis, CORFO contributes 17 UF and the enterprise 3 UF, while CORFO subsequently finances up to 50% of the consultancy costs. In the case of collective arrangements, CORFO finances up to 50% of the consultancy costs, with a maximum of 100 UF per company
National Fund for Technological and Production Development (FONTEC). Administered by CORFO	To promote, guide and sponsor, through 5 lines of assistance, projects in the areas of technological innovation, associative technology transfer and implementation of technological infrastructure	Lines 1, 2, 3 and 5 finance private enterprises producing goods and services which can demonstrate the necessary technical, administrative and financial capacity and are not in arrears with their debts. They can apply individually or in association, provided in the latter case that they are not linked with each other commercially. Line 4 finances enterprises producing goods and services which belong to a single sector of production and are applying for assistance in tackling technological problems of an associative nature	Open window basis: for lines 1, 2, 3 and 5 an application for finance must be submitted to either FONTEC or CORFO, which will consider the project in line with their rules for applications, together with information on the legal and financial status of the enterprises. Open window basis: line 4 requires application for a diagnostic stage involving the preparation of a Relevance Analysis for FONTEC or CORFO

Source: ECLAC, 2004.

Appendix 3

A DEMAND BASED MODEL (III): THE TECHNOLOGY FUNDS IN MEXICO

Administering body	Fund type	Objectives	Origin of financial resources	Instruments used and forms of allocation
CONACYT	Sectoral Mixed Institutional International cooperation	▪ Reinforcing the interaction among sectoral secretaries, federal governments, C&T institutions, universities and business sector ▪ Supporting specialized human capital formation ▪ Strengthening technological and scientific capabilities, mainly supporting basic and applied research ▪ Supporting S&T diffusion	CONACYT, Public administration entities and eventual complementary resources. CONACYT and federal and municipal governments (they support the ongoing process of decentralization of S&T activities) CONACYT International organizations	Loans assigned by public competitive calls Loans assigned by public competitive calls Additional funds to support National innovation plan
Public Research Centres (Centros Públicos de Investigación CPI)	Scientific research and technological development fund (instrument whereby established: S&T law 2002)	▪ Financing or co-finance special R&D projects ▪ Creating and maintain R&D infrastructure ▪ Financing postgraduate studies through grants ▪ Supporting high level human capital formation	Public funds assigned to public research centres and eventual complementary resources	Funds' administration and allocation mechanisms are directly run by CPI

Source: authors' elaboration.

Appendix 4

COORDINATION BETWEEN SUPPLY AND DEMAND: INDUSTRY RELATED TECHNOLOGY FUNDS IN BRAZIL

Sectoral funds

Funds	Objectives	Origin of financial resources	Activities
CT-PETRO (1999) Sectoral fund for the oil and natural gas sector. Instrument whereby established: Law No. 9487 of 1997	Sectoral development through promotion of research and development and human resources training	25% of value of royalties exceeding 5% of production of oil and natural gas	Collaboration in the definition of policies and the implementation of specific programmes. In 2001, the CNPq approved 144 projects worth 7 million reales. Expenditure between January and November 2003: 16,431,002.70 reales
CT-ENERG Sectoral fund for the energy sector. Instrument whereby established: Law No. 9991 of 2000	Sectoral development through promotion of research and development	Between 0.75% and 1% of the net income of enterprises with concessions for the generation, transmission and distribution of electricity	In 2001 the CNPq approved 132 research and development projects involving the investment of 8 million reales by the fund. In 2001 an association agreement was signed between the National Electric Power Agency and the CNPq to promote cooperation between research centres and enterprises. Total expenditure between January and November 2003: 8,397,738
CT-HYDRO Sectoral fund for water resources. Instrument whereby established: Law No. 9993 of 2000	Reduction of disparities between regions through investments in science and technology activities of importance for the sector. Strengthening of water resource sustainability	Made up of 4% of the financial compensation of electricity generation enterprises	Financing of scientific and technological development projects and programmes designed to improve water quality and use. In 2002, 28.6 million reales were invested, of which at least 4 million were for the training of specialized personnel. Expenditure between January and November 2003: 3,735,635.85 reales
CT-MINERAL Sectoral fund for mining. Instrument whereby established: Law No. 9993 of 2000	Promotion of sectoral technological development through support of science and technology activities	Made up of 2% of the financial compensation of mining sector	Financing human capital formation, maintenance of science and technology infrastructure and support installation of high tech research and development laboratories
CT-TRANSPO Sectoral fund for land transport Instrument whereby established: Law No. 9992 of 2000	Strengthening of competitiveness of the sector through research and development programmes and projects	Made up of 10% of the National Roads Department (DNER) income coming from contracts with telephone or communication companies which use transport infrastructure	Financing incorporation of new technologies in the sector. A minimum of 30% of the resources is devoted to support projects in the Northern, North-western and Centre-West regions
CT-SPACIAL Sectoral fund for aerospace industry Instrument whereby established: Law No. 9994 of 2000	Sectoral development through promotion of research and development	Total income coming from licensing and authorizations of the Brazilian Aerospace Agency and 25% of income derived by the commercialization of orbit positions	Subsidizing research and development to create new products and services

(continued)

Appendix 4 (continued)

FUNTEL Sectoral fund for telecommunications Instrument whereby established: Law No. 10052 of 2000	Promotion of sectoral technological development through innovation support	A given percentage of gross income of licensing enterprises and the whole Telecommunication Fiscalization Fund (FISTEL)	Financing of sectoral innovation. SMEs benefit from privileged access to financial support
CT-INFO Sectoral fund for information technology. Instrument whereby established: Law No. 10176 of 2001	Promotion of the competitiveness of the sector through research and development programmes and projects	At least 5% of the gross annual turnover in the domestic IP goods and services market of enterprises producing goods and services relating to information technology which receive fiscal incentives under the law to promote the IP industry	It is estimated that over 50 million reales are spent each year on the promotion of research and development activities in this sector. Expenditure between January and November 2003 was 9,971,983.70 reales
Sectoral fund for health services Instrument whereby established: Law No. 10332 of 2001	To increment sectoral services' quality	Law No. 10168 of the year 2000 lays down the sources of financing for this fund, which receives 17.5% of the resources covered by that law	Financing of research and development activities to promote technical characteristics of equipment and to increase technical expertise of professionals.
Sectoral fund for agribusiness. Instrument whereby established: Law No. 10332 of 2001	To consolidate the competitive position of products of this sector in international markets	Law No. 10168 of the year 2000 lays down the sources of financing for this fund, which receives 17.5% of the resources covered by that law	Financing of research and development and science and technology activities. Expenditure between January and November 2003: 2,140,277.92 reales
Sectoral fund for biotechnology Instrument whereby established: Law No. 10332 of 2001	To be a permanent financing source via subsidies for the Biotechnology and Genetic Resources Programme	Law No. 10168 of the year 2000 lays down the sources of financing for this fund, which receives 7.5% of the resources covered by that law	It promotes ongoing cooperation and networking among research institutes like EMBRAPA, Sao Paulo Biology Institute and Osvaldo Cruz Foundation
Sectoral fund for aeronautics Instrument whereby established: Law No. 10332 of 2001	Strengthening sectoral international competitiveness	Law No. 10168 of the year 2000 lays down the sources of financing for this fund, which receives 7.5% of the resources covered by that law	Promotion of production of scientific and technological innovations

Transversal funds

Funds	Objectives	Origin of financial resources	Activities
FVA "Green and Yellow fund". Instrument whereby established: Law No. 10168 of 2000	Promotion of technological cooperation among universities, research centres and enterprises	Contributions in the form of royalties from enterprises holding user licenses or acquiring technological know-how abroad	A minimum of 30% of the resources is devoted to technological training and modernization in the Northern, Northwestern and Centre-West regions. Expenditure between January and November 2003: 58,071,768.19 reales
CT-INFRA (2002) Infrastructure fund. Instrument whereby established: Law No. 10197 of 2001	Subsidies for maintenance and modernization of the technological infrastructure of public universities and research centres, in order to improve the competitiveness of the production sectors	The fund consists of 20% of the resources allocated to each sectoral fund from the National Technological Development Fund (FNDCT) and from the other funds for financing science and technology activities	In 2002, 100 million reales were provided to create suitable conditions for the execution of science and technology activities in science and technology bodies. The Northern, Northwestern and Centre-West regions are to receive at least 30% of the resources. Expenditure between January and November 2003: 70,284,331.74 reales

(continued)

Appendix 4 (cocluded)

CT-AMAZONIA (2004)	Promotion of research and development in the Amazonian region	At least of 0,5% of income of enterprises specialized in the production of informatics goods and services localized in the free trade area of Manaus	The sectoral fund is part of the project for supporting research and development of the Brazilian informatics enterprises localized in the free trade zone of Manaus.

Source: author's elaboration based on ECLAC, 2004.

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