A resource-based strategy for technological dynamism and social inclusion for Latin America: a discussion in the light of the Mexican experience

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1. Introduction[2]

Latin America faces today a crossroads, as the advances in the globalization impose the need to redefine its position in the world economy for the next decades. After the reform process of the late 1980s and 1990s was implemented some Latin American countries showed important growth results in a range of dimensions: education indexes, income per capita, and exports competitiveness in specific world markets. Also there has been significant advancement in democratization and organization of the civil society. In institutional terms, the level of sophistication of the NSI increased considerably; there have been

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important advances in terms of the variety of agents and the deployment of their functions. Many countries have improved their level of industrialization and today they are considered to be middle income economies. However the growth performance of most countries in the 1990s has been rather disappointing. Besides this unsatisfactory growth performance, equity aspects and social needs constitutes important worrying characteristic of contemporary trends in the region.

The limited achievements of Latin American economies as compared to the success of several Asian economies have highlighted the urgent need that the region have to start building upon a new way of thinking its strengths, and built a new insertion in the world economy. But, what are the analytical tools that it can count upon? The NSI and RSI approaches have been broadly diffused, as well as the 'fitting' innovation policies to strengthen these systems. In both cases the analytical frameworks were though for other context, the central economies environment, and there have been difficulties in adapting them to the region's conditions. Partially this explains the poor achievement obtained and makes clear the need that Latin America has to rethink all these ideas from its own perspective and conditions.

Latin America has important endowments of natural resources and many countries have specialized on manufacturing sectors and got position in world markets. However, natural resources have been mostly seen as a source of funding manufacturing activities and industrialization; to the extreme, this has been seen as a discouragement to look for alternatives for development due to the success of raw materials export. In the last decades, after the crisis of the import industrialization model, there has been an increasing attention to the role of natural resources as an alternative for Latin America. In this direction, Katz (2000) argues that Latin-American countries have restructured in the direction of their underlying 'natural' (static) comparative advantages, making better use of their high quality natural resources (mines, forests, gas and petroleum, agriculture) as well as of the abundant, relatively cheap and unskilled labor. These changes in production specialization came hand-in-hand with concomitant changes in the trade specialization.

Referring to changes in innovation systems, Arocena and Sutz (2005) argument that advances of knowledge in biological fields have provided a new basis for

transformations in the production of goods and services. This may apply to the emergence of innovation systems based on life sciences (bio-innovation systems), which are connected with agriculture and health services. However, until now there has not been an explicit strategy for development considering natural resources. In the last few years, has emerged a new perspective on their contribution to development (de Ferranti, Perry, Lederman and Maloney 2001 Bortagaray 2007, Perez 2008), the most articulated proposal of a strategy for Latin America has been presented by Perez (2008).

Recently, Carlota Perez presented the document titled "A vision for Latin America: a resource-based strategy for technological dynamism and social inclusion", elaborated for ECLA. This document reflects about Latin America's opportunities during the current deployment stage of the Information and Communications Technology (ICT) paradigm, and the installation stage of a new paradigm, which seems to be oriented towards biotechnology, nanotechnology, new materials and new energy sources. It suggests a dual development strategy for Latin American countries – "dual integrated model" – based on science, technology and innovation (STI) for building robust resource based-processing industries and specializing on high added value products. Such a model integrates a top-down strategy of development, which aims at achieving competitiveness on world markets for specialized natural resources-based products, with a bottom-up strategy, which seeks to generate employment and identify and promote wealth-creation activities amongst localities.

As it has been broadly discussed, each paradigm implies not only technological change but also new ways of thinking or a new common sense towards efficiency and innovation, new ways of acting and new institutions (Dosi 1982, Perez 1985 and 2002). In this sense, in order to establish a strategy that benefits from the deployment of a paradigm or takes advantage of the installation stage, it requires the emergence of new social norms and new forms of agents' behavior. In this proposal of a dual strategy, social norms related to STI and forms of behavior acquire a particular relevance.

Social norms are built and change at a slow pace. They are inserted into the social systems that operate inside society, and even more, they influence the forms of behavior from academics, entrepreneurs and other agents, and even society's perception

regarding the STI community.[3] The behavior of agents obeys to social norms, and therefore, while facing paradigm shifts, and even other changes of minor depth, agents tend to reproduce old ways of doing things and observe difficulties in changing their behaviors.

Social norms are influenced by existing incentives. In this way, policy should generate a range of incentives consistent with the paradigm, in order to foster new opportunities, and stimulate change in agents' behavior. Difficulties to generate a new coherent incentives structure could restrict the shift towards new behaviors, and therefore, towards the diffusion of new technologies and the taking advantage of a new window of opportunity. This is why a reflection oriented to taking advantage of a window of opportunity should include the issue of the incentives structure required to induce change amongst agents' behavior and promote new ways of thinking and acting. There is limited knowledge regarding the influence of public policy over the shift in established social norms and the behavior of the STI community.

The aim of this paper is to contribute to the discussion of the dual strategy based on natural resources for Latin America proposed by Carlota Perez (2008). It focuses on the required changes of the existing incentives to promote new behaviors among STI agents according to the mentioned strategy, and on other issues related to the viability of such strategy, such as leadership and the building of consensus and governance. This reflection draws on the Mexican case.

The Mexican experience is interesting for different reasons: there are abundant natural resources and important technological capabilities in resource based processing industries, also it has been built capabilities in other manufacturing industries; there has also been a huge effort devoted to the formation of human resources, and recently, STI is flourishing in several regions of the country. Additionally, since 2001 a change has been introduced in the design of STI policy oriented to accelerating the building of technological capabilities and stimulating innovation. The experience of designing and implementing this STI policy and the problems that it has been confronted allow the

[3] An example of existing social norms, which particularly affect the academic community, is the publication of articles in specialized journals of international circulation. Both the actual paradigm of ICT and the paradigm that is emerging require teamwork and a multidisciplinary approach to problems. This demands for other social norms, amongst which links with other agents is particularly relevant.

identification of some caveats associated with the design and implementation of a new strategy.

The content of this document is as follows: after this introduction section 2 raises some doubts about the applicability of the current innovation policy framework to DC context; section 3 presents a brief description of Carlota Perez´s proposal of the dual strategy of development based on natural resources; section 4 synthesizes efforts that have taken place in Mexico during the last decade to design and implement a new STI strategy; section 5 reflects over such experience on topics related to the structure of incentives and the behavior of agents, the definition of leadership, the conditions to ensure the governance of the National System of Innovation (NSI) and the construction of consensus between agents. Section 6 contains final reflections.

2. Current innovation policy framework and developing countries context

From the systems-evolutionary perspective there were significant advances in the approaches to STI policies. International organizations have adopted many of its ideas and integrated them in an analytical framework for the so-called 'innovation policy', which has been diffused in developing countries. However, there is still a lack of understanding about how to apply this framework in developing countries settings, particularly Latin American and African countries. (Dutrénit et al 2007, Kaplan 2008)

There are at least two features of these countries' NSI that may affect whatever policy making and implementing processes is attempted: (i) there is neither the required amount of STI capabilities nor the diversity of agents, or in other words they have not acquired a critical mass of these capabilities, and (ii) the links between the agents are limited. Therefore, the initial conditions are different from those of the developed countries whose structural features and experiences have been taken into account for building such analytical framework. Several studies have documented the weaknesses of the NSI in these countries (Cimoli 2000, FCCT 2006, Lorentzen 2009, Cassiolato, Lastres and Maciel 2003, Lall and Pietrobelli 2002, Muchie, Gammeltoft and Lundvall 2003, Oyelaran-Oyeyinka 2006), and other have focused on the flaws of STI policy

design and implementation (FCCT 2006; Velho 2005; Chudnovsky, Niosi and Bercovich 2000; Vonortas 2002, Mani 2004, Kaplan 2008).

In current decade there have been a wave of evaluations of the NSI and their innovation policy, which were based on international methodologies developed by OCDE, European Commission, BID, etc. The most consistent worldwide evaluations have been the reviews by OCDE of the NSI of several countries, such as China, Mexico, Chile, New Zealand, Hungary, Korea and others. A set of recommendations for the innovation policy has been issued to strengthening the NSI. Which is tricky is that the same type of recommendations are given to developing countries as well as to more advanced economies like Belgium, Spain, France, Finland or even UK.

Mexico, like other countries, has followed recommendations by OCDE, BID and European Commission, as described in Section 3 and 4, but the results of implementing those recommendations are far from those expected. Why Mexico cannot reach better results? Is there a problem with the policy design? Is there a problem with the policy implementation? It is difficult to give a simple answer to this question, as the problem is complex one and depends on a set of factors. However, there are some issues that can make a contribution to explain these 'failures'.

First, these recommendations are based on an analytical framework that was designed according to countries that have more mature NSI or bases of experiences of successful countries, like Korea. Then, the focus is located more on the increase and mould of a critical mass of STI capabilities than on the creation of this critical mass to generate endogenous processes. In the same line, the policy in this arena is defined as innovation policy and not as STI policy. Even though innovation policy includes programs to strengthen science and technology, the message that is sent is that innovation goes first. If a country has the critical science and technology bases, then it is possible to focus on innovation, but if not, then it is still necessary to strengthen science and technology to generate the critical mass at the same time that innovation is fostered. In this sense, it would be more appropriate to call it STI policy so that the right message is given. Second, as discussed in section 4, the resources allocation shows a different set of implicit priorities that rule the policymaking process. This is related to programs that cannot be eliminated without a conflict with the scientific community, like the funding

for basic science, the productivity programs for researchers, and the postgraduate scholarships. This brings about an old discussion about implicit/explicit STI policies in Latin American (Velho 2005). Third, as it is discussed in section 5, implementation was affected by: a low public investment on STI, slow changes of the institutional set-up for the public research system, and governance and coordination between multiple new agents.

Concerning to the first issue, it is related in some way with general features of the developing world, which are present in Mexico and not considered in the analytical framework of innovation policy: inequity (unequal income distribution, high poverty level and low level of satisfaction of basic needs); immaturity of the democratic processes and of the civil society; only recent macro stability after long periods of disequilibrium and instability; immaturity of the institutions and the whole institutional set-up; persistence of failures in the markets functioning and regulation processes; and huge unbalances in different economic and social dimensions. In the case of the STI arena it is important to consider: the lack of a social contract for STI; poor endowment of scientific and technological capabilities to generate endogenous processes; the presence of most of the NSI's agents, however they do not entirely play their functions; and emergence of new agents and lack of a shared vision generate a very slow process of governance building.

As discussed in more detail in sections 4 and 5, these features contribute to explain why STI are not a national priority. In fact, there is a set of needs (food, health, housing, security) that is much more urgent for politicians than the investment in STI when the federal budget is being negotiated; short-term decisions has been privileged over long-term goals; there have been difficulties to change agents´ behavior and create new social norms (agents react slowly to new incentives because they are confident that few changes will last); and there are unbalances in the evolution of science and technology, on one side, and innovation, on the other, that make it difficult to generate co-evolutive processes (Dutrénit et al 2007, Avnimelech and Teubal 2006).

Do the policy models take into account these initial conditions? To what extend can Mexico copy the policy design of Germany, France or US, or even Korea and China? What is clear is that there is an urgent need to think in a more appropriate policy design

that starts from the problems of the developing countries world. In this sense, the proposal of Perez (2008) is a contribution in this direction.

3. A natural resource-based strategy for the development of Latin America

Perez (2008), titled "A vision for Latin America: a resource-based strategy for technological dynamism and social inclusion", examines actual trends in globalization and in the diffusion of the ICT revolution, and discusses Latin Americas' potential to enter into a new paradigm, which has begun to be installed. She proposes a dual strategy for development. This section outlines her ideas.

The document points out that given the globalizations' recent evolution, Latin America faces two important challenges. The first one is competition with China and other Asian countries in global markets, and the second is the uneven distribution of income, and high poverty levels that rule the region.

Asia is a very densely populated continent with a relatively low endowment of natural resources. It has several advantages over Latin America in the fabrication of high volume and low cost products, generally produced through cheap labor-intensive assembly processes. In contrast, Latin America has abundant natural resources and energy, which offers the opportunity to specialize in processes industries based on these resources. In the face of the scarcity of raw materials in Asian countries relative to their need of growth (e.g. China and India) and the increase in international food prices (cereals, processed food, etc), Latin America could become the supplier of raw materials, food and other agricultural goods (from the most standard to the most sophisticated custom-made products) for the rest of the world.

Concerning the ICT paradigm, it is in the deployment stage; the globalization process and the ICT revolution have brought with them the hyper-segmentation of three key areas: markets, value chains and technologies. These processes are in the base of the proposed strategy.

The hyper-segmentation of markets refers to the fact that 'the ICT revolution has led to a refined fragmentation of all markets, not only in manufacturing but also in raw materials and services'. This is expressed in the appearance of upper layers of products in most markets, which are produced under conditions that allows associating them to the 'special', the 'unique' or the 'custom made'. From the standpoint of production, the ICT open opportunities to produce at lower scales than those allowed by mass production. This creates quasi-monopolistic conditions that would allow the steady maintenance of high prices. Perez (2008) argues that new opportunities are opened to specialize on "premium" natural resources based products directed to local and global niches.

The hyper-segmentation of value chains refers to the fact that ICT have created optimal conditions to allow the coordination of activities of different firms integrated into global chains. This greater ease of coordination generates, as a counterpart higher motivation of global corporations to grant autonomy and incentives to their subsidiaries to innovate, foster local advantages, achieve higher positions in the value chains and shift the export profile of countries. She asserts that this opens spaces for mutually beneficial negotiations with host governments to increase the quality of employment and of activities locally developed.

The hyper-segmentation of technologies is associated with an increase of specialization in high technologies and its coexistence with traditional methods. In other words, ICT allows the coexistence of a greater diversity of technologies. This opens spaces for global corporations to focus on their core technologies and outsource with specialized suppliers the components they do not wish to produce. She argues that this unlocks many opportunities for small local firms, which supply specialized services.

As Perez (2008) argued, today, in the deployment stage of the ICT paradigm, it seems that future revolutionary industries will be a combination of biotechnology, nanotechnology, bioelectronics, new materials and new energy sources, modeled socially by increased interest and concern about the environment. These technologies can be broadly related to natural resources based process industries. During the actual period of installation of the new paradigm, these technologies would tend to develop in connection with some existent leading industries.

Facing the challenges and opportunities put forward by the new paradigm, as well as by the hyper-segmentation processes associated with the ICT, the document states that a window of opportunity for Latin America appears. It is argued that there is a quite clear possibility to now start a capability improvement process, aimed at preparing to enter the next technological revolution, by using current raw material exports as a platform and source of funding. In order to grasp this opportunity it proposes a 'dual integrated model' for Latin America, based on two strategies. The first one is to promote, from the top, competitiveness in world markets. This strategy would be oriented to the activation and strengthening of the economies' growth engines by providing the resources that make the model viable. The second is to support, from the bottom, wealth-creation activities at local level to generate employment and reduce poverty. This dual strategy cannot be implemented only by means of the market; even though it cannot be imposed with efficacy by the government, it requires strong governmental leadership.

As every development strategy, it demands a long-term effort. The objectives should consider the gradual migration towards products with increasing added value, with characteristics each time more specialized and custom-made for the clients, and the establishment of strong innovation networks (with participation of firms and local, national, continental and international universities).

In order to accomplish all of the objectives, the strategy demands a complementary effort amongst different agents to promote some labor-intensive industries, such as construction, health and personal services. To achieve this, it is required to strengthen the knowledge and the accumulated 'know-how' of each country regarding their current export products to move technologically upstream, downstream and laterally.

The document recognizes that this dual strategy also requires the development of a process of consensus building amongst agents aiming at the convergence of actions; moreover, the 'State or Market' dichotomy is obsolete and results counterproductive.

The proposal is suggestive, and as such it needs to be discussed broadly in the region. There is a set of critical issues that emerge, looking at the design and implementation of

such a dual development strategy, which would allow Latin America to take advantage of the window of opportunity that emerges from the new paradigm.

- The "dual integrated model" is a dual long-term development strategy. It requires the integration of several objectives that historically have been regarded as a trade-off: those oriented towards increasing competitiveness and those oriented towards reducing poverty. Both should be articulated from the set-up.
- It is required to reorient technological capabilities and the formation of human capital. The accumulated technological capabilities should be reoriented towards export markets of the processes industries, and towards local, national and global niches. This requires an intensive learning process at three complementary levels: learning in the public sector to develop capabilities to lead the process, learning in the business sector to gradually increase its innovative capabilities; and learning, updating and adapting of the education and public research systems. The knowledge production and the formation of human capital have to be reoriented to the needs of new markets.
- As Perez (2008) points out, "development opportunities are a moving target, and development strategies are temporary". In this sense, there is an urge to discuss, generate agreement and reorient institutional and technological capabilities to seize them. This is why it is fundamental to generate consensus amongst agents, which implies the creation of effective policies to ensure cooperation of all the involved agents (public and private, scientists and entrepreneurs, local and national), as well as the coordination of policies and the negotiation of mutually beneficial agreements.
- In the new paradigm, key knowledge areas seem to be biotechnology, nanotechnology, bioelectronics, new materials and new energy sources. The building of capabilities in these areas requires a shift in the way of thinking and acting; behaviors characterized by cooperation, work inside networks, multidisciplinary efforts and teamwork appear to be appropriated and should be promoted.
- Even though it is argued that the source for funding could come from the increase in raw materials prices, commitments of public and private funds are also required.[4]

[4] The present crisis has dropped raw materials prices; but it is too early to know the final impact.

4. Efforts to build a new STI strategy: the Mexican case

Recent experience in designing and implementing a new STI policy in Mexico may contribute to reflect on some of the challenges that the introduction of a new strategy in Latin American countries may confront.

The main efforts of STI policies directed toward the construction of STI capabilities in Mexico are connected with the creation in 1970 of CONACYT, as the agency responsible of promoting STI activities in the country. As in the case of many other similar agencies in the world, the regulatory framework assigns it two roles: policymaker and funding agency. In spite of occupying a crucial position in the NSI, in practice and since its foundation, its intermediary role between the principal (government) and the agent (STI community) has been complicated because of the weakness of the social contract regarding STI in Mexico.[5]

Such weaknesses result, on one hand from CONACYT's 'weak political position' inside the government structure, and on the other, from the historically low public investment in these activities.

4.1 Recent changes of the STI policy

A number of studies have documented that Mexico, similarly to several Latin American countries, has exhibited weaknesses in STI policy design and implementation (FCCT 2006; Velho 2005; Chudnovsky, Niosi and Bercovich 2000; Vonortas 2002). However, the Mexican STI policy has evolved over time. The design of STI policy during the period 2000-2006 benefited from several changes on the regulatory framework and cumulative learning processes from previous experiences, as well as from the adaptation of applied instruments in other countries, particularly from the OECD and Brazil.

[5] See Braun (1993), van der Meulen (2003) and Morris (2003) about the role of intermediary agents, according to the principal-agent theory applied to STI policy.

Amongst the most significant legal reforms we could highlight the Law for the Foment of Scientific Research and Technological Development in 1999, the publication during the year 2002 of the Special Program of Science and technology 2001-2006 (PECYT 2001-2006) – as the main document that guidelines STI policy in Mexico – and later the Science and Technology Law and the new CONACYTs' Organic Law in 2002. These laws include a set of vertical and horizontal mechanisms for the coordination of policies and decisions, such as the budget inter-secretarial committee integrated by vice-ministries with scientific and technological activities, and the National Conference on Science and Technology integrated by STI organisms from state and municipal governments. In addition, during 2002 the Advisory Forum for Science and Technology (FCCT) was created, associated with CONACYTs' Organic Law, an organism integrated by representatives from communities of agents (associations of private industrial and agriculture sectors, and of academics, the most important universities, etc.) to propose policies, programs and budget orientation to CONACYT and hence contribute to the generation of the required consensus for the installation of a modern institutional framework.

The Science and Technology Law of 2002 created the base for a 'State Policy' on the matter; STI received a greater priority under the assumption of an increasing investment and commitment from governmental organisms, as well as the adoption of an integrated budget for STI at federal level. In this manner, reforms from 2002 granted CONACYT greater autonomy and independence from the Ministry of Public Education, where it was previously located, as well as greater coordination powers as head of the NSI. The new CONACYT's Organic Law in particular, located it under the direct command of the President of Mexico, as the head of the National Council of Scientific Research and Technological Development

The principles that shape the new STI model include: (i) the adoption of tighter quality standards and the pursuit of pertinence amongst research and development (R&D) activities in the public research system, which is perceived as a greater orientation towards the solution of national economic and social issues, (ii) the explicit intention to promote the interactivity and coordination amongst NSI's agents, (iii) compromise towards the regionalization of country wide STI capabilities, (iv) the promotion of innovation activities, particularly in the private sector, and finally (v) the creation of

spaces for the participation of large groups of the Mexican society. (PECYT, 2001-2006)

Such objectives translated into the introduction of 60 funds and programs operated by CONACYT, individually or in connection with other organisms and entities. The policy mix includes:

- 17 Sectoral Funds: Operated jointly by CONACYT and ministries or other governmental institutions, which promote the development and the consolidation of STI capabilities according with the strategic needs of each of the participating sectors (e.g. basic research, innovation, energy, agriculture, etc.); they operate as competitive funds.
- 30 Regional Funds: Operated jointly by CONACYT and state and municipal governments, which aim to develop local STI capabilities and fund projects oriented to local needs and conditions, they operate also as competed funds.
- Institutional Funds: This category includes a wide range of instruments – from the development of human resources to strategic projects-, under CONACYTs' direct control. The most important has been the AVANCE program, which seeks to promote innovation amongst private firms (last mile).
- The National System of Researchers: It is one of the STI instruments with more tradition in the country, it was created in 1984 and its main objectives include the promotion of formation, development and consolidation of a critical mass of high-level researchers, mainly inside the public system. It grants pecuniary incentives (monthly compensation) and non-pecuniary (status and recognition) to researchers based on their productivity and quality of their research.
- Post-graduate Scholarships Program: This program was created in 1971 and it grants scholarships to post-graduate students in Mexico and abroad.
- R&D Fiscal Incentives: This has been the most successful instrument to promote R&D activities amongst the private sector between 2001and 2008. The Ministry o Finances has decided the granted amount, which has grown throughout the period to reach 450 million dollars.
- Direct Support to Innovation. During 2009 R&D Fiscal Incentives were substituted by direct support to R&D activities.

The Special Program for Science, Technology and Innovation (PECiTI 2007-2012), introduced by the new administration, provides continuity to the efforts to redirect STI activities. The document, with vision to the year 2030, defines the steps to follow in order to achieve gradual development and consolidation of the NSI in four stages: (i) 2007-2012, strengthen STI capabilities, (ii) 2013-2018, accelerated development, (iii) 2019-2024, competitive consolidation, and (iv) 2024-2030, NSI maturity. This program provides continuity to the strategy from the previous administration, reinforcing weak points. However, there are no significant changes in the funding commitments, which sustain the previous historical trends towards low investment levels in STI.

According to the goals established on the PECYT 2001-2006, gross expenditures in research and experimental development (GERD) in relation to GDP should reach 1.0%. However, recent data obtained from CONACYT (2007) shows the persistence of a significant gap in relation to this target. Both the Federal Expenditures on Science and Technology (FES&T) and the GERD as a percentage of the GDP have leveled at below 0.5%. Figures for 2007 were 3,500 and 4,000 million dollars respectively. The ministries of Public Education and Energy appear to have a greater control over the NSI, since their individual participations inside FES&T are 33% and 18%, respectively, while CONACYT's amount represents 17% (Dutrénit et al. 2008). This has weakened CONACYT's role as coordinator of the NSI.

Aside from budget deficiencies, there are certain remarkable achievements, such as the emergence of new actors and the NSI reconfiguration, the existence of STI capabilities built throughout the country, universities in every state and public research centers in several areas of technology and different states, an increase in the amount of R&D financed by the business sector (from 14.3% in 1993 to 41% in 2005), and successful performances in some specific areas. Actually, recent evidence shows greater technology incorporation by the business sector, with a group of firms achieving some commercial and innovative successes (FCCT 2006; Dutrénit et al. 2008). The emergence of knowledge-based regional productive clusters is also apparent. The system has proved to have the capacity to absorb the new public funding, and the STI policy has shown capabilities to introduce changes in agent behavior, in this sense, sectoral and regional funds have stimulated the reorientation of research groups towards the solution of sectoral and regional problems. R&D fiscal incentives have helped

increase firms' R&D, and the use of competitive funds has stimulated the generation of country wide capabilities to define demands, evaluate and manage projects.

In spite of the achievements, assessment of the Mexican NSI suggests that this system is still rather small and is mainly derived from the 'aggregation' of a number of institutions and public and private organizations operating in a poorly articulated fashion. In spite of improvements in some performance indicators, the bulk of Mexican firms observe their competitiveness to be threatened, given their poor performance in knowledge production and transfer. Similarly, firms face strong difficulties for absorbing knowledge generated by universities, public research centers, and from abroad. The dearth of linkages between knowledge producers and users hinders the articulation required to produce positive and cumulative effects. In addition, current programs in support of innovation remain weak, poorly integrated, and only in 2009 will provide direct subsidies for R&D. Likewise, there is a bias of the public funds towards large firms for which investment in these activities appears more attractive. Resources available to promote innovative capabilities among small and medium-size firms remain limited.

4.2 Challenges

In spite of accumulated improvements since 1999, STI policy faces several important challenges: (i) slowness regarding the institutional reform related to the public research system, (ii) limited public investment in STI activities, (iii) insufficient empowerment of CONACYT as the agent responsible for the NSI governance, (iv) inertias associated to the operation of policy instruments from previous administrations, which hold a large share of the STI budget, (v) a policy mix designs which have not contributed to a coherent incentives structure, thus contradictory incentives allow for opportunist behaviors, and (iv) slow learning processes inside CONACYT due largely to an orientation towards implementation.

Additionally, there have been observed difficulties to build consensus, when STI resources are extremely small and the budget does not grow. There have been of particular importance the tensions generated between funding to science versus funding to innovation, between curiosity-driven science and problem-oriented science, and

between funds managed by federal and regional governments.

According to Van der Meulen (2003: 325), we could characterize CONACYT amongst the agencies which "strongly identify with the scientific community, and monitoring is organized through the evaluation of peers denominated by the scientific community, which also request funding. In such configuration, even when the governments transfer resources, in practice scientists keep control of actions". This has demanded great lobbying work and generation of consensus in the scientific community to change the composition of the budget, which has not been enough.

Recent reforms and the – albeit limited – transformations recorded in the NSI suggest that the current environment may be potentially more conducive to the development of STI activities. There is also a growing awareness and willingness of specific sectors of Mexican society to tap into STI activities in order to achieve some of their long-term socioeconomic development goals. There is strong evidence which suggest that agents are sensitive to the necessity of generating consensus. The Mixed Funds are the result of a concern to favor the regionalization of STI capabilities, and have allowed for learning amongst regions. Further than the observed deficiencies in its design and implementation, since 2000 the STI policy has shifted the incentives, which seek to build new social norms able to lay foundations for strategic behaviors amongst agents.

5. Lessons from the Mexican case[6]

The experience of introducing new STI policy design in Mexico throughout this decade allows the extraction of a set of lessons in relation to the construction of a coherent incentives structure that stimulates shifts amongst agents' behavior, the definition of the leadership for the strategy, the conditions to ensure governance of the NSI and the building of consensus. Such elements should enter into the discussion of any new strategy for Latin American countries.

[6] This section draws on FCCT (2006) and Dutrénit et al. (2008).

5.1 Incentives structure and agents' strategic behavior

The Mexican case shows that putting in practice a new STI policy strategy requires that agents – individuals as well as organizations – that integrate the academic, entrepreneurial, and governmental sectors, adopt new patterns of behavior. In order to accomplish the emergence and reinforcement of such patterns it is necessary to modify the incentives structure and introduce some changes into formal institutions. Both types of changes should be based on the existing legal framework, which should be reformed and operated in a consistent manner. However, a slow pace for change in the legal framework and institutions delays the emergence of new social norms in relation to STI and the new strategic behaviors required.

Features of strategic behavior from agents

The characteristics of the deployment stage of the ICT paradigm, and in the face of possibilities to seize windows of opportunity that could open during the installation stage of a new paradigm, demand changes of the agents' behavior. The Mexican case suggests that some strategic behaviors that appear to be relevant are the following:

- The *business sector*: Assume business risks implied in R&D investment, post R&D and innovation to accent the observed transformation in some segments that tend to link with universities and public research centers in order to generate knowledge, improve the way in which public funding is taken advantage of, and implement new strategies to develop managerial capabilities and business know-how in the case of the small and medium-size firms (e.g. elaboration of business plans, capabilities of negotiation, etc.)
- The *academic sector*: Reinforce the commitment to attend human resources and knowledge generation demands from the business sector and society, improve research's social commitment, and keep and deepen excellence evaluation processes.
- *Public administrations at every level (federal, state, municipal)*: Increase the strategic capacity to design policy; change significantly the coordination with other agents and the global coherence of the policy mix; provide close follow-through to the implementation of policy and prevent changes that could affect the context, the rules and the policies in every required moment; design institutions and incentives

in order to make more flexibly public intervention according to swaps in the demands and requirements from the different agents; and at state level to design and implement more and better instruments to foster STI according to each region. Additionally, the proposal of a dual strategy requires the mixture of top-down and bottom-up policies emanated from regions and localities, which should be compatible and interactive.

- Jointly, *the academic sector and public administrations*: Develop science education programs at the primary level, and science divulgation and other activities to increase the sensitivity of society in relation to achievements obtained by scientific and technological knowledge.
- *Every agent in the NSI*: Build strategic intelligence capabilities, comprehend its position on the system, and develop cooperative strategic behavior with other agents and seek for collective learning from experience. The success of fostering STI will largely depend on the development of collaboration modes amongst agents, and overcoming distrust inherited from past experience, which is particularly relevant amongst universities and public research centers.

The initial conditions to breed and induce these behaviors are diverse in agent type and country. In the Mexican case, there are observed behaviors that point out, in some cases, incipient movements and in others, more decisive action towards strategic behaviors. These shifts have been encouraged and should be reinforced by formal institutions and the incentives structure. These gradual shifts also require an understanding of the strategy by the agents in order to continually adjust their behavior.

Incentives structure and social norms

In order for strategic behavior features to emerge or reinforce, it is necessary to modify the incentives structure. This refers to a set of mechanisms – penalties and rewards – that shape social norms, and determine a set of accepted social norms, in this case associated to STI, over which agents' behavior is built. Some of these norms refer to ways of funding, contracting, promoting and rewarding researchers and firms.

Social conducts are very complex, norms and behaviors that have been taught or have developed through time, play an important role in the construction of a society (Laffont and Martimort 2002). In face of the design and implementation of a new strategy, it is to

be expected that agents tend to replicate behaviors that they have learned as a result of a particular conception of the role of STI in society. This makes difficult the transformation of behaviors towards strategic ones, when STI policies are introduced with new objectives and instruments. However, as agents respond to incentives, their modifications may induce shifts amongst agents' behavior. There are several types of incentives that influence the behavior of the STI community (Puchet 2008):

(i) Economic incentives associated with the policy mix and the budgetary assignation of resources.
(ii) Incentives that change the rules of the game relative to specific STI activities.
(iii) Incentives that modify general aspects of the regulatory framework.

Economic incentives related to the policy mix and budgetary assignations of resources emerge from government intervention based on financial resources, which tend to induce certain social behaviors amongst agents. There is a set of these incentives that change the behavior of agents and hence generate permanent guidelines or behavior (e.g. productivity based rewards to researchers), in other words, they change premises from agents' decision-making processes, and therefore become unquestionable. There are other incentives that only change opportunity costs from decisions related to the realization of an activity, but the conduct disappears if the incentive related to the activity is gone (e.g. scholarships). It is necessary to modify the incentives structure, particularly those incentives that contribute to building new premises for action.

It is necessary to stimulate strategic behaviors for the design and implementation of a new strategy. The Mexican experience suggests that in the case of rewards for researchers based on productivity (so popular today in Mexico and other Latin American countries), it would be convenient to migrate towards the constitution of specific stimulus systems that distinguish several types of activity – scientific research, technological development, high level human resource formation-, with more precise orientation and less generic evaluations. These stimuli should be incorporated in the lines of action defined for the new strategy.

In the case of incentives for universities and public research centers, private firms and state-owned firms, the foment funds could be reoriented towards programs in several stages and aspects of technological development, such as the adaptation, diffusion and transfer of technologies. These funds should privilege the assignation of resources towards collaborative projects amongst agents from the academic and productive sectors, and amongst agents of different regions. In the case of incentives for firms that perform R&D and innovation, it could be appropriate to emphasize the support to small and medium-size firms and processing industries.

The incentives that shift the rules relative to specific STI activities, and those which modify general aspects of the regulatory framework, are normative; they materialize in the introduction of specific norms, which tend to change the rules to which NSI agents are subject. The vast majority of such norms emanates from legal ordinances different form the STI ones, and do not articulate coherently with those incentives associated with the policy mix. They include aspects related to intellectual property, governance, evaluation of universities and public research centers, the creation of technology based firms with the participation of researchers, as well as other normative incentives that emerge from a more general environment and influence not only STI agents, but also those which participate in a wider range of economic activities. Included in these sets are: capital markets regulation relative to portfolio investment and the introduction of risk capital instruments into the stock exchange; labor markets regulatory framework relative to employment stability and qualification of labor; norms that rule the aperture of firms; fiscal operation and the deduction of investment expenditures; regulations related to the use of ICT; and the criteria for public purchases. (Puchet 2008)

The economic and normative incentives configure the incentives structure and regulatory framework for STI, which in turn condition agents' behavior and contribute to the generation of strategic behaviors. The analysis of the integration and the consequences of these normative frameworks over the mentioned behaviors appear to be a crucial task for the implementation of a successful strategy.

5.2 Leadership, governance and the generation of consensus

The Mexican case shows a set of difficulties that emerge for the coordination between local/regional and federal levels, different ministries, academy and private sector, and even within CONACYT between different directions. It was quite difficult to build the required consensus to support the process of change. Efforts to introduce modifications in the incentives structure to generate certain agents' strategic behaviors should have been accompanied by changes in formal institutions and forms of governance.

It seemed particularly important to define more clearly the required features of the regulatory framework, introduce a coherent set of legal reforms and generate consensus about the composition of the organisms in charge of the orientation, approval and implementation of the strategy.

The distinction between legal regulations and formal institutions is pertinent here. The regulatory framework around the NIS is seen as a structured set of rules and norms. Some components of this set emerge from pieces of laws, presidential decrees, regulations and other legal principles of secondary importance. These shape formal institutions as a subset of rules that is used and practiced by agents and organizations. In practice, such a subsystem is formed in an independent manner in relation to those written regulations of different kinds – legal, by decree, regulations, etc. To the formal institutions thus conceived one should incorporate routines, habits, codes of conduct for both agents and organizations that shape the subsystem of informal institutions, referred to above as social norms.

In the Mexican case, the legal reforms from 1999 were a step forward but are still insufficient to provide the formal institutions that could facilitate the new strategy. Even today, the regulatory framework remains insufficient and fragmented and interferes with the NSI's consolidation and development.

A lesson learned from this experience is that it would be useful to distinguish between different roles of leadership. On one side, the representatives of the NSI's main agents should be included as part of the *decision-takers*, and on the other, the *policy-makers* should have the specialized function of designing and implementing the strategy. This distinction has a double purpose: (i) to improve the forms of harmonization between representatives of the main agents and government officials, and (ii) to separate two

different arenas, the political-strategic agreements and the design and operation of the policies.

Three relevant lessons learned from the Mexican case are the following:

- **On the regulatory framework.** An appropriate regulatory framework is required to facilitate the coordination between the regulations set specifically to govern STI activities and the regulations to other activities that somehow overlap (or even comprise) those related to STI, to improve the government organisms, and to facilitate the coordination mechanisms between agents to allow them to agree around the strategy's objectives and lines of action, and to interact.

- **On the leader team.** The process of change should be led by a team integrated by the main decision-takers in STI from the government (ministries with the highest investment in STI), the main universities, the states or cities with larger expenditures in STI, and large private and public-owned firms with large R&D centers. They can have the political and financial capacity to encourage a process of change. This composition of the leader team would empower the strategic decisions with the required autonomy from short-term policies or measures decided by the Executive. At the same time, the involvement of the main agents in the decision about the strategic objectives of the strategy would generate better conditions to induce changes in the agents' behavior towards strategic ones. The leader team would take the long-term decisions.

- **On the STI agency role.** The STI agency can play the role of policymakers of the strategy; experts in design and implementation of STI policies should be called for this role. This team would take the short-term decisions and would be responsible for the implementation and operation side of the strategy. The STI agency, as CONACYT in the Mexican case, should take the strategic coordination of the NSI, which overcome the usual role of a funding agency.

As the installation period of the new paradigm could be short, conditions for rapid learning from the agents are essential. In this sense, the decision-takers should be

convinced about the opportunity for such strategy and, as highlighted by Perez (2008), understand 'that development opportunities are a moving target and that development strategies are temporary and must be updated and reshaped accordingly'. In parallel, policymakers should develop and continuously improve certain skills, such as: interpreting trends; designing an appropriate policy mix, with the flexibility to redesign it as the strategy evolves; understanding the variety of firms, sectors and technologies, and their productive and technological chains, and therefore be able to intervene in the weak points in each moment; and inducing changes within the incentives structure to stimulate new social norms and then to foster the strategic behaviors required in each stage. All these entail a good system of indicators, monitoring and evaluation.

Firms and academy should also develop a learning capacity to adapt to the moving targets. Firms should react promptly to the new policy instruments and academy should develop the capability of response to new demands generated by the new instruments.

This type of strategy requires the generation of consensus between agents, both for the design and start-up as for its sustainability over time. But, such a consensus demands that each agent has a clear idea of what it could win and lose, and of his commitments. The strategy should promote the participation of all the stakeholders through forums, seminars and other activities to take into account their opinions on the results in each strategy stage. The idea of generating a participative society could be called for again. The generation of consensus should be the main feature in the decision taking process, which requires an evolution toward efficient and horizontal forms of NSI governance. In this respect, different levels of coordination are essential: academic sector, business sector and government; national/federal and regional/local policies; private and public sector; objectives of both branches of the strategy; and STI policies amongst others policy arenas.

Even though the generation of consensus and the emergence of new forms of governance are a difficult task and can be seen as a key challenge, what is clear is that only long-term policies based on consensus and the agents commitments can reach cumulative effects and generate the necessary changes in agents' behaviors.

Another challenge refers to the dual feature of the proposed strategy and the need of combining the objectives of the top-down strategy with those related to the bottom-up one. In this sense, the challenge is to be able to articulate an integrative vision of all the national potentialities and demands.

5.3 Resources and viability of the strategy

The recent Mexican experience also illustrates that a successful change of incentives to induce modification in the agents' behavior should go hand in hand with a substantial increase in the STI budget. Changes in the composition of an invariable budget affect agents' interests, and generate tensions that militate against the process of change. Thus, to avoid confrontation in the initial period, it would be better to keep the traditional resources allocation and reorient the additional resources to the new targets of the strategy.

In this context, a successful strategy requires a commitment from the government to increase the budget for STI. Certainly, the private sector should assign concurrent funds, however it is hard to believe that most of the additional resources could come from the private sector, at least during the initial stage.

If additional public funds are imperative in the initial stage, the Ministry of Finances is called on to be involved in this process from the very beginning. It should be involved not only to ensure the increase of public resources and the reorientation of these resources as the strategy evolves along different stages, but also to support the required institutional reforms of the NSI. In other words, the Ministry of Finance should be involved in the governance of the NSI. In the Mexican experience, the lobbying with the Ministry of Finance was not successful in convincing it about the future increase of public income associated with an investment in the designed strategy.

6. Final reflections

Mexican as many other Latin American governments have not believed that STI can stimulate economic growth and solve its problems of unemployment and poverty. There is no clear social contract for STI, and the investment in STI has been extremely reduced over time. In the last decade, agents have observed gradual changes towards the strategic behaviors described above. This suggests the emergence of the minimum conditions to rethink the role that STI and knowledge can play in satisfying social needs and creating welfare. However, it seems that the government lacks clarity about the appropriate strategies and the required consensus.

Concerning to the strategies, Mexico has designed and implemented innovation policy models promoted by international organizations. They were clearly built having into mind the initial conditions of central economies, with a critical mass of science and technology capabilities, several economic and social problems already solved, and still weaknesses on innovation capabilities, which explains the emphasis on innovation alone and not also on science and technology.

The dual development strategy based on both STI for building robust resource based-processing industries and attending the employment generation in the localities proposed by Perez (2008) is very suggestive. First, because it looks at Latin America's endowments, and second because it positions these endowments as potentialities to the new technological paradigm.

However, the design and implementation of this strategy requires breaking inertias and acquiring a long-term vision, generating consensus between the main agents, and taking risks by the local and national governments. This strategy should be supported in the formulation of a long-term public policy, where coordination and governance mechanisms acquire relevance to allow the participation of society. This policy should be designed and implemented with the participation of all the agents – academy, business sector and governments at national/federal and local levels. Its implementation has to be independent of the different administrations in order to give certainty to STI's development.

This new strategy requires additional public resources. The increase of the budget would be the way to reorient fresh resources to new targets while avoiding tensions that could emerge when the same budget is allocated in a different way.

A flexible incentives structure has to be built and to evolve according to the moving targets to avoid opportunist behaviors that can come out when contradictory incentives coexist. A slow rhythm of change of the general framework conditions delays the emergence of new social norms in relation to STI and of the strategic behaviors required for the success of the strategy.

Leadership, consensus and commitments seem to be key features to initiate and sustain a process of change led by a dual strategy of development for Latin America. If the main agents are involved in the decision-taking process, it is more likely that they are going to fulfill the required commitments. Long-term policies based on leadership, consensus and commitments of the main agents can breed cumulative effects and generate changes in agents' behaviors, which feedbacks this process and produces endogenous dynamics.

Thus, the emergence and evolution of such a strategy depend on the initial commitments, the joint efforts of the main agents and the building of a cooperative dynamic between them. Four aspects seem to be extremely important for the success of this process:

1. An explicit agreement between all the agents about the objectives and lines of actions of the dual strategy.
2. An agreement between the main agents and the government about the composition and role that the leader team of the strategy can play.
3. A commitment of the Executive, jointly with the Ministry of Finance, to assign additional resources to the STI budget and to allow the reorientation of these resources according to the stages of the strategy.
4. An agreement with the Congress to approve the budget suggested by the Executive.

Gradually over time, the progress of the strategy will generate a reduction of the need for additional public resources, as innovation is endogenized and catalytic attribute of the STI policy emerge (Teubal 1997; Avnimelech and Teubal 2008). In addition, an increase in tax collection is expected, associated with the increase of the economic activity. All this will reduce the pressure on the public resources, changing the composition of the STI budget on the private sector.

References

Antonelli, Cristiano. 2005. "Models of knowledge and systems of governance." *Journal of Institutional Economics* (1) 51-73.

Arocena, Rodrigo and Judith Sutz. 2005. "Innovation systems based on life sciences: Towards a study by means of constructive approaches . Innovation: management, policy and practice", Vol. 7 (2-3), p. 310-321.

Avnimelech, G. and M. Teubal. 2006. "Creating VC industries which co-evolve with High Tech: Insights from an Extended Industry Life Cycle (ILC) perspective to the Israeli Experience", *Research Policy*, 35(10), 1477-1498.

Avnimelech, Gil and Morris Teubal. 2008. "From direct support of business sector R&D/innovation to targeting venture capital/private equity, A Catching-Up Innovation and Technology Policy Life Cycle Perspective." *Economics of Innovation and New Technology* 17 (1&2), 153-172.

Bortagaray, I. 2007. "The building of agro-biotechnological capabilities in small countries: The cases of Costa Rica, New Zealand and Uruguay", Georgia Institute of Technology.

Braun, Dietmar. 1993. "Who governs intermediary agencies? Principal–agent relations in research policy-making." *Journal of Public Policy* 13 (2), 135–162.

Casas, Rosalba. 2005. "Exchange and knowledge flows between large firms and research institutions." *Innovation: management, policy and practice* 7 (2–3), 188-199.

Cassiolato, José E., Helena M.M. Lastres and Maria Lucia Maciel (ed). 2003. Systems of Innovation and Development. Evidence from Brazil. Edward Elgar: Cheltenham.

Chudnovsky, Daniel, Jorge Niosi and Néstor Bercovich. 2000. "Sistemas nacionales de innovación, procesos de aprendizaje y política tecnológica: una comparación de Canadá y Argentina." *Desarrollo Económico* 40 (158), 213-252.

Cimoli, M. (ed.). *Developing Innovation Systems, Mexico in the Global Context*. London: Pinter Publisher.

CONACYT. 2002. Programa Especial de Ciencia y Tecnología, 2001-2006 (PECYT). Mexico: CONACYT.

CONACYT. 2007. Programa Especial de Ciencia, Tecnología e Innovación (PECiTI), 2007-2012. Mexico: CONACyT.

de Ferranti, D., G. E. Perry, D. Lederman and W.F. Maloney. 2001. From Natural Resources to the Knowledge Economy: Trade and Job Quality, World Bank: Washington DC.

Dosi, Giovanni. 1982. "Technological paradigms and technological trajectories". Research Policy 11, 147-162.

Dutrénit, Gabriela and Alexandre O. Vera-Cruz. 2009. "Innovation policy and incentives structure: learning from the Mexican case". In Drechsler, Wolfgang, Rainer Kattel and Erik S. Reinert (ed). *Techno-Economic Paradigms: Essays in Honor of Carlota Perez*. ANTHEM PRESS.

Dutrénit, Gabriela et al. 2007. "Coevolution of science and technology and innovation: a three stage model of policies based on the Mexican case." In Susan E. Cozzens and Elena Berger Harari (eds). *Atlanta Conference on Science, Technology, and Innovation Policy*, Piscataway, NJ, USA: IEEE, Spring (forthcoming).

Dutrénit, Gabriela et al. 2008. *The Mexican National System of Innovation: Structures, Policies, Performance and Challenges*, Background Report to the OECD Country Review of Mexico's National System of Innovation. Technical Report. Mexico: CONACYT.

Dutrénit, Gabriela, Fernando Santiago and Alexandre O. Vera-Cruz. 2006. "Influencia de la política de ciencia, tecnología e innovación, sobre los incentivos y comportamiento de los agentes: lecciones del caso mexicano." *Economía, Teoría y Práctica* (24), 93-118.

FCCT. 2006. *Diagnóstico de la política científica, tecnológica y de fomento a la innovación en México (2000-2006)*. Mexico: Foro Consultivo Científico y Tecnológico.

Kaplan, David. 2008. "Science and Technology Policy in South Africa: Past Performance and Proposals for the Future", Science, Technology and Society, Vol. 13 (1).

Katz, Jorge and Giovanni Stumpo. 2001. "Regímenes sectoriales, productividad y competitividad internacional." *Revista de la CEPAL* (75), 137-59.

Katz, Jorge. 2000. *Reformas Estructurales, Productividad y Conducta Tecnológica en América Latina*. Santiago de Chile: CEPAL/Fondo de Cultura Económica.

Laffont, Jean Jacques and David Martimort. 2002. *The Theory of Incentives: The Principal-Agent Model.* Princeton: University Press.

Lall, S. and C. Pietrobelli. 2002. *Failing to Compete. Technology development and technology systems in Africa*, Edward Elgar.

Larédo, Philippe and Philippe Mustar (eds). 2001. *Research and Innovation Policies in the New Global Economy.* Cheltenham: Edward Elgar.

Lorentzen, Jo. 2009. Learning by firms: the black box of South Africa's innovation system, Science and Public Policy, Vol. 36 (1), 33-45.

Mani, Sunil. 2004. "Government, innovation and technology policy: an international comparative analysis", *International Journal of Technology and Globalisation*, Vol. 1. (1), 29-44.

Morris, Norma 2003. "Academic researchers as 'agents' of science policy." *Science and Public Policy* 30 (5), 359-370.

Muchie, M., Gammeltoft, P. and Lundvall, B.A. (eds). 2003. *Putting Africa First. The making of African innovation systems*. Aalborg University Press.

Murmann, **Johann Peter** 2003. "The Coevolution of Industries and Academic Disciplines." Working paper WP03-1. Northwestern University: Kellogg School of Management,

Nelson, Richard. 1995. "Coevolution of industry structure, technology and supporting institutions, and the making of comparative Advantage." *International Journal of the Economics of Business* 2 (2), 171–184.

Oyelaran-Oyeyinka, B. 2006. *Learning to Compete in African Industry. Institutions and Technology in Development*. Aldershot: Ashgate.

Perez, Carlota. 1985. "Microelectronics, Long Waves and World Structural

Change: New Perspectives for Developing Countries." *World Development* 13 (3), 441-463.

Perez, Carlota. 1996. "La modernización industrial en América Latina y la herencia de la sustitución de importaciones." *Comercio Exterior* 46 (5), 347-363.

Perez, Carlota. 2001. "El cambio tecnológico y las oportunidades de desarrollo como blanco móvil." *Revista de la CEPAL* (75), 115-136.

Perez, Carlota. 2002. *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages.* Cheltenham: Edward Elgar.

Perez, Carlota. 2008. "A vision for Latin America: a resource-based strategy for technological dynamism and social inclusion", Paper prepared under contract with the ECLAC Program on Technology Policy and Development in Latin America, CEPAL, Santiago de Chile.

Puchet Anyul, Martín and Pablo Ruiz. 2008. "Aspectos económico institucionales del marco regulatorio mexicano del sistema nacional de innovación", *Revista REDES* (forthcoming).

Puchet Anyul, Martín. 2008. "Incentivos, mecanismos e instituciones económicas presupuestas en el ordenamiento legal mexicano vigente para la ciencia y la tecnología." In Giovanna Valenti (ed). *Ciencia, tecnología e innovación. Hacia una agenda de política pública*. Mexico: FLACSO, 169 – 190

Sanz-Menéndez, Luis et al. 2007. Evaluación de la política de I+D e innovación de México (2001-2006), Informe final del Panel Internacional Independiente. Mexico: CONACYT/ADIAT.

Smits, Ruud and Stefan Kuhlmann. 2004. "The Rise of Systemic Instruments in Innovation Policy." *International Journal of Foresight and Innovation Policy* 1 (1&2), 4-32.

Teubal, Morris. 1997. "A Catalytic and Evolutionary Approach to Horizontal Technological Policies." *Research Policy* 25, 1161-88.

Teubal, Morris. 2002. "What is the Systems of Innovation (SI) Perspective to Innovation and Technology Policy (ITP) and how can we apply it to developing and industrialized economies?" *Journal of Evolutionary Economics* 12, 233-257.

Van der Meulen, Barend. 2003. "New roles and strategies of a research council: intermediation of the principal-agent relationship." *Science and Public Policy* 30 (5), 323–336.

Velho, Lea. 2005. "S&T institutions in Latin America and the Caribbean: an overview." *Science and Public Policy* 32 (2), 95-108.

Volberda, Henk W. and Arie Y. Lewin. 2003. "Coevolutionary dynamics within and between firms: from evolution to coevolution." *Journal of Management Studies* 8, 2111–2136.

Vonortas, Nicholas S. 2002. "Building competitive firms: technology policy initiatives in Latin America." *Technology in Society* 24, 433-459.

Walker, M. and Jourdan, P. 2003. "Resource-based sustainable development: an alternative approach to industrialisation in South Africa", Minerals & Energy - Raw Materials Report, Vol 18 (3), pp. 25-43.