OECD Reviews of Innovation Policy

MEXICO

Overall Assessment and Recommendations

(Draft-3nd revision)

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OECD REVIEW OF MEXICO'S INNOVATION POLICY

Overall Assessment and Recommendations

Foreword

This synthesis report summarises the main findings of the OECD review of Mexico's Innovation Policy.[1] The review was requested by the Mexican authorities, represented by the National Council for Science and Technology (CONACYT), and was carried out under the auspices of the OECD Committee for Scientific and Technological Policy (CSTP), as part of its new programme of country reviews of innovation policy.[2]

This report provides the Overall Assessment and Recommendations of the review and is based on information collected from various sources:

- Interviews conducted by the OECD Review Team in Mexico in mid-November 2007 with a variety of stakeholders of the science, technology and innovation (STI) system: federal and state governments, officials responsible for relevant policies and programmes, representatives of the enterprise sector and public research institutions (universities and research centres), parliamentarians, non-governmental organisations, and independent experts.
- A background report prepared under the responsibility of CONACYT, with comprehensive information on the governance, design, financing, implementation and outcomes of Mexico's policies and programmes in support of science, technology and innovation.
- Official documents such as CONACYT Annual Reports and the draft Special Programme for Science, Technology and Innovation (PECITI 2007–2012).
- OECD knowledge regarding STI policy practices in member and non-member countries and its experience with STI policy assessments.[3]

This report, which has benefited from a peer review process within the OECD,[4] is structured as follows.

- Section 1 provides an overview of Mexico's main socio-economic challenges and the need for sustained improvement of its innovation performance.
- Section 2 examines the main characteristics of the Mexican STI system from a double viewpoint: on the one hand, the achievements of recent policy initiatives as well as assets on which future policy development should build; on the other, the structural and institutional weaknesses that continue to affect the system's performance and call for policy reform, notably as regards governance, funding instruments and schemes in support of the public and private sectors, as well as issues stemming from imbalances in the policy mix.

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1. All the factual evidence and analytical material that underpin the current assessment and recommendations will be presented in the full report on the detailed results of the review to be published by the OECD later this year.
2. Countries reviewed to date are: Chile, China, Luxembourg, New Zealand, Norway, South Africa and Switzerland. The reviews of Greece, Hungary, Korea, Russia and Turkey are under way and a number of others are expected to be launched in 2008-09.
3. Including lessons learned by some members of the OECD team in the framework of their participation in the International Panel entrusted by ADIAT in 2006 to carry out an evaluation of Mexico's R&D and innovation policy during the period 2001-06 (ADIAT/CONACYT, 2007).
4. The two examiners were Luis Sanz, Professor at CSIC (Spain) and Chair of the OECD Committee on Scientific and Technological Policy (CSTP), and Patrick Vock, Director of CEST (Switzerland) and Chair of the CSTP Working Party on Technology and Innovation Policy (TIP).

- Against this background, Section 3 highlights the main strategic objectives for innovation policy in Mexico. It then formulates a set of guiding principles for policy design, management and implementation, presents the main institutional options for improving the governance of Mexico's STI policy, and concludes with specific policy recommendations for enhancing Mexico's innovation performance and its contribution to the country's sustainable economic and social development.

1. Fostering innovation to boost Mexico's socio-economic development

Preamble

Over the past decade, Mexico has made significant progress towards macroeconomic stability and has launched important structural reforms to open the economy further to trade and investment and improve the functioning of markets for goods and services. However, potential GDP growth remains much too low to bridge the wide gap in living standards with wealthier OECD countries and reduce widespread poverty. Mexico increasingly struggles to compete with many other large emerging economies, which are building their capabilities to harness the benefits of globalisation at a much faster pace. Indeed, China overtook Mexico in 2003 as the United States' second largest trading partner after Canada.

One important reason is that Mexico has been slow to realise the importance of investment in innovation as a driver of growth and competitiveness (see Box 1). OECD analysis has revealed the strong links between innovative capabilities and economic growth. Losing competitiveness in knowledge-based activities can become a self-reinforcing process that is increasingly hard to reverse because weak innovation capabilities limit the opportunities offered by international spillovers from competitors' growing investment in knowledge.

To provide the Mexican economy with stronger, sustainable growth, renewed efforts at reform are needed on a broad front, motivated by a sense of urgency and vision and backed by strong political commitment and leadership.

To create an innovative Mexico able to meet citizens' growing needs and aspirations (higher standard of living, improved health, better security and environment, enriched cultural life, etc.), the government should commit to setting its policies in line with this objective and should back business strategies and civil society initiatives in order to stimulate all forms of individual and collective creativity and innovation. Boosting investment in human capital, particularly in education, and fostering innovation in the business sector will be crucial to achieving this goal.

This report focuses on the economic aspects of moving towards a broad and ambitious innovation agenda. In addition, while underlining the importance of many areas of public policy that shape the framework conditions for innovation (*e.g.* macroeconomic, education, competition, labour market and entrepreneurship policies), it concentrates on the role of science, technology and innovation policies *stricto sensu* (*e.g.* public support to R&D, promotion of innovation in small and medium-sized enterprises [SMEs], measures to better link science with business), whose primary and explicit objective is to enhance innovation capabilities in the public and private sectors.

1.1 Economic performance and new challenges

Improved macroeconomic management, yet insufficient growth of GDP per capita

Mexico has benefited significantly from reforms undertaken over the past two decades to liberalise its economy and improve macroeconomic management. It has made considerable progress in achieving macroeconomic stability; since the 1995 peso crisis Mexico's GDP growth has been reasonable, averaging 3.6% a year. Yet, in recent years its growth performance has been weaker than that of Latin America's more dynamic economies such as Brazil and Chile and economic growth has not been sufficient to help move per capita output to the level of the more advanced OECD economies (Figure 1). GDP per capita is still the second lowest among OECD countries (after Turkey), largely owing to lagging labour productivity (as measured by GDP per hour worked).[5] In addition, the productivity gap *vis-à-vis* the best-performing countries has not been narrowing. In fact, Mexico's labour productivity growth has been one of the lowest

5. The small remaining gap is accounted for by a relatively low labour utilisation rate.

among OECD countries since 2000 (Figure 2). It is therefore a key objective of Mexico's economic policy to foster productivity gains and put the economy on a sustainable path of higher growth.

Box 1 Innovation-fuelled growth: new empirical evidence and policy initiatives

In the last decade a series of major OECD projects,[1] drawing on an expanding body of literature, have contributed to an emerging consensus among policy makers around the critical importance of innovation among the factors determining economic performance. In May 2007, the OECD Ministerial Council Meeting, recognising the growing importance of this policy area, mandated the Organisation to develop an *Innovation Strategy* to help member countries to devise more efficient policies to strengthen innovation as an engine of growth.

In an increasingly global economy, innovation has become the key driver of growth and competitiveness

Most of the rise in living standards since the Industrial Revolution has been the result of new and improved products, processes and services. However, innovation has now become even more important for a wider spectrum of economic and social activities. Globalisation is forcing all countries to move their economic activity further up the value chain to ensure that they can continue to compete and prosper. Continued leadership, but also the capability to catch up, will therefore come from staying a step ahead of the competition in higher value-added elements of the economic process. Economic research provides new empirical evidence of this tightening relationship between innovation capability and economic success at both the macro (aggregate) and micro (firm) level:

- *At the macro level*, about half of the cross-country differences in per capita income and growth is due to differences in total factor productivity (TFP), which in turn is mainly driven by technological development and innovation, with a strong influence of R&D (World Bank, 2007). Recent empirical research (Coe *et al*., 2008) confirms the role of both domestic and foreign R&D capital as significant determinants of TFP. Human capital and institutional factors, notably those that condition the efficiency of national innovation systems (NIS), also have a significant impact on TFP. Moreover, countries where doing business is facilitated and quality of tertiary education is high tend to derive more benefits from domestic R&D, from R&D spillovers from abroad and from human capital formation.
- *At the micro level*, it has been demonstrated that in all sectors of activity, from high-technology to the more traditional resource-based industries, *innovative* firms exhibit better performance and create more and better jobs. For example, recent OECD analysis of innovation at the firm level (OECD, 2008a) shows that product innovation increases business firms' labour productivity: in a sample of 16 OECD countries plus Brazil, productivity is higher in firms with more sales of innovative products per worker in almost all countries, and especially in Korea, New Zealand and Brazil.
- *From microeconomic to macroeconomic performance.* For business innovation to translate into better macroeconomic performance, structural change is required to shift resources from non-innovative towards innovative firms irrespective of the industry. In successful countries the government facilitates such processes by providing favourable framework conditions and specific support to induce more companies to enter the "innovation game" in the first place, and to provide incentives to already innovative companies to invest even more in innovation. The OECD study shows that firms that receive financial support from government or engage in co-operation (with other firms and/or public research institutes) invest more in innovation.

Most countries, including the largest emerging economies, have raised the ambition of their innovation policy

The importance of innovation is recognised across the OECD (*e.g.* the EU–Lisbon agenda, the US competitiveness agenda, Japan's Innovation 25, Australia's Backing Australia's Ability, Finland's and the United Kingdom's New Innovation Strategy, etc.). Most importantly a number of emerging economies (China,[2] India, Russia, Brazil and South Africa,[3] but also Chile,[4] Turkey and new EU member countries) are stepping up their efforts to complement their traditional comparative advantages with new ones based on own R&D and innovation. Success in creating their own R&D base will not only enable these countries to boost their competitiveness directly, but will also allow them to maximise the benefits from monitoring, accessing and using knowledge created through massive investment elsewhere in the world.

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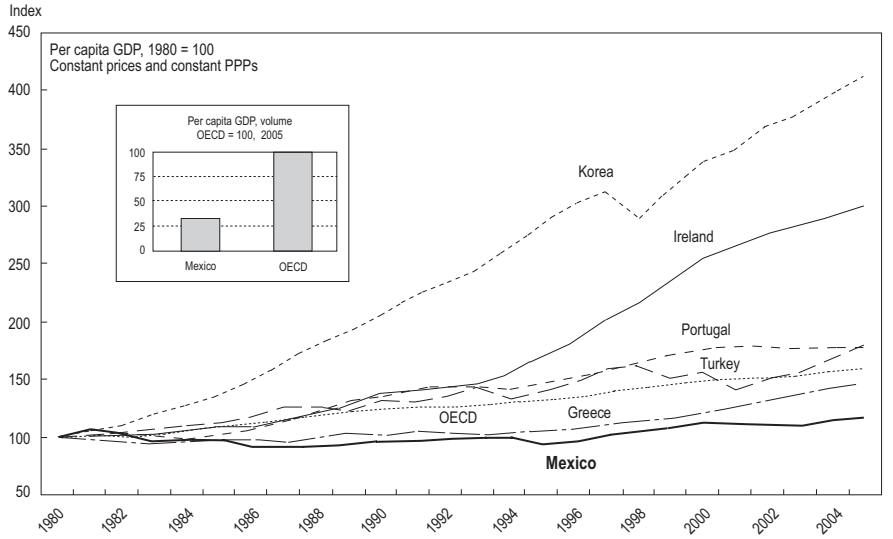
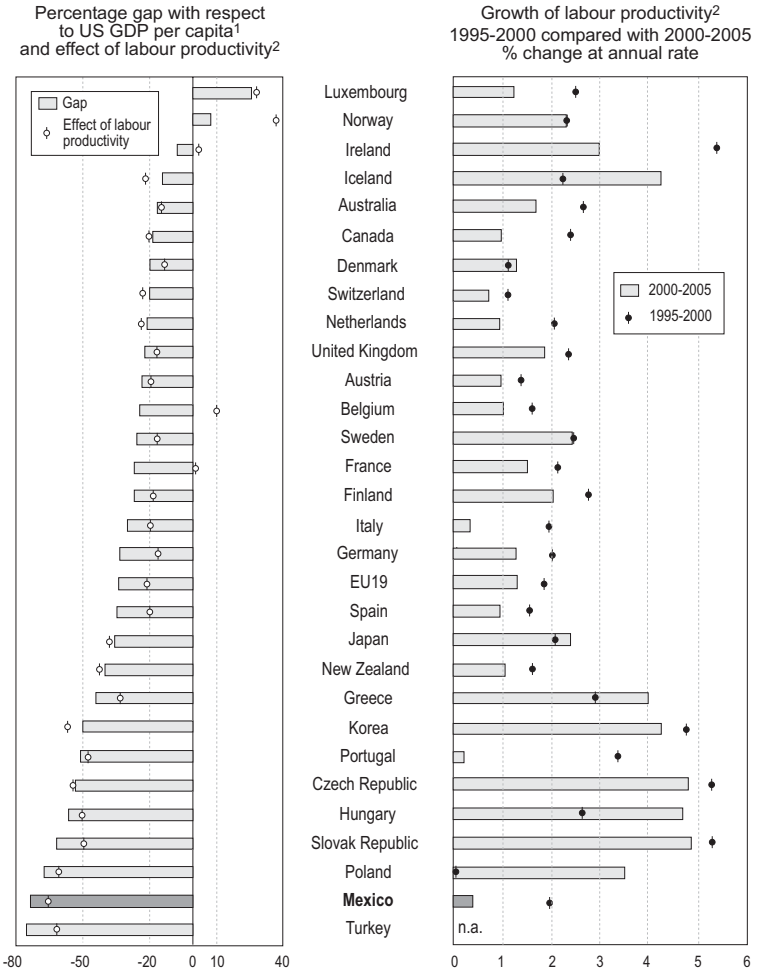
1. *E.g.* the Technology and Economy Programme, the Job Strategy and the Job Study.
2. See *OECD Reviews of Innovation Policy: China* (2008b, forthcoming).
3. See *OECD Reviews of Innovation Policy: South Africa* (2007a).
4. See *OECD Reviews of Innovation Policy: Chile* (2007b).

Figure 1 Per capita GDP - Mexico's performance in comparison



Source: OECD Economic Surveys: Mexico, OECD (2007).

Figure 2 The sources of real income differences, 2005



Note: 1. Based on year 2002 purchasing power parities (PPPs); 2. Labour productivity is measured as GDP per hour worked.
Source: OECD.

High growth in manufactured exports and successful integration in global value chains …

One of the main drivers of economic growth has been Mexico's opening to international trade and investment. Along with other important – albeit often incomplete – structural reforms, trade liberalisation was initiated in the mid-1980s with Mexico's accession to the World Trade Organization and was enhanced in the context of NAFTA (North American Free Trade Agreement). It has had a profound impact on the structure of the Mexican economy. Largely owing to the opportunities provided by NAFTA and the Maquila/Pitex programmes, Mexico has recorded high growth in manufacturing exports, mainly to markets in the neighbouring United States. The share of trade in gross domestic product (GDP) has doubled over the last 20 years, with the share of manufacturing rising from 20% to about 85% and an increasing export specialisation in sectors or products integrated in global value chains.

… but signs of eroding competitiveness

In spite of the sizeable initial positive effects induced by technology imports and factor reallocation within and across sectors related to trade integration and increased foreign direct investment (FDI), the growth of total factor productivity – which measures the overall efficiency of the use of production factors – appears to have levelled off since the beginning of this decade. In fact, Mexico's recent trade performance can be attributed more to comparatively low labour costs than to high and rising productivity and innovative capacity.

At the sectoral and firm level, the preference for imported technology over the development of domestic innovation capacity – and a resulting lack of absorptive capacities in Mexican firms – has limited technology diffusion and transfer through increased intra-industry trade and FDI flows. Spillovers to domestic SMEs seem to have been limited. This has been compounded by framework conditions that are not conducive either to the adoption of innovative strategies – which entail managing risk – or to the creation of inter-industry linkages. In Mexico, industries classified as high-technology do not invest significantly more in R&D and innovation (in relation to their value added) than those in lower technology categories. Accordingly, they do not play a driving role in the dissemination of knowledge and technology throughout the business sector or in the formation of technology-based value chains.

The absence of robust productivity growth and the low overall innovative performance of the business sector (as measured, for example, by innovation inputs and outputs as well as the creation of technology-based firms) along with the rise of Mexico's relative unit labour costs since the late 1990s have tended to erode Mexico's international competitiveness.

A new challenge: increased competition from China

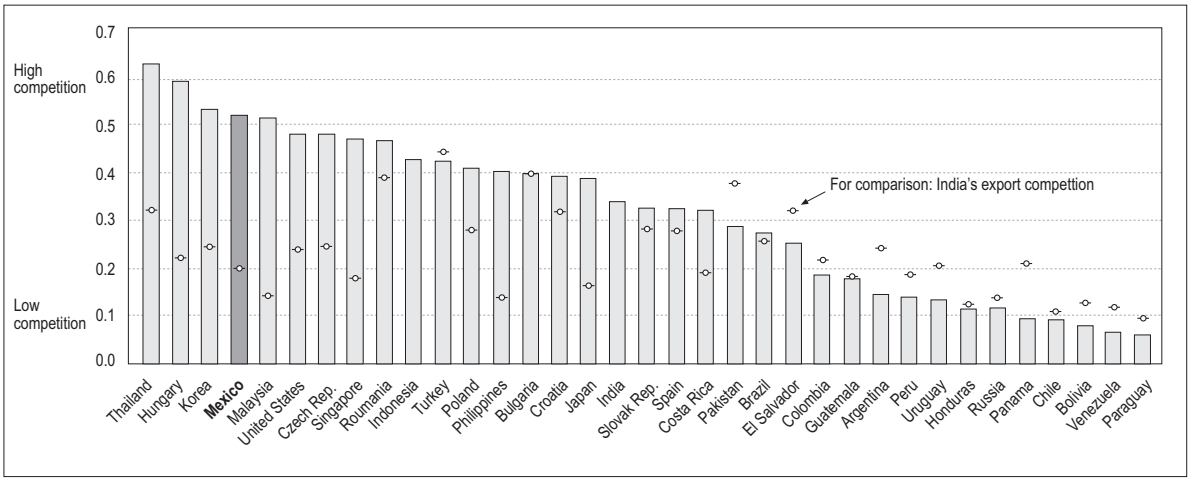
Mexico faces new challenges arising mainly from China's emergence as "the world's factory". Indeed, Mexico has lost market share for several years and, as of 2003, was overtaken by China as the United States' second largest trading partner after Canada. While most Latin American countries' exports – which are largely commodity-based – benefit, at least presently, from high Chinese and, to a lesser extent, Indian demand, the composition of Mexico's exports is very similar to that of China's (Figure 3). For this reason Mexico's manufacturing export industries face vigorous competition from China, competition which is particularly fierce in the contested product markets of the United States.[6] Moreover, China can be expected to retain, and to further develop, comparative advantages in a broad range of products both in the low-cost and in knowledge- and technology-intensive segments of production.[7] Of course, the rise of China and other emerging economies also presents opportunities, but these are less easily seized and require

6. Strikingly, since 2003 China has even overtaken Mexico in exports to the United States of products derived from nopal cactus (food, cosmetics and pharmaceuticals).

7. See *OECD Country Review of Innovation Policy: China* (forthcoming, 2008b). For a preliminary synthesis see: .www.oecd.org/sti/innovation/reviews/china.

considerably more effort by Mexico than by the countries that can satisfy the high demand for raw materials and commodity-based goods of these fast-growing countries. This underlines the need for Mexico to diversify its exports and to seek new comparative advantages by encouraging better performance in its innovation system in order to upgrade the technological base of the economy.

Figure 3 China's export competition with Latin American and other selected countries



Note: Measured by average coefficients of specialisation and coefficients of conformity.
Source: Latin American Economic Outlook 2008, OECD (2007).

An increasing role for innovation and innovation policy in achieving sustainable high growth

As pointed out above, achieving higher growth of GDP per capita is the key policy challenge and a necessary basis for alleviating the high incidence of poverty. Innovation can play a leading role by boosting productivity growth. It is also needed to maximise the benefits of Mexico's integration in the global economy by increasing Mexican firms' capacity to absorb and adapt technologies developed abroad and to raise their competitiveness through the introduction of new products, processes and organisational arrangements.[8]

Public policy can play an important role in boosting innovation via a broad range of actions:

- *Improved framework conditions* are necessary to increase both the incentives and the capacities to innovate throughout the Mexican economy by increasing competition and adopting better regulation, improving corporate governance, notably in public enterprises, lowering administrative burdens and the cost of doing business, upgrading the physical infrastructure and raising educational achievements.[9]

- *OECD experience shows that* – in addition to creating favourable framework conditions – *dedicated policies to foster science, technology and innovation are needed* to improve the overall performance of the innovation system and allow it to contribute more to economic growth. Dedicated policy measures are discussed in subsequent sections.

8. China and Brazil have outpaced Mexico in innovation-related investment as a share of GDP or manufacturing output.

9. The most recent *OECD Economic Survey: Mexico 2007* (OECD, 2007c) investigated a number of these issues in depth.

1.2 Creating framework conditions that are more conducive to innovation

Innovation cannot thrive in a business environment that restricts competition, imposes regulatory, administrative or financing burdens on new enterprises, discourages intangible investment, overprices infrastructure use and creates undue barriers to the mobility of labour. Reforms introduced in recent years to improve the business environment of Mexican firms have certainly borne fruit, but they are often incomplete or insufficiently enforced. This may be partly due to administrative inefficiencies or lack of resources, but it also reflects the resistance of vested interests. The main shortcomings of Mexico's framework conditions are listed in the following paragraphs.

Failure to benefit sufficiently from Mexico's integration in the global economy, by boosting international trade, attracting more FDI and strengthening spillovers from FDI projects to domestic firms, including SMEs.[10] This requires improving the absorptive capacities of Mexican firms, notably through the more adequate training and more efficient use of human capital. Expanding exports will require diversification towards goods and services with greater knowledge content.

Difficulties in accessing capital. New technology-based firms and innovative firms more generally have difficulty accessing financing. The effects of a traditionally conservative banking system, inherently adverse to financing intangibles, are compounded by scarce and costly systems of guarantees and the paucity of alternative sources of finance. Indeed, private investment and venture capital remain notoriously underdeveloped. This systemic failure hampers innovative entrepreneurs who wish to create new firms and induces a strong preference for the acquisition of technology over investment in R&D for carrying out innovation-oriented activities.

Lack of competition. Innovation and productivity can be boosted by strengthening competition through better regulation, notably in network industries, and rigorous enforcement of competition policy. Competition regimes in markets for goods and services have improved, but competition remains weak in key sectors such as financial and telecommunication services, energy production and distribution, and transport. In these sectors, *de jure* or *de facto* public or private monopolies and/or high market concentration, as well as the frequent use of *amparo* procedures, result in high input prices and create barriers that further restrict the entry of innovative firms. In some manufacturing sectors, standards and norms dating from the closed economy still apply to some industrial products. This has adverse effects on FDI and hinders innovation and international competitiveness.[11]

Problems concerning intellectual property rights (IPR), standards and quality certification. In areas of the business environment which are more closely linked to the technological infrastructure and which affect the capacity or propensity of firms to innovate, institutional developments have not always met expectations, particularly in the case of IPR regimes, international standards and quality certification. Mexico generally lacks a sufficiently developed IPR culture. IMPI (Mexican Institute of Industrial Property) and CENAM (National Metrology Centre) are sound, well-qualified institutions but still fall short of delivering their technological services efficiently to the business sector and particularly to SMEs. More importantly, they have been unable to stimulate demand for such services, which remains too low.

Barriers to entrepreneurship. Many barriers still hamper entrepreneurial activity. While the introduction of the SARE fast-track system for start-ups decreased administrative barriers, this system does not yet seem to have full national coverage.

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10. Mexico has launched structural reforms to further international trade and investment and to improve the functioning of markets for goods and services.

11. The Ministry of Economy has recently undertaken a comprehensive review of the standards system with a view to addressing this issue.

Lack of private intermediary institutions. Most public research institutions, particularly CONACYT research centres, play a positive role in metrology services and technology transfer. However, compared to most OECD countries, Mexico lacks a well-developed network of certified private intermediary institutions that act as "technology brokers" active in knowledge transfer and provision of technology upgrading services.

Shortcomings in the physical infrastructure. Weaknesses in the physical infrastructure (*e.g.* transport) hamper productivity growth and international trade and reduce Mexico's attractiveness as a destination for FDI and also hinder innovative activity.

Deficiencies in corporate governance, notably in the public sector, reduce incentives to pursue efficiency gains and introduce a bias against R&D and innovative activity.

1.3 Human capital – a current major weakness but a source of promise for Mexico's future

Investment in human capital plays an essential role in the growth and competitiveness of knowledge-based economies and helps to reduce inequalities and alleviate poverty. Despite the recognition of its importance and the major efforts undertaken over the last 20 years to expand education services, Mexico still fares poorly by OECD standards in the quantitative and qualitative formation of human capital at all stages of education, from primary schooling to lifelong learning. This relatively poor performance is reflected in particular in:

- The low level of educational attainment of the working age population (Figure 4) and Mexico's very weak scores in the PISA survey (notably in mathematics) (OECD, 2007e).
- The small percentage of students enrolling in tertiary education.
- The relatively small number of doctorates awarded each year by the higher education system (Figure 5).

In addition, the business enterprise sector creates little demand for qualified personnel, especially researchers, and labour market regulations hinder the mobility of such personnel between public and private institutions.

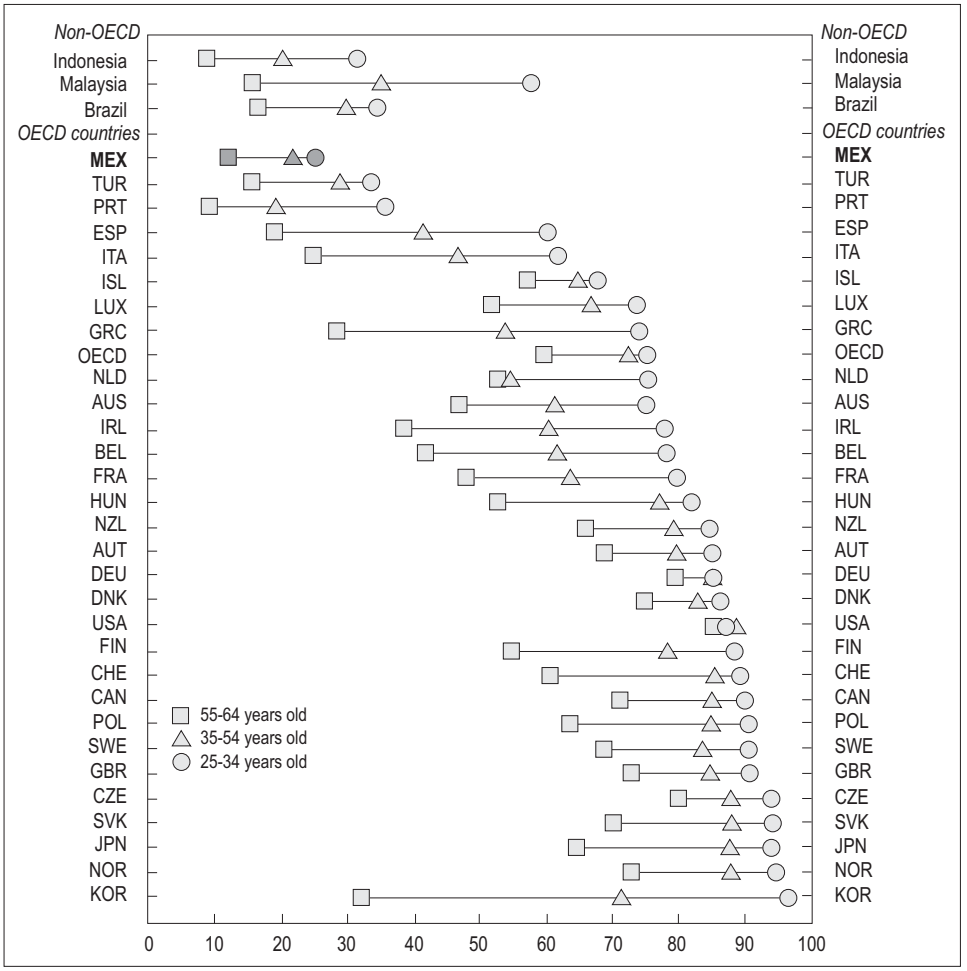
Improving the development of human capital requires not only a sustained budgetary effort, well balanced among the different levels of education, but also – and probably more importantly – a greater share of expenditures for educational infrastructure, the modernisation of curricula and teacher training, laboratories in the higher education system, etc.

Developments that may help to reduce the human resource bottlenecks for R&D and innovative activities include:

- The performance of the higher education system in training engineers has clearly improved in the last decade, and Mexico's share of science and engineering graduates in all newly awarded tertiary degrees is above the OECD average.
- The number of doctorates awarded, while quite small by international standards, has doubled since 2000 and more than trebled in engineering and technology (CONACYT, 2007a).

Figure 4 Educational attainment of the working-age population

Population with at least an upper-secondary qualification, 2003[1]

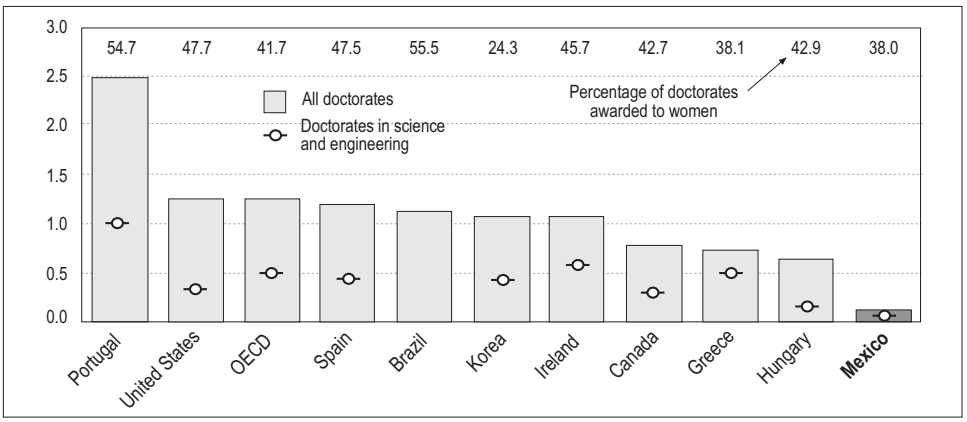


1. Percent of each group. 2002 for Czech republic, Iceland, Italy and Netherlands.

Source: OECD.

Figure 5 Graduation rates at doctoral level, 2004

As a percentage of the relevant age cohort



1. 2003 for doctoral degrees in science and engineering.

Source: OECD.

2. Mexico's science, technology and innovation system: assessment and policy challenges

2.1 Overall assessment

With the adoption of the 1999 and 2002 science and technology (S&T) laws, the new CONACYT Organic Law and the approval of the 2001-06 Special Programme for Science and Technology (PECYT), a number of initiatives were taken to improve the design and implementation of Mexico's STI policy. However, overall, the goals set have not been reached. In a context of scarce public resources, resources for R&D have fallen short of the stated objectives. Moreover, given the difficulties encountered by CONACYT, despite the authority conferred to it by law for assuming an inter-ministerial co-ordinating role in priority setting and resource allocation, efficient governance practices have not developed as anticipated.

With some exceptions, a multiplication of relatively poorly funded support instruments has generally been unable to overcome the structural weaknesses of the Mexican innovation system and address the priorities recognised in the preparation of the PECYT as pointed out in subsequent evaluation exercises (FCCyT, 2007 ; ADIAT/CONACYT, 2007).

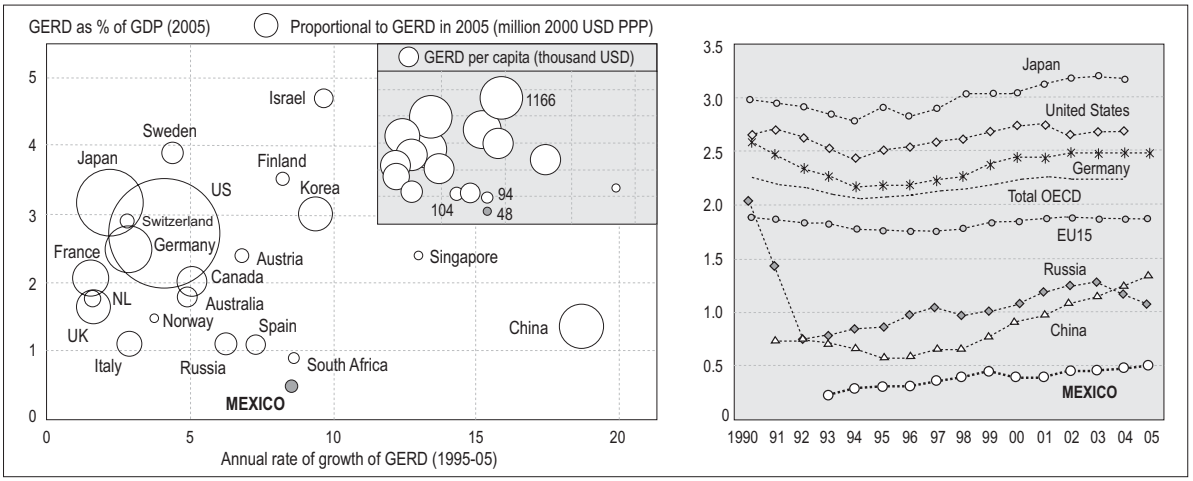
In terms of innovation inputs and outputs, Mexico's STI system lags other OECD countries and some important emerging economies (Figures 6, 7 and 8). The ratio of R&D expenditures to GDP is the second lowest among OECD countries and, despite growing R&D investment by industry, most R&D is still performed by the public sector. Patenting activity per capita or unit of R&D is among the lowest in the OECD area. The technological balance of payments shows a very large and persistent deficit, with exports covering less than 10% of imports, and technology licensing agreements among Mexican institutions are extremely scarce. Despite recent progress, the training of human resources for science and technology is insufficient, and the low propensity of firms to hire such resources discourages their further development. This adversely affects the diffusion of knowledge and the innovative capacity of the business sector.

These outcomes reflect a low-level equilibrium based on a limited supply of S&T knowledge, in particular of the type that can be disseminated in the productive sector, and weak demand for such knowledge in the business sector. Moreover, the weak interface between science and industry and the low technological absorptive capacity of a large majority of firms have generally not been efficiently addressed by reforms of framework conditions, a reorientation of incentive systems, or the development of new support programmes or institutional changes that would make it possible to escape the low-level equilibrium trap and initiate dynamic interaction among all actors involved in the production, diffusion and application of knowledge.

While there have been valuable efforts to strengthen the technological infrastructure and improve access to technological services, the vast majority of Mexican SMEs still lack the capacity to introduce and manage innovative activities, owing in part to the low level of qualifications of their workforce and their management. In addition to the services provided by public research centres or specialised foundations, essentially to firms with the capacity to absorb them, the challenge is to develop technology intermediary institutions along with the financial instruments necessary to meet the demand for technological and innovation management services by firms that lack this capacity.

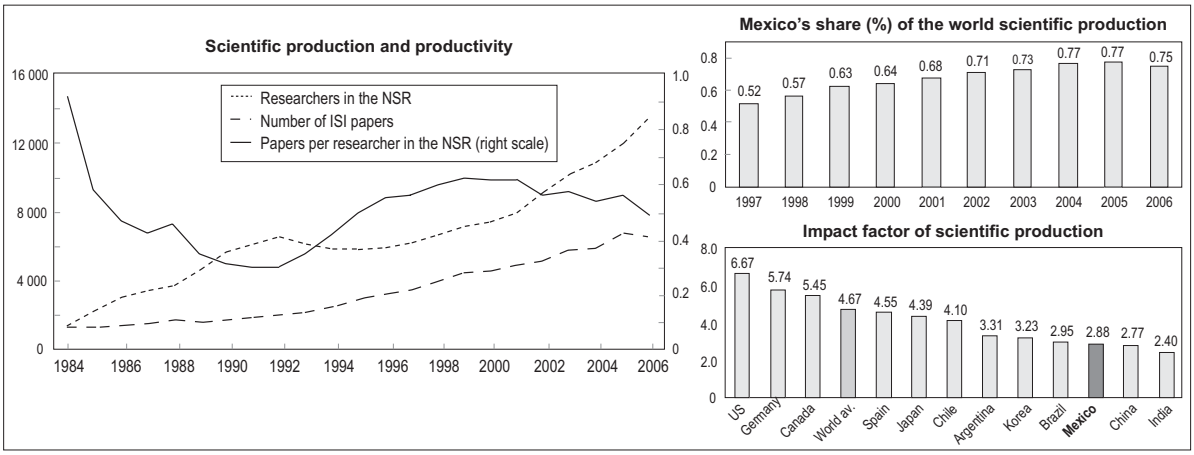
While there are examples of successful Mexican firms and clusters whose international competitiveness is due to the development and application of domestically generated knowledge and advanced technologies, the acquisition of knowledge and technology from abroad has been the norm among Mexican firms engaged in technological upgrading and innovative activities. The rent-seeking behaviour that still characterises a large fraction of Mexican industry, owing in part to the lack of competition in some sectors, too often prevents firms from seeing knowledge as a key production factor and innovation as a fundamental pillar of competitive strategies.

Figure 6 R&D expenditures and R&D intensity



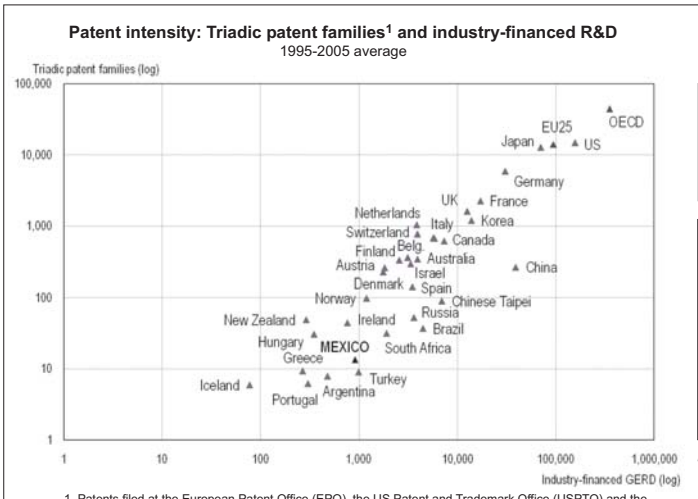
Source: OECD.

Figure 7 Scientific production



Source: CONACYT.

Figure 8 Patenting

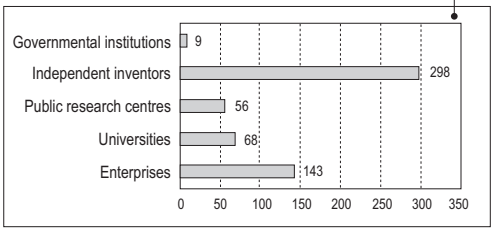


1. Patents filed at the European Patent Office (EPO), the US Patent and Trademark Office (USPTO) and the Japan Patent Office (JPO) which protect the same invention.

Source: OECD.

Patent applications in Mexico
1996-2006

Number	1996	1998	2000	2002	2004	2006
Total	*6 751*	*10 893*	*13 061*	*13 062*	*13 194*	*15 500*
By foreigners	6 365	10 440	12 630	12 536	12 629	14 926
By nationals	386	453	431	526	565	574



Source: IMPI.

Table 1 SWOT analysis of the Mexican national innovation system

Strengths	Weaknesses
• A set of top quality universities (both public and private) and public research centres • A sizeable pool of qualified scientists and engineers • A relatively large domestic market • A set of globalised, internationally competitive firms • Regional and sectoral clusters of excellence • Geographical proximity to the United States • Attractiveness for FDI inflows into specific sectors • The accumulated experience of some public agencies for the promotion of STI and economic development • Good natural resources endowment • Cultural diversity as a source of creativity	• Poor performance of the education system; low qualification of the labour force • Low budget allocation and weak political commitment to STI policy • Insufficient technological infrastructure • Low technological absorptive capacity of the vast majority of SMEs • Weak IPR culture • Little competition in some sectors; barriers to enterprise creation; deficient corporate governance in the publicly owned industrial sector • Premium on imported technology • Financial markets ill-adapted to innovation-related investment • A very low level of public/private co-operation; low mobility of human resources in S&T • Inefficient governance of the NIS • Unbalanced policy mix • Bureaucratic management of support programmes
Opportunities	**Threats**
• A young population • Incipient development of a significant pool of engineers • Growing demand for knowledge-intensive social goods • Insertion in global knowledge networks and technological platforms • Diversification of production and trade towards goods and services with higher knowledge content • Engaging SMEs in more innovation-driven strategies • Technology diffusion around multinational enterprises in line with the development of innovation-based global value chains • Biodiversity as a potential economic asset • Additional income from high energy prices	• Growing competition from emerging economies • Accelerated expansion of the scientific and technological frontier • Intensifying global competition for talent • High economic and technological dependence on low-growth economies • Poor linkages with dynamic emerging regions experiencing rapid economic, scientific and technological development • Regional concentration of innovation capabilities

Private firms have a low propensity to hire highly qualified human resources, particularly at the doctoral level, although there is an upward trend in the hiring of engineers by large and medium-sized enterprises that cater for international markets or are subject to international competition in the domestic market. Here again, the weak interaction between supply of and demand for knowledge, either as an intangible or embodied in highly qualified human resources, is a major weakness of the Mexican innovation system.

Yet, while the PECYT did not manage to overcome these structural and institutional weaknesses, it resulted in some positive achievements and good practices that should be recognised. They can form the basis for strengthening the performance of the Mexican innovation system in the new Special Programme on Science, Technology and Innovation (PECITI 2007-2012) to take advantage of untapped opportunities offered by Mexico's social and economic endowments (see Table 1).

2.2 Positive but limited impact of recent policy initiatives

In recent years, the steering of public research institutes has generally improved, allowing them to step up their technology transfer and co-operation activities with the business sector. CONACYT and various ministries, notably the Ministry of Economy, have established new support programmes to foster

enterprises' R&D investment and innovative activities, in part through fiscal incentives. Their basic design is in line with international good practice but they are often poorly endowed. Efforts have been made to ensure better articulation of federal and state policies in terms of focus and funding. In granting support to R&D and innovation activities, greater attention is given to public/private collaboration and the technological upgrading of SMEs. New initiatives, such as the AVANCE programme, foster the creation or development of new technology-based firms, support the development of technological clusters or strengthen enterprises' skills through programmes to promote mobility. A culture of evaluation is beginning to emerge, paving the way for more efficiency and accountability in policy implementation. On the whole, therefore, these initiatives have started to bear fruit but their impact remains limited.

At the regional level, several states have demonstrated greater awareness of the importance of devoting more resources to innovation capacity building, either through their own funding or in collaboration with the federal level. A number of initiatives launched by regional stakeholders aim to develop sectoral or regional innovative clusters. Some intermediary institutions have played an active role in promoting a culture of innovation and/or channelling public support to promising high-technology ventures. Successful medium-sized dynamic innovative firms and large Mexican global enterprises provide evidence that it is possible to develop a competitive edge through greater reliance on domestic knowledge inputs (including highly qualified human resources) and they provide a demonstration effect for elements of the business sector engaged in international competition.

2.2.1 Increased business investment in innovative activities

Evidence of the positive effects of government initiatives during the 2001-06 PECYT is provided by the evolution of the structure of R&D funding and performance since the beginning of the decade. The increased emphasis on programmes in support of business innovation, and the growing awareness of regional authorities and parts of industry of the benefits to be gained from sustained innovation capacity building have led to a significant increase of both the volume of business R&D and the shares of total R&D financed or performed by the business sector (see Figures 9 and 10). This upward trend, which highlights important growth in the number of firms engaged in S&T-related activities over the last seven years,[12] has been boosted by an increase in direct and indirect public support. Between 2002 and 2005 the share of direct government financing of total business R&D investment increased from 1.5 to 5.7% (OECD, 2007f). More importantly, the fiscal incentive put in place by CONACYT in 2002 represented more than 75% of total support in 2006.[13]

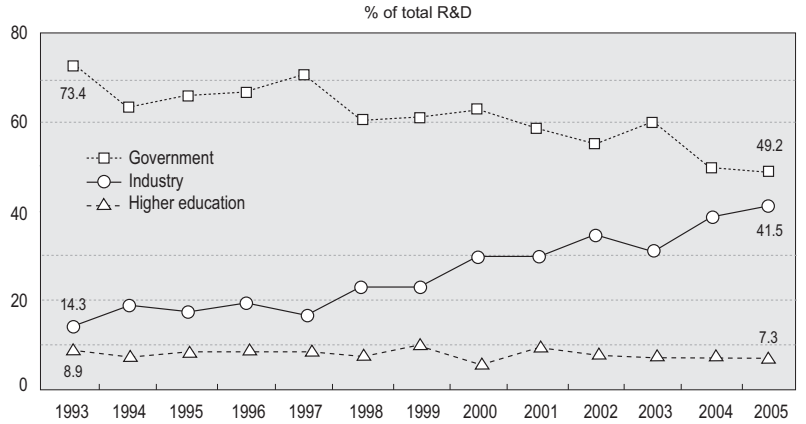
The distribution between the public and the private sector of highly qualified employment has followed a similar evolution, with a rapid increase in the share and volume of R&D personnel employed in the business sector (see Figure 11).

Innovation surveys also show that the traditional emphasis of Mexican industry on acquisition of technology embodied in machinery to develop new products or processes is giving ground to greater reliance on R&D. Between 2001 and 2005, the share of acquisition of machinery in firms' expenditures on innovation decreased from 66.5 to 39.7% while that of R&D expenditures increased fivefold from 8.6% to 42.5% (CONACYT/INEGI, 2007).

12. Since 2001 the number of firms and institutions accredited by the National Registry of S&T Institutions and Firms (RENIECYT), which entitles them to R&D and innovation-related support, has increased more than 15-fold.

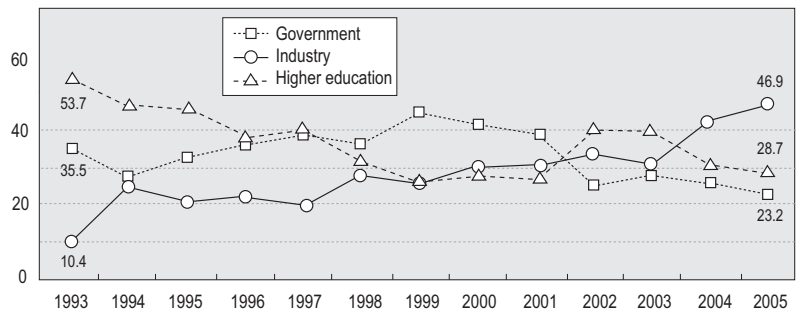
13. If the cost of fiscal incentives is added to the amount of direct support, the percentage of business R&D financed by government reaches about 25% in 2005 and is probably higher in subsequent years.

Figure 9 R&D by financing sector, 1993-2005



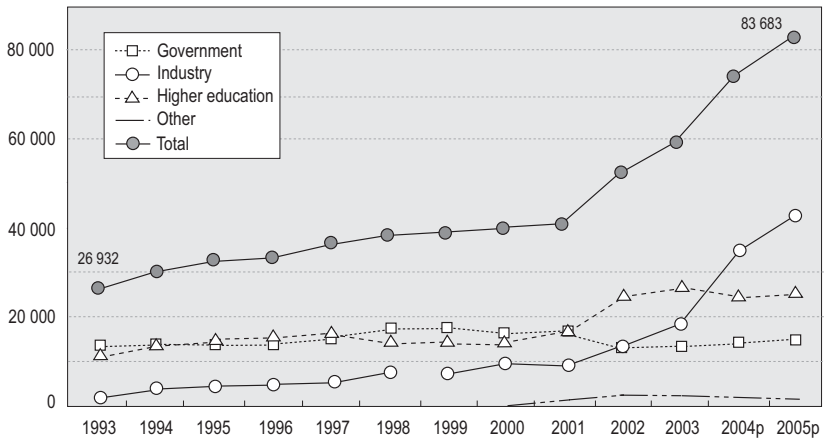
Source: CONACYT.

Figure 10 R&D by sector of performance, 1993-2005



Source: CONACYT.

Figure 11 R&D personnel by sector of performance, 1993-2005



Source: CONACYT.

This positive trend must however be nuanced by some observations that put Mexico's business innovation performance into perspective when compared to that of other countries:

- In spite of the observed growth of private R&D expenditures, *the share of private-sector spending remains very low* by OECD standards, and even compared with the present situation in countries such as China and Chile (Table 2).

Table 2 R&D by funding source (% of total R&D)

	Government		Industry		Others	
	1995	2005	1995	2005	1995	2005
Japan	22.8	16.8	67.1	76.1	9.9	6.8
Korea	19.0	23.0	76.3	75.0	4.7	1.3
China	-	24.7	-	69.1	-	-
Germany	37.9	28.4	60.0	67.6	0.3	0.3
US	35.4	30.4	60.2	64.0	4.4	5.7
Canada	35.9	32.9	45.7	47.9	6.9	10.5
Spain	43.6	43.3	44.5	46.3	5.2	5.0
Chile	58.4	44.5	26.5	45.7	9.0	2.1
Mexico	**66.2**	**49.2**	**17.6**	**41.5**	**16.2**	**9.3**
Brazil	59.1	58.3	38.2	39.4	2.3	2.2
Argentina	46.6	64.3	27.7	31.4	22.4	3.2

Source: OECD.

- The *absolute level of business R&D remains small* for a country with Mexico's industrial structure and level of development. This reflects both the low propensity of firms to invest in R&D[14] and the low level of overall R&D expenditures as a ratio of GDP.
- *Fiscal incentives play a very strong role* in the overall system of support to business R&D and innovation; this raises questions about the efficiency of the policy mix of support measures.
- *Business R&D expenditures are highly concentrated* in a small number of large enterprises[15] (and regions) and the dominant mode of innovation remains adaptation of foreign technologies rather than creation of domestic technologies or innovations.
- Innovative *Mexican firms still largely follow a "closed" innovation model*. Collaboration with the public sector, as well as with other domestic or foreign firms, still plays a marginal role in business innovative activities and remains limited in scope.[16] This reflects persistent weaknesses in knowledge and technology diffusion mechanisms as well as low mutual leveraging of private and public resources in innovation capacity building.
- In contrast to the majority of other countries, *the source of financing for innovative projects is overwhelmingly internal*, reflecting structural weaknesses in financial markets with a low propensity to finance risky ventures.[17]
- The *output performance* of increased innovation-related expenditures remains rather poor in terms of its impact on productivity (as noted above) and especially on patenting performance by residents,[18] which is among the lowest among OECD and emerging economies.

14. In 2005 the ratio of business R&D to value added in industry was only 0.38% compared with 1.58% in the EU, 3.15% in Korea and 2.60% in the United States.
15. Over 75% of business R&D is performed by enterprises with more than 250 employees.
16. According to the 2006 Innovation Survey, more than 80% of innovation projects are developed without any kind of external collaboration.
17. Only around one-third of the total costs of innovation incurred by firms is financed by external sources.
18. As measured by the number of triadic patent applications per million population or per volume of business R&D.

2.2.2 More proactive role of public research institutes

In Mexico public research can be divided into three broad categories with different modes of governance: the CONACYT research centres, the research institutes administered by sectoral ministries and the research institutes and centres that are part of public higher education institutions (HEIs).

The benefits of improved steering in CONACYT research centres

CONACYT's 27 public research centres (PRCs) remain institutionally under presidential authority and are governed by the Law on Science and Technology.[19] In recent years two parallel changes in the governance and financing of these centres have led them to take a more proactive approach to strategic decisions. The institution of "performance agreements" established a governance mechanism which includes appraisals and accountability to increase transparency and induce the centres to give priority to research and technological activities or programmes with acknowledged social or economic relevance. Concomitant changes in funding allocation have driven most PRCs to increase the share of self-financing in their overall budget.[20]

These changes have led PRCs to change the orientation and organisation of their activities with a view to increasing their co-operation with the private sector and other entities to which they provide R&D and technological services. Another factor that has favoured this evolution has been the priority given to projects involving co-operation between public research institutes and enterprises in submissions for financial support to CONACYT and other funding bodies such as the Ministry of Economy. A specific example is the increased share of projects involving co-operation with PRCs among those supported by the Economia-CONACYT S&T Fund for Economic Development (recently renamed the Fund for Technological Innovation).

Although this trend has not yet had a significant impact on the intensity of science-industry relationships, it is a positive one that could gather momentum if remaining constraints to PRCs' management autonomy are reduced. These concern in particular regulatory frameworks that make equipment investment and personnel management subject to centralised control, which tends to adversely affect contractual arrangements with private enterprises and the management of intellectual property.

Generally speaking, efforts and resources are insufficiently devoted to technology diffusion and the provision of technological services to the vast majority of firms that lack access to technological information and financing. Government support might more usefully foster enterprises' (mainly SMEs') demand for such services rather than subsidise their supply by public institutions. This would in particular help the development of a technology market in which private brokers complement and compete with PRCs in response to the needs of a growing number of innovative firms.

Research centres under the administration of sectoral ministries

A large number of public research institutes were created by sectoral ministries during the expansion of the Mexican public sector (1940-80) to develop and disseminate new technologies and provide services to other public organisations, enterprises and social sectors in areas mainly related to energy, agriculture, health, natural resources and environment. Table 3 lists the most important institutes.

It is generally acknowledged that a number of these institutes have high scientific standards, with a notable share of their staff belonging to the National System of Researchers (SNI). Some, like the Mexican Petroleum Institute (IMP), the Mexican institution with the largest number of patents, have a good record

19. As well as by the Law on Parapublic Entities.

20. The share of self-financing by CONACYT centres reached 35% in 2006.

in terms of innovation.[21] However, it can be argued that the proliferation of research institutes now raises questions regarding their overall performance, modes of governance and accountability. When they were created, CONACYT did not exist or did not have its present co-ordinating role, and each institution may have had a legitimate role as their ministry's scientific and technological arm. Moreover, interdisciplinarity in scientific and technological development was less fundamental than it is today.

Table 3 Public research centres under the administration of sectoral ministries

Ministry of Energy (SENER)	• The Electrical Research Institute (IIE) • Mexican Institute of Petrol (IMP) • Research Institute for Nuclear Research (ININ)
Ministry of Agriculture, Livestock, Rural Development, Fishing and Food (SAGARPA)	• Institute for Forestry and Farming Research (INIFAP) • Mexican Institute for Water Technology • College of Postgraduates
Ministry of Health (SSA)	• National Institute for Public Health (INSP) • National Institute of Cardiology (INC) • The Paediatrics Institute (IP) • Salvador Zubiran National Nutrition Institute (INNSZ) • 16 other centres and research institutes in the health sector

Source: FCCyT (2007).

International experience shows that there is still a rationale for public research institutes linked to sectoral ministries, notably to mobilise S&T resources to address social needs. However, the issues of possible streamlining and regrouping, governance, evaluation, financing, and articulation with other S&T institutions and industry need to be addressed as part of the reform and strengthening of Mexico's science, technology and innovation system.

Research institutes and research centres of higher education institutions

The third group of research institutes and centres are found in the major higher education institutions: the National Autonomous University of Mexico (UNAM), the Centre for Research and Advanced Studies (CINVESTAV), the National Polytechnic Institute (IPN) and the Metropolitan Autonomous University (UAM). These four institutions are the main centres of academic excellence and account for nearly 50% of national scientific production. Outside Mexico City, the University of Guadalajara (UdG) and the Autonomous University of Puebla (BUAP) are two of the country's largest state universities and they conduct research and train highly skilled human resources. Among private HEIs, the most prominent is the Monterrey Technological Institute for Higher Education (ITESM).

In the recent past HEIs have stepped up their collaboration with the private sector, albeit to a much lower extent than in more developed countries. In most cases this collaboration takes the form of provision of technological services rather than joint R&D projects. The main reasons for the currently underdeveloped state of the linkages between academic science and industry are examined further below.

Towards more differentiated development strategies for public research institutes

Public research institutes, whether administered by CONACYT or sectoral ministries, do not form a homogeneous set. Some have as their core mission the promotion of scientific activities in various disciplines or socio-economic areas, while others are more specifically oriented towards technology development and diffusion, generally along sectoral lines. These differences should be reflected in their financing structure. The former should be able to count more on institutional or competitive research

21. In 2007 IMP held 610 national patents, 60 at international level, 90 trademarks and 1 327 authorship property rights.

funding while the latter should evolve towards a larger share of self-financing through the provision of technological services.

As in most OECD countries, the missions, governance and modes of financing of PRCs should evolve as the innovation system matures. Some should forge stronger links with the academic sector in their research and training activities and others with industrial associations more interested in applied research and the training of engineers and technicians that the centres can provide. However, the diversity of PRCs' missions means that greater management autonomy must be predicated upon the implementation of performance evaluation mechanisms and the generalisation of common governance structures or charters. In this regard, public research institutes co-ordinated by sectoral ministries should be subject to the same type of performance agreements as those of CONACYT centres. This would probably help to increase the transparency of the S&T activities funded by the sectoral ministry responsible for their management and ensure greater efficiency in terms of research productivity and expected social benefits.

2.2.3 Emergence of technological and sectoral clusters

Emerging innovative clusters have benefited from federal and local support policies

Policy initiatives at the federal, but probably more importantly at the state or municipal levels, have facilitated the emergence of technological and/or sectoral clusters in some of the most advanced states of the Federation, such as Jalisco (electronics and high value added food and agro-industries), Guanajuato (traditional industries and biotechnology for agriculture), Nuevo Leon (software and electronics), Queretaro (machinery) and Baja California Norte (micro-electronics and biotechnology). These clusters have indeed benefited from support measures jointly funded at the federal (CONACYT and the Ministry of Economy) and state levels, often with matching funds from industry. However, a prerequisite for their success appears to have been the strong participation of concerned business associations and intermediary organisations. Together with state and municipal authorities, these have fostered the development of technological infrastructure, human capital and knowledge transfers in collaboration with local higher education institutions and public research centres.

Their consolidation necessitates further action

Experience with cluster development highlights the catalyst role that government policy can play in promoting regional innovation when: *i)* there is strong commitment and involvement of local public and private stakeholders that put investment in knowledge at the centre of their social and economic development strategies; *ii)* decentralised bodies lead the management of jointly funded programmes; and *iii)* attention is given in priority to technological infrastructure, in particular ICT, metrology, standards and managerial capacities, and to the organisation of knowledge spillovers and transfers between public research and industry and among enterprises participating in the cluster.

Building upon the experience and achievements of the cluster approach, the opportunity should now be seized to integrate it into a broader vision of regional innovation systems. This implies strengthening endogenous innovation capacities at local and regional levels through co-ordinated and complementary investment by the municipal, state and federal levels in S&T infrastructure for well-defined technological or sectoral priorities. This also requires removing constitutional or legal obstacles that impede co-operation among states or between municipalities in different states.[22]

2.2.4 Sustained efforts to train human resources for science and technology

As emphasised above, Mexico lags most other OECD countries and emerging economies such as Brazil, Chile and China in the production of highly skilled human resources for S&T. However, it should be

22. Such as the Federal Planning Law.

acknowledged that in spite of the instability of Mexico's STI policy over the last two decades, CONACYT has maintained its efforts, at least in terms of the share of its budget, to develop these resources. These efforts need to be maintained, but the attention to supply needs to be complemented by efforts on the demand side, as envisaged by the PECITI.

The postgraduate scholarship programme is bearing fruit

In one form or another, this programme has been in existence since the early 1980s and, through a continuous learning process, its operation and administration have gradually improved. To date it has benefited more than 150 000 students[23] and it is currently the most important source of funding for Mexicans interested in pursuing postgraduate studies either in Mexico or abroad. In recent years the number of scholarships has increased and they have been more regionally balanced.

However, this programme may require further changes in terms of its financing modes, selection criteria in terms of scientific disciplines, and likely imbalances in the labour market for scientists and engineers. The introduction of a greater degree of selectivity in CONACYT's scholarships may be in order. Some states have developed similar programmes and tend to award scholarships in disciplines related to their areas of comparative advantage or to areas they wish to strengthen. At the federal level the postgraduate programme should emulate this approach. With the use of improved prospective methods it should seek to anticipate possible imbalances in supply and demand for HRST, notably in strategic areas that benefit from R&D and innovation support programmes. Concurrently, information surveys on the professional trajectories of scholarship beneficiaries should be developed to provide indicators that can be included in the existing National System of Evaluation of Quality of Postgraduate Studies.

New initiatives in support of the mobility and insertion of HRST

The IDEA programme was recently introduced to foster the insertion of highly skilled S&T personnel (at master's and doctorate levels) in enterprises. It lowers hiring costs by granting scholarships and is a sound initiative that complements on the demand side the support to the supply side. It is however too soon to evaluate its results and to determine whether the chosen financing modality (scholarship) is the most appropriate for ensuring the sustainability of S&T employment in the private sector, as compared to instruments used in other countries.[24]

2.2.5 Scientific and technological infrastructure

The development and maintenance of advanced scientific and technological infrastructure has long suffered from low priority and limited sources of funding, in part owing to severe budgetary restrictions.

Only recently has this situation begun to change, with a doubling of federal investment between 2002 and 2006. This investment has helped to facilitate the decentralisation of S&T capacities; in a number of instances, state governments have contributed funding in addition to the federal investment effort. This was the case in Guanajuato for the National Laboratory of Genomics for Biodiversity (LANGEBIO) (Box 2).

In comparison with more advanced OECD countries, Mexico underinvests in S&T equipment and infrastructure per unit of R&D expenditures or number of qualified researchers. This increase in investment is therefore welcome and deserves to be maintained, because the level and quality of S&T

23. Including scholarships funded by sectoral ministries, mainly Education and Health. Overall, CONACYT presently funds around two-thirds of postgraduate scholarships.

24. Such as direct wage subsidies to lower the cost of newly hired S&T personnel with subsidy rates declining over time, or inclusion of such wages in the R&D expenditures eligible for fiscal incentives at a premium rate.

infrastructure is an important determinant of research productivity, attraction of highly qualified research teams and efficient provision of S&T services to industry.

Box 2 CINVESTAV's National Laboratory of Genomics for Biodiversity – LANGEBIO

Mexico is one of the world's five countries with the highest degree of biodiversity. This genetic diversity represents an invaluable asset and a strategic advantage for crop improvement and biotechnological developments. The development of new technological platforms in the last 15 years, such as genomics, proteomics and metabolic profiling, has tremendously facilitated gene discovery, the identification of active compounds for medicine and the development of biotechnology-based industrial processes. To exploit the potential of Mexico's biodiversity it was necessary to create the human and physical infrastructure to carry out complex functional genomics projects. In this context the Mexican government decided to create a research unit to exploit functional genomics for the sustainable management of the country's biodiversity.

The creation of this unit, the National Laboratory of Genomics for Biodiversity (LANGEBIO), was proposed by internationally recognised scientists with experience in genomics[1] from the Irapuato Unit of Mexico's Centre for Research and Advanced Studies (CINVESTAV) in the State of Guanajuato. A formal proposal was submitted to the Mexican federal government.

It had the following major objectives: the development of a research unit capable of carrying out world-class research on the biotechnological utilisation of Mexican biodiversity, the provision of genomic services to national research organisations and enterprises, an effective programme for intellectual property protection and technology transfer and a solid programme of public awareness of biotechnology. The proposal included the acquisition of state-of-the-art scientific equipment, the creation of 70 permanent positions, including 18 principal investigators, technicians and support staff and the construction of new buildings.

In 2005, in an unprecedented action for Mexican science, three federal departments (CONACYT and the Ministries of Education and Agriculture) together with the Government of the State of Guanajuato signed an agreement to provide the USD 50 million required for construction, acquisition of all required equipment and creation of the new positions needed for the activities of LANGEBIO.

In spite of the difficulties imposed by legal and regulatory framework for public spending and acquisitions in Mexico, at the beginning of 2006 a state-of-the-art genome sequencing facility, undoubtedly the best in Latin America, was established in provisional laboratories provided by the Irapuato Unit of CINVESTAV. In parallel, Enrique Norten, one of Mexico's most prestigious architects, was chosen for the construction of LANGEBIO´s new buildings. An international search to hire new staff members was initiated in 2006.

The scientific challenges also began early on with a request by the Minister of Agriculture for the sequencing of the gene encoding regions of the maize genome. Gene enrichment techniques, high-throughput Sanger and pyrosequencing strategies and efficient bioinformatics platforms for assembly and gene annotation had to be established. Over 7 billion bases of whole and gene-enriched maize genome were sequenced and approximately 50 000 maize genes (excluding those encoded by transposable elements) were characterised. More recent projects include the sequencing of the transcriptome of chili peppers, the fungus *Trichoderma atroviridae,* agave and avocado, as well as LANGEBIO's participation in an international programme for sequencing and annotation of the complete genome of *Trichoderma viridae* and *Trichoderma atroviridae*. Global gene expression analysis of drought-tolerant and fertiliser-use-efficient maize varieties is also under way.

The LANGEBIO initiative has so far been a success. The federal and the Guanajuato state governments have responded positively to a bottom-up initiative. An impressive scientific infrastructure has been developed and a world-class research team assembled. It has created new knowledge with important patented applications in the health, agriculture and industrial areas. This infrastructure is also contributing to the provision of technological services to enterprises and facilitating the development of a biotechnology cluster in Guanajuato. However, owing to budgetary constraints, the investment in facilities, equipment and human resources is progressing at a slower pace than anticipated. Longer-term financial commitment has to be secured to support the priority given by Mexico to biotechnology as an important component of economic and technological development in the PECITI.

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1. Drs. Luis Herrera, Jean Philippe Vielle, Alfredo Herrera and Octavio Martínez.

2.3 Remaining challenges

Despite some positive outcomes of institutional reforms and other policy initiatives through the PECYT, only limited progress has been made in overcoming the chronic structural weaknesses of Mexico's innovation system. These weaknesses continue to hinder the emergence of a virtuous dynamic in which the production of knowledge and its diffusion and use are mutually reinforcing. In such a situation, stakeholders interact through market and non-market mechanisms, under favourable framework conditions, institutional set-ups and incentive structures. The examples of good practice and successful experiments in programme implementation suggest a route to overcoming these weaknesses. This section highlights some of the remaining weaknesses of Mexico's innovation system and puts forward some recommendations for policy initiatives, related to policy design, implementation and governance, that may contribute to overcoming them.

2.3.1 Low public investment in S&T and R&D activities

Whatever the soundness of framework conditions, the merits of institutional reforms, or the efficiency of support programmes in fostering scientific and innovative activities, no countries have advanced decisively up the ladder of innovative economic performance without sustained investment in tangible and intangible S&T assets. In countries like Mexico that suffer from a fragmented innovation system that limits the production, diffusion and productive use of knowledge for economic growth and social welfare, increasing the volume of resources devoted to R&D and developing the absorptive capacities to put them efficiently to use are a prerequisite for engaging in a virtuous dynamic in which increased public and private investment in innovation complement each other to ensure rising social returns to investment in knowledge.

In this regard, and in spite of the 1% objective of the R&D/GDP ratio for 2006 set by the 2002 S&T Law, Mexico's performance remains chronically low with a ratio of 0.49 in 2007, the lowest among OECD countries and even behind countries such as China (1.43), Brazil (1.0), South Africa (0.9) and Chile (0.7).

Worse, while this ratio increased moderately from 0.42% in 2002 – mainly owing to the business sector – federal budget expenditure on S&T has remained practically unchanged in constant value over the past six years. This has meant a reduction in its share of the federal budget and of GDP. Indeed, by international standards, the government devotes very few resources to its public research system[25] and they have been declining as a share of GDP. Yet international comparisons show that in better-performing countries, an increasing share of the business sector in total R&D expenditures is not achieved in a sustainable manner when absolute public R&D expenditures decline. In most OECD countries, public expenditures continue to grow, albeit at a slower rate than private expenditures, but their leverage on business spending increases because of more efficient incentives and better synergies within the STI system.

In Mexico such a situation has not been realised. As noted above, the business share of R&D expenditures has grown significantly. But, as Figure 12 shows, the federal budget for S&T activities as a share of GDP has decreased over the last decade. The trend in the combined share of government and HEIs in total R&D expenditures has been similar.[26]

This wedge between the evolution of private and public expenditures is certainly an impediment to the strengthening of Mexico's innovation system. Increasing articulation and collaboration between the private and public sectors requires the development of interactions between two dynamic partners. It cannot be achieved if the resources allocated to one of them stagnate or decrease.

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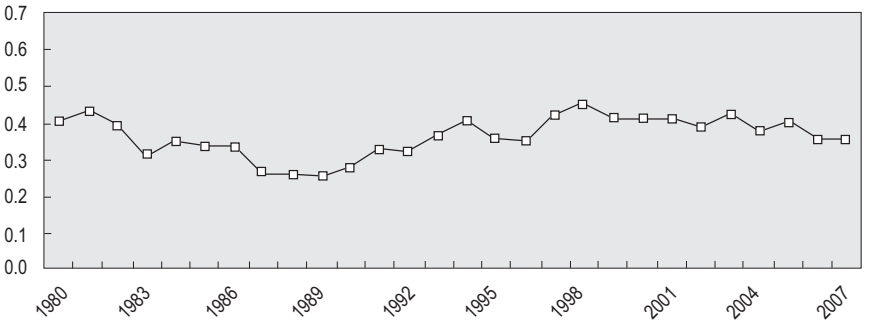
25. Research performed by government and higher education institutions.

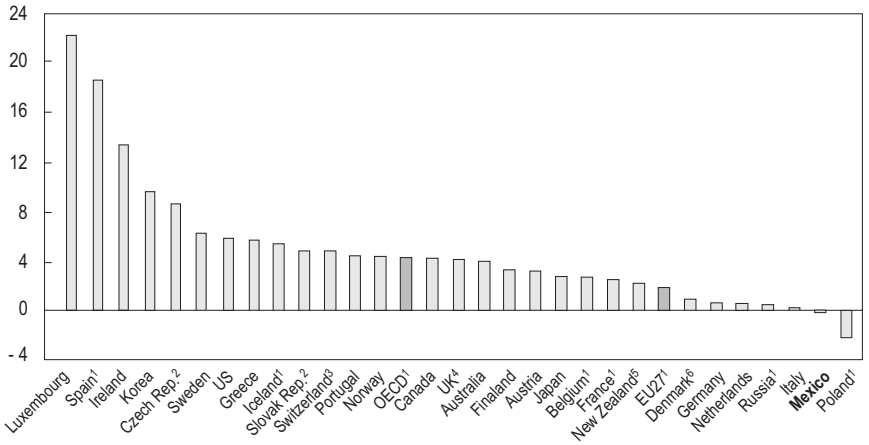
26. 0.25% as a proportion of GDP in 2005, as compared to 0.70% for the OECD as a whole and to 0.28% in 2002.

Figure 12 Mexico: Federal expenditures on S&T activities
as % of GDP, 1980-2007



Source: CONACYT.

Figure 13 Change in government R&D budget
Average annual growth rate of GBAORD, 2000-2006 or closest years available



Note: GBOARD = Government budget appropriation or outlays for R&D.
1. 2000-2005; 2. 2002-2006; 3. 2000-2004; 4. 2001-2005; 5. 2001-2003; 6. 2001-2006.
Source: OECD Science, Technology and Industry Scoreboard 2007.

The ADIAT International Panel Report notes that in the implementation of the PECYT "the Mexican Government did not give STI policy the budgetary support required to develop the set of instruments required to meet its ambitious objectives" (ADIAT/CONACYT, 2007).

Whether or not the objective of the 2002 S&T Law was realistic, it did reflect a political commitment based on the understanding of this prerequisite. Unfortunately, that commitment was not maintained, and the multiplication of poorly endowed support programmes could not make up for the lack of overall resources and it created new issues relating to scale, absence of critical mass and management of implementation.

Against this rather gloomy background one cannot but welcome the encouraging signal sent by the current budget appropriations for S&T which are expected to increase by 16.2% in 2008 over 2007.[27]

2.3.2 Fragmentation of support programmes and policy co-ordination issues

Well-meant efforts under the PECYT to make STI policy more coherent through better adapted institutional set-ups and support programmes have suffered from problems of *co-ordination, dilution of responsibilities and fragmentation* of often underfunded programmes. This may be because support

27. With 20% growth for CONACYT appropriations.

programmes were organised less according to policy objectives than as a result of compromises between CONACYT and sectoral ministries regarding management and funding responsibilities. Such a situation generates significant inefficiencies due to transaction costs, administrative rivalries and bureaucratic obstacles, of which the programme beneficiaries are the ultimate victims.

Mexico has developed an unusually large number of support programmes, with many eligibility criteria and very cumbersome decision-making procedures. Alone or in co-ordination with other federal government or state bodies, CONACYT manages over 60 funds or support programmes. Given that only around 30% of CONACYT's total budget is devoted to these – most of the rest is committed to financing the SNI and the scholarship programme – these support programmes are more akin to policy experimentation measures than to fully fledged support instruments. Two support programmes that deserve closer attention are the sectoral funds and the mixed funds available to both enterprises and research institutions registered in RENIECYT (National Registry of Scientific and Technological Institutions and Enterprises).

Sectoral and mixed funds

The 17 sectoral funds are financed and operated in conjunction with sectoral ministries to promote STI capabilities according to the "strategic needs" of the participating "sector".[28] Their budgetary endowments are quite low, averaging less than USD 100 million a year overall (see Table 4). Moreover, selection criteria often define priorities at a detailed level,[29] thereby distorting the selection process.

Table 4 Total budget of the sectoral funds, CONACYT and partners, 2002-07

USD millions

	CONACYT	Partner	Total amount
Total sectoral funds	**308.9**	**230.0**	**538.8**
SEP- CONACYT	163.1	80.5	243.6
SEMARNAT	18.7	19.6	38.3
ECONOMY	40.8	29.3	70.0
HEALTH	26.9	32.8	59.7
SAGARPA	20.0	25.3	45.3
Other sectoral funds	39.4	42.4	81.8

Source: CONACYT and FCCyT .

The scheme suffers from high rejection rates.[30] Possible reasons are high demand with respect to available funding, poor qualifications of applicants, weak project relevance, bureaucratic conflicts, and/or unclear criteria. Given the limited amount of support that these funds can offer individual proposals, high rejection rates are likely to mean very high administrative costs for project selection.

There may be a case for replacing sectoral funds focused on applied research[31] by sectoral priority programmes with increased *ex ante* contributions from S&T budgets of sectoral ministries funded on a competitive basis. This would be in line with practices increasingly observed in other OECD countries, in which the definition of priorities is accompanied by the setting of a budget of pooled resources allocated competitively by a "means agency" with oversight responsibility. This practice would be more appropriate

28. In the Mexican system, the term "sector" as it relates to sectoral funds refers to the area of a ministry's administrative responsibility, not to a field of economic activity.

29. 15 sectoral priorities for the Economia-CONACYT Fund.

30. Rejection rates were above 70% for the SEP-CONACYT Fund and close to 90% for the Economia-CONACYT Fund in the last two years.

31. All sectoral funds except SEP-CONACYT and Economia-CONACYT.

for sectoral funds oriented towards basic or applied research, but probably less so for the SEP-CONACYT and the Economia-CONACYT funds which are not sectoral in the economic sense of the term.

The 32 mixed funds, jointly administered by CONACYT and state government bodies and progressively developed since 2001, were meant to play a significant role in fostering research and/or innovation capacity at the regional level and in articulating federal and regional STI policies and support programmes.

Although they constitute in principle a valuable means of federal/state co-ordination, their present record is uncertain:

- In many cases they have suffered from a lack of well-defined demand on the part of the states owing (at least in part) to inefficient co-ordination among stakeholders, especially in less developed states. On the whole they have been of greater benefit to the narrowly defined S&T interests of locally established research centres and HEIs.[32]
- The amounts allocated have generally been quite low[33] and have supported a narrow base of projects with limited spillovers to regional innovative capacity.[34]
- Their management and effectiveness have often suffered from lengthy selection and disbursement processes and from a number of states' weak capacity to develop and submit adequate R&D and innovation projects.

In light of present experience, success would seem to depend on several factors:

- Enhanced capacity at state level to develop an innovation strategy involving local stakeholders.
- Support for projects with critical mass and building on local public S&T capacity to enhance collaboration, notably for technological cluster development as several states have done.
- Increased federal support to build such capacity in less developed states.
- Streamlining of management procedures.

Most countries which have implemented funds that are co-financed and managed by different government bodies have more often than not encountered problems of implementation. Mexico is no exception and, apart from more substantial resource requirements, *clearer and more efficient rules for managing the schemes* are needed. Among beneficiaries there seems to be widespread consensus that, in addition to their limited endowment, sectoral and mixed funds suffer from inefficient management and delayed disbursement of funds to selected projects. Moreover, the advisory panels responsible for screening projects are generally composed of SNI members who may have a bias towards basic research projects. Therefore, decision processes are at times influenced by vested interests and, in the case of mixed funds, they are often complicated by differences in objectives and procedures between federal and state entities. However, CONACYT has recently taken steps towards streamlining the management procedures of these funds.

Other support programmes

In contrast with the mixed outcomes of the sectoral and mixed funds, the Mexican administration has developed other instruments in support of R&D, innovative activities or technological development, which have proved more efficient in terms of management and co-ordination, and more successful in terms of

32. Between 2002 and 2006 research centres and HEIs received more than 60% of the grants.

33. 4.2% of CONACYT budget for 2002-06.

34. However, funding increased in 2008 with MXN 350 million allocated to so-called "strategic projects", with MXN 30 million minimum per project.

outcomes. Prominent among these are the CONACYT AVANCE programme, the PROSOFT programme and SME Fund, both of which are financed and managed by the Ministry of Economy, and, with important nuances, the R&D fiscal incentive system managed by CONACYT in co-ordination with other ministries.[35]

- The *fiscal incentive system* has generally substantially increased the volume of the business sector's investment in R&D. However, the system's efficiency can certainly be improved and its budgetary and administrative costs reduced, notably by a correction of the biases that give rise to windfall profits and advantage larger firms, a stricter definition of eligibility criteria, the replacement of the current discretionary allocation procedures by automatic ones, and a bonus for incremental R&D expenditures. While co-ordination of selection procedures between CONACYT and other government bodies has not raised major issues, recommended institutional reforms aim at further streamlining management procedures to involve only CONACYT and the Ministry of Finance, following the practice in the vast majority of countries with such a support scheme.
- The *PROSOFT programme*, which was introduced in 2002, does not specifically aim at fostering R&D or technology capacity building. Its role has been to provide specific support to the development of enterprises in the ICT sector. It is praised by its beneficiaries for the simplicity of its management and the swiftness of its decision and disbursement procedures. PROSOFT manages funds from three sources: federal government, state government and the companies that submit projects to the programme through "promoting organisations" that facilitate the review and management processes. Unlike several instruments in support of innovation managed by CONACYT, PROSOFT has enjoyed a relatively important and sustained flow of resources.[36] The economic impact of the programme is quite positive in terms of job creation, firm creation, technological infrastructure, spillovers and cluster formation, and productivity. The coincidence of interests among the stakeholders, their shared participation in the financing of projects and a more "participatory" approach to decision making have probably been important reasons for the programme's success. A further step would probably be to build upon this success to develop similar initiatives in other priority sectors and use this type of programme as one pillar for promoting regional technological clusters and building linkages with the regional research base.
- The *SME Fund* of the Ministry of Economy presents another notable example of successful bottom-up initiatives by entrepreneurial stakeholders. Although not primarily focused on fostering innovation and technological development, the fund does have a line of action in this area. The SME Fund has supported valuable initiatives thanks to the role played by intermediary institutions in the design and submission of projects for funding, with matching resources from state and local governments and enterprises. Initiatives supported by FUMEC (The Mexico-United States Foundation for Science) for the development of high-technology Mexican SMEs abroad and the technological upgrading of supplier networks of firms in high-technology sectors dominated by multinationals are particularly noteworthy. Other examples are those of IESTM in Monterrey or of the State of Jalisco for the development of high-technology clusters. Although the volume of resources involved remains limited, their leverage and economic impact have been quite high. These cases illustrate the important fact that a key to the success of support programmes aimed at enhancing the innovation capacity of SMEs in Mexico or at expanding their internal and external markets is reliance on *dedicated intermediary institutions*, often at the local level, which can efficiently manage projects and channel resources for their implementation. This points to the importance of decentralised design and implementation of innovation support programmes.

35. The Ministries of Finance, of Economy and of Education are involved with CONACYT in the final decision regarding the granting of the fiscal incentive. CONACYT is responsible for management of the applications submitted by enterprises and other eligible institutions.

36. In 2004, the programme budget surpassed USD 13 million. In 2005 the amount distributed increased to more than USD 18 million, and the number of projects increased from 68 in 2004 to 181 in 2005. In 2006 the volume of resources allocated by PROSOFT to software development amounted to USD 40 million distributed to more than 300 projects.

- The *AVANCE programme* managed by CONACYT is another example of a well-designed initiative for helping innovative firms (or other entities) to bring new products, processes or services derived from research results to the market in the priority areas defined by the PECYT. Well-defined eligibility criteria and operating rules have been developed in concertation with the beneficiary stakeholders, decision procedures are clear and disbursement is swift. Unfortunately, the programme is poorly endowed and the bulk of its resources go to relatively mature projects that are in the later stages of development. The financial components of AVANCE, the provision of risk capital and guarantee funds (to be co-financed by NAFIN) are still essentially non-existent and therefore start-ups are too often excluded from this programme.

It should be emphasised that, apart from the fiscal incentive, each of these programmes is managed by a single government body that is solely responsible for eligibility decisions and disbursement of financial support, a fact that may account for their relative success and the positive views of beneficiaries.

2.3.3 Rigidities in academic research limit its contribution to innovation performance

Over the last decade, in a context of nearly stagnant resources, the productivity of Mexico's science system, as measured by scientific performance and relevance, has improved notably. The volume of scientific production has increased significantly[37] and its quality has also improved to some extent[38] (see Figure 7).

However, public research in Mexico's higher education institutions continues to present important weaknesses that limit their capacity to generate knowledge, to train an adequate supply of highly skilled personnel, and to ensure that scientific activities address social needs and strengthen the innovation capacity of the productive sector. Moreover, academic research remains highly centralised and most scientific production emanates from a very small number of institutions of excellence.[39] This hinders knowledge spillovers.

The SNI reward system, which is biased towards evaluation of individuals and published scientific results, acts as a disincentive to undertake long-term projects and multidisciplinary research on challenging problems that offer potential benefits in terms of innovation. Hence, a relatively small fraction of scientific production results from co-operative efforts or multidisciplinary research. Technological achievements are not recognised on a par with published scientific results. and this negatively affects co-operation with industry, research activities to address social needs and the institutional mobility of researchers between academia and industry.

The statutory distinction between research and teaching in higher education institutions is detrimental to the quality of tertiary education and training for research.

Remuneration and pension systems and their effect on retirement lead to a dangerous ageing of the scientific community which may affect future productivity in terms of output, novelty and quality.

2.3.4 The underdevelopment of industry-science linkages and intermediation

A major element of the coherence and dynamism of an innovation system is the depth and breadth of knowledge exchanges between science and industry. These are fuelled by supply and demand and their efficient development is conditioned by actors' incentives, the availability of highly skilled human

37. Between 1997 and 2006 Mexico's share in the world total scientific production grew from 0.52 to 0.75% (see Figure 7).

38. As measured by the number of citations per scientific article.

39. Four HEIs account for more than 50% of total scientific production, and a large share of domestic patents.

resources, institutional set-up and the framework conditions that shape and facilitate market and non-market transactions.

The roots of the problem

In recent years, a number of PRCs and some HEIs have stepped up their co-operation with the enterprise sector via joint research activities on product and process development and the provision of technological services. Similarly, there are successful, albeit limited, initiatives by enterprises or social sectors to source knowledge in research institutions to strengthen their innovative activities. Yet, as illustrated in Table 5 one of the major weaknesses of Mexico's innovation system is the low level of knowledge exchange between science and industry.

Table 5 Collaboration in developing innovation projects

	Products	Processes	Products	Processes
	2001	2001	2006	2006
Only in-house	79.4	72.6	83.7	83.1
Collaboration with PRC	2.3	0.8	4.9	2.7
Collaboration with HEI	0.5	2.4	1.8	2.6
Collaboration with other firms	15.0	20.4	8.2	9.0
Others	3.0	3.7	1.4	2.6

Source: CONACYT, Innovation Surveys of 2001 and 2006.

Many factors account for this situation:

- On the demand side, the scarcity of highly skilled labour in a large majority of firms and the weakness of technology transfer schemes hinder the possibility to absorb knowledge from, and effectively interact with, research institutions in the initial stages of product or process innovation. Support for the provision of technological services should be more closely linked to demand (than to supply-related subsidies) and there should be more support for the initial recruitment of researchers and engineers or temporary mobility. In this context the IDEA programme is certainly a valuable initiative, although its implementation should be made more flexible and decentralised.
- On the supply side, given the SNI bias towards rewarding scientific publications, researchers lack incentives to engage in collaboration with firms. Restrictions on inter-institutional mobility reinforce existing disincentives. At the institutional level co-operation is slowly increasing. On the one hand, the move towards increased self-financing by research centres drives them to seek opportunities for collaboration. On the other, the increased importance of science-based innovation in sectors such as biotechnology, ICT, metallurgy and chemistry is starting to define the research agendas of research centres and advanced HEIs such as CINVESTAV and to foster collaboration with enterprises with research capabilities. Relaxing some of the regulations derived from the Law on Parapublic Entities that govern public research centres and hinder swift and efficient management of their human resources and infrastructure would undoubtedly facilitate collaboration with innovative enterprises. Strengthening their capacity to develop, protect and manage intellectual property would also contribute to that objective.
- On the institutional side, despite initiatives by public or private intermediary institutions, such as Infotec, CENAM, IMPI, FUMEC or PRODUCE, technology diffusion mechanisms remain weak and access to technological information and services too poorly supported. The scarcity of private intermediary bodies and certification bodies also hinders technology diffusion.

Box 3 Public/private partnerships for research and innovation: a high-leverage public support instrument

An important conclusion of recent OECD work on the role of government in fostering knowledge-based growth is that greater use of public/private partnerships (P/PPs) can enhance the contribution of science, technology and innovation policy to economic performance. P/PPs for research and innovation offer a framework for the public and private sectors to join forces in areas in which they have complementary interests but cannot act as efficiently alone (risk sharing and mutual leveraging effects). They can fill some gaps in innovation systems more effectively than other policy instruments.

P/PPs are unique tools to promote collaborative research in areas where innovation is deeply rooted in science:

- Major programmes to promote strategic R&D co-operation among universities, public research institutes and private firms have been launched or reinforced in many OECD countries since the late 1990s, following the pioneering examples of the Australian CRC and Swedish Competence Centre programmes (*e.g.* Kplus and Kind/Knet in Austria, the Innovation Consortiums in Denmark, the National Technological Research and Innovation Networks in France, the Technology Leading Institutes in the Netherlands, and the CENIT programme in Spain).
- P/PP is the best approach to building innovative networks in new multidisciplinary research fields, either as stand-alone initiatives (*e.g.* Genomics in the Netherlands) or as part of broader P/PP programmes (*e.g.* nanotechnology, Gehomme and Genoplante networks in France, and the Kplus centre on bio-molecular therapeutics in Austria).

In addition to providing effective springboards for frontier and pre-competitive R&D in areas of strategic importance, P/PPs can contribute to other objectives and yield broad benefits:

- *Input, output and behavioural additionality*. Cost-sharing arrangements and industry leadership within P/PPs (as in the case of Spain's CENIT programme) translate into high leverage of public support on business R&D and innovation. P/PPs have also a lasting effect on the behaviour of public and private researchers, by contributing to build trust and personal networks that facilitate further formal and informal co-operation.
- *New avenues for commercial spillovers from public research*. P/PPs provide participating firms with easier access to public research outputs and facilitate the creation of new technology-based firms, especially spin-offs from public research, as well as the mobility of human resources between the public and private sectors (*e.g.* Israel's MAGNET programme, see Box 6).
- *Linking SMEs with scientific research*. Most innovative SMEs find it difficult to establish direct contacts with universities and public labs. P/PPs can play the role of effective bridging institutions (*e.g.* ProInno in Germany).
- *Increased synergies within and between regional innovation systems* (*e.g.* Korea's Regional Innovation Centre programme). National P/PP programmes can enhance co-operation between local innovative clusters in order to ensure critical mass and better exploit complementarities.

Whereas P/PPs can potentially achieve what other policy instruments cannot, handling them is a delicate matter since the partners must engage in sustained co-operation with partners from different managerial cultures and partly conflicting goals. OECD work points to the following critical factors for success:

- Long-term commitment from both government and industry, based on a shared vision.
- Critical mass but also depth of the national and regional innovation systems. P/PPs should not create "high-technology islands" but be embedded in local and regional innovative clusters, and benefit innovative SMEs as well as large firms. Programmes to promote large P/PPs can be complemented by measures to support smaller P/P research teams (*e.g.* Austria's CDL programme, Australia's ARC Linkage Grants and Fellowships programme).
- Building on existing networks without neglecting areas where potential actors are still dispersed (*e.g.* multidisciplinary research) and/or inexperienced in accessing government support.
- Efficient steering mechanisms that ensure a sustainable balance between public and private interests, especially: *i)* competitive selection of projects and participants; *ii)* optimal financing; *iii)* efficient organisation and management; and *iv)* rigorous evaluation.

A more direct approach to strengthening science-industry linkages is in order

Most current policy instruments in support of R&D, innovation and technological development include collaboration between public and private institutions as a criterion of project selection. This is particularly true for the fiscal incentive system, the mixed funds and most of the sectoral funds. Unfortunately, and probably in part owing to the low level of financing of the funds, the preferential treatment given to collaborative projects has not yielded the expected fruit.

This highlights the important fact that, to succeed, support instruments should focus on the priority issue they are designed to address and not seek to meet a multiplicity of objectives. At the same time, instruments specifically designed to promote collaboration between public and private institutions, such as the Consorcios competitive programme launched at the beginning of the decade, have been rather unsuccessful. Important factors include the lack of medium-term commitment, weak involvement of public and private stakeholders in the design of the programme, and, as elsewhere, their poor funding. Nonetheless, rather than a secondary objective of support programmes with different primary objectives, industry-science relationships would be more efficiently fostered in the framework of well-funded dedicated programmes or instruments designed with the involvement of stakeholders.

Among such programmes figure prominently public/private partnerships for research and innovation, which have been as developed in a number of OECD countries (see Box 3). This approach has been emulated in Mexico with the recent launch of the Strategic Alliances for Research and Innovation (AERIs). Others are devoted to the creation or development of R&D-intensive SMEs that have forged and maintain links with public research. Still others are oriented towards traditional SMEs and emphasise technology diffusion, access to technological information, subsidisation of technological services, and recruitment of highly skilled personnel.

Other types of actions do not necessarily require funding but are based on incentives provided by institutional reforms such as those on the mobility of researchers and the development of technology transfer or licensing offices (TTOs and TLOs) in research institutions receiving public funding. As compared with more advanced countries and major emerging economies (*e.g.* Brazil,[40] Chile and China) the development of such offices is slow in Mexico and the rules that govern the management of IPRs by public research institutions and the appropriation or allocation of the proceeds deserve to be clarified. It is expected that in the short term an IMPI/CONACYT Fund will be crated, being a welcome initiative that should facilitate the development of TTOs and TLOs.

2.4 Policy mix, financing and governance

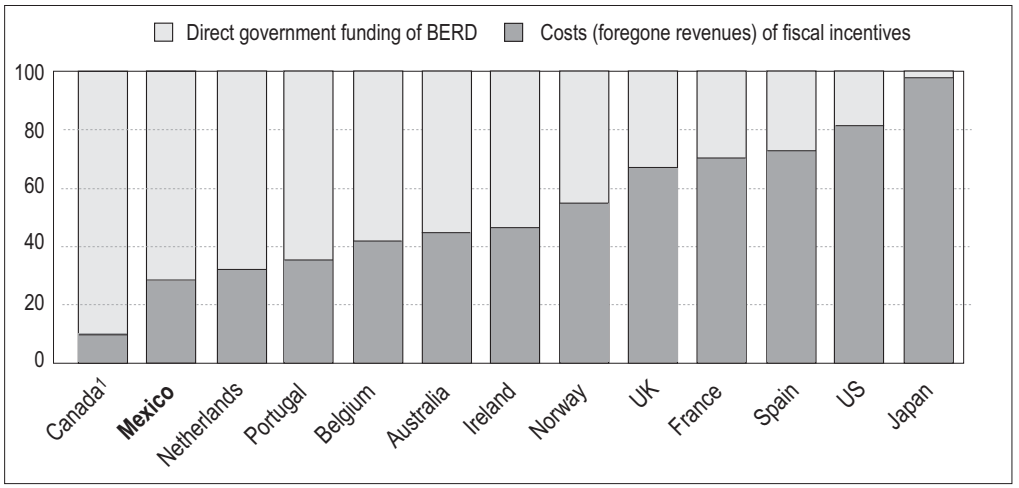
In practically all countries the governance structure of STI policy and the relative power of major stakeholders influence the policy mix of financing instruments and funding programmes designed to enhance the performance of the innovation system. This influence has been and continues to be particularly strong in Mexico. Against the general background of limited budgetary resources devoted to S&T, governance issues concerning the respective roles of CONACYT and other ministries and their co-ordination in the design and implementation of STI policy have strongly affected the policy mix of programmes and instruments in support of STI.

This is reflected in *i)* the multiplicity of poorly funded programmes, *ii)* a mismatch between the level of resources allocated to various instruments and the nature of the problems or type of market or systemic failures they are meant to address, *iii)* the frequent multiplicity of eligibility criteria attached to funding instruments, which may hinder the attainment of their stated priority objective, *iv)* the risk of overlap among different support programmes and, last but not least, *v)* the problems posed by the dilution or

40. In Brazil the development of such TTOs or TLOs in research institutions receiving public funding is compulsory by law.

conflicts of responsibilities among co-ordinating agencies which often result in inadequate design and management complexities of some instruments.

Figure 14 Share (%) of fiscal incentives and direct funding in total support to business R&D, 2005



1. Canada's fiscal incentive has a much lower level of generosity than that of Mexico (0.17 % as compared to 0.39 %) and direct R&D support provided by Provincial governments which can be quite substantial is not included.
Source: OECD.

2.4.1 Business R&D and innovation

At a central level, the main bodies that support business R&D and innovation are CONACYT and the Ministry of Economy,[41] along with some intermediary institutions. In this area the policy mix is characterised by an important bias: the wide discrepancy between the amount of resources allocated to the fiscal incentive scheme as compared to the amount allocated to other instruments, given the nature and the relative importance of market or systemic failures the various instruments are meant to address.[42] Indeed, in this respect, Mexico stands out among OECD countries for its very high share of fiscal incentives in total R&D support, particularly when the generosity of its fiscal incentive is taken into account (see Figure 14).[43]

Fiscal incentives are poorly adapted to supporting the innovation projects of the vast majority of firms. Many do not engage in R&D activity to innovate and therefore cannot, in principle, benefit from fiscal incentives. Other instruments that should address the needs of such firms, such as matching grants or subsidised or conditional loans, are in effect much less well endowed than fiscal incentives, often not efficiently designed or managed, or simply lacking. It is clear that a rebalancing of endowments, a streamlining of support programmes, and a simplification of management structures are in order.

41. As well as the Ministry of Finance through its role in the determination of the ceiling of fiscal incentives and the selection of beneficiaries.

42. Although fiscal incentives are not accounted as budgetary resources, the fact that a ceiling is set and selection criteria are applied gives them at least the perception of financial support the magnitude of which affects the other instruments. The situation is very different in other OECD countries with a similar instrument which they apply without predetermined ceilings.

43. Calculated for international comparisons as the amount of tax relief incurred by one currency unit of R&D expenditure, according to the following "B-index" formula: B = (1-A)/(1-t), where A is the net present discounted value of depreciation allowances, tax credits and other R&D tax incentives available, and t is the corporate income tax rate. In Mexico, the level of generosity is 0.37%, second only to that of Spain (0.39%).

Box 4. Fiscal incentives: possible reforms

1. Type of fiscal incentive

- *Maintain the tax credit* to be claimed against corporate tax liability as the form of fiscal incentive. Decrease the rate of benefits for volume-based R&D expenditures if an increment-based tax credit is instituted (see below).

2. Design

The system should be designed so as to ensure clarity, stability and low administrative costs of compliance with the rules that govern it. It should not discriminate against any type of firms that qualify for eligibility, *notably as regards the incidence of the tax reform.*

- *Ceiling of total tax expenditures*. Abolish the ceiling of total tax expenditures as of the next fiscal year.
- *Ceiling of tax credit benefits for eligible enterprises.* Set a maximum tax credit benefit that an enterprise can receive (presently large enterprises that benefit from the scheme get an average of USD 950 000 in tax credits).
- *Eligibility criteria.* Adhere strictly to the OECD *Frascati Manual* definition of R&D for tax benefit purposes. Ensure the wide dissemination of eligibility criteria by CONACYT.
- *Eligibility of enterprises.* As is currently the case, all qualifying enterprises subject to corporate taxation should be eligible, irrespective of type of activity. "Anti-fragmentation" rules should be applied to prevent enterprises from artificially splitting R&D expenditure claims among affiliates in order to maximise benefits.
- *Volume-based* vs. *increment-based tax credits.* Introduce a *mixed system with a higher rate for incremental expenditures* with a reference period of three years.[1] Given the costs incurred, the introduction of a mixed system would likely lead to reducing the present rate of tax credit for volume-based R&D expenditures. It is premature to propose tax credit rates for a mixed system but they could be between 15 and 20% for volume-based and between 45 and 50% for increment-based.
- *Targeted incentives.* Innovative SMEs and science-based start-ups face more financing problems than large enterprises, especially in a country like Mexico which lacks an active venture capital market. As in many OECD countries *extra (volume-based) incentives for SMEs seem to be justified* with a carry forward provision. Similarly an extra incentive could be granted to *R&D expenditures incurred in co-operation with or contracted to public research institutions.* To maintain the neutrality of the fiscal incentive system and avoid duplication with sectoral priority programmes *no particular sector of activity should benefit from preferential tax credits.* Eventually Mexico could also emulate other OECD countries that use their fiscal incentive system to facilitate employment of highly qualified S&T personnel in enterprises, for instance by discounting social security costs or applying a multiplying factor to these personnel wages in the calculation of eligible R&D expenditures.

3. Management

- *Management responsibility.* CONACYT and the Ministry of Finance should jointly manage the fiscal incentive system.
- *Automatic* vs. *discretionary decisions*. The proposed elimination of the ceiling of total tax expenditures and *the institution of a ceiling for beneficiary enterprises* renders the cumbersome and bureaucratic discretionary decision process obsolete. It is recommended to adopt the lighter procedure used in most OECD countries, *i.e. automatic granting of the tax credit* to qualifying firms whose claims satisfy the eligibility criteria. Automatic granting should reduce management costs.
- *Compliance control*. *Develop* ex post *control procedures similar to those applied in other OECD countries.* The main responsibility for conducting these controls, and if needed determining penalties for firms guilty of tax evasion, would obviously be that of the Ministry of Finance but, as in other OECD countries, the institution in charge of S&T policy, CONACYT, should be involved in control procedures or at least be called on to provide advice.
- *Compliance costs.* Good management of the fiscal incentives system implies that all firms that are in a position to qualify for eligibility are actually in a position to do so. As mentioned above, compliance costs for submitting tax claims can be particularly high for smaller firms. CONACYT could eventually develop advisory programmes for first time and smaller claimants.
- *Evaluation.* Introduce a regular evaluation system to monitor the impact of the fiscal incentive on firms' innovation strategy and performance. Link this system with innovation surveys.

1. Increment calculated over the average annual R&D expenditures during the last three fiscal years.

The fiscal incentive system: a powerful instrument in need of reform

By the level of its resources, the fiscal incentive system is by far the most important support programme for business R&D and innovation.[44] It has contributed significantly to the growth of business R&D over the last five years and in this respect can be considered a success. However, the system should be critically examined for several reasons:

- Fiscal incentives are generally used by firms already engaged in R&D and innovation activities in order to develop incremental innovations. This means that a disproportionate share of the benefit of such schemes accrue to large enterprises and, to a lesser extent, to smaller ones with experience in R&D management. In 2006 close to 80% of fiscal incentives went to large enterprises in a few sectors,[45] and there is no ceiling on the benefits that can accrue to a single enterprise.
- There is a reason to doubt whether there is much "additionality" in terms of investment in R&D that would not have taken place in the absence of the scheme, particularly since the Mexican scheme is based on volume and most of the beneficiaries are large enterprises. There is therefore some danger that the system gives rise to windfall profits.
- Although the criteria of eligibility for R&D expenditures are in principle those defined in the OECD's *Frascati Manual* (OECD, 2002), it is more than likely that the scope of expenditures that actually benefit is broader and encompasses activities related to innovation, technological upgrading and even acquisition of capital equipment for production rather than for research. In fact the multiplicity of selection criteria (which includes attraction of foreign investment) has distorted the likely positive effects on private investment in R&D and innovation.
- By design, the system cannot efficiently support the vast majority of SMEs which face risks different from those associated with R&D investment and whose innovation projects do not necessarily involve R&D expenditures. In such cases, matching grants that support innovative ventures seem much more appropriate.

On the basis of the experience of the other 20 OECD countries that, to date, have implemented a fiscal incentive system, it can be argued that the rationale for and usefulness of such a system still exists in Mexico. Whatever its weaknesses, the system has had positive effects and its elimination would send negative signals regarding policy continuity to the business community engaged in innovative activities. However, its maintenance should not be envisaged without major reforms addressing two major issues related to two important peculiarities of the Mexican scheme:

- An *unbalanced policy mix* resulting from the relative importance of the scheme in terms of resources and its limited capacity to address some specific market or systemic failures affecting investment in R&D and innovation activities create the risk of "crowding out" other more direct and appropriate forms of support. This highlights the need to strike a more efficient balance between direct (*e.g.* grants) and indirect (*e.g.* fiscal incentives) measures to support business innovation.
- An *efficiency issue related to the design and management* of the scheme as compared with those in other countries, notably regarding the predetermined fiscal expenditures ceiling, the eligibility criteria and sectoral priorities that tend to distort allocations.

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44. MXN 4 500 million (approximately USD 450 million) in 2007. This is larger than the combined budget of Economia and CONACYT for programmes in support of business R&D and innovation. The generosity of the scheme is one of the highest among OECD countries that use this type of incentive (see note 43 above).
45. Moreover, while 81% of eligible expenditures submitted by large enterprises were supported, the figure for SMEs was 65%.

Possible reforms are detailed in Box 4. They should be envisaged in light of the implications of the radical corporate tax reform instituting the IETU (Impuesto Empresarial a Tasa Única) for the management of the R&D fiscal incentive and the setting of the tax credit rates. They should reduce the budgetary costs of fiscal incentives, raise their efficiency and facilitate a transition to a more balanced policy mix with a reorientation of part of the amount "budgeted" for fiscal expenditures towards appropriations for direct forms of support.

Fostering innovation in SMEs

SMEs that face types of risk different from those associated with R&D investment and whose innovation projects do not necessarily involve R&D expenditures should in principle be targeted by the Economia-CONACYT Technological Innovation Fund. However, its endowment is too small and its eligibility criteria include sectoral priorities that complicate its management. Support to innovative projects through matching grants and/or subsidised loans is a very common policy instrument in OECD and advanced Latin American countries such as Brazil, Argentina or Chile. In most countries project-oriented support programmes involving matching funds are usually proportionally much better endowed, and their management is entrusted to a single government body or agency. Such programmes may or may not include sectoral priorities and projects are assessed and selected according to the expected social returns to investment in the innovative venture. An element that presently weakens the management efficiency of the Economia-CONACYT Fund's operation is its relatively low capacity to assess the return on investment in R&D and innovation of the project proposals submitted for funding. Such a "valuation" capacity is essential, as it can secure guarantees that can facilitate access to external sources of financing and therefore stronger involvement of the financial sector in innovation projects. The scarcity of such valuation capacities in the public sector is a weakness that affects the management structure of most programmes in support of business R&D and hinders the leveraging of public support on private sources of funding for innovative projects.[46]

Through its Technological Development and Innovation activity the SME Fund, managed by the Ministry of Economy, does not primarily focus its support on innovation projects *stricto sensu*, but rather on building up the technological capacities of SMEs and on non-technological innovation in the areas of organisation, knowledge management, access to information and ICT capabilities, following international good practices (see Box 5). The management of this fund does not suffer from co-ordination issues and adopts an effective bottom-up approach by relying on intermediary institutions (*e.g.* FUMEC, RENAP). Here again its endowment is probably too limited in view of the magnitude of the technological lag in the overwhelming majority of Mexican SMEs.

Stimulating innovation in strategic areas

In spite of the explicit identification of strategic priority sectors and technology areas in the 2001-06 PECYT, no fully fledged dedicated programmes were designed and implemented to foster research and innovation in these strategic areas. Projects supported by the sectoral funds do not really fill this gap, even if some of them did help to strengthen research and innovation capacities in these areas.

To compensate for the lack of dedicated programmes aimed at developing leading-edge knowledge and technological capacities in specific industries in order to enhance international competitiveness, better address social needs and strengthen the competitive advantages of resource-based activities in which Mexico benefits from natural endowments, the chosen approach has generally been to add sectoral criteria to the selection process of other support programmes, including the fiscal incentive.

46. The CONACYT-NAFIN Entrepreneurs Programme and the CONACYT-NAFIN Guarantee Fund of the AVANCE programme are valuable initiatives for addressing such weaknesses, but their endowment is extremely small and their development is hampered by the limited availability of qualified human resources to manage them efficiently.

Box 5 Promoting innovation in SMEs: OECD countries' experience

When placing greater emphasis on innovation in their SME policies, governments face two challenges. First, given the variety of factors that influence firms' capabilities and incentives to innovate, they need to co-ordinate their actions in a variety of areas of government policy. Second, the heterogeneity of the population of small firms precludes any "one-size-fits-all" approach. In some sectors the bulk of R&D-based innovations are due to new entrants or start-ups that challenge incumbents' market shares. In most industries, however, SMEs contribute to the innovative process in a very different way. They operate in medium- to low-technology environments and innovate without engaging in formal R&D activities. They focus on improving production processes through the use of codified knowledge embedded in up-to-date equipment and on improving product design and marketing techniques through the use of tacit knowledge embedded in human resources.

OECD countries' experience demonstrates the importance of finding the right balance between measures addressing generic problems related to firms' size or newness and more targeted actions to solve problems that are specific to particular types of firms. Best practice policies have the following main components:

- *Conducive framework conditions.* The first responsibility of government is to provide a favourable climate in which entrepreneurs can easily create firms, have incentives to innovate and grow, and can access the necessary resources at a reasonable cost.
- *Measures to build innovation capacities.* Up to the early 1990s government promotion of innovation in SMEs was largely equated with support to technology diffusion. It focused on supply-led technology transfer and was biased in favour of manufacturing. However, mixed experience with supply-driven programmes, improved understanding of the role of new firms in increasingly interactive innovation processes, as well as growing evidence that the obstacles to innovation in most SMEs were internal to the firm and stemmed from deficiencies in labour skills and in organisational and managerial capacities prompted the emergence of a new generation of policies that put more emphasis on: *i)* fostering an entrepreneurial culture; *ii)* building the "innovative and absorptive capacity" of firms through skills development and improved management; and *iii)* promoting e-business and developing other business infrastructure for small innovative firms.
- *Measures to facilitate financing of innovation.* Insufficient access to financing is a persistent obstacle to the creation, survival and growth of innovative SMEs. Policies to reduce financing gaps broadly fall into three categories: *i)* subsidised loans and loan guarantees; *ii)* provision of seed financing and support for the development of venture capital; and *iii)* tax incentives and/or grants to correct market failures that lead to under-investment in R&D.
- *Measures to promote networking and partnerships*. Even more than larger firms, SMEs depend on external sources of information, knowledge, know-how and technologies in order to build their own innovative capability and to reach their markets. For complementary knowledge and know-how, innovative firms increasingly rely on collaborative arrangements in addition to market-mediated relations (*e.g.* purchase of equipment, licensing of technology). Inter-firm collaboration within networks is now by far the most important channel for the sharing and exchange of knowledge. Interactions are also intensifying between firms and a number of other institutions involved in the innovation process: universities and other institutions of higher education, private and public research labs, providers of consultancy and technical services, etc. In OECD countries, public programmes and initiatives that explicitly address networking are a rather new phenomenon. They address market failures at different stages of the networking process through SME-specific or less targeted measures: *i)* raising awareness of networking opportunities and helping search for partners; *ii)* organising, financing and operating networks; *iii)* interfacing scientific and innovation networks through public/private partnerships (P/PPs – see Boxes 3 and 6); and *iv)* creating international linkages and building global networks.

This approach is certainly not optimal. Established priorities should have given rise to synergies, co-ordinated by CONACYT, between funding administrations, research institutions and private stakeholders. This did not happen owing to conflicts over administrative prerogatives, loose co-ordination and lack of funding.

The 2007-12 PECITI draft also includes sectoral and technological priorities that should be pursued through specific programmes. It is important that PECYT's failure to deliver should not be repeated but, to date, implementation details provided by the PECITI are unfortunately scarce and imprecise.

Box 6 Israel's MAGNET programme

The objective of the MAGNET programme,[1] launched in 1994 and managed by the Office of the Chief Scientist of the Israeli Ministry of Industry, Trade and Employment, is to strengthen industrial companies' capacity to draw from a vast and varied research and technological pool, giving them the capability to develop innovative, high value-added products with important export potential. It has contributed significantly to the creation and initial growth of new technology-based firms, a process which has been particularly dynamic in Israel. [2]

The programme provides financial support to "pre-competitive" R&D projects developed jointly by enterprises and academic research institutes organised in the framework of a consortium specifically dedicated to the project and governed by "collaborative agreements" among parties. The intellectual property rights derived from technologies developed by a consortium belong to the members that developed it; however other members receive at no charge a licence to use the technology for further development of its own products.

Eligibility, management and selection criteria

- Every Israeli industrial entity can apply; consortia must be formed as legal entities with a non-profit status. There is no limit on the number of companies participating in the consortium. There is no sectoral criterion.
- Projects presented by consortia are selected by the MAGNET Committee headed by the Chief Scientist, Ministry of Industry, Trade and Employment. The majority of members are external to his/her office.
- Projects are selected on the basis of: *i)* expected innovation output; *ii)* expected returns (benchmark is USD 10 in expected sales for USD 1 of R&D investment); *iii)* potential exports; and *iv)* academic contribution and partnership contributions. The MAGNET Committee checks if the consortium has the financial and human resources to carry out its proposed project.
- Outcomes are evaluated on a yearly basis with an impact on the following year's financing; a more in-depth evaluation is undertaken after three years. A comprehensive evaluation of the programme is carried out every seven years or so.

Funding

- The annual budget of the MAGNET programme is around USD 60 million to be disbursed as grants to the selected consortia (about 20% of total direct support to industrial R&D in Israel).
- Project expenses eligible for financing by the MAGNET programme are: salaries to the direct employees of the consortium plus overhead; research equipment and materials; patent- and licence-related costs.
- MAGNET grants to enterprises can amount to 66% of the approved budget. The consortium adds the rest, with the breakdown determined by the members of the consortium.

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1. MAGNET is the Hebrew acronym for "Generic Pre-competitive Technologies and R&D".
2. Most of the approved consortia are in the areas of ICT, mechatronics, pharmaceuticals and health and biotechnology.

Support of new technology-based firms

This is a weak point in the Mexican policy mix. Only AVANCE and, to a lesser extent, the business accelerators initiative funded by the Ministry of Economy, support the development of research-based innovation activities in high-technology firms. These programmes fulfil an important mission but are also under-funded and provide few opportunities for researchers from public research institutions to create high-technology firms or spin-offs. In this regard, more attention and support should be given to access to financial markets and the development of financial products (*e.g.* seed and venture capital) adapted to the creation of this category of firms.

Support to pre-competitive R&D projects undertaken in partnership by industrial firms and public research institutions, including academic research centres, can also play an important role in the development of high-technology firms and academic spinoffs, as demonstrated by the experience of many OECD countries

as well as non-members. The Israeli MAGNET programme is particularly interesting owing to its simplicity of management (Box 6) and could be an inspiration for the future development of AERIs.

Public procurement

It is rather surprising that Mexico has not attempted to use public procurement as a means to encourage enterprises' innovative capacity as one way to better respond to pressing social needs in areas such as health, environment, energy, education and transport. As the experience of many developed and emerging countries illustrates, an active public procurement policy at both national and regional levels, compatible with international trade rules, can be a potent driver of innovation and strengthen public/private collaboration in submissions to public tenders for social infrastructure, and goods and services with a high technological content.

2.4.2 Public research

Just as support for business innovation includes incentives to undertake R&D, either in house or in collaboration, support for public research should include incentives aimed at encouraging more problem-oriented research in PRCs and HEIs. For the PRCs, increased management autonomy and pressures for more self-financing facilitate such a change in the research agenda. However, curiosity-driven research should continue to receive appropriate financing through institutional and competitive funding, subject to evaluations based on criteria of excellence. The policy mix and the governance structure that support public research institutions have to evolve accordingly.

Improving patterns of financing and strengthening accountability

The resources allocated to public research should be increased and should meet various conditions in order to ensure that the funding makes an efficient contribution to the generation of knowledge, the training of highly skilled personnel, and the strengthening of the innovation capacity of the productive sector. These conditions involve the modes of financing research activities, the incentives provided to researchers and research teams, and evaluation mechanisms.

A better balance should be struck between institutional funding, competitive funding and other sources of funding. A growing share and volume of resources should be devoted to competitive funding through the restructuring of sectoral funds that support basic and applied research which are presently financed and managed by CONACYT in co-ordination with SEP and other sectoral ministries.

Institutional funding of public research is much too limited, as it essentially only covers salaries and other current costs. While the level of institutional funding[47] should probably continue to evolve according to traditional quantitative criteria (*e.g.* size of institution, salaries, training activities and current costs), a non-negligible share should help finance discretionary research (including research infrastructure) in areas of specialisation defined by the institutions. Following best practices in other countries, the magnitude of institutional funding should evolve, based on the results of periodic evaluations, with emphasis on the quality of research according to academic standards, as well as criteria pertaining to the contribution of researchers and other highly qualified resources in S&T to innovation performance (*e.g.* patents and relationships with industry). Moreover, increases in institutional funding should continue to be examined in light of the need to further decentralise research activities. Armed with the necessary resources, the Ministry of Education should continue to be responsible for the management of institutional funding of academic institutions.

47. Mainly provided by SEP for HEIs, and other ministries and CONACYT for their research centres.

Like large public institutions responsible for research funding in other countries, such as the US National Science Foundation, CONACYT would be responsible for the *competitive financing* of two categories of research projects:

- One is the so-called "blank" projects that are selected on the basis of criteria of research excellence irrespective of scientific discipline, with an emphasis on collaborative projects. The source of finance would be the SEP-CONACYT Fund for basic research, and its budget should increase in line with the country's evolving scientific potential.[48] Management should be entrusted to CONACYT to avoid delays in disbursement.

- The second is research projects submitted in the framework of research and innovation priority programmes as defined in the PECITI. The source of finance for such projects would be a consolidated fund with the resources previously available under the sectoral funds. The fund would be under the main responsibility of CONACYT in order to reduce the problems of co-ordination and dilution of responsibility (see below) that presently hamper the efficient management of the sectoral funds. The fund would finance medium-term research and innovation programmes[49] with emphasis on public/private partnerships such as those launched in the framework of the AERIs. Their management would be entrusted to a consortium of partners. Other countries that have furnished such schemes with sufficient resources have found that they provide a strong incentive to public research institutions to re-orient their scientific activities towards problem-solving research more closely related to innovation. An added benefit is a resource multiplier effect due to mutual leveraging of public and private resources. However, as emphasised above, the successful implementation of such programmes, as well as other forms of co-operation with the private sector, requires a lessening of the stringent constraints on the hiring and mobility of research personnel and the purchase of equipment as well as less bureaucratic monitoring of implementation.

- Other sources of finance for public research should be more actively sought, in particular those stemming from international co-operation as part of CONACYT agreements. Public research institutions should also be encouraged to develop their own international collaboration networks and regulatory obstacles that hinder such developments should be removed or lessened.

In Mexico, with the exception of the SNI and projects funded by the SEP/CONACYT Fund, *ex post evaluation* of the results of research activities is rare. Too often it merely involves checking that the operating rules have been respected and budgetary control. It needs to be developed in line with best practices in other OECD countries. The counterpart of autonomy and increased resources is greater *social and economic accountability*. *Ex ante* evaluations of project submissions should follow best practices of peer review involving international experts, and *ex post* assessments of outcomes should affect future funding patterns.

Another important aspect of policy relating to public research institutions is the *training of highly skilled human resources.* In this regard, the CONACYT scholarship programme and the various recent initiatives to support doctoral programmes and post-doctoral activities seem to go in the right direction and should be maintained.

Finally, there is little doubt that allocations from the federal level should continue to foster a more balanced *spatial distribution* of scientific and technological infrastructure. Here, the trend to link the granting of increased institutional resources to PRCs and HEIs at least in part to a regionalisation of their

48. It is likely that the current high rejection rate of projects highlights the scarcity of funds more than poor quality or lack of relevance. The Mexican science system has certainly a higher absorptive capacity for basic research than the resource ceiling of the fund.

49. The difference with the sectoral programmes initially considered in the PECYT is that they would be managed by the "means agency" and not by the sectoral ministries.

facilities should be maintained if not reinforced. More account should also be taken of the possibility of states' contributions to physical infrastructure and to the value added by other scientific facilities when developing local centres of excellence. The respective efforts of the federal and state levels will of course differ depending on states' levels of development. As state governments receive larger budgets under the recently implemented fiscal reform, their participation in the financing of S&T infrastructure and projects should probably increase, at least in the most developed states.

Reforming the SNI: short-term objectives and long-term goals

Mexico's National System of Researchers was established in 1984 in response to increasing risks of brain drain caused by researchers' worsening remuneration and working conditions. It has played a very positive role in the constitution and development of a community of qualified researchers, who are selected, promoted and rewarded with non-taxable complements to their remuneration according to criteria based on the volume and excellence of their scientific production. Without this system, centrally managed by CONACYT and financed on its budget, the level of excellence of Mexico's research activities and the number and diversity of internationally recognised researchers would not be what they are presently.

Today, this unusual system both insures against brain drain and presents a longer-term risk. While its role in developing a high-quality research base and ensuring the attractiveness of research careers should be preserved, reforms are needed to address the nature of the evaluation criteria used, the management and funding of the system, and the dangers of an ageing research community. In the longer term, the reform process could lead to the adoption by research institutions of remuneration patterns based on nationally defined standards.

- First, the *criteria of excellence* should not be restricted to scientific publications but should include contributions to research-based innovation developed either in research institutions or in collaboration with the private sector.[50] There are welcome initiatives in that direction. More credit might be given to research work carried out in international teams or networks, and the links between collective research and individual rewards could be reconsidered.[51]
- Second, *financial rewards* in the form of a non-taxable complement to remuneration should eventually become part of researchers' regular salary once they have been confirmed at the same SNI level over a certain period. This is obviously a delicate issue with important budgetary consequences in terms of pension provisions and would require changes in labour laws governing public servants as they apply to SNI members.[52] It would change the salary scales of researchers in public research institutions and help deal with the pension issues that contribute to the ageing of the researcher community. It would also be in line with a desirable reform that would give researchers teaching responsibilities beyond those related to the training of postgraduates. While the obstacles are quite daunting and such changes would be difficult to implement in the short to medium term, there is no *a priori* reason why Mexico's practices should be so different from those of other countries with a strong scientific base.
- Third, while *selection procedures* might continue to be centrally managed to avoid moral hazards, evaluation committees should increasingly include members of the international scientific community. The increased costs should be compensated by reducing the frequency of evaluations relating to promotion to higher SNI levels. The inclusion of expatriate Mexican scientists in evaluation panels is a good move in this respect.

50. In the context of a desirable reform of IPR management in public research institutions, part of the proceeds of IPRs should also go to individual researchers.

51. To avoid abuses, more weight could be given to international recognition in the credit given to individual researchers participating in collaborative work.

52. One possibility is that, upon retirement, SNI members would continue to receive a fraction of their last SNI premium in their pension.

- Finally, in a longer-term perspective, the possibility of moving towards a more decentralised system in which the management of rewards would increasingly be devolved to the research institutions themselves, which have a vested incentive in promoting the quality and relevance of their research, should not be excluded. The management of the system would remain with the institution with oversight responsibility for a research base defined by its excellence and social relevance. Funding, however, would come from government bodies with responsibility for personnel. In this case, the Ministry of Education would eventually incur most of the costs and would either transfer resources to CONACYT or make the disbursements according to the results of evaluation procedures overseen by CONACYT.

3. Recommendations

3.1 Strategic objectives

In an increasingly global competitive environment, in order to maintain productivity growth in its economy, alleviate poverty and better respond to pressing social needs, Mexico must pursue sound macroeconomic policies and deepen the structural reforms that have been engaged.

To close the gap in income per capita with the more developed countries and, in the shorter term, to avoid being overwhelmed by the most dynamic emerging economies, Mexico must harness the potential of science and technology. In addition to the urgent improvement of some key framework conditions for innovation (especially in education, competition and basic infrastructure), it needs to pursue political, economic and social objectives:

- Build a more powerful, firm-centred innovation system by significantly increasing public (financial and other) support to innovation which can then leverage private investment in market-pulled innovation.
- Ensure that basic and mission-oriented research is supported only in areas in which both critical mass and excellence can be achieved, and use regulatory reform and competitive funding more effectively to strengthen public research on well-defined priority socio-economic needs.
- Pursue the decentralisation of innovation policy while reinforcing state-level management capabilities and carry out strict evaluations, based on a consistent national model, of programmes using federal resources.

Political commitment and social impact

Reaping the economic and social benefits of investment in science and technology takes time. Therefore, sustained political commitment and social visibility of the benefits to the economy and society as a whole are essential to a successful S&T and innovation policy. There are no examples of developed or emerging countries that have succeeded in putting knowledge and innovation at the core of their development strategy without such a long-term commitment.

In Mexico, this commitment has too often been unsustained. The objective of a ratio of R&D to GDP of 1%, to be achieved by the end of the previous administration, was not reached. It may have been unrealistic in the first place, but for the main stakeholders it was at best a missed opportunity, at worst a lack of political commitment. The present administration has made a similar commitment in the PECITI, and in 2008, the S&T budget was increased significantly. This commitment needs to be maintained over time by the executive and legislative branches of government, and the scientific, economic and social outcomes of increased public investment should be highlighted in due course in the public debate.

Political commitment also encompasses consensus building when determining of national priorities and setting oversight processes to ensure that these priorities are effectively addressed in the design of

innovation policies and reflected both in budgetary appropriations and institutional arrangements for policy implementation.

Policy efficiency

Efficient use of public funds to meet economic and social challenges is a principle of sound budgetary management. Public resources for scientific and technological development compete with other current or investment expenditures in areas that are often perceived as having higher or more immediate priority. Resources for the alleviation of poverty and the development of social and economic infrastructure put strong pressure on the budget. While fiscal reform and additional revenues stemming from energy price increases can open new margins of manoeuvre, the opportunity costs of public resources devoted to S&T policies and their legitimacy for addressing market and systemic failures must still be justified by appropriate accounting of expected economic and social returns and *ex post* evaluations.

Improving the overall level of skills while developing HRST

A qualified human resource base is a cornerstone of any innovation-based strategy for socio-economic development. Mexico has a pool of qualified scientists and engineers thanks to efforts over the past two decades, notably through the scholarship programmes, .but it is insufficient in light of the country's size and economic potential. The bulk of the labour force is largely unskilled or low-skilled, and in a large majority of firms the lack of managerial skills hinders their capacity to absorb technology and makes them unwilling to take the risks associated with innovation. This is one source of the low demand for highly skilled human resources for S&T. Mexico thus faces both a supply and demand problem with respect to HRST. Along with the issue of educational attainment, which raises concerns beyond innovation policy, addressing the mismatch relating to HRST should be high on the S&T policy agenda. In this regard, measures considered in the framework of the PECITI deserve to be financed at an appropriate level and in a sustained manner.

Linking science to innovation

One of the main challenges for Mexico's S&T policy is to foster synergies between curiosity-driven science and market-led innovation through favourable institutional settings and incentive structures. While curiosity-driven research should continue to be supported as a public good, more social accountability should be required, especially when its aim is to solve specific problems. Demand and supply policies in support of research and innovation should have a mutual leveraging effect. Resource limitations encourage entrenched behaviour by vested interests and hinder collaboration. To a large extent, an increase in \resources for S&T should be made conditional on an increase in co-operative behaviour. With the development of consortia and AERIs, the emphasis on co-operation in a number of support programmes, the increased emphasis on competitive funding and self-financing of research institutions, Mexico is moving in that direction. This evolution needs to be pursued and strengthened.

In this context, as increasingly in other OECD countries (see Box 6), STI policy should give more emphasis to well-endowed research and innovation programmes that support public/private partnerships for collective goods in priority areas such as health, environment, energy and communication and in sectors in which Mexico enjoys comparative advantages based on its endowment of natural resources. In such programmes the scientific and business communities should share management responsibilities.

In co-operation with state or municipal governments that already have valuable initiatives in this direction, increased emphasis should be given to the promotion of technology or sectoral competitive advantages around clusters that pool scientific, infrastructure and managerial resources and foster innovation performance through knowledge spillovers and technology diffusion.

Engaging lagging SMEs in innovative activities

Beyond a set of globalised, high-performance domestic or foreign enterprises and an increasing number of smaller innovative ones, Mexico still has an overwhelming majority of firms, mostly SMEs, that lack the capacity to make knowledge management and technological development part of their competitive strategy. In many sectors, these firms constitute an untapped mine of employment, productivity and growth, and no lasting success can be expected from innovation policy if this structural duality is not overcome. Notwithstanding some valuable programmes, essentially those of the Ministry of Economy with the support of intermediary institutions and, to a lesser extent, of CONACYT and its PRCs and sectoral ministries, the development of human resources, technological infrastructure and the promotion and the provision of technological services must remain a strategic objective of Mexico's STI policy.

3.2 Guiding principles

The strategic orientations of the 2001-06 PECYT responded to a valid diagnosis of the main weaknesses of the Mexican STI system. However, its largely unfulfilled expectations highlight failures, as well as partial successes, from which to draw lessons for the guiding principles in the design, governance, funding and implementation of STI policies in the framework of the PECITI. These principles should be inspired by best practices in more advanced countries, taking into account the specificities of the Mexican situation.

- *Effective governance.* A prerequisite is political commitment at the highest executive levels of government regarding adequate budgetary appropriations in support of STI activities. This commitment should also be reflected in the operation of the governance structure entrusted with the preparation of the S&T budget in accordance with the Federal Budgetary Law, the steering of STI policy and its co-ordination with major stakeholders, including relevant ministerial departments whose actions impinge on the framework conditions that affect the performance of the STI system. Congress committees on competitiveness, S&T and budgetary appropriations should also play a more important role in the monitoring and funding of S&T policy.
- *Effective and transparent priority setting* should be achieved through the involvement of all major stakeholders, including the scientific and business communities and the civil sector. Outcomes should be reflected in planning and budgeting documents submitted by the government to the legislative branch and widely disseminated to the public upon approval.
- *Dynamic balance between public and private resources devoted to R&D and innovation.* A condition for improved innovation performance by the private sector is access to and collaboration with the public research system funded on the basis of criteria of excellence and relevance of research activities.
- *Clarification of functional responsibilities.* Following international best practices the political bodies responsible for defining priorities and for policy design should be distinct from agencies in charge of policy implementation, the latter being accountable to the former.
- *Single agent management.* While co-ordination of various government bodies or different levels of government is necessary for policy design and/or programme funding, single body management of implementation is generally preferable to arrangements involving joint management and funding. These usually entail high transaction costs and complicated or even antagonistic decision-making processes.
- *Critical mass and lean procedures in the delivery of government support.* Multiplication of programmes should be avoided. This often reflects opacity in policy design, response to vested interests and/or overlapping responsibilities among government agencies. Moreover it often involves high administrative costs, inefficiencies in delivery and can lead to fragmentation and programmes of less than critical mass. The devolution of management responsibility for mixed funds to states addresses this issue. Sectoral funds that reflect strategic priorities should, to the extent possible, be funded and managed according to unified operating procedures.

- *Balanced policy mix*. The policy mix should reflect the importance of various policy priorities and the critical mass necessary for effective programmes. For support to business R&D and innovation, the policy mix should strike an appropriate balance between direct (*e.g.* matching funds) and indirect support measures and sectoral support and take better account of the types of market or systemic failures these measures can address. In the case of support to public research institutions, it should strike an appropriate balance between institutional and competitive funding while encouraging access to external resources.
- *Balance between top-down and bottom-up approaches*. Stakeholders such as intermediary institutions and state bodies can contribute more to the definition and implementation of programmes that benefit their constituencies. Good practices already adopted (*e.g.* technological infrastructure, technological clusters, AERIs) should be generalised when appropriate.
- *Evaluation and accountability*. Regular evaluation of support programmes and institutions receiving public support should become the norm, with practical consequences for further rounds of support. However, a balance must be struck between the need for periodic adjustments based on evaluations and stability of support programmes to ensure their long-term impact on the behaviour of beneficiaries. Regular audits should also check that budgetary appropriations earmarked for S&T are effectively spent in that area.

Two prerequisites: improvements of governance and increased public spending on STI

One of the main conclusions of the preceding sections is that, in spite of the co-ordinating authority entrusted to CONACYT for working towards the objectives of the PECYT, the low levels of resources devoted to S&T/R&D during the preceding administration, together with the dispersion of budgetary and management responsibilities, resulted in ineffective governance and a distorted policy mix of often under-funded support programmes. A set of measures to strengthen Mexico's innovation system can only be successful if it is designed and implemented within the framework of an effective overall governance system.

3.3 Improving governance structures

Given Mexico's institutions and government structure, there is no silver bullet to improve the governance of the STI system.

The creation of a Ministry of Science and Technology (or of Higher Education, Science and Technology), a common practice in OECD countries, would in principle be worth considering. Such a ministry would be in charge of policy design and entrusted with the power to co-ordinate the whole of the S&T budget and oversee government agencies responsible for policy implementation. CONACYT legitimately aspired to fulfil that function[53] but has not been given the means, and was not in an institutional position, to do so.

However, the creation of a new ministry seems unrealistic at the present time. Moreover it is politically unlikely that the power that was denied to CONACYT for the implementation of the PECYT would now be assured by the granting of ministerial status, especially since a decision has recently been taken to make the Minister of Economy chairman of the CONACYT Board.

The creation of a new ministry remains nevertheless a valid option to be considered in the future. For the shorter term the most feasible option is an inter-ministerial council chaired by the president and including ministers with management and budgetary responsibility for S&T programmes or institutions.

53. However policy design and co-ordination were not clearly distinguished from implementation.

3.3.1 An effective S&T inter-ministerial council

An S&T council at ministerial level would be entrusted with defining national priorities and ensuring interdepartmental co-ordination of S&T policy orientation and national support programmes. It would be involved in the preparation of the S&T budget. While such a council, albeit with fewer prerogatives, formally exists – the General Council of Scientific Research and Technology Development – in the framework of the S&T Law, it did not effectively function in the previous administration.[54]

The current revision of the S&T law, which extends its scope to innovation, maintains the formal existence of the Council[55] and contains provisions which may help to ensure its more effective functioning, notably the creation of an Intersectoral Committee on Innovation.

The Council should have real influence – or at least a consultative say – regarding resource appropriations (including all S&T resources beyond those of Chapter 38), and possibly resource transfers between the federal and state levels. Its oversight responsibilities should also encompass regulatory policies that impinge upon the performance of the STI system, via legislative proposals or a consultative role regarding the impact on innovation of key framework conditions such as competition policy or labour regulations. In this respect it would seem important for the Council be in a position to review the provisions of existing laws and regulations (*e.g.* the Law on Parapublic Entities, the Law on Public Procurement and the Labour Law) that may presently hinder the efficiency of public research institutions and, more generally, may adversely affect the performance of the S&T and innovation system. In fact, for the new law on science, technology and innovation to have a real and lasting impact would require other legislative or regulatory changes as well.

The Council could be assisted by a tripartite S&T Consultative Board composed of representatives of the scientific and business communities and intermediary institutions. The existing Advisory Forum for Science and Technology (FCCT) instituted by the S&T Law could in principle perform the functions of such as body, but its role and composition should be reconsidered. One the one hand, its membership should be better balanced between representatives of the academic and the industrial sectors;[56] on the other, it should better manage its dual role of advocacy for S&T and innovation and consensus building among the stakeholders it represents.

The Council would be expected to meet at ministerial level at least once a year to address strategic issues concerning S&T policy and their consequences in terms of budgetary appropriations and legislative or regulatory action. More frequent meetings at lower levels would be devoted to inter-ministerial co-ordination and monitoring of policy implementation.

In addition, and in order to acknowledge and enhance the role of S&T and innovation in Mexico's social and economic development, CONACYT could also become a full member of the Government's Restricted Cabinet which deals with economic matters and competitiveness.

In this institutional setting, S&T planning and budgeting would be distinguished from financing and implementation of competitive programmes, with the latter performed by "means" or financing agencies. However, non-competitive forms of financing would continue to be assured by sectoral ministries, for example mission-oriented STI programmes or projects executed in the research institutions under their authority, or the institutional funding of basic research by the Ministry of Education.

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54. It has met only three times in six years.

55. Including ministers whose administration receives earmarked S&T budgetary appropriations.

56. Presently the Forum is composed of 14 representatives of the academic sector and three members of industry.

CONACYT and the Ministry of Economy would be entrusted with particular responsibilities not only as the main government bodies responsible for policy implementation and programme funding, but also because of the complementarity of their actions in support of R&D and innovation at the interface of scientific and technological development. The question of their respective roles is therefore important for the governance of the STI system.

3.3.2 An evolving role for CONACYT

In order to ensure stability and avoid disruptions associated with the current practice of rotating chairmanships, the Minister of Economy should chair the CONACYT Board on a more permanent basis. In addition to its role in the overall co-ordination of S&T policy, which could be strengthened if its director general reported directly to the president, CONACYT would evolve into a "means agency" with the following main responsibilities.

Management of competitive funds to finance R&D-intensive projects or programmes:

- The *Basic Science Fund* for non-oriented research performed by public research institutions.
- A limited number of *sectoral funds* in areas corresponding to national technological or sectoral STI priorities and devoted to the financing of medium-term applied R&D and innovation programmes submitted by public research institutions and/or industrial associations. While CONACYT would be responsible for the management of these funds, ministries with administrative responsibilities for the priority sectors would be involved in programme definition and evaluation of outcomes. Part of the resources allocated to these funds would be explicitly devoted to the medium-term financing of public/private research and innovation partnerships (consortia and AERIs). A condition of the effective management of these funds would be a streamlining of the bureaucratic decision and disbursement procedures.
- The *AVANCE institutional fund*, whenever projects are presented in collaboration with public research institutions.

Management of the interface with sub-federal entities for the development of STI capacities

- Programming and co-financing of *mixed funds* according to national and regional priorities with particular attention to the development of S&T infrastructure for regional innovation systems and technological clusters, with increased devolution of project selection and management to the states.

Public research centres

CONACYT would continue to oversee and fund the institutional component of its research centres while encouraging their greater management autonomy (including further progress towards self financing), closer links with HEIs, or even possible partial or total privatisation for those that primarily provide services.

Fiscal incentives

CONACYT should jointly manage the reformed fiscal incentives instrument with the Ministry of Finance, with particular responsibility for information dissemination, procedural support, *ex post* control and monitoring and evaluation.

Finally, It would also keep its oversight and financing responsibilities for the programmes aimed at enhancing international scientific co-operation (FONCICYT) and developing the supply of HRST (*e.g.* postgraduate scholarship and IDEA programmes).

3.3.3 The role of the Ministry of Economy in the promotion of innovation for competitiveness

The Ministry of Economy plays an important role in fostering competitiveness and, like ministries with similar responsibilities in most OECD countries, it should move towards increased emphasis on the promotion of enterprises' innovation capacity building and technological infrastructure. Its actions could be organised along the following lines.

Technological Innovation Trust Fund

This fund would cover the missions presently attributed to the Economia-CONACYT Technological Innovation Fund and support innovation projects submitted by firms, essentially SMEs. Support would be granted through matching funds or grants. Eligible investment expenditures would include R&D costs and technological infrastructure (*e.g.* ICT, logistics, metrology, certification, IPRs). Projects should be assessed on the basis of expected returns and supported irrespective of sectors or technological area. The only conditions of eligibility should be related to a project's constraints[57] on developing economically viable innovative activities. The only discriminating factor among projects could be preferential treatment for those carried out in co-operation with PRCs or HEIs.

The fund would develop links with the financial sector through its contribution to the development of venture and seed capital funds and guarantee funds in co-operation with NAFIN.

Like innovation agencies in various OECD countries, it could also provide special incentives to the creation of new technology-based firms.[58]

Technological infrastructure and diffusion

In liaison with institutions such as INFOTEC, CENAM and IMPI, the Ministry of Economy should develop or strengthen its support for technological infrastructure and diffusion programmes submitted by intermediary institutions or industry associations, notably for the development of innovation clusters and productive networks. In this important area of promotion of regional innovation capacities, strong co-ordination with CONACYT will be required.

Finally, the Ministry of Economy should be endowed with adequate resources for emulating the PROSOFT programme in other priority technology areas, provided that the support is complemented by funding from other sources, including firms, intermediary institutions and local governments, and contributes to the development of sectoral and regional clusters.

3.3.4 Improving the articulation between the federal and state levels

Governance reforms should also concern the design, management and financing of policies and programmes that aim at strengthening STI capacities at state and local levels. This raises several questions.

Co-ordination mechanisms between the federal and state levels that involve CONACYT and state S&T councils should be reinforced with a view to identifying projects that correspond to national priorities, and therefore call for a larger share of federal funding, and those that correspond to state priorities, and therefore imply differentiated shares of funding, especially in light of the fiscal reform that increases resource transfers. The more strategic approach currently adopted by CONACYT in the definition and

57. These constraints can be diverse: access to finance; access to proprietary technology; availability of qualified personnel; etc.

58. Eventually, this fund could become an autonomous innovation agency able to participate financially in firms it supports. In this case, it would have to receive endowments from the public sector and financial institutions.

design of projects selected for funding is a good step in that direction which deserves to be developed further.

Figure 15 Mexico's regional S&T and innovation landscape

	% of national GDP	Number of NSR[1] researchers	Number of HEIs[2] with doctoral programmes	Number of S&T institutions and enterprises in RENIECYT[3]	% of R&D tax incentives	% of Mixed Funds
Distrito Federal (DF)	21.84	5 846	30	864	43.6	--
México	9.48	797	13	221	7.7	0.9
Nuevo León	7.43	449	5	260	22.1	14.0
Jalisco	6.31	688	9	245	4.2	1.7
Chihuahua	4.33	152	5	112	3.6	1.6
Veracruz	4.17	311	9	70	2.0	2.7
Guanajuato	3.60	415	12	251	3.0	12.1
Puebla	3.55	534	11	75	5.1	0.6
Baja California	3.50	412	8	67	2.4	3.3
Coahuila	3.37	189	9	120	0.9	2.8
Tamaulipas	3.34	110	6	42	1.3	5.2
Sonora	2.68	245	4	97	0.0	3.9
Michoacán	2.21	390	4	47	0.2	3.9
Sinaloa	1.99	151	6	41	0.2	1.4
San Luis Potosí	1.81	253	3	50	0.2	2.6
Querétaro	1.72	281	6	83	2.6	1.4
Chiapas	1.70	116	4	27	0.1	6.4
Guerrero	1.68	39	1	5	0	0.7
Quintana Roo	1.64	53	0	23	0.0	1.9
Oaxaca	1.52	119	6	26	0.0	0
Yucatán	1.41	276	5	37	0.0	2.5
Morelos	1.38	753	9	46	0.1	2.1
Durango	1.33	60	5	33	0.1	1.2
Hidalgo	1.30	173	1	65	0.2	4.8
Tabasco	1.25	78	1	27	0.0	6.7
Campeche	1.24	59	2	11	0	1.6
Aguascalientes	1.23	69	1	51	0.1	2.6
Zacatecas	0.76	95	1	12	0.0	6.0
Baja California Sur	0.60	183	3	7	0.0	0.4
Tlaxcala	0.57	68	2	16	0.1	1.5
Nayarit	0.54	17	1	4	0.0	1.3
Colima	0.53	104	1	23	0.2	0.7

1. NSR = National System of Researchers *(SNI);* 2.Higher Education Institutions; 3. National Register of S&T institutions and firms.

Source: CONACYT

As noted above, the management and effectiveness of mixed funds have quite often been impaired by lengthy selection and disbursement processes, and, in a number of states, by weak capacity to develop and submit adequate R&D and innovation proposals. The supply/demand balance of mixed funds should be modified to give states more management responsibility for funds allocated to institutions located in their territorial jurisdiction. Decentralisation of policy should be accompanied by decentralisation of management[59] and, to a larger extent than is the case now, by decentralisation of resources. This would greatly reduce the administrative burden borne up to now by CONACYT, as mixed funds would eventually merge with, or contribute to, the state S&T budget for financing projects presented or led by local institutions. The shifting balance of management and financing responsibilities between the federal and state levels would obviously not be the same for all states.

As concerns the strengthening of S&T capacities of less developed states, a mechanism similar to the European Union's Structural Funds for overcoming regional disparities in terms of infrastructure would deserve consideration by the Congress.[60]

3.3.5 Evaluation

Finally, good governance implies regular evaluation exercises with feedback on policy design and financing. In Mexico an embryonic culture of evaluating outcomes has to be further developed, as too many policy assessments tend to be simply a description of resource allocation, a check that procedures have been respected, and sometimes consideration of the quality of management. Too often issues of the effectiveness of the policy instrument *vis-à-vis* its stated objectives and its cost effectiveness are not addressed. Following practices increasingly implemented in other countries, CONACYT and other ministries responsible for the funding of S&T and innovation programmes or projects should develop monitoring and assessment systems based on qualitative and quantitative information and indicators. The rationale of support programmes as well as the expected outputs and outcomes should be highlighted at the outset. Monitoring and *ex post* assessments should provide feedback on policy design and funding.

3.4 Specific policy recommendations

Various policy recommendations have already been proposed and are summarised here. Others, which remained implicit in the overview of the assessment and policy challenges, are highlighted.

3.4.1 Improve the policy mix in support of business R&D and innovation

- *Shift the fiscal incentive system*[61] from discretionary to automatic by eliminating the resources cap and instituting a cap per beneficiary enterprise. Eliminate the multiplicity of selection and eligibility criteria by restricting them to R&D and innovation-related activities without any discrimination among sectors or firms. Consider a dual volume/increment system to provide better incentives to innovative SMEs,[62] and a preferential tax credit rate for SMEs. Reduce compliance costs so as not to deter smaller firms. Establish a joint CONACYT/Ministry of Finance Commission entrusted with the definition and implementation of new operating rules for the

59. This, as well as federal/state co-ordination, would be facilitated by more homogeneous state administrative structures regarding the administrations responsible for S&T policy and programmes.

60. The Structural Funds clearly go beyond the S&T issue. In the European Union, they have played a significant role in the catching-up process of backward or peripheral regions and have demonstrated that resource transfers aimed at improving the infrastructure of such regions can yield global benefits for the EU as a whole. See for example http://ec.europa.eu/regional_policy/innovation/index_en.htm.

61. Detailed recommendations are presented in section 2.4.1.

62. This is already considered in the framework of the PECITI.

reformed fiscal incentive system. This should reduce the budgetary cost in terms of foregone revenues.[63]

- In parallel with the reduction of indirect support provided by fiscal incentives, *increase the volume of direct support* to firms through existing (or reformed) competitive support schemes by providing resources in the form of matching funds, subsidised loans or, in certain cases, grants. Give a bonus to collaborative projects. Streamline eligibility criteria. Increase support for developing new technology-based firms, reduce obstacles to their creation and facilitate their access to capital markets. Part of this increase should be financed by the savings incurred from the streamlining and more stringent eligibility criteria of the fiscal incentive system.[64]
- Link the management of direct support schemes to the strengthening of *contributions from the financial sector* (guarantees, venture and seed capital), notably its public component (NAFIN). Strengthen *project assessment capacity* in support programme management structures.
- Increase the leverage of public research on private investment in R&D in national priority areas through *public/private partnerships for research and innovation* (AERIs).
- Consider *sectoral support programmes* under the condition of matching resources from firms, intermediary institutions and regional governments; use this instrument to support the development of clusters. Emulate the PROSOFT programme in other priority areas.
- Develop an innovation-friendly *public procurement policy*, based on international good practices and compatible with international agreements, to support innovation in sectors with high social demand (health, energy, transport, environment, education). This would probably require a modification of the public procurement Law (*Ley de adquisiciones*).
- Support SMEs' demand for, and access to, *technological services* (metrology, certification) and information, and encourage the development of a competitive public and private supply of these services. Strengthen *technology diffusion* programmes by encouraging collaboration between public institutions and industry associations.
- Strengthen the mission of IMPI regarding the *diffusion of technological information through easier access to its patent information base* and the provision of services to facilitate patent application and filing procedures.

3.4.2 Strengthen public research and foster its contribution to innovation

- Consolidate non-competitive *institutional funding of HEIs,* expanding it to cover infrastructure costs. Evaluate outcomes of institutional funding regularly. Use institutional funding to foster decentralisation of research capacities.
- *Increase the volume and share of competitive funding*, in both basic research and applied R&D and innovation programmes in national priority areas. Give preferential treatment to collaborative research.
- Use the planned IMPI/CONACYT Fund to foster the systematic creation of, or affiliation to, *technology licensing and transfer offices* in public research institutions, including HEIs, in order to promote the diffusion of research results.
- Streamline rules and procedures for *contractual agreements* with the private sector.
- *Consolidate the evaluation criteria used by the SNI* to better account for researchers' innovation-related output.

63. This commission should also estimate the budgetary impact of future residual tax credit claims by firms that have benefited from such credits in the past years.

64. The calculation of these savings should take into account the residual costs of tax credits.

- Initiate a consultative process involving the administration and the scientific community *on the long-term future of the SNI.*
- Reduce the barriers to the *inter-institutional mobility of researchers*.
- *Adopt common governance structures and accountability requirements* in all public research centres; in particular *extend performance agreement* schemes to research centres overseen by sectoral ministries. Review the established performance agreements in the light of other OECD countries' experiences and draw lessons for Mexico.
- Strengthen the move towards *greater management autonomy of PRCs* regarding investment and personnel. Remove management constraints stemming from the Law on Parapublic Entities that hinder the pursuit of S&T activities, in particular those conducted in collaboration with the private sector. Consider increasing levels of self-financing or even the possibility of privatisation of those more involved in technology development and transfer.
- Entrust the Science Consultative Council and/or the Mexican Academy of Science with the preparation of annual reports on ways in which the scientific community can best address Mexico's social and economic challenges.

3.4.3 Foster the development, insertion and mobility of highly skilled human resources

- *Adopt a more strategic approach in the Postgraduate Scholarship Programme* by introducing some degree of selectivity in awards.
- Facilitate temporary *hiring of postgraduates in public research centres for secondment in industry*.
- Strengthen existing programmes that facilitate the *insertion of highly skilled personnel in the business sector* and remove obstacles to the institutional mobility of researchers.[65]

3.4.4 Strengthen regional STI capacity

- In concertation with state S&T councils, develop *a medium- to long-term master plan for federal/state co-operation* on the development of S&T infrastructure.
- Strengthen *regional S&T infrastructures* through institutional funding of HEIs and PRCs.
- Consider the establishment of a "structural fund" specifically dedicated to the *development of S&T infrastructure in less developed states*.
- Use sectoral funds to foster the development of *regional innovation clusters* with matching resources from the states, local governments and industry associations.
- Increase *states' management autonomy for* deciding allocation and disbursement of joint federal/state funds for research and innovation projects.

Concluding remarks

This report argues that Mexico has moved too slowly towards an innovation-fuelled growth path, which, in the short term, would enhance the country's knowledge-based competitiveness and allow it to reap benefits from globalisation similar to those reaped by dynamic emerging economies. In the longer term, such a path would allow Mexico to bridge the wide gap in living standards with wealthier OECD countries.

65. This may involve a reform of the labour law as it applies to the statute of public research institute personnel.

The report suggests that, as part of a wide and ambitious "national innovation agenda", the Mexican government should urgently increase the priority given to reforms and policies that can enhance capabilities throughout the economy and drive innovation.

It first reiterates the call of other recent OECD reports (OECD, 2006, 2007c, 2007d) for reforms in policies that shape framework conditions for innovation, with emphasis on education and competition policies.

Focusing on the role of science, technology and innovation policy *stricto sensu*, whose primary and explicit objective is to enhance innovation capabilities in the public and private sectors, it proposes the following prioritisation and sequencing of government initiatives.

In the short term, the government's increased commitment to fostering innovation should lead to:

- Improved governance structures to ensure more effective leadership and coherence in the formulation, implementation and evaluation of relevant policies at federal and state level.
- Sustained budgetary spending in support of R&D and innovation through better designed and managed programmes. In particular, the overall budgetary effort in support of business innovation (defined as the sum of foregone tax revenues and cost of direct support) should be at least maintained but a new balance should be found between tax incentives and grants, to the benefit of the latter.

In a longer term perspective, the government should initiate or contemplate other changes in the infrastructure and incentive structures of the Mexican innovation system. As well as the future of the SNI, the position of public research centres and universities in an increasingly firm-centred Mexican innovation system should be re-examined.

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