Trade and innovation performance of Mexico after NAFTA[1]

Guillermo Abdel Musik

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Introduction

By many standards, Mexico is a surprisingly strong economy. In terms of total GDP, the combination of a population of 100 million and a per capita GDP exceeding US$5,000, makes Mexico the ninth largest economy in the world. With US$232 Bn in trade for 2002, it is the US´s second trading partner (behind Canada), and far ahead from the third trading partner (Japan with US$184 Bn). This could be considered surprising for a country that is often thought of as a "developing" country.

Export figures are even more impressive when we consider the country's economic history in the last fifty years. From the 1950s to the early 1980s Mexico followed a strict import substitution policy; high tariffs were levied on most products, based on a policy of protection for infant industries. Regulations were also imposed on foreign investment and ownership in order to insure the development of Mexican-owned industry. After a severe economic crisis in the early eighties, the government recognized the need for stabilization and structural change; by 1985, it unilaterally dropped requirements for import permits on most products, and a year later joined GATT, decreasing tariff and non-tariff barriers for most products. This liberalization strategy was continued, most importantly through the signing of 11 free trade agreements, which include 32 countries. These agreements include: the European Union, the European Free Trade Area, several Latin American Countries, and, most importantly, the North American Free Trade Agreement (NAFTA).

NAFTA created many opportunities for Mexico, both in terms of fostering domestic industry, and attracting international firms. The main achievement was a substantial increase in exports, and a change in industrial structure from petroleum to manufacturing products.

Most of the exports are based on firms taking advantage of the country's proximity and labour cost differences with the U.S. However, this model of growth is starting to show severe limitations. For example the *Maquiladoras*[2], which showed annual labour force increases for 37 straight years, reached its maximum level of employment of 1.35 million in early 2002, and shed over 21% of its workforce in 15 months. In terms of number of plants, 545 (15% of total) closed in the 8 month period following June 2001. Similarly, the "star" sector of NAFTA, the automotive industry, shed several thousand jobs in 2002.

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[1] Many ideas presented in this paper were developed while producing inputs for the Mexico document of the Knowledge for Development (K4D) program of the World Bank and resulted from suggestions and continued discussion with Yevgeny Kuznetsov and Carl Dahlmann.

[2] Refers to firms performing in-bond operations, paying export duties only on the valued added inside the firm.

This could easily be dismissed as part of an adjustment caused by the contraction of the US economy. If these were definitive closures, they could be attributed to market conditions; however, this unfortunately seems not to be the case. An estimated 34% of the Maquiladoras which left the country did not disappear, but went to Asian countries, mostly China (Consejo Nacional de la Industria Maquiladora de Exportación, 2003). Similarly, while Daimler-Chrysler closed 3 plants in 2002, and shed over 2000 jobs, company executives have expressed intention of building a new plant in the North American region, with an investment of US$400 to US$600 million, reflecting a loss in relative competitiveness.

Both government and industry leaders are extremely concerned about Asian countries attracting assembly firms. This concern was clearly reflected when Mexico was the last country to accept China´s inclusion in the World Trade Organization (WTO). However, these leaders seem to understand the competitiveness problem as one arising from differences in labour cost, ignoring the close relation between a country's performance and its technological capabilities (in a broad sense which includes adoption, adaptation and creation). Failure to recognize this critical link will result in further loss of competitiveness.

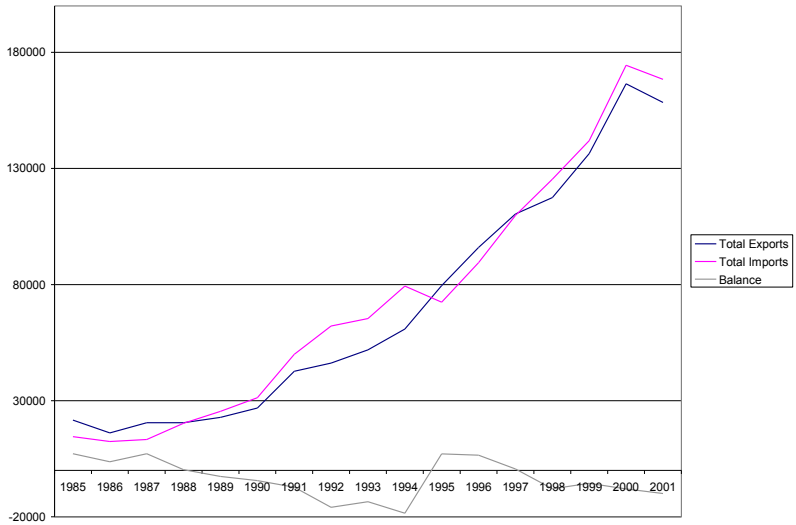
The objective of this paper is to relate the outstanding export performance with other economic variables. The main argument is that the missing link between trade liberalization and high growth rates, has been the absence of innovation from firms. This hypothesis builds on a growing body of research which shows the relationship of the capacity to innovate, particularly in the private sector, with economic growth and productivity improvements. This means that constant underinvestment in R&D, rather than just being a problem resulting in low levels of innovation output (such as patenting) is a barrier to achieving sustained economic growth.

The rest of the paper is divided into four sections. The first section describes the evolution of export and productivity, showing that the extraordinary increase in exports has not been reflected in increased firm efficiency. The second section describes the innovation system in Mexico, and the inherent weaknesses of the system. The third section describes industrial development and innovation policies pursued in the last ten years, including the more recent attempts to link these two policies. The final section presents conclusions and recommendations on how to strengthen the innovation system in the near future.

Evolution of exports and productivity

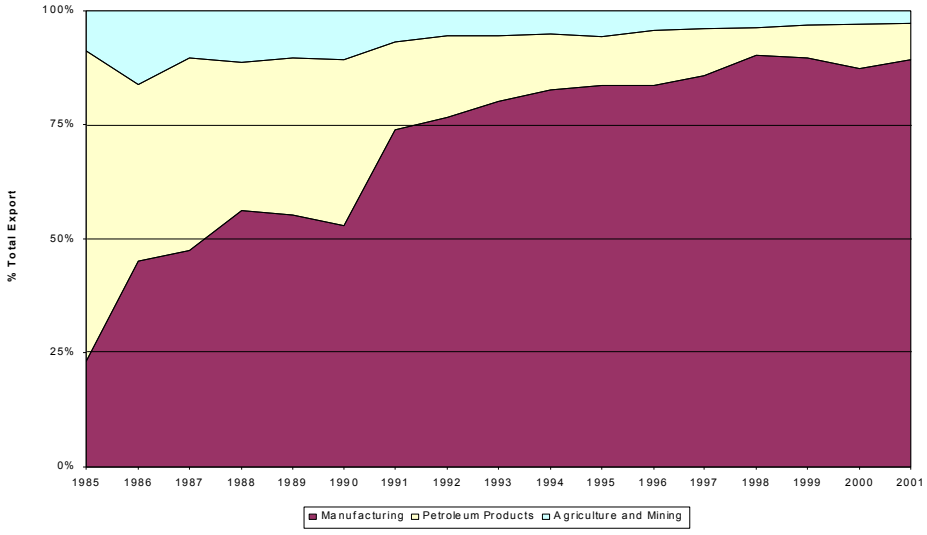
The efforts by the Mexican government to liberalize trade have resulted in a dramatic transformation of both the quantity and structure of trade. In terms of quantity, exports have increased eight-fold, from 20 to 160 US$Bn, and imports have increased over 10 times, from 14.5 to 170 US$Bn. (See Figure 1). Currently, exports represent over 30% of GDP. Perhaps more importantly, the increase in exports is a result of a profound transformation in the structure of trade, with a major shift from oil-related to manufacturing exports. In 1985, petroleum accounted for 68% of total exports, while manufacturing was just 23%. Since 1998, manufacturing has accounted for 87 % to 90%, while petroleum related products have only been between 6% and 10%. (see Figure 2).

Figure 1. Growth of Imports and Exports



Source: www.inegi.gob.mx

Figure 2. Structure of Exports



Source: www.inegi.gob.mx

Within manufacturing exports, the products have also increased in complexity. Using the OECD classification, high-tech products accounted for 26.9% of total exports in 1999, up

from 7.0% in 1990. Table 1 shows the quantities exported of different high-tech goods. High-tech and medium-high-tech industries constitute 74.1% of total exports, higher than countries such as Germany and United Kingdom, and 11.6% higher than the OECD average.[3]

Table 1. Exports of Technology Equipment by Trade Regime

US$ billion, 2001

	Non-Maquila	Maquila	Temporal	Total
Aeronautical	144	280	750	1,173
Computers and Office Machinery	225	8,020	4,751	12,996
Electronics	242	13,380	769	14,391
Pharmaceutical	588	17	322	926
Scientific Instruments	70	1,230	743	2,044
Electrical Machinery	63	1,799	200	2,061
Chemical	111	2	194	313
Non-Electrical Machinery	18	4	18	40
Weapons	4	5	14	22
Total	1,464	24,736	7,760	33,965

Source: Conacyt (2002)

Other achievements of the Mexican economy, which can at least be partially attributed to its trade liberalization strategy, include a more decentralized regional structure, with economic activity moving away from the Mexico City region to the center and north of the country, and a reasonably stable macroeconomic environment since 1996.

This growth in manufacturing exports seems to reflect a transformation of the economy, where firms have improved their operations, allowing them to be competitive in the world market. This story is partly true, for some firms have been successful in absorbing technology and translating it into increased output and exports. However, a closer look shows that, despite this good performance in terms of exports, there are underlying vulnerabilities in the system. Three factors can give us a more accurate picture of this performance: growth, total factor productivity (TFP) and export composition. These are explained below.

i. Growth Performance

Despite the huge increase in exports, economic growth has been rather mediocre since 1982. Table 2 shows the evolution of per capita GDP growth in Mexico for the last four decades. We can observe that during the 1980s (commonly called Latin America´s lost decade), per capita GDP growth was negative. Despite the major liberalization efforts taking place after 1985, average annual per capita growth rate in the 1990s was still less than half the growth achieved during the 1960s and 1970s.

[3] The classification used for technology intensity of export is the one defined by the OECD. High-tech goods include: aircraft and spacecraft, pharmaceuticals, Office, accounting and computing machinery, radio, television and communication equipment, and medical, precision and optical instruments. Medium-high-tech industries include: electrical machinery and apparatus, motor vehicles, trailers and semi-trailers, chemicals (excluding pharmaceuticals), railroad equipment and transport equipment, and machinery and equipment.

Table 2. Annual GDP per capita Growth (1961-1999)

	1961-1970	1971-1980	1981-1990	1990-1999
Average annual growth of GDP Per Capita	3.37%	3.58%	-0.29%	1.42%

Source: Loayza, Fajnzylber and Calderon (2002)

This performance becomes more obviously poor when compared with its main trading partners and competing countries. Mexico has consistently lagged behind its partners in the NAFTA area and major East Asian competitors. Particularly relevant are the differences with Korea and China, countries which have exceeded Mexican GDP growth by several orders of magnitude during the period (see Table 3).

Table 3. Comparative Annual GDP Growth Rate

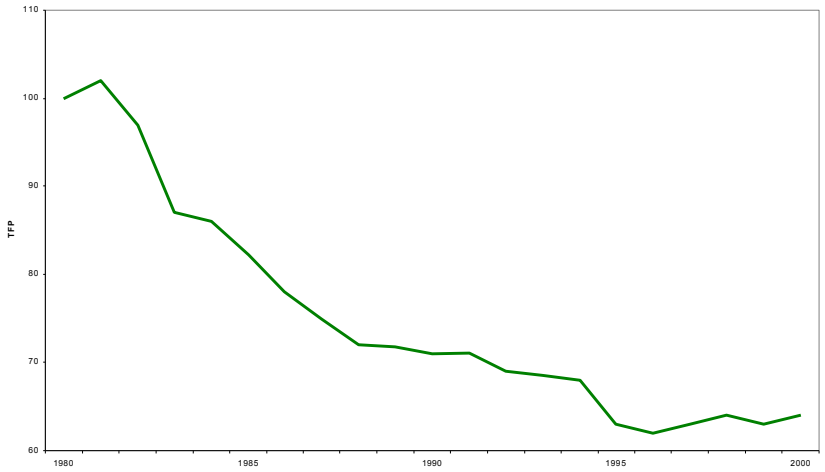
	GDP Average Annual % Growth	
	1980-1990	1990-2000
Mexico	1.1	3.1
U.S.	3.5	3.5
Canada	3.3	2.9
Korea	8.9	5.7
China	10.1	10.3

Source: World Bank, 2002

ii. Total Factor Productivity

Several authors have estimated the Total Factor Productivity (TFP) evolution during the last twenty years. These estimates have some variation, resulting from differences in data sources and estimation techniques. Despite the slight differences, the story seems to be quite consistent across different authors: TFP in Mexico declined sharply during the 1980s and has remained relatively stagnant during the 1990s (see Figure 3). This stagnation is counterintuitive given the great export growth after liberalization. This empirical evidence from Mexico (and other countries) also contradicts conventional theory which predicts increases in TFP as a consequence of trade liberalization.

Figure 3. Evolution of Total Factor Productivity (1980-2000)



Source: Bergoeing et al (2002)

Authors account for this stagnation in a variety of ways (see Table 4 for key findings from recent references). Some of the main explanations provided are: 1) the lack of banking sector law reforms are at least partly responsible for stagnant TFP, (Bergoeing et al, 2002), 2) investment has been too low to expand the capital stock, (Bosworth, 1998), 3) foreign capital participation has a negative impact on TFP, but forward or backward linkages to sectors with foreign capital participation have a positive effect, (Lopez Cordoba, 2002) and 4) sharp differences in TFP growth (ranging from –35% in basic metal industries to +28.5% in precision instruments) can be observed across sectors, so that the observed decline is explained by a composition effect. When analyzing labor productivity, the results are also mixed. According to INEGI (2001), overall labor productivity in the *maquiladora* industry decreased in the period from 1988 to 1998. On the other hand, Lopez-Acevedo (2003) finds significant increases in labor productivity, particularly in firms which invest in training.

Table 4. Recent References on TFP in Mexico

	Key findings
Raphael Bergoeing et al (2002)	- TFP in Mexico and Chile dropped during the 1980s, but while output in Chile returned to a growth path, it never recovered in Mexico, and two decades later it still is 30% below trend. - Comparative evidence does not support that this recovery was due to exports or to large external debt. - The explanation for the difference in economic performances is based on the different timing of structural reforms in the two countries. - The crucial difference in performance is explained by the reform of banking and bankruptcy laws.
Barry Bosworth (1998)	- Economic collapse of the early 1980s created a persistent disequilibrium situation in which large portions of labour are effectively under-employed - Direct estimates of appropriate measures of factor income cannot be obtained. - After 1988, the growth in output was barely adequate to match the expansion of the factor inputs, and there was little or no increase of capital - Despite an enormous expansion in foreign borrowing, México has been unable to generate an expansion of the capital stock commensurate with the growth in the labour force. - TFP reflects allocative inefficiencies, as an excess supply of workers is pushed into

	jobs below their normal skills levels since the 1980s - Mexico needs ways to smooth the flow of jobs form the informal (low technology) to the formal sector
Pablo Fajinzyber and Daniel Lederman (1995)	-TFP growth was faster when Mexico was "reformed", in fact average TFP growth is negative in the periods of no reform, due to the fact that recessions have been frequent during this period. - Observed productivity growth is subject to the effect of short-term fluctuations that can obscure the impact of reforms on the long-run economic performance.
Kristin Hallberg, Hong Tan, and Leonid Koryukin- World Bank (2000)	- For the manufacturing sector as a whole, TFP growth accelerated between 1993 and 1995, from an annualized growth rate of 0.6% to 13.8%. Subsequently, TFP growth rates declined, to 1.3% in 1995-96, and turned negative in 1996-97. - Non-exporters have had less TFP growth than exporters during this period. - Learning through exporting is taking place. While the immediate productivity gains from exporting are modest, sustained productivity gains accrue as experience accumulates. Overall, firms learn and improve productivity, through experience and exporting, specifically with years of experience as suppliers. - Firm-level productivity is improved by investments in worker training and implementation of quality control practices.
Norman Loayza, Pablo Fajnzylber, and César Calderón(2002)	- Strong-market oriented reforms conducted during the 1990's increased growth in Mexico in comparison to the previous decade. - Educational attainment has increased in almost every period. - Low TFP may be due to the declining efficiency of market organization due to policy or other changes. - TFP has a more important effect in growth than factor accumulation. - Upsurges in growth precede a rise in investment and saving.
Ernesto López-Córdoba (2002)	- Mexico's total factor productivity performance since the early 1980s and through the mid 1990s was rather disappointing, with average annual growth between -1and -2 percent. - Exporting does not have a positive effect on TFP growth. In fact, being an exporter appeared to be negatively correlated with productivity growth. - In contrast to the strong support for the view that trade competition fosters improvements in productivity, there is at best scant evidence showing that improved access to more and better intermediate inputs translates into productivity growth - Foreign capital participation reduces productivity, but FDI in industries in which a plant has backward or forward linkages has a significant and positive effect.
Gladys López Acevedo (2003)	- Considers only labour productivity. - Schooling has a high impact on wages and productivity, a factor that may explain the slow growth in labour productivity in Mexico is the low education level. - Investment in human capital magnifies technology-driven productivity gains, but Mexico has not invested enough. - Findings in labour suggest that training obtained outside of firms increase productivity, but Mexico has under-invested in training as can be seen with the high percentage of in-house training.

iii. Export Performance

As mentioned in the first section, the brightest spot of the Mexican economy in the last ten years has been export performance. The large increase and clear contribution to GDP growth suggest that the trade liberalization model was indeed successful. However a closer look shows weaknesses within the export structure.

Concentration in few firms: An important limitation comes from the fact that exports are extremely concentrated, with few dozens of firms accounting for 90% of manufacturing exports. Table 5 presents the 8 largest firms exporting from Mexico (the list does not

include Maquiladoras[4] where other prominent foreign electronic and automotive firms, such as Sony and Delphi, that export several billion dollars in goods).

Table 5. Largest Firms Exporting from Mexico

	Firm	Exports
1	Pemex	$9,914
2	General Motors de Mexico	$5,050
3	Volkswagen de Mexico	$5,040
4	Chrysler Mexico	$3,792
5	IBM de Mexico	$3,000
6	Cemex	$2,665
7	Ford Mexico	$2,330
8	Nissan Mexicana	$1,586

Source: America Economía web page[5]

Exports based on foreign firms: Most of the largest exporters from Mexico are foreign owned firms. Table 5 shows that only one of the eight largest exporters is a private Mexican firm. Similarly, Table 1 and Figure 2 point to the great increase in both automotive and high tech sectors. However, with the exception of a handful of autopart firms, these sectors are composed entirely of foreign firms. This excessive reliance on foreign firms presents two risks in the medium term. First, foreign companies tend to be more willing to shift production capacity in response to changes in relative factor costs, creating instability in the labour market. Second, parent companies tend to give priority to their own country facilities in issues such as training. For example, labor market rigidities in U.S. manufacturing (such as those created by the UAW in the auto industry) create the need for constant productivity increases achieved through local training. Thus, limited regional training budget reduce the possibilities of increasing skills in Mexico.

Exports as enclave: The concentration of exports in few foreign firms would not represent a problem, if they created significant spillover effects through vertical linkages. Unfortunately, exporting firms tend to operate largely in isolation from the rest of the economy. An example of this "shallow" economic development is the small degree of local content integration in Maquiladora industry, which after 40 years of presence in Mexico, has recently increased its local input integration to 4%. This small percentage of integration has several problems. In the short term, lack of integration means that the economic benefits to the region will be limited to wages, without the possibility of the multiplier effect resulting from linkages to other parts of the economy. In the medium term, lack of linkages will greatly limit the possibility of diffusing knowledge to local firms, which might improve capabilities in response to foreign buyer requirements. In terms of firm mobility, the absence of local suppliers also decreases the cost of changing locations, making industry more footloose.

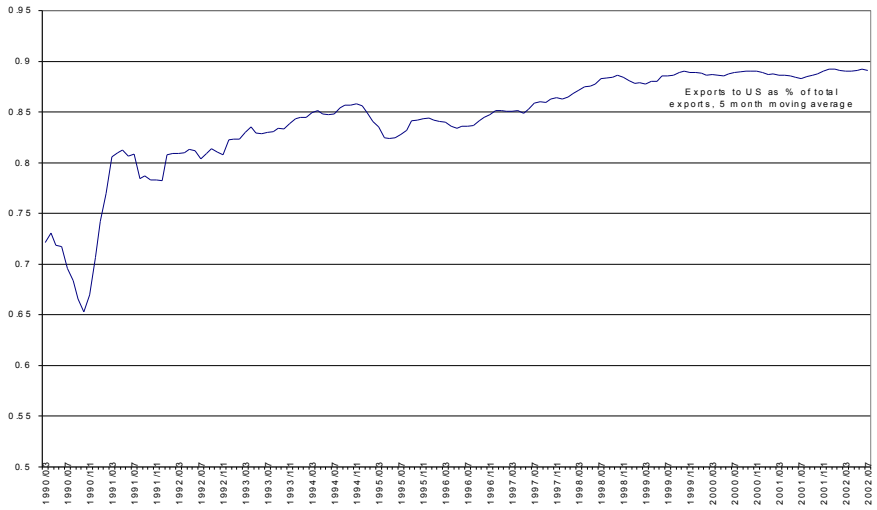
Extreme dependence on one export market: While exports to the U.S. accounted for approximately two thirds of total exports in the early 1990s, this percentage has increased steadily for ten years, and exports to the U.S. have stabilized at around 89% (See Figure 5). This means that simple comparative advantage, in the form of proximity to the world largest has overshadowed the advantage of having trade agreements with

[4] The reason for excluding Maquiladoras is that their accounting practices usually consider value added rather than total export value.

[5] http://www.americaeconomia.com/FilesMC/ranking-SP02.pdf, consulted in June 26, 2003

31 other countries, many of which also have higher labour costs. As with the case of foreign firms, this extreme reliance on one market increases risk, by making exports vulnerable to contractions in the U.S. economy.

Figure 4. Exports to U.S. as Percentage of Total Exports



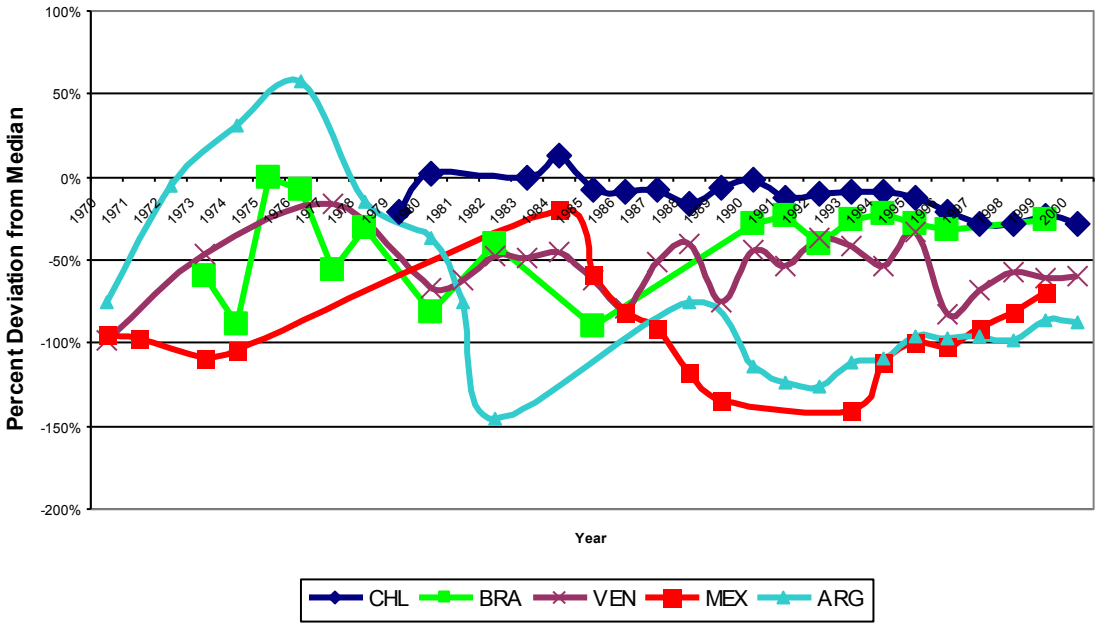
Source: www.inegi.gob.mx

The four factors mentioned above (concentration, foreign ownership, few local inputs, and extreme dependence on the U.S. market), suggest that increasing exports are more a result of international division of labor than of the development of advanced capabilities by previously established firms. The proximity to the U.S. and its labor cost advantage, created a massive migration of labor intensive manufacturing operations into Mexico. A lot of the growth registered in the last fifteen years can be attributed to comparative advantages (as opposed to competitive advantage) to its main trading partner, the U.S. This does not rule out operation and process improvements to be able to compete in a very open economy, with a diverse manufacturing base.

Innovation system in Mexico and its weaknesses

Mexico, as the rest of Latin America, is caught in a low-level equilibrium trap in innovation and learning. Despite very significant changes in the macro environment and increased competition within the economies, economic agents (particularly firms) have not been able to shift towards knowledge-intensive activities with higher value added. Figure 6 shows the deviation from predicted investment gap from median R&D/GDP relative to its per capita income for a variety of Latin American countries. It shows that, with the exception of Argentina in the 1970s and Chile in the early 1980s, investment in Latin American countries has been significantly below the median.

Figure 6. R&D/GDP Relative to its Per Capita Income

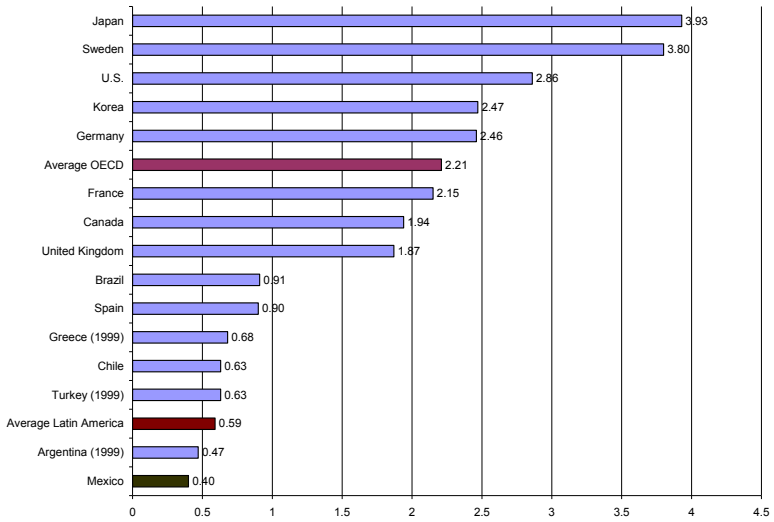


Even though empirical evidence shows returns to investment in R&D are on average higher in emerging economies, Latin American countries have been notorious for their meager investment in R&D activities. Maloney (2003) estimates that the optimal amount of investment is between 4 and 10 times current amounts, and provides a variety of reasons for this underinvestment. Perhaps the most important constraint mentioned is the lack of learning capacity, which would allow firms not only to use a technology, but also to develop it further. Other reasons provided for the low investment are: lack of competitive pressures, absence of well functioning capital markets, limited entrepreneurial capital, unstable macro-economic growth and limited access to intermediate inputs. All of these factors help explain why the technology gap between Latin America and innovating countries has increased, despite a variety of existing elements such as trade, abundant foreign direct investment, and significant investment in capital goods, which in theory should spur innovation.

Within the world and regional context, Mexico's indicators of innovative activity are quite poor. For example, its investment in R&D as a percentage of GDP is the lowest within the OECD. Perhaps more surprisingly, it also is lower than investment in other large Latin American countries such as Brazil, Chile and Argentina (See Figure 7).

Figure 7. Investment in R&D as % of GDP

(Year 2000, except otherwise indicated)

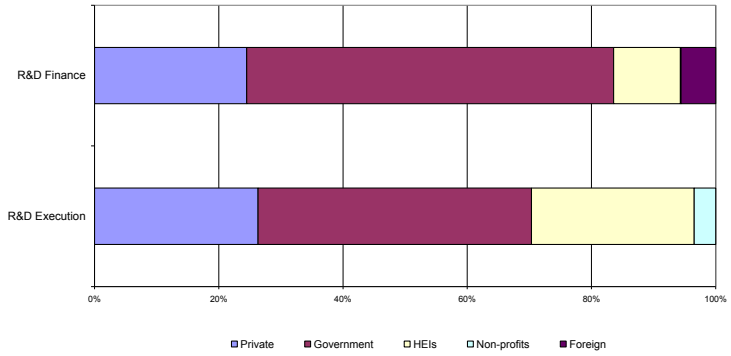


Source: OECD (2001)

An additional problem of R&D investment is the low involvement of the private sector. Figure 8 shows the financing and execution of R&D by economic sector. We can observe that the public sector finances 59.1% of innovation, while the private sector accounts for only 24.5%. Similarly, in terms of execution, the private sector performs 26.3% of R&D activities, with the rest being done by the government, higher education institutions (HEIs) and non-profit organization. This situation is in sharp contrast with countries such as Germany, Korea, U.S. and Japan, all countries where over 70% of total R&D is performed by the private sector, and over 65% of total R&D is financed by the private sector.

This distribution reflects both the lack of interest of managers in investing in innovation activities and a policy system which has provided an adequate framework for the development of science, but not of technological activities. This allocation tends to make investment in R&D less relevant for immediate problems and slower in adapting to changes in the environment conditions.

Figure 8. Finance and Execution of R&D in Mexico
(By sector, 2000)



Source: OECD (2001)

Using a "systems of innovation" approach, we can identify the presence of a variety of elements necessary to generate innovation, including: the research system, large export-oriented firms, small and medium enterprises (SMEs), clusters and government institutions. Government institutions and policies are explained in the following section, while the others are described below.

Research System: Mexico has a public scientific research system which is sizeable in terms both of basic research produced and resources spent. According to RAND (2003), "The Mexican science base can serve as a significant resource to technology development and application within Mexico. The government of Mexico has increased R&D spending from 4 billion pesos to 18.5 billion pesos during the 1990s. In an index created by RAND to rank countries by S&T capacity, Mexico ranks a respectable number 50 among 150 countries. In an index of technology transfer capabilities, Mexico ranked number 4 in 2001."

Scientific productivity also shows a strong performance. In terms of publications in internationally recognized journals, Mexican scientists have been prolific during the 1990s in the fields of physics, clinical medicine, biology, biochemical research and chemistry. In addition to improving their position in journals, Mexican scientists are also increasingly likely to collaborate with international colleagues, showing a global awareness of knowledge creation. These indicators provide evidence of world-class level research and indicate the potential for knowledge creation within academic institutions.

Despite its relative strength by world standards, research in Mexico is public and supply-driven, where scientists rarely establish any relationship with industry. This model has resulted in research which, although publishable, rarely addresses any clear short or long-term need of society or firms.

Large Exporting Firms: The main motor of growth in the last decade, and the key indicator of good economic performance from the domestic economy, is the increase in

exports. Table 4 shows revealed comparative advantages (RCA) of Mexico vis-à-vis its NAFTA trading partners. We can notice that the two largest sectors, both in absolute terms for 2000, and in terms of increase from 1973 to 2000, are road vehicles and telecom equipment, products which can certainly be classified as knowledge industries. These sectors are based on large, mostly international, firms competing with world class manufacturing systems.

Table 6. Share in Total Exports of Commodity Groups in Which Mexican Strength Is Concentrated, 1993-2000 (%)

	1993	2000
Mexico has comparative advantage	**3.6**	**2.0**
vegetables and fruit		
Petroleum	**13.7**	**9.0**
Manufactures of metals	**2.5**	**2.4**
telecom equipment	**8.9**	**11.6**
road vehicles	**13.6**	**17.0**
Furniture	**1.3**	**2.0**
Clothing	**2.3**	**5.2**
Both countries are strong	**4.9**	**3.8**
power-generating machinery		
office machines and ADP equipment	**2.9**	**7.1**
electrical machinery	**16.0**	**15.8**

Source: RAND (2003)

Although these firms certainly have become able competitors in the regional markets, they rarely carry out product and process innovation. Most domestic firms rely heavily on technology licenses or other types of assistance from foreign companies, rather than developing their own technology. Multinationals rely on their parent companies for most R&D activities. Given that their role is mostly as manufacturing facilities, export-oriented MNCs and larger domestic firms, concentrate their innovation efforts into organizational and marketing activities, rather than product and process technology.

Even though lack of innovation is the general rule, some firms have been shown it is possible to be innovative within the context. One example is Delphi Engineering Center, member of Delphi Automotive Group, the largest automotive parts firm in the world. Like most other large, US-based automotive firms, Delphi established several plants in northern Mexico during the mid-80s, using the country as a base for labor intensive manufacturing operations.

In 1995 Delphi took a giant step forward by establishing an engineering center in Ciudad Juarez. This center is primarily involved in doing research, design and development activities for the corporation. While the average Delphi engineering center in the U.S. employs 500 people, the Juarez facility employed 860 by 1995, and currently employs over 1000, most of them Mexican engineers. According to Carrillo and Hualde (1996), the firm cut development costs by 60% and delivery time by 20% during the first year of operation. This extraordinary performance has continued. During 2002, the center

developed 50 inventions, which received intellectual property protection (35 patents, 14 defensive publications and 3 industrial secrets). While assembly maquilas have reacted to the strong peso by decreasing their labor force in the past two years, Delphi Engineering has maintained its employment level, and other automotive firms such as GM and Visteon are creating or expanding their engineering facilities in the country, at least partly following Delphi`s success.

SMEs and Clusters: The rest of the firms, the 98.9% of small and micro enterprises (and many of the medium firms) are, with few exceptions, in a weak competitive position. Rather than focusing on innovation, firms have been focusing on surviving and adapting themselves to a variety of on-going changes in the past decades. These changes include: increased competition as a result of NAFTA, a severe contraction of the economy in 1995 (with GDP growth of –6.4%), virtually no financing for investment or working capital for and a strengthened peso in the last four years. Many thousands of firms have disappeared as a consequence of these changes, while surviving firms spend most of their innovation efforts taking reactive measures against changes in the macroeconomic environment, and limiting their growth to retained profits.

SMEs certainly have important innovation potential, if for nothing else, because of the sheer number of possible agents that can try new products and processes. This potential has not been realized, at least partly because of the environmental instability requiring constant adaptation. This potential could be substantially increased if firms could integrate into well articulated clusters.

In successful cases, firms within clusters have frequently evoke images of Silicon Valley or Route 128, with pockets of highly innovative firms interacting to create innovation. In the case of Mexico, one finds that the phenomenon of clustering of economic activity seems to take place in a completely different sense. Perhaps the most noticeable clusters can be found in traditional handicraft industries: silver in Taxco, majolica ceramics in Puebla and Tonalá or fine embroidery in Patzcuaro are just some examples of specialized, geographically concentrated economic activity with constant interaction. One positive aspect of these clusters, is that they are “knowledge based”, in the sense that it is not a particular natural resource advantage which has kept them alive, but rather a combination of agglomeration factors including: support services, specialized educational institutions, design facilities and sophisticated market knowledge. Taxco is an interesting example of the power of the clustering phenomenon. A major silver mine was found in Taxco in the 16th century, and soon thereafter, silversmiths followed. By the time when the mine was depleted in the mid-20th century, Taxco had a variety of specialized suppliers, educational institutions and markets around several hundred families working around the area. Currently, Taxco still produces a large percentage of hand-made silver products, despite the fact that silver production facilities are concentrated in Coahuila.

Trying to find more technology intensive cases, perhaps the best example of a cluster in Mexico is the city of Monterrey. Monterrey is located in a barren land, with scarce natural resources and a very extreme climate. The city is not a cluster in a traditional sense, for it is an agglomeration of a variety of industries (particularly branches of metalmechanical, chemical, ceramics) rather than one industry. This has generated urbanization economies which contribute to the welfare of the region. The state of Nuevo Leon has

8.7% of manufacturing output, with only 3.7% of total national population. From 1993, the state has increased its share of domestic GDP, from 6.4% to 6.9%, In terms of GDP per capita, it has gone from 4th place in 1995 to 2nd place in 2000. Manufacturing activity index is 141.3 compared with national 123.7. It has 9.9% of commercial bank receipts.

Besides the presence of many multinational corporations, a significant part of production is done by large multi-industry conglomerates. FEMSA (beverages and retailing), AXA (chemicals metal, autoparts, food), Proeza (food and automotive), Vitro (Glass), Cydsa (Chemical, textiles), Pulsar (biotech, financial), Alfa (chemical, food, autoparts) Imsa (steel, batteries) and CEMEX. These industrial groups bought two of the largest national banks (Bancomer, Banorte) so that the city is currently increasing its importance as a financial center.

Human resources for industry are trained in 19 universities, of which the largest is the Instituto Tecnológico de Estudios Superiores de Monterrey (Tec). Tec was originally formed by Alfa, Vitro and other leading industrial groups, with the purpose of forming high quality engineers for their firms. It remains a leading institution in the country, which, following its origins, keeps close contracts with industry. One of the key functions of Tec has been providing an environment where local firms, government and researchers can discuss the future of the region. This has resulted in a shared vision, with all the economic agents working towards becoming a center for high tech manufacturing and services.

Another, more sofisticated case, is the case of electronics in Jalisco. Central Jalisco has been called euphemistically the “Latin American Silicon Valley”. Two years ago, the list of international companies with manufacturing facilities was quite impressive: IBM, Hewlett-Packard, NEC, Motorola, Intel, Siemens, Flextronics, Jabil Circuits, USI (these three from Korea, Singapore and Taiwan respectively). According to Secretaria de Economia, Jalisco´s production accounts for 35% of production for the largest Contract Electronic Manufacturers, and the value added within the region is 27%. This would certainly suggest clustering of high value added activity.

Unfortunately, the story has changed dramatically in the last two years. Firms such as IBM and Motorola, plus many other smaller ones, have pulled their manufacturing out of the region, taking it to China and other Asian countries. When asked why they were moving, one of the major firms provided three reasons: China´s accessibility to the global market (while Mexico deals almost exclusively with the North American Market); the presence of most component suppliers in Asia (proximity to suppliers increases the responsiveness of the supply chain); and lower labour costs.

Even though Central Jalisco´s position as a successful electronics cluster is now being questioned, the region still has a significant concentration of talent and knowledge in this industry. The state government and local organizations are doing significant efforts to convert the low-value added assembly jobs into higher value added software development jobs. There are some examples which show that there is a good possibility of making such a transition. IBM currently runs a Guadalajara Development Lab, which works on developing AS/400 and Server applications. This facility is one of the few companies in Mexico to have a CMM 3 certification. A successful conversion into software would not only re-vitalize the cluster, but also provide higher value-added, better paying jobs.

From the above descriptions, we can see that the first two elements, (science culture and export pragmatism) are relatively strong, in the sense that they have pockets of world-class quality, large institutions, with a size large enough to reap the advantages of scale economy. These agents could easily be inserted in a global innovation system. Nevertheless, these elements have not had the incentives to become innovative. However, small firms and clusters are quite weak.

Another major problem is the isolation of the different elements. Despite their relative strength and size, large firms are disconnected, in that the different elements hardly interact with each other, and interaction is small even within elements of the same system. This lack of interaction can be seen in a variety of ways: few collaborations between industry and academia, small degree of local content in exporting firms, limited number of industry consortia among others. Creating these linkages would be at least as important as strengthening the individual elements.

Industrial development and innovation policies

It has been widely recognized that under market conditions, investment in technology and innovation tends to be suboptimal. One of the main reasons is that the social return tends to be higher than the private return, so that firms then to underinvest in innovation activities. Though intellectual property law contributes to correct this distortion, the government can play an active role supporting innovation activities to bring investment closer to optimal amounts.

The current section describes programs related to innovation activities. In order to make a complete analysis, and take a broader definition of innovation, it considers institutions dealing with both technological development activities and with enterprise support programs. The section will first describe traditional innovation and enterprise support programs, which largely function totally independent from each other, and then the new technology programs, where innovation and enterprise support tend to converge.

Public sector innovation support organizations:

One of the key weaknesses of the Mexican Innovation System is that innovation is takes place mostly in the public sector, and also geographically centralized. As mentioned previously, innovation takes place mostly within public sector institutions, funded by public sector institutions. Research takes place, particularly public universities, and particularly UNAM and Politecnico (both located in Mexico City), which account for 80%. By contrast, the center of manufacturing has been slowly moving north towards the border

Research in Mexico has traditionally been supply-driven with scientists submitting proposals to get research grants. Rewards, particularly for researchers within public universities, have been mostly tied to published papers. Joint work with industry has traditionally been penalized by the conservative scientific community. The country has relative scientific strength in fields such as biotechnology, astrophysics and mathematics. But, who are generally the clients for these innovations? Frequently, the answer is

nobody. In other cases, the answer is the public sector. This model has resulted in research which does not necessarily solve any clear short or long-term needs of society.

Table 5 shows the largest receivers of federal R&D resources in the country. We can observe that education and energy account for 85% of total expenditure. Within this environment a few institutions have seen the advantages of cooperating with production agents. Several public institutions participate in R&D related activities. As shown in Table 5 in the previous section, education concentrates the largest share of resources related to R&D, with 62.4% of total, followed by energy with 22.4% of total. Most of these resources are focused on doing basic research.

Table 5. Main Sectors of Federal R&D Expenditure
Percentage of Total (2001)

Main Sectors	**Main Subsectors (as percentage of Sector)***
Education (62.4%)	Of which: UNAM 27% Conacyt 23.8% SEP-Conacyt 22% Cinvestav 6.8%
Energy (22.4%)	Of which: IMP 52.4% Pemex 32.4% Instituto de Investigaciones Electricas 8.3% Instituto de Investigaciones Nucleares 6.9%
Others (15.2%)	Of which: Agriculture and rural 49.3% Health and social security 19.7%

*Includes main subsectors only, so does not necessarily add 100%.

A good example of public research centers of excellence, with little social impact, is the IMP (Mexican Petroleum Institute), the largest research institution in the energy sector. IMP is an important generator of academic publications, with 630 papers published between 1981 and 2000. Between 1996 and 2001, the IMP requested 96 patents, the largest number filed by any Mexican institution.

Despite this impressive academic output of the innovation is done for basically a single client: PEMEX, the state-owned oil monopoly. The number of patents is significant when compared with other domestic agents. However it is small compared with the largest foreign requestor for Mexican patents, with 2615 patents requested in a similar period. The impact of IMP on Mexican society would be greatly enhanced with an increased participation of the private sector in energy.

Enterprise support programs: The complement of the research infrastructure is the large variety of programs focused on enterprise support. Table 7 shows a count of the Federal Enterprise Support programs. We can observe the wide variety of enterprise support programs existing in 2003. There are 98 "legacy" programs from 11 different institutions (inherited from the previous administration), plus an additional 31 new (not including 20 additional ones on institution attributes and databases). In addition to federal programs, there are state and local level programs. For example, Aguascalientes, one of the more active states in terms of enterprise support programs, has 53 support programs dealing with similar issues. In total, there are over 400 federal and state enterprise support programs.

Table 7. Number of Federal Enterprise Support Programs by Type and Organization (2003)

	Fiscal	Information	TTAC	Credit	Supply Chain	New programs
Bancomext		4	5	11		4
CONACYT			3	3		3
Economia	5	2	6	1	5	21
NAFIN		3	2	14		1
SAGARPA		1	3			
SEDESOL				4		
SEMARNAT	2		2	3		
Other	SHCP 14		STPS 1, SEP 4			SECTUR 2

Source: List of Federal Programs

Notes: TTAC refers to Training, Technical Assistance and Consulting. Credit combines the categories Credits, Risk Capital and Subsidies with Development Bank Financing. The new CONACYT programs (Fondos Sectoriales, Fondos Mixtos, Avance) were included, though they did not appear in the original source.

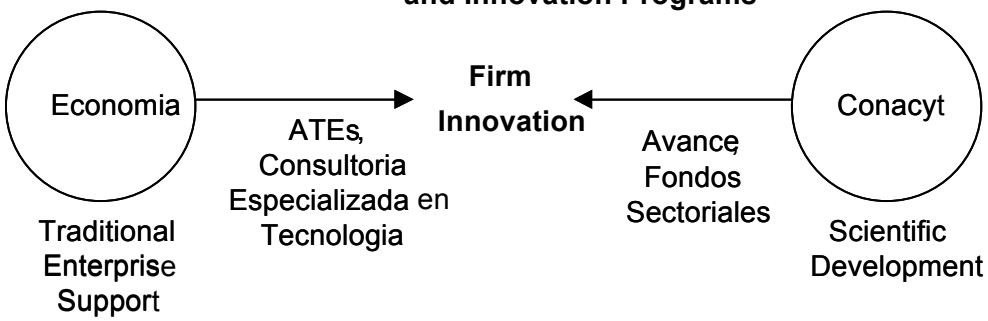
Even though the budget is centrally approved by the Federal Congress, which in theory should evaluate trade-offs in the use of total resources, there is virtually no coordination among programs. Design of these programs is the responsibility of its managing Secretaria. Each program has its own budget, infrastructure and human resources, and several have overlapping objectives.

When trying to analyze the relation between enterprise support programs and technology, we see that few of the programs are directly related to technical innovation. Nevertheless, many of the programs do have an indirect impact on technological capabilities, as they are geared toward upgrading the quality of inputs for production. For example, all of the programs related to training are important in building human capital either for general tasks (like Economias Promode which focuses on general management knowledge for SMEs) or more industry-specific knowledge (such as SEP and STPS Competencias program which develops competencies for specific positions within industries). Similarly, a number of NAFIN and Bancomext programs help in acquiring machinery and equipment.

New Technology programs

Traditionally, programs directly targeted toward technological improvement have been rare, and have lacked continuity. For example, the Programa de Modernizacion Tecnológica supported new projects for only two years. This program has ben replaced by the Fondo Sectorial of Secretaria de Economia and Conacyt (National Council of Science and Technology), and by AVANCE (both described below). Nevertheless, we can see that new Economia and Conacyt programs are trying to create programs which combine elements of enterprise with innovation, (Figure 5). Such programs Asesores Tecnologicos Empresariales (ATE) and Consultoria Especializada en Tecnologia from Economia, and Fondos and Avance from Conacyt.

Figure 5. Convergence of Enterprise Support and Innovation Programs



Of particular relevance for firm innovation are the new Conacyt programs of Fondos Sectoriales, Fondos Mixtos and Avance. With these programs, Conacyt is taking advantage of its experience in evaluation of science and technology projects, to generate projects which are relevant to solve specific problems. These programs are described below

- *Fondos Sectoriales* are funds created with matching funds from Conacyt and different ministries. Each of the ministries defines a set of priorities which need to be researched and emits a request for proposals by scientific institutions. The funds that are currently operating are: Semarnat (environment), Sagarpa (agriculture and rural), Semar (marine), Sedesol (social development), Economia (mostly for private development projects), Conafovi (housing), Conafor (forestry), Salud (health), SEP (education), Sener (energy), SCT (communications), Segob (government) and Asa (Airports). The total capital of the funds is over $1,2 billion pesos, of which roughly half has been contributed by Conacyt, and the other half by the ministries. These funds replace the traditional Science Support program, which used to support research projects. Research for pure science is now supported by the SEP-Conacyt sectoral fund.

- *Fondos Mixtos* are a similar scheme, but are joint funds with a Mexican state, instead of a ministry, where each state defines a set of topics to be researched. Of the 32 state governments (including the Federal District), 25 have a fund operating, and a vast majority have already selected its first set of projects. The speed of formation of

the 25 centers, shows the growing awareness of the importance of Science and Technology at the state level. These funds have the additional advantage of promoting descentralization of research. Traditionally, most of Conacyt`s resources have stayed in Mexico City, and specifically UNAM and IPN. For example, 48.6% of SNI support are going to Mexico City institutions; concentration is even more dramatic if we consider only level II (60.9%) and level III (71.6%). Fondos Sectoriales will naturally tend to disperse funds

- *Programa Avance* (Alto Valor Agregado en Negocios con Conocimiento y Empresarios): The objective of the program is providing "last mile" financing which helps translate scientific and technological developments into product, processes and services with market potential. The types of activities being supported include: construction and test of the last round of prototypes, market tests, development of basic engineering of product and process, and expenses related to patent registration. The concept behind the program is that there are virtually no success stories of innovations in Mexico going from the lab to the marketplace. This program intends to provide a critical mass of demonstration cases which should spur innovation at a wider level.

These programs clearly show that Conacyt is trying to make science more relevant to industry. In terms of players, what Conacyt is doing with Fondos Sectoriales and Mixtos is important in two ways. On the one hand, it is putting itself in the center of every institution, so that in fact it can coordinate the variety of agendas. By being in the center of all the Fondos, it can avoid the danger of creating a multitude of uncoordinated ad hoc efforts. On the other hand, the Fondos allow Conacyt to leverage its resources, by providing matching funds for resource contributed.

It is a significant achievement that Conacyt was able to assemble so many Fondos in less than three years, particularly considering the significant contributions from the counterparts. This certainly suggests a strong leadership from Conacyt side, and a clear perception by the counterparts of the need to deepen the knowledge on their respective areas.

Their novelty and the quick speed of design and implementation have meant that the attitude is "learning by doing". Even though some of the Fondos Sectoriales and Mixtos are experienced some operational problems at the start, the concept of creating funds which respond to needs of a specific sector or state are a great step forward. According to the people using the funds, there are some weaknesses, such as finding evaluators who understand the academic rigor of research and the relevance of the proposal to solve specific problems. Unfortunately, people with both of these skills are very hard to find. Programs such as environment and health, where there is a strong tradition of scientific research in Mexico, are being evaluated by scientists on these fields, using traditional science criteria such as papers published previously, and papers to be published, which certainly are not sufficient criteria to guarantee the relevance or applicability.

In summary, there are a large variety of programs from ministries and states. Even though there is no formal evaluation, industry performance indicators have not improved

dramatically, suggesting that so many programs are really uncoordinated efforts by different institutions, resulting in significant inefficiencies. Even though every federal program in theory needs to be evaluated every year to receive federal budget, evaluation is practically non-existant. Given the absence of clear metrics, there are no criteria by which programs should be evaluated.

Traditionally, programs have not focused on innovation, though several have impacted the quality of labor and equipment. Conacyt`s new programs are shifting away from pure research, towards applied researchand firm support. It is critical to create a top-down effort to coordinate all these legacy programs, and concentrate in fewer, more effective and efficient programs. Better evaluation, which could be translated into design and operational improvements, could really help transform the science system from supply to demand based.

Recommendations on how to strengthen innovation system

Economic development policy of the past decade has largely been based on the signing of trade agreements, resulting in agreements with 32 countries. From the perspective of domestic firms, these agreements have had a double effect: on the upside, they have permitted access to hundreds of millions of customers in potential market, where they can offer their products and services. On the downside, they have presented an exponential increase in domestic competition, particularly in manufacturing products. Unfortunately, the majority of domestic firms have not been able to adapt to the new competitive conditions, particularly with the low growth and financing shortage which has prevailed in Mexico for the last ten years.

Despite the disadvantages, growth during the past ten years has largely been a result of firms (mostly foreign) taking advantage of NAFTA, by using Mexico as an export base. As Mexico has been losing its preferential trade status vis-a-vis other low labor cost countries, many of the firms, particularly in the electronics and garment sectors, have migrated to lower cost countries. NAFTA provided a one-time bonus for attracting firms which wanted to export. It is quite possible that Mexico has extracted most of the advantages of NAFTA in its first eight years.

From a knowledge and innovation perspective, Mexico can be characterized by the clear presence of a dual economy; on the one hand, dynamic strong economic agents which have taken advantage of the opportunities presented by NAFTA; on the other, weak agents (and states) which have not taken advantage of these opportunities and are stagnant. This presents plenty of opportunities for the weak to catch up with the strong.

Now it is necessary to create new policy framework. The Post-NAFTA agenda is largely about concerted private-public effort of transformation from low to higher equilibrium. Industry has suffered a severe shake-up with many thousands of firms disappearing. Those firms which have survived the last ten years with increasing competition, recurrent crisis, slow growth rate and limited availability of credit, unstable macroeconomic conditions, have shown a large resourcefulness for survival. For many years, firms tried to resist competition not through increased competitiveness or innovation, but by trying create pressure on the government to close the borders. Survivors now understand that

trade liberalization and increased competition are here to stay, and that they need to adapt to this new situation.

What will Mexican industry look like twenty years from now? A question difficult to answer, justas it was difficult to predict Mexico's current industrial structure in the immediate aftermath of the 1982 debt-crisis. Policy response to the debt crisis was a turning point which culminated in NAFTA. Now Mexico once again is in the turning point and the issue is transition to from narrow integration with us (based mainly in labor cost advantages) to knowledge-based integration.

The previous sections have shown that Mexico is caught in a low-level trap. However, this is by no means an inescapable one. It is worth noticing that many countries have been able to escape these traps and that there is no unique way of leaping into a higher level equilibrium. Different countries have found ways to build on their strength to improve their competitive position. Perhaps the country which best illustrates this upgrading Korea, which used a model of growth based largely on diversified conglomerates. These conglomerates took advantage of its protected domestic market which allowed to generate surplus capital for investment. At the same time they started investing in industries where the minimum efficient scale was the global market, such as shipbuilding or microchips. This private strategy was complemented with an excellent education system. When the domestic market was open, these firms were world-class companies with significant technological capabilities.

Mexico shares many elements with Korea and has additionally a variety of factors to be considered on creating the new advantage. There will soon be a demographic bonus, which results from the bottom of the population pyramid starting to shrink. This means that the proportion of people in working age is going to peak in the next few years, providing an opportunity of creating wealth. The possibility of foreign firms using Mexico as a base for knowledge activities is currently limited, basically because the supply of high-quality, high-skilled workers, is likely to remain limited in the years to come. Few firms have the individual scale to be leaders in innovation, one has to take advantage that the size of the overall economy, large by world standards. Another advantage is the integration with the North American market in production. It is key that this integration in production is extended to integration in knowledge creating activities both by academicians and industry. Local firms need to find niches where distance (not transport cost) is a critical factor. Such products would include inputs which need to be used in a just-in-time fashion in the North American region.

Mexico needs **a dynamic and flexible innovation system**. The leadership of the private sector in innovation, is a **necessary condition** for a real transition into the higher value added production of goods and services. The danger of not developing the system is to continue being squeezed between lower-cost and high-value-added producing countries. A first step to establish this common vision and discourse would be involving major private and public players into a technology foresight process. This would help build shared vision of Mexico as a knowledge economy: Private-sector led technology foresight process. On the basis of successful private-sector driven projects and a joint vision, proceed to more substantial commitments.

At the first stage, this means shooting for a substantial increase in added value. This vision makes the private sector the CENTER for innovative activity, with strong capabilities within, and being able to draw from support institutions such as research

centers, universities, and other government programs. Move innovative activity from public to private, by instead of subsidizing research activities in universities, being sure that more of these are relevant for productive activities. This new system has five elements, each one playing an ideal role[6]:

1. Larger firms, as powerful engines of innovation with clear technology strategies. Innovation will be long term activity, carried out at all levels of the organization, to which firms dedicate resources. Larger firms would understand the importance of technology, what their core technologies are and would constantly promote innovative activities throughout the organization. In the process of developing their core capabilities, they would generate demand for technological activity from other elements of the system, actively seeking collaboration with research centers, universities and foreign partners. Firms have taken important strides at improving process performance, in order to be cost competitive, but they would have to step one more step to become innovative.

2. Smaller firms, effectively integrated into clusters (horizontal) and supply chains (vertical), taking advantage of club goods, which collectively give them economies of scale and increased competitiveness. In terms of clustering strategies, it is critical to create local and sector specific strategies which include both the public and private sectors. Articulate dynamic public-private innovation community.

3. Government supporting R&D projects through grants, and providing the incentives for innovation and cooperation. Traditionally the government has had disparate policies for manufacturing and science. Enterprise support programs have concentrated on developing basic competencies such as quality control, playing a key role in the upgrading of competitive capabilities through some successful programs (CIMO, Cetro, Compite, Conocer, supplier development). From the science and technology side, Conacyt has traditionally been very strong in supporting science and has been trying (though unsuccessfully) to start pushing the innovation agenda at least for the last 8 years. The government is meeting the challenge by trying to change the programs in two ways. The new Fondos Mixtos, Fondos Sectoriales and programs for the development of high-value- added technology-based products. This means both trying to make research more related to real problems for certain sectors and regions, and allocating funds created specifically for the promotion of technology intensive products in existing and new firms. The sectoral and regional fondos provide resource-rich programs for promoting demand driven R&D. They have created great output expectations, now not only in Conacyt, but also in the partnering organizations (states, other Secretarias), and so they definitely are politically in the spotlight.

Traditional programs have resulted in reasonable strength in manufacturing performance and in science, but very weak linkages between the two. New programs linking both activities would include: tax rebates for SMEs undertaking technological efforts with some results, actively supporting a constituency which understands and promotes issues related with technological development, a totally new SNI (Sistema Nacional de Investigadores) which takes into consideration not only published papers, but also technology projects to solve specific industry problems. It is important noticing that in terms of number of programs, more is not necessarily better. Even though STPS runs only one program by itself (CIMO), plus Competencias Laborales in coordination with SEP, CIMO has the reputation of being one of the best programs.

[6] These were oringinally suggested by Yevgeny Kuznetsov of the World Bank

4.Traditionally strong science institutions (HEIs, SEP-Conacyt) actively linking/responding to the needs of the private innovators. This would mean a radical overhauling of incentives at universities and research organizations to encourage linkages with private sector. From the innovation perspective, evaluation of technology programs should take into account factors beyond cost-benefit analysis. Ideally, the evaluation would include other types of metrics which incorporate how its projects are creating linkages within the system. Such metrics would include: involvement by private demand and responsive to private sector needs; strong academic-industry linkages; a significant percentage of public centers research budgets should be devoted to; insertion into international knowledge networks (e.g. through a network of Mexican expatriates in the US); and continuous evaluation and monitoring.

5. An effective financing system, particularly in the earlier stages (VC, angels). Though this topic is not explored in the current paper, a major constraint to economic development in Mexico has been the financial system. This weakness exists for all stages of financing: from almost inexistent early stage financing from venture capitalists and angel investors, to a passive banking system which rarely promotes growth projects and finally a stock market where the number of firms has remained practically constant for the last ten years. Obsolete financial regulation and enforcement is partly to blame.

Strengthening these five agents would provide solid building blocks on which innovation could …. Playing on the strengths…

Several lines of enquiry follow naturally from the results presented in this paper. Perhaps the more interesting ones have to do with the concept of national system of innovation as understood by the OECD, and its applicability to less developed nations. A first line would question whether the traditional innovation indicators (e.g. investment in R&D as a percentage of GDP) are applicable to countries dealing with more basic capacities upgrading, or whether a more suitable set of indicators needs to be created(e.g. adoption of a certain innovative technology). Second, it would be important to understand the role of innovation and tacit knowledge in traditional industries, such as crafts, and find what would be the key institutions for its system of innovation. Finally, it is interesting to ask in a broader sense whether the traditional definition of national innovation system is applicable in countries where differences in capabilities of diverse agents (domestic vs. international, large vs. small), make it dificu.

Bibliography

Bergoeing R., Kehoe P., Kehoe, T., and Soto, R., 2002. "Policy-Driven Productivity in Chile and Mexico in the 1980s and 1990s", NBER Working Papers 8892, National Bureau of Economic Research, Inc.

Bosworth, B. 1998. Productivity Growth in Mexico, World Bank Report No. 17392-ME, Country Economic Memorandum, August.

Carrillo and Hualde 1996

Consejo Nacional de la Industria Maquiladora de Exportación, 2003, cited by El Economista, June 2003.

Conacyt, 2002. Informe General del Estado de la Ciencia y la Tecnología 2002, Conacyt, Mexico City

Fajnzylber, P. and Lederman, D. 1997. "Economic Reforms and Total Factor Productivity Growth in Latin America and the Caribbean, 1950-95: An Empirical Note, World Bank, mimeo.

Hallberg, K., Tan, H., and Koryukin, L. 2000 "Exporting Dynamics and Productivity: Analysis of Mexican Manufacturing in the 1990s, World Bank Report No. 19864 ME, Mexico Country Department, February.

INEGI, 1997. Encuesta Nacional de Dinámica Demográfica, INEGI, Mexico.

INEGI, 1999. Micro, pequeña, mediana y gran empresas; Censos Económicos, 1999, INEGI, México.

INEGI, 2000. Encuesta Nacional del Empleo, INEGI, México.

INEGI, 2001. Sistema de Cuentas Nacionales de México, La Producción, Salarios, Empleo y Productividad de la Industria Maquiladora de Exportación, INEGI, Mexico.

International Labor Organization, 2002. Key Indicators of the Labour Market 2001-2002, ILO, Geneva.

Loayza, N., Fajnzylber, P., and Calderón, C., 2002. "Economic Growth in Latin America and the Caribbean: Stylized Facts, Explanations, and Forecasts, supported by the World Bank Latin American Regional Studies Program, Washington D.C., June.

López-Acevedo, G., 2003. "Wages and Productivity in Mexican Manufacturing, World Bank Policy Research Working Paper 2964, January.

López-Córdova, J.E., 2002. "NAFTA and Mexico´s Manufacturing Productivity: An Empirical Investigation using Micro-level Data", Interamerican Development Bank, July.

McCandless, M.E., 1999. "Using Twin Plant Strategies," Business Facilities, http://www.facilitycity.com/busfac/bf_99_09_cover1.asp

OECD, 2001. Science, Technology and Industry Scoreboard, OECD, Paris

RAND 2003,

Robertson, R. 2002. "Did NAFTA Increase Labor Market Integration Between the United States and Mexico?", Macalester College- Department of Economics, mimeo.

Secretería de Economía (2003), Reporte de Inversión Extranjera Directa, mimeo.

World Bank, 2002. World Development Indicators, World Bank, Washington D.C.