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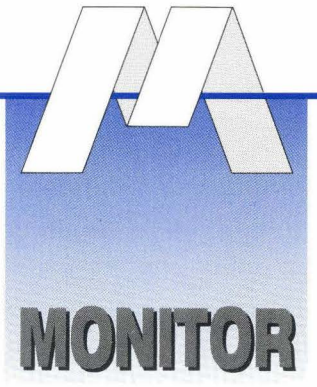

MONITOR - SAST ACTIVITY
STRATEGIC ANALYSIS IN SCIENCE AND TECHNOLOGY

THE NEEDS AND POSSIBILITIES FOR COOPERATION BETWEEN SELECTED ADVANCED DEVELOPING COUNTRIES AND THE COMMUNITY IN THE FIELD OF SCIENCE AND TECHNOLOGY

(Sast Project N° 1)

COUNTRY REPORT ON MEXICO

by
Constantine Vaitsos, Athens University

December 1990

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FOREWORD

This report has been prepared for the Strategic Analysis in Science and Technology Unit (SAST) of the Directorate-General for Science, Research and Development of the Commission of the European Communities. SAST activities are part of the MONITOR Programme which aims to identify new directions and priorities for Community research and technological development (RTD) policy and to help show more clearly the relationship between RTD policy and other Community policies.

For questions already identified as of interest for the development of Community policy, SAST projects provide an investigation of the perspectives opened up by science and technology. SAST projects thus serve as an input to the process of policy formulation. In the case of the SAST project to which this report contributes, "The needs and possibilities for cooperation between selected advanced developing countries and the Community in the field of science and technology", the context of policy questions includes the evolving economic relations between the Community and these countries, the interest to the Community of promoting international cooperation in science and technology with various types of countries, and the Community's role in European science and technology.

This report is one of a set of country studies carried out for the project. The set comprises the Republic of Korea, Thailand, other ASEAN countries, the People's Republic of China, India, Brazil and Mexico. An overall strategic review will also be available in 1992.

It should be borne in mind in reading the country studies that the fieldwork on which they are based was carried out almost entirely in the country concerned. The points of view of European industrialists/researchers/policy makers were not explicitly sought for this part of the project. (They will be sought as part of the work for the overall strategic review.)

SAST presents this report as a stimulus to reflection and debate within the European Community on the best strategies to adopt towards a group of increasingly important countries. It must be stressed, however, that the orientation and content of reports prepared for SAST cannot be taken as indicating the considered opinion of policy advisors within the Commission services.

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INTRODUCTION AND READERS' GUIDE

The main purpose of this report, is to provide a strategic review and a decision base on the main areas of possible cooperation in science and technology between the European Community and Mexico, the latter being one of the advanced developing countries selected for examination within the context of SAST Project no. 1.
Such a cooperation is broadly defined to include diverse knowledge intensive economic activities (such as trade in machinery, technology embodying inputs and factoral flows, corresponding production operations, direct investment commitments, etc), together with R&D and knowledge diffusion mechanisms, training, technological infrastructure and related initiatives on scientific and technical development.

The contents of this report are presented in two main parts preceded by a brief Executive Summary. This Executive Summary does not intend to present a synthesis of the diverse elements and analysis of the report but, instead, to highlight some overriding considerations. The latter transcend the rest of the main conclusions and define the context within which the Mexican S&T system can be understood. They also condition the possible initiatives for the promotion of an effective and knowledge intensive cooperation with the European Community.

Part I, appearing under the title of Strategic Review, represents the core of the Report. It contains a comprehensive synthesis of the Mexican S&T system as it has evolved within the process of the country's overall development performance and its broader socio-economic realities. Initially, attention is drawn to some key macroeconomic conditions which greatly affect the overall evolution of sectoral performance and the policy initiatives of distinct economic actors. Subsequently, the contents of such government and business policy options are analyzed and special reference is made to the main characteristics of the country's external sector transactions. Also, each of the principal components of the science and technology system of Mexico is addressed and succinctly evaluated. Finally, a set of priority proposals are presented in what appear to be the more promising areas for advancing a concerted effort on science and technology cooperation between Mexico and the European Community.

Part II, under the title Decision Base, provides, in more detail, the supporting evidence of the Report. It is divided into four main sections. The first covers the conditions of stability, expansion and collapse of the Mexican economy over the more recent decades and the content of the radical stabilization and restructuring programs pursued during the 1980's. Section II.2 focuses on the business and broader economic expression of Mexico's external sector with the aim to identify the country's evolving position in the international economy and the relative presence of European economic interests in meeting the needs and prospects of the Mexican productive system. Section II.3 analyzes the main areas, characteristics and potentialities of the country's S&T system. In this case, emphasis is being placed on the identification of the country's knowledge specialization and on the representative aspects of the institutional, skill intensive and technological resource commitments and activities. Also, the analysis focuses on the key areas and on the deficiencies of the Mexican S&T system, so as to conclude with the required changes

within which a European cooperation will be of greater mutual value. Finally, section II.4 presents a more sectoral perspective in two fields (biotechnology, and electronics and informatics) by combining both business and strictly S&T references and analysis.

Statistical tables and background information are mainly provided in the Annexes of the Report. The sources of this information originate from published and unpublished official and business publications and from the interviews undertaken in the course of this Project.

The country research and preparation of the main statistical supporting evidence was undertaken by Mauricio de Maria y Campos and by Lilia Dominguez Villalobos of Mexico. Sectoral analysis in the field of biotechnology was prepared by Paolo Bifani of Italy and in electronics and informatics by Ricardo Soifer of Argentina.

I am particularly grateful to Bruno Schmitz and to the SAST staff for their efficient support and encouragement in executing this project. Also thanks are due to Kurt Hoffman for his overall co-ordinating guidance.

Constantine VAITSOS
Athens University

EXECUTIVE SUMMARY

Mexico represents a major security consideration for the U.S. and a special case within the context of North American economic interests. Its proximity to and extensive border with the U.S., its widespread poverty (with the lower 40 % of income earners receiving less than 3 % of its GNP of about U.S. $ 130 billion in the late 1980's), and its large and fast growing population (presently exceeding 80 million), have always created conditions of particular concern to the country's northern neighbor. These, together with the policy implications of and dependence conditions from the severe debt crisis during the last decade, have reinforced past trends which placed significant parts of Mexico's external economy and important areas of its internal operations under the controlling influence of the U.S. This is expressed in both broader policy options and specific business matters.

In economic affairs, about or more than two thirds of all major types of Mexico's external sector transactions are presently - as they had also been in the past - linked directly to the U.S. economic space. Given the evolving negotiations for a North American Free Trade Agreement and reinforced by broader regional prospects (such as the "Initiative for the Americas" proclaimed on June 27, 1990 by President Bush), it is to be expected that Mexico will continue to increasingly gravitate within the sphere of the U.S. economic influence. In contrast, the European and Japanese presences tend to constitute what have been referred to as "residual factors". This situation is unlikely to change in the coming years despite the official rhetoric and past concerted yet largely frustrated efforts (including the recent visit to Brussels by President Salinas) to attempt to meaningfully diversify Mexico's external economic relations.

On the domestic front and directly linked to the external sector, the macroeconomic stabilization programs of the latter half of the 1980's were accompanied by a massive restructuring commitment based on two key principles :

First, a profound and comprehensive policy reversal was introduced promoting an extensive "internationalization" of Mexico's economy. As a result, the latter has today become one of the more open economies in the world. (e.g. The weighted average external tariff is presently well below 10 %, and quantitative restrictions have been almost completely eliminated at a pace which far exceeded the country's commitments when it joined the GATT in 1986).

Second, a far reaching initiative for the "liberalization" of the Mexican economy has been pursued through a massive deregulation process, an elimination of screening and restrictive or negotiating practices in the entry of foreign direct investments and technology flows, an active privatization commitment and a "denationalization" of intellectual property provisions and of standards and norms requirements.

The implications of all of the above have certainly altered the terms of investment and the terms of trade of the Mexican economy leading to new conditions for undertaking business activities in the country. Their longer term effects may be subject to different interpretations or to diverging political debate in Mexico, yet, these have not altered the government's commitment to further pursue this course of policy orientation. At the same

time, given the productive bases established during the pre-liberalization periods and the heavy foreign exchange demands posed by the debt servicing obligations of the 1980's, the country has developed a definite external sector profile with respect to its comparative advantages. The latter are expressed, in an overwhelming manner, by two categories of product lines : capital intensive resource processing activities and labor intensive intra-firm assemblying operations. As a consequence, close to 70 % of total exports presently involve non-oil goods, even if a significant part of them are petroleum or energy based.

The continuous process of economic crisis management during the last decade and the realities of the required stabilization programs have also brought about a dramatic fall in the overall, public and private, gross fixed capital formation (from 28.5 % of GDP in 1981 to 15.6 % in 1988). Particularly hit have been the areas of technological development, of human capital formation and of the overall knowledge intensive infrastructure needed for productive activities. All of them have been directly affected by the resource demands posed by the servicing of the accumulated foreign debt.

Such far reaching and strategic implications on the development base of the country together with its broader economic performance have transformed the context of the Mexican science and technology (S&T) system. The latter, having started from a low and highly deficient level up to the early 1970's, was strongly supported by the resources of the oil boom and began to be explicitly incorporated within the economy's overall development strategy. Yet, the "lost decade" of the 1980's brought along a complete turnabout in this area.

In view of the above and taking into account the particularities of the Mexican case in its relations with the European Community, a strategy for S&T cooperation is proposed in the pages which follow. Its contents comprise three major fronts : (i) initiatives of direct concern to the business sector, (ii) S&T cooperation in key areas of broader social impact, and (iii) cooperation in selected and priority high technology fields.

PART I : STRATEGIC REVIEW

I.1. - THE MAIN ISSUES

I.2. TECHNOLOGY INTENSIVE EXTERNAL SECTOR ACTIVITIES

I.3. - THE SCIENCE AND TECHNOLOGY (S&T) SYSTEM

I.4. - PROPOSALS FOR MEXICAN-EUROPEAN COMMUNITY S&T COOPERATION INITIATIVES

I.1. MAIN ISSUES

Three key areas of conditioning realities transcend the overall context and evolution of the broadly defined, science and technology (S&T) capabilities in Mexico together with the relevant policy environment; They also circumscribe the thrust of possible options for corresponding co-operation initiatives with the European Community. These strategic issues involve : (1) the pervasiveness of the macroeconomic crisis and its implications for the evolution of the S&T system; (2) the complete reversal of the overall policy direction and the comprehensive modification of policy instruments during the 1980's in the management of the external sector and in the domestic functioning of public and private economic actors; and (3) the dominating presence of U.S. business interests reinforced by the prospects of the North American Free Trade Agreement. Each one of these areas will be succinctly summarized separately, although all of them are directly or indirectly interrelated.

I.1.1. THE PERVASIVENESS OF THE MACROECONOMIC CRISIS

During the last ten years, Mexico's economy, with a total GNP in the range of U.S. $ 130 billion and a population exceeding 80 million inhabitants, underwent a dramatic and continuous process of crisis management. The latter is affecting, in fundamental ways, the fibre of its society and economy - hence the overall S&T context - and the framework and content of government policies. Central in this crisis management were the heavy resource demands posed by the servicing of Mexico's foreign debt obligations which in the mid 1980's, had reached the level of 50 % of the overall export earnings. Related to the above loomed the urgent needs to confront the corresponding structural disequilibria of the economy's internal and external sectors.

The magnitude of the compounding resource demands to cover past debt obligations is vividly portrayed by the following comparison : the gap between real interest rates on external debt and real GDP growth went from -6.3 % in 1980-81 to a full +10.5 % in 1983. Since, accumulated past debts have reached very important proportions of annual GDP, such major shifts in the relationship between the cost of borrowed foreign capital and domestic growth cause sizeable resource demands which amount to significant macroeconomic magnitudes.

The severity and length of the stabilization efforts are affecting, in strategic cases, the longer term economic prospects of the country and its growth potential. Of special importance has been the impact on investment activities and production capabilities in human, social, physical and technology intensive infrastructure and in business operations. Also, the already existing staggering inequalities of Mexican society, in which the lowest 40 % of income earners receive less than 3 % of national income, have deepened. Poverty has increased by the combined effects of inflation and the macroeconomic policy constraints, real wages fell by 45 % from 1983 to 1988 and unemployment increased while the supply of labor force grows by about one million new entrants every year.

The domestic counterpart to the non-interest current account improvement which has been required to pay foreign banks, was a fiscal adjustment effort that is probably unmatched on a sustained basis in any country. A primary fiscal deficit of 7.1 % of GDP before the debt crisis was turned around into an outstanding surplus approaching 8 % of GDP in 1987. This took place while revenues from oil exports declined by more than 7 % of GDP and the overall growth of the economy came to a standstill. Natural disasters, like the 1985

earthquake, further aggravated the economic situation. About half of the turn-about in fiscal performance was achieved by cutting the public sector investment budget from almost 10% of GDP to 3.3 % during the corresponding period.

The dramatic fall in overall fixed gross investment (both public and private) from 28.5 % of GDP in 1981 to 15.6 % in 1988, caused a major debacle in the allocation of resources in R&D (where the public sector has traditionally accounted for more than 80 %), in education, in technology intensive infrastructural activities and in the overall expectations for new productive investments. Such far reaching and strategic implications on the development base of the economy are bound to affect its future performance and growth prospects including its effective S&T context.

I.1.2. THE POLICY REVERSAL FOR ECONOMIC RESTRUCTURING

The necessary macroeconomic stabilization programs were accompanied by a massive restructuring commitment which brought about a complete policy reversal in the development strategy and in the specific instruments to promote economic development. Such a comprehensive reversal has involved the joint pursuit of what is referred to as the "internationalization" of Mexico's economy and the "liberalization" of its internal activities. As far as the S&T system is concerned and its relations with foreign technology and other resource flows, the following policy areas loom crucial :

- Contrary to past and rigid import substitution policies, by 1988, Mexico had a weighted average external tariff of 5.3 %, according to some estimates, or of about 8 %, according to others. Such a level of protection is among the lowest reported in the world, with a tariff structure of 0, 5, 10, 15 and 20 % as a maximum. Imports licensing and quantitative restrictions were, in practical terms, almost completely eliminated. In several cases this was undertaken at a pace much faster than it would have been required by Mexico's commitments to join the GATT in 1986. These drastic changes in trade policies have affected the whole panorama of import, investment and production opportunities.

- The original policy objectives, set for the 1980's by the National Program for Industrial Development and Foreign Trade 1984-88 (PRONAFICE), with explicit sectoral proposals to attain various levels of industrial targeting, were in effect completely overuled by the economic policy orientation of the new Salinas government. The latter pursued a concerted effort to drastically modify previous laws, decrees and procedures with the aim to eliminate domestic content and other performance requirements, preferences for local vertical and horizontal integration, preferential treatments for domestic investors and producers, subsidized credit and other related incentives. A key overall characteristic of the new approach is that the government will not establish priority sectors for overall industrial development. Instead, priorities are to be defined by the market through the functioning of an open economy at very low levels of protection. The prospects of a North American Free Trade Area reinforce such an approach given the proximity to and the degree of integration of the Mexican with the U.S. economy.

- Economic deregulation and privatization have implied the opening up of ownership requirements in such key sectors like petro-chemicals, infrastructure, the automobile sector and its components, the electronics and computer industry, pharmaceuticals, aquaculture and fisheries, communications including telecommunications. New initiatives are also expected in areas such as forestry. Privatization procedures have been actively

pursued in a number of key publicly owned enterprises. Given the size of resource commitments and the present functioning and past history of the Mexican stock exchange, the whole process often involves a complex presence of partly contrasting and partly overlapping interests between highly concentrated domestic private economic groups and large foreign corporations.

- As far as foreign investment promotion is concerned, the May 1989 procedural law not only broadened foreign investment opportunities but also allowed automatic majority foreign ownership in practically all sectors of the economy. Both in the case of foreign direct investments as well as in technology licensing agreements (with new rules published in January 1990), the authorization and registration procedures have been massively liberalized taking more the form of a promotional rather than a regulatory character. On the whole, the consolidation of an open market economy involves, in addition to the liberalization of the trade of goods, equivalent practices in the trade of services, technology and capital flows.

  Also, in a number of cases and especially in the 1986-89 period, foreign direct investments are, through the active use of debt-equity swaps, being heavily subsidized. Such a practice depends on the discount rates prevailing in the secondary markets of Mexico's debt titles. In fact, the subsidization to foreign capital or to foreign located and repatriated Mexican capital constitutes the main exception to the elimination of subsidies as applied by the Mexican government and with the strong urging of the World Bank.

- In intellectual property matters the country is rapidly revising its procedures to give protection similar to that offered in industrialized countries together with an extension of the period of protection for patents and trademarks. The new law of January 1987 (radically modifying the 1975 Ley de Invenciónes y Marcas) establishes, after a transition period, the patentability of biotechnological processes for pharmaceuticals, agrochemicals, food and feed, genetic processes for the production of animal and plant species and varieties, chemical products and medicines in general. The only exception concerns living organisms including microorganisms.

  Finally, in the case of technical norms, compulsory Mexican standards are restricted only to three areas : health and consumer protection, improved labelling, and environmental protection.

I.1.3. THE OVERWHELMING PRESENCE OF THE U.S. IN MEXICO'S EXTERNAL SECTOR TRANSACTIONS

What distinguishes the Mexican case from other debt and inflation riddled economies is the recognition of the long standing and dominant weight exercized by U.S. business interests in the country's external sector transactions. As far as trade relations are concerned, about two thirds of imports and/or exports are presently directly linked to the U.S. productive sector and its market.

In contrast, the EEC countries register, as a whole, a share which oscillates between 13-16 %, depending on the year, and Japan represents around 6% of the corresponding totals.

In the case of the maquiladora export oriented sector, U.S. investors account for about 78 % of total fixed investments and the rest is divided between Mexican subcontractors and other foreign owned firms. In terms of number of plants, the U.S. is reported as having an even larger share (well above 90 %) of the total foreign owned firms. With respect to the registered foreign direct investments in the whole economy of Mexico, the U.S. presence exceeded by far the level of 60 % during the whole decade of the 1980's, while the EEC countries oscillated between 15-20 %. Similarly, in the case of technology licensing contracts and up to 1981, the U.S. accounted for 68 % of the total number involving foreign licensors and it reached 72.5 % in the 1982-89 period.

In Mexican government, private sector and academic circles there exists a noted sense of frustration from the many unsuccessful past attempts to diversify Mexico's economic relations, especially with Europe. Mexican trade analysts express their concern about what they refer to as the protectionist structure of the EEC market not only in the agricultural sector but also in a number of manufacturing products of special interest to Mexico (e.g. steel, synthetic fibers and textiles).

It is evident that the present situation of the U.S. predominance in Mexico's external sector is being cemented and further tilted by the prospects of the North American Free Trade Agreement. A closer European attention to this evolution is well merited with the objective of a more diversified strategy which will include not only the Mexican market but access to the U.S. one, through the Mexican productive base.

I.2. TECHNOLOGY INTENSIVE EXTERNAL SECTOR ACTIVITIES

I.2.1. EXTERNAL TRADE PATTERNS

Together with the mounting export efforts so as to pay foreign creditors, an important transformation took place in the country's trade composition during the 1980's. In 1983, non-oil exports were only 22.4 % of the total and manufacturing exports accounted for 14.4 %. By 1988, these shares were 68 % and 56 % respectively.

Instead of continuing on a pattern of inter-industry specialization, basing exports on specific labor intensive sectors and importing capital intensive products, Mexico's external trade patterns became increasingly dependent on exchanges within the same industry. By the late '80's, intra-industry trade accounted for 50 % of Mexico's total manufactured exports and for nearly three quarters of the corresponding increase in trade. On the other hand, "traditional" branches have not had such an outstanding performance.

Two main factors explain this pattern of exports :
- comparative advantage is increasingly centred on natural resources processing through the promotion of capital intensive and resource based manufactured goods.
- intra-firm trade, controlled by foreign TNC's in assemblying operations, is becoming increasingly important.

On the whole, Mexico's exports portray a very high degree of concentration. This occurs not only with respect to market destination (mainly the U.S. as noted above), but also with respect to products (10 product categories account for about half of total industrial exports) and enterprises (80 % of exports in manufactures originate from 300 firms).

On the import side, trade liberalization and the prevailing macroeconomic conditions have altered significantly the corresponding composition : capital goods dropped from 27 % in 1980 to less than 20 % by the end of the decade, consumption goods increased by 2 % reaching the level of 15 %, and intermediates increased by 6 % to a level close to 65 % of the total. Also, by 1989, the freeing of imports led to the first external trade deficit of the decade.

As far as the EEC is concerned, Mexico's exports still concentrate on oil (50 % of the total at the end of the '80's). Also, a significant increase took place in automobile engines and components (15 % of total) mainly through the activities of V.W. and Renault. Mexican imports from the EEC are more diversified with consumer goods increasing sensibly from 5.6 % to 11.5 % during the past decade. The most important EEC exports are mature technology intensive goods in machinery and equipment (with a relative share above average) automobile components, chemicals and pharmaceuticals, electrical spare parts, and processed food items.

I.2.2. FOREIGN DIRECT INVESTMENTS AND THE MAQUILADORA INDUSTRY

The increased flexibility in the respective legal and administrative provisions resulted in a highly dynamic performance in foreign investment flows, especially since 1986, aided by

special provisions incorporated in debt rescheduling negotiations (debt-equity swaps). Real flows of foreign investments increased by US $ 6.2 billion (or 40 % of approvals) during the 1982-88 period. About 44 % of such real investments were due to debt equity swaps of which close to one third were in the tourist industry (mainly by U.K. firms), 16 % in motor vehicles, 11 % in capital goods and 11 % in maquiladora activities. The industrial sector still concentrates the majority of foreign direct investments (around or more than 70 %) and the service sector reached close to 23 % in the 1986-89 period. Among EEC countries, the U.K. surpassed the FRG to reach 7.3 % of total foreign investments, Germany 6.3 %, followed by France (2.9 %), Spain (2.6 %) and the Netherlands with around 1 %.

As a result of the end of the official guest workers program to the U.S. in 1965, the Mexican government promoted the Northern Border Development Program, with the support of the U.S. government and in spite of periodic protests from U.S. labor unions. This policy orientation, known as the maquiladora industry program, focuses on the establishment of labor intensive assembly industries, subsequently extended to a number of Mexican cities.

An overall spectacular increase in such "foot-loose activities" has taken place with 600 firms already established in 1973 and growing to 1975 by the end of the previous decade. Direct employment went up by almost three times from about 150,000 to close to 430,000, representing today close to 15 % of manufacturing employment in Mexico. Value added generated by this sector increased by 24 % in the last seven years reaching the level of US $ 3 billion. Yet, of the almost US $ 9 billion of intermediates and raw materials purchased by the maquiladora industry, less than 2 % originates from the Mexican productive sector. The remaining 98 % plus comes from foreign sources, mainly from the U.S. and increasingly lately from Japan and South East Asia.

I.2.3. TRADE IN KNOW-HOW AND LICENCING AGREEMENTS

Up to 1981 close to five thousand technology contracts with foreign firms had been registered while in the following decade slightly more than an additional four thousand were signed. The EEC share increased from about 13 % to more than 17 %, with France and the F.R. of Germany leading with around 5 % each during the 1980's. Up to 1981, close to three quarters of the contracts referred to know-how, trademarks and technical assistance agreements, almost equally divided among them. During the 1980's, these three categories came down to 48 % while managerial service agreements multiplied to more than 24 %, software increased to close to 10 % and diverse consulting services represented 2.5 % of the total.

Despite the significant liberalization of the technology procedures during the past decade, many Mexican companies interviewed consider that it has become more difficult to obtain licensed technology and that, when technology has been available, this has happened at higher prices and under more restrictive conditions. Two main reasons are provided, both related to the overall liberalization of trade and foreign investment practices. Foreign firms, especially in electronics, petrochemicals and other technology intensive products, have stated that they prefer to either export directly to Mexico or to establish wholly owned subsidiaries, now that trade and investment barriers have been eliminated, rather than to enter into technology agreements with Mexican partners or in joint ventures with them.

I.3. THE SCIENCE AND TECHNOLOGY (S&T) SYSTEM

I.3.1. THE EVOLUTION OF S&T EXPENDITURES

After the establishment of the National Council on Science and Technology (CONACYT) in 1970 and starting from a very low level of 0.15 % of GDP, S&T expenditures increased significantly but erratically to 0.35 % by 1974 falling to 0.29 % in 1977. With the oil boom, science and technology gained a new impetus, reaching 0.46 % by 1981 and being explicitly incorporated in Mexico's development programs. During the 1980's, macroeconomic problems have gravely affected the amount of resources devoted to the country's S&T system : during the 1981-83 period, real S&T expenditures declined by one third. At the end of the decade such expenditures dropped down to 0.27 % of GDP, mainly as a result of the resource requirements to service the foreign debt.

Projections for the future indicate that if Mexico were to reach by 1994 an S&T share of 0.5. % of GDP, which is only half of the target set by "desirable" development strategies on S&T, the budgetary allocations would have to increase by a formidable 46 % annual rate of growth. Undoubtedly, important efforts have been undertaken during the past ten years to rationalize the use of financial resources for S&T, to increase the productivity of such commitments and to develop new sources to counter the decline in overall expenditures. Also, some specific centers have attained satisfactory performance reaching levels of international competitiveness in specific areas (e.g. various research units at UNAM, CINVESTAV, the Institute for Electrical Research, the Mexican Petroleum Institute and a number of regional technological research centers). Nevertheless, the overall S&T infrastructure has deteriorated, in some cases severely so, during the past decade.

The share of publicly financed institutions is by far the largest (more than 80 % of R&D personnel) and can be grouped into two sub-sectors : (a) government ministries and decentralized institutions (especially the Ministry of Mines and State Industry with the major program in "Coordination of R&D in Energy and the Petrochemical Industry", having an overall S&T budget of almost 1.74 times the equivalent of the second in importance Ministry of Health and more than twice that of the Ministry of Public Education), and (b) educational institutions.

Public S&T expenditure was mainly broken down, in 1988, among the following activities:

- university and diverse (mostly applied) technological research institutes : 34.5 % (having gone up from 22 % in 1980)

- research in agriculture, forestry, livestock : 20.2 % (having dropped significantly from 29 % in 1980)

- research in medicine and public health : 15.7 % (whose share started declining after 1984 and which had maintained the first place up to 1981)

- assessment of natural resources (energy, minerals and marine resources) : 9.6 %.

Human resources working in R&D almost doubled between 1974 and 1984, while in the subsequent years significant cuts, as noted above, took place in overall research budgets. Thus, although in 1984 the R&D personnel had reached 0.83 per thousand of the total

labor force (it was 0.58 in 1974), by 1988 it dropped to 0.79. In the last comprehensive, mainly in the public sector, study on human resources working in R&D (1984) it was identified that out of 631 institutions, 15 reported 80 % of the qualified R&D personnel. Also, major state enterprises, like PEMEX, SIDERMEX, CFE tend to undertake their research efforts in public independent institutions rather than in house.

The activity breakdown of R&D personnel was as follows :

	1974	1984
- Basic and exact sciences	26 %	24 %
- Social studies and humanities	31 %	23 %
- Medical sciences	14 %	22 %
- Engineering and technology	14 %	16 %
- Agriculture, forestry and livestock R&D	12 %	15 %

In percentage terms and over the decade the most important changes involved the significant reduction in the relative share of social studies and humanities and the corresponding increase in medical sciences. Applied research in engineering, in agriculture, etc, increased somehow thus compensating for the small relative drop in basic and exact sciences.

Information on in-house R&D activities is scant. However, some of the available data shows that such activities have not played a major role among most of the Mexican firms. Important exceptions refer to some large public sector companies and to a selected group of, mainly large, private firms in the construction, steel, glass and petrochemical sectors. Also, two programs to promote in-house R&D in mainly foreign pharmaceutical and electronics firms were based on certain performance requirements in exchange for market reserve opportunities. Yet, these programs have recently lost their impetus in view of the overall trade liberalization being followed. Furthermore, another initiative, the Programa Mexico, based on the flexibilization of foreign royalty payments in exchange for a voluntary increase in domestic R&D, attracted the interest of mostly U.S. subsidiaries. This program also lost momentum in the late '80's due to the generalization of freedom on technology payments.

The external financing of technological development in private enterprises during the 1990's is being circumscribed by two recent institutional changes which need to be taken into account in proposing corresponding cooperation initiatives from abroad :

(a) All industrial development funds, including FONEI which was the main such source of finance for enterprise based technological development, have been absorbed by NAFINSA and integrated into a single financial development program. The allocation of funds to enterprises will take place not directly by NAFINSA but through a small number of commercial banks. This is a major institutional change and constitutes part of the overall reorganization of Mexico's (development) financial system, strongly influenced by, among others, the World Bank's recommendations.

(b) CONACYT has recently established a new program directed towards the productive sector (mainly large enterprises) to help finance long term training and R&D activities. Contributions to this program (the Industrial Technology for Production Program-TIPP) are made on an one-to-one basis between the Federal Government and the participating companies.

I.3.2. QUALIFIED HUMAN RESOURCE DEVELOPMENT

After a long and sustained growth period in public expenditures for education, since 1982 corresponding commitments have been unstable and declining. In real terms such resource allocations are today smaller by 30 % compared to 1982. As in the case for R&D expenditures, the decline in the educational budget - 3.8 % of GDP in 1982 down to 2.5 % in 1988 - is mainly attributed to the resource requirements for servicing the foreign debt.

The reduction in expenditures has not affected so much the enrollment rate as the dramatic fall (real and relative) of teachers' salaries. The most important changes took place in the resources for primary education (minus 37 % between 1982 and 1988). In contrast, expenditures for undergraduate and graduate studies were less affected leading to a more than 3 % increase in their relative share (23.4 %) in the overall educational budget. The post-secondary enrollment increased from 11.7 % (1982) to 13.1 % of total educational enrollment.

At the undergraduate level, the public university system reported in 1989 a total number of 781,700 students and the private one 179,000. In 1989, about 108,000 higher education students completed (not necessarily graduating) their studies, or 8.6 % of total enrollment. On the average, 5.1 students completed their studies in 1988-89 per thousand of the employed labor force. Of these, two students per 1000 employed labor force were in social and business studies (or 46,300 students), 1.4 in scientific and engineering studies including 0.48 agronomic engineers and veterinarians, and 0.15 per thousand in mathematics, physics and biology.

Graduate studies are relatively new in Mexico (5,753 enrolled students in 1970 growing to 45,100 in 1988 or 4.6 % of undergraduate enrollment). Of these slightly less than 40 % were in social and business studies, followed by medical sciences with almost 30 %, engineering and technology with only 13 %, natural sciences 8 %, education and humanities 6.7 % and agriculture 3 %.

There are no official targets regarding the number of graduate students required per year. However, from the diagnosis of graduate programs it is possible to detect serious future shortages in specific highly trained personnel. One of these cases, for example, concerns the area of M.Sc. in electronics, where the number of graduates has been reported as being about one sixth of the industry's potential additional demand. Also, significant shortages exist in the case of PhD lecturers and researchers.

In the fields of chemistry and chemical engineering it has been stressed that the number of graduates is insufficient to cope with the growth of the chemical industry and the needs of research institutions. It has been estimated that in order to meet the expected increase in R&D in the petrochemical industry from 0.32 % of sales in 1985 to 1.0 % in the year 2000, demand for graduates in these programs would multiply by ten. This implies an accumulated shortage of 600 specialists, equivalent to 25 % of industrial demand and 85 % of research personnel in academic institutions.

The above indicators confirm the important shortages existing in highly qualified human resources in comparison to the growth of student population and, even more so, with respect to the needs of the economy. The dimensions of the problem are enlarged by the drop noted in quality standards. Such a decline is mainly due to the lack of long needed

institutional and financial reforms in the educational system. They require bold actions, yet they also confront great political and social complexities.

An important consideration in the field of educational policy and its link with the S&T system had to do with the broader concern about the growing trend of the brain drain from Mexico. Although the U.S. has been the most important destination of such qualified migration, EEC countries also play a significant role. This is particularly so in the case of the United Kingdom and France, since Mexican graduate students often decide to stay abroad because of lack of jobs, inadequate salaries or limited research opportunities back in Mexico. These concerns could be the object of specially structured S&T cooperation programs with Mexico that should benefit, in the medium and longer term, Mexican-EEC relations in technical, but also in trade and investment matters.

I.4. PROPOSALS FOR MEXICAN-EUROPEAN COMMUNITY S&T COOPERATION INITIATIVES

Given the nature of Mexico's broadly defined S&T system as described in Sections I.2 and I.3 above, and the three sets of strategic issues discussed in Section I.1 (with respect to (i) Mexico's severe macroeconomic disequilibria, (ii) the fundamental economic policy changes in the 1980's and (iii) the dominant U.S. business presence), the formulation of the main proposals for S&T cooperation with the European Community can be oriented in the following fields :

I.4.1. AREAS OF DIRECT CONCERN TO THE BUSINESS SECTOR

The move towards an unprecedented level of trade liberalization coupled with the massive deregulation and flexibilization of procedures plus, finally, the commitment to advance in the course of the North American Free Trade Agreement, have radically changed business options for the future. In addition to considerations which emanate from broader macroeconomic management, concrete market conditions and market power together with corporate competitive advantages, rather than specific policy induced opportunities, will tend to shape the internal Mexican economic environment for business concerns. As such, the following priority initiatives for the Community are proposed :

- Technology and foreign investment intensive European business interests could, in view of the North American Free Trade Agreement, perceive the Mexican economic space as a platform for "preferential" treatment in the U.S. market. The Japanese and South Koreans have already moved in that direction in the automotive and electronics sectors and their components, so as to protect their exports and related activities in the U.S. Also, the U.S. has evolved to become the largest host country for foreign direct investments in the world. In order to protect its national interests in the light of this new situation, the U.S. government is advancing with certain crucial policy initiatives. Some of them are placed under the "fair (rather than the "free") trade" principle.

  Three such broader areas of concern need special attention by European business interests :

  (i) Foreign investment performance requirements, such as on local content in the automotive sector, could present differential levels among the members of the North American Free Trade Area having unrestricted access to the region. Monitoring such sectoral cases in the light of the development needs of Mexico could provide added advantages to European enterprises.

  (ii) The unemployment problems of Mexico and the refusal of the U.S. administration to include freedom of labor movement in the provisions of the Free Trade Agreement require a serious re-evaluation of the prospects of the "maquiladora" sector in the Mexican border industries. European firms have, up to now, made very limited use of the differential in the Mexican cost of labor for assembly operations of European products destined for the U.S. market.

  (iii) The comprehensive new legislation, expected during the coming months in the U.S., on transfer pricing practices covering related party transactions of foreign

investors, involves important tax considerations. Under certain conditions, such provisions could indirectly favor enterprises located in Mexico and exporting to or importing from the U.S., depending on product or other input categories and their degree of differentiation.

For all of the above cases, the Commission could plan a monitoring, information and advisory service in connection with a network incorporating, among others, the following contacts : the joint Industrial Cooperation Sub-committee within the Mexican-EEC Cooperation Commission; the permanent Mexican-EEC Business Council; the EEC International Partners Fund in NAFINSA set up in 1990 to promote joint ventures in Mexico; and the Business Information Networks on investment projects created in CANACINTRA this year.

- The consolidation of most development financing schemes under NAFINSA, which will now operate through commercial banks for the promotion of technological activities on the basis of competitive banking criteria, has eliminated discretionary practices on the cost of capital for such operations. Instead, the newly created facility in CONACYT, under the heading of Industrial Technology for Production, offers the possibility of co-financing on an one-to-one basis between the Mexican government and business concerns. European firms have, up to now, not been very active in taking advantage of this opportunity for their technological operations in Mexico. This case could prove of interest not only for individual firms but also for the Commission in support of European wide technology projects linked to Mexico.

- The far reaching privatization plans of the Mexican government could prove to be a major item for promoting initiatives within the context of the Mexican-EEC Cooperation Commission. In this case, both European development financing institutions and European commercial banks involved in debt rescheduling and debt relief measures for Mexico, could participate, in direct coordination with large European industrial firms, in proposing competitive offers for the purchase of shares of key Mexican state enterprises.

- Some of the Community's special programs on S&T - like EUREKA, RACE, ESPRIT, etc - offer a promising scope for joint ventures between European and Mexican enterprises. However, there presently exist various obstacles for the establishment of such joint ventures. Some of these obstacles stem from the rules governing these programmes and others from the lack of mechanisms for establishing the necessary rapport between European and Mexican enterprises. It is, therefore, proposed :

  (i) to consider establishing a joint task-force to study ways for improving the participation of Mexican firms in the special Community programs on technology and economic cooperation;

  (ii) to improve information channels between Mexican and EC enterprises; and

  (iii) to create through NAFINSA and with European participation a special risk capital fund to support feasibility studies and key technological activities regarding the participation of Mexican institutions and enterprises in the Community special programs. In other countries (especially Brazil) the World Bank has already expressed interest in this area. Debt conversion could constitute a mechanism for creating such a fund coupled with fresh European and Mexican financial commitments.

I.4.2. MEXICO'S SOCIAL NEEDS AND S&T COOPERATION

Mexico's social sector needs are presently staggering. A number of priority fields, involving technological and trade transactions, could signal a number of key initiatives for marking an important European presence. The following areas are proposed for S&T cooperation together with the relevant Mexican counterparts :

- Water

  Projects :

  Water is one of the scarcest resources in Mexico, particularly in the northern areas. Therefore, significant attention needs to be addressed to projects related to the development of water resources for human consumption and irrigation, as well as to projects directed to avoid water wastage and to promote recycling. Exploration and exploitation of hydraulic resources, and the design of measurement systems for the last user, are also priorities.

  Key institutions involved :

  The National Water Commission, the Ministry of Agriculture, the National Bank for Public Works and Services (BANOBRAS), the Department of the Federal District - responsible for the administration of Mexico City - and various research centres related with such government authorities.

  Environment

  Projects :

  Pollution has become a very severe problem in Mexico City, other big industrial cities and the oil producing regions. Therefore, land, sea and atmospheric pollution control constitute areas of very high priority, particularly in relation to Mexico City. Also, of great importance are cooperation programs in monitoring systems, sanitary draining of urban sites, pollution prevention, environmental planning and regulation.

  Key institutions involved :

  The Ministries of Urban Development and Ecology, Agriculture and Hydraulic Resources, Trade and Industry, Mines and State Industry, and Health, the Department of the Federal District, State governments, PEMEX and the Federal Electricity Commission (CFE). Also, relevant are research institutes linked to these Ministries and public enterprises, as well as research institutions specialized in environmental matters.

- National program on extreme poverty and population

  Projects :

  Mexico has a rapidly growing population and an extremely skewed income, wealth, education and health distribution. Specific programs, addressing problems of extreme poverty, attach high priority in the organization of community affairs and services, population and demography, food and nutrition, family planning, traditional crops,

development of urban marginal zones, health, housing, education, and small business development.

Institutions :

The National Solidarity Program, depending directly from the Office of the President, coordinates the activities of all Ministries and decentralized agencies to alleviate extreme poverty. Leading participants are the Ministries of Programming and the Budget, the Interior (Gobernación), Treasury and Public Credit, Public Education, Agriculture, Agrarian Reform, Health, as well as the National Institute for Indian Groups (INI), and State and municipal governments. The National Population Council and the Colegio de Mexico are the most active institutions in the areas of demography and population planning.

I.4.3. COOPERATION IN HIGH TECHNOLOGY AREAS

In the case of high technology products and related services in the Mexican market, Japan and the U.S., although both adhering and promoting the same general principles on matters such as intellectual property rights, foreign investment, market reserve, etc, pursue different entry strategies at the business level. Japanese firms and institutions undertake particularized and well targeted efforts, practically at specific product levels, to increase the share of their equipment and technical inputs in key product areas including the promotion of selected laboratories and research centers. For example, in the case of biotechnology, the Kyowa Hakko and Sumitomo US $ 100 million expansion in a joint venture with FERMEX, has achieved world presence in the production of aminoacids concentrating in supplying the North American market with lysine.

In the case of the U.S., the already strong presence of North American transnational enterprises in Mexico calls for broader official actions which obtain more generalized concessions on market access, production possibilities and the dismantling of regulatory provisions, leaving the rest to company initiatives. Thus, the U.S. official positions concentrate more on the broader terms accompanying debt renegotiations and affecting the flow of factors and of products to Mexico, including the presence of some large U.S. enterprises (as happened in the case of informatics); the policies of multilateral financial institutions involved in restructuring programs; and the overall policy direction which could emerge from the North American Free Trade Agreement.

In the case of the European Community, the official side (e.g. the Commission) does not reflect the degree of "intimacy" that Japanese firms have with their country's government. Also, in Mexico, the European presence falls obviously far behind the influence exercized by U.S. national and business interests. Thus, a different strategy is proposed here so as to promote technological cooperation and business activities in high technology areas. Such a strategy includes the identification of some important (in economic and/or social terms) subsectoral areas towards which a longer term and targeted European effort could concentrate. This will need the support of adequate resources, agreements with Mexico and corresponding company commitments. It will also require consultation with and the joint presence, in guiding such subsectoral initiatives, of representatives from the Commission, business firms and the S&T community in Europe.

The following two main areas are proposed in the case of Mexico : biotechnology and new materials. Furthermore, specific and high visibility projects could also be promoted for the

application of high technology evolutions such as the use of informatics in education and public administration endeavors and special programs such as the Mayan World Program with research and scholarships on oceans, tropical jungles and conservation of archeological monuments.

Biotechnology

- Cooperation in Agrobiotechnology

  (i) Fertilization and biological fixation of nitrogenous.

  The development of capabilities so as to make optimal use of a natural system of fertilization through coordinated technological activities in soil biology in order to increase energy efficiency and to protect the natural environment, is of paramount importance both in Mexico and in Europe. In the latter case, nitrogenous fertilizers are used extensively and are associated with the increasing nitric contamination.

  Contrary to what has already been achieved in the Brazilian case, where more applied research and productive activities exist, in Mexico the main advancements concentrate in basic research at the Centro de Investigacion sobre Fijación de Nitrogeno. Thus, in this case a more active and applied business European presence is required so as to promote potential opportunities for specific economic activities.

  (ii) Cooperation in seed production and tissue culture.

  The micropropagation of tropical and temperate fruits, tubers, ornamental plants and forest species can have a significant impact on the diversification of the Mexican agriculture and its reforestation possibilities. Tissue culture has major potentialities for crops like potato, cassava, strawberries, banana, pineapple.

  In Mexico there are seventeen research centers (see special report on Biotechnology in the Annex) working actively on the micropropagation of different species. There have also been commercial scale applications by firms (such as Biogenetica Mexicana S.A. founded in 1984).

  (iii) Biotechnology cooperation for disease and pest control.

  Biopesticide development has already been advanced through the cooperation of a number of European firms and various Latin American countries. Of particular importance have been projects on biotechnological applications for the production of pesticides (biological insecticides of bacterial origin, the replacement of traditional agrotoxic pesticides in specific agricultural produce, biological control through sterile insect techniques and assessment of industrial production of viral insecticides).

- Cooperation in Biotechnology for Food and Feed Production

  Europe has already advanced significant technological and commercial experience in animal agriculture, artificial insemination and animal food. These advancements are of special relevance to Mexico given its serious deficiencies at the nutritional level, particularly in the intake of protein.

A number of areas exist in which research work (e.g. the dynamic centre of CINVESTAV of the Politecnico National) and applications have already been advanced in Mexico. Such efforts include SCP protein production using molasses and other feedstock with sugar cane bagasse and cassava. French institutions have been particularly active in these areas in Mexico.

- Health Matters Cooperation

Like many other countries with tropical climates, Mexico faces severe problems of endemic tropical diseases. New biotechnology, particularly recombinant DNA and genetic manipulation, now permits the understanding of the unique biology of parasitic organisms that cause malaria, schistosomiasis, leishmaniasis and other tropical infectious diseases. It also provides methods to produce vaccines more specific and safer than traditional ones.

The responsibility of the public health authorities in the control requirements of endemic diseases have brought public sector institutions at the centre of managing immunological products. Thus, contrary to other important cases in the pharmaceutical sector, where foreign private firms dominate the production and commercialization of key products (e.g. in antibiotics), in the field of endemic tropical diseases European cooperation with public authorities is essential for the formers' market entry into Mexico in these product categories.

- Cooperation in the Infrastructure for Biotechnology Advancement

A concerted European cooperative program could be promoted for the coordination and advancement of activities in three major areas concerning the infrastructural base of the whole field of biotechnology in Mexico. It concerns :

(i) the availability and maintenance of hardware and of related inputs for biotechnology,
(ii) specialized training for expertize in biotechnology,
(iii) institutional building, policy formulation and informational networks for biotechnology advancement in Mexico.

- National Materials Program

Superconductors, high grade ceramics, optic fibers, and engineering plastics are potentially priority growth product areas for Mexico. Highly relevant work is presently undertaken particularly in superconductors and engineering plastics, in view of the country's wealth in oil and rare minerals. Key institutions in this field involve the following : UNAM's Material Research Institute, Mexican Oil Institute (IMP), the Electrical Research Institutes (IIE) and private firms in the plastic (Resistol) and optic fiber (Condumex) sectors.

- Concluding Comments

The realization of all the above S&T cooperation efforts in fields of social concern and specific high technology areas, as well as in educational matters, call for a quantum increase in resource commitments from Europe. Although bilateral agreements tend to be more substantial and have had a much longer duration, the formal S&T cooperation between Mexico and the EEC dates back to the early eighties. In the four-year period,

1986-1989, the total resource allocation in the EEC-Mexican S&T cooperation programmes amounted to a sum of only ECU 4.6 million.

The concrete expression of political will and its actual implementation with increased resource allocations in the areas of research, training and industrial applications constitute a precondition for any serious proposals in this area. If such a decision and corresponding commitments are made then key fields of S&T cooperation could advance. The latter will also require some institutional innovations to manage and promote such efforts along the lines recommended above.

PART II : DECISION BASE

II.1. - THE MACROECONOMIC CONTEXT

II.2. - TECHNOLOGY INTENSIVE EXTERNAL SECTOR ACTIVITIES

II.3. - THE SCIENCE AND TECHNOLOGY SYSTEM : STRUCTURE, TRENDS AND CHALLENGES

II.4. - HIGH TECHNOLOGY SECTORS

A brief economic overview

During the last ten years, Mexico's economy has been undergoing a continuous and dramatic process of crisis management in an effort to correct its severe macroeconomic disequilibria. Some key policy implications from tackling such disequilibria (especially those concerning the burden of its foreign debt and the terms of debt negotiations), together with the international context within which Mexico's external sector is gravitating, have also brought about a radical opening-up of its economy. Such a complete reversal from previous economic policy directions has involved the joint puirsuit of what is referred to as the "internationalization" of its domestic economy plus a "liberalization" of its internal activities. The combined effects of these two policy shifts and the continuous presence of a number of structural weaknesses in the Mexican economy, will be examined here from the point of view of the country's broadly defined science and technology (S&T) base and its future prospects.

During the late 1980's, Mexico's reported GDP was in the order of US $ 130 billion and its population exceeded the level of 80 million. Of the total value added produced by the economy at that time, slightly more than 46 % was reported as originating from the services sector which absorbed 53 % of the labor force. Industry (including utilities and construction) accounted for about one third of value added and one fifth of employment, while agriculture produced less than 10 % of total output employing more than 26 % of the work force. The value of output of the mining and petroleum sector was, in the mid '80's, much larger than the equivalent for the whole agricultural sector, reaching more than 11 % of total national output, with a share of less than 1.5 % of total employment.

Staggering inequalities characterize the Mexican society in which the lowest 40 % of the income earners obtain around or less than 3 % of national income. Poverty had deepened not only during the oil boom, in view of the implications of inflation, but particularly so during the more recent years in which the economy's performance has been dominated by the effects of and the policy requirements to confront the foreign debt crisis. This led, during the 1983-1988 period, to a fall of 45 % in real wages. In the mid '80's, infant mortality exceeded 50 per thousand live births while access to safe water was available to only a bit more than half of the population. Also the supply of health services was characterized (in 1983) by such average indicators as one physician for more than 1,200 inhabitants and one hospital bed per 1,780 people.

Mexico's external sector transactions are dominated on practically all fronts by the country's relations with the U.S. economy. About two thirds of trade (exports and/or imports) are with the U.S. Even higher geographic concentration phenomena appear in other key areas, especially in the context of activities of foreign corporations. Undoubtedly, Mexico's economic constellation is very much determined, at least as far as the external sector is concerned, by the forces and initiatives of U.S. economic interests. This situation is further affected by the promotion of the North American Free Trade Agreement.

Exports of goods and non-factoral services increased from US $ 5.2 billion in 1974 to US $ 30.1 in 1984, to fall to US $ 21.3 in 1986 mainly as a result of the decrease in petroleum prices. From the mid '70's to the mid '80's, the inflow of factoral payments in terms of worker's remittances (ranging between US $ 0.2 and 0.3 billion per year) were about half of the outflow for explicit payments on foreign know-how (in terms of royalties and commissions) and dividend claims by foreign equity holders. These figures do not include the much more sizeable payments implicitly made through transfer pricing practices in the sales of goods and services tied to foreign technology and equity commitments.

In contrast to the explicit factoral payments on labor, technology and direct capital movements, all amounting to a fraction of US $ 1 billion annually during the mid '80's, net interest payments on foreign debt rose from U.S. $ 3 billion in 1979 to $ 9.7 billion in 1984. (See comprehensive country data information on Table 1 of the Annex).

The merchandise exports' structure indicates the country's production specialization in its external trade relations. In the period 1980-86, more than two thirds of Mexico's corresponding foreign exchange earnings were due to petroleum products. Garden vegetables exports (6.4 % of total exports) were about three quarters of the equivalent of machinery equipment and related industrial goods. Agro-industrial products reached an average annual volume of about US $ 0.8 billion or 4 % of total exports in the 1980-86 period. The overall export performance of Mexico, judged in the light of its external debt burden, meant that the debt service ratio was approaching about 50 % of export earnings by the mid '80's. (See Table 1 in the Annex).

In the late '80's, resource based industrial goods and related party transactions by foreign firms in the assembly of certain manufacturing items (particularly in the automobile and some electronics products) have caused significant changes in Mexico's export structure. Also, the composition of imports has been altered in the light of the drastic reduction of tariffs and of other import impediments. These matters are discussed in more detail in the chapters which follow.

II.1. THE MACROECONOMIC CONTEXT

II.1.1. "STABILITY", EXPANSION AND COLLAPSE [1]

Between 1950 and 1974, Mexico enjoyed a long period of sustained high growth rate, low inflation and moderate external debt accumulation all of which, nevertheless, were not able to alleviate its mounting social problems and deep economic inequalities. Real growth averaged 6.4 %, and inflation was in single digits throughout the period. This era of fiscal conservatism came to an abrupt end in the early seventies. Rapidly expanding government spending in the economy pushed up the rate of economic growth. However, increasing government expenditure was not matched by rising public sector revenues. At the same time a decline in private savings incentives (real interest rates turned sharply downwards) prevented a matching increase in private savings. As a result, inflation tax and external debt became increasingly important sources of finance. The period of single digit inflation ended in 1973, the real exchange rate started to appreciate and external debt accelerated beyond the rate of growth in GDP from that year onwards.

Sharp adjustment measures in 1976 were not followed by a major crisis because key oil discoveries and subsequent oil price increases provided relief of both fiscal and external problems. In fact, the subsequent period was characterized by both rapidly expanding government revenues and vastly increased public sector borrowing. This expansion, based partly on the increased oil revenues, was also largely financed from abroad : Mexico's external debt increased from US $ 16 billion to US $ 86 billion between 1975 and 1982.

All this came to an end in 1982 when rising world interest rates and falling oil prices put an end to the increasingly expansionary policies of the Lopez-Portillo administration. The subsequent cut off from external capital markets left no option but fiscal retrenchment. Mexico, which had run non-interest current account deficits in each of the preceding thirty years, suddencly needed to run surpluses on that account in every following year to pay its foreign creditors. The ratio of external debt to GDP shot up anyhow under the influence of rising interest rates and falling growth rates. The gap between real interest rates on external debt and real GDP growth went from -6.3 percent in 1980-81 to a full + 10.5 percent in 1983. Differences this high mean that, even without deficits on the non-interest current account, the burden of debt will increase rapidly, simply through the compounding effect of interest on debt inherited from the past. In addition, substantial capital losses were incurred on external debt due to the necessary real exchange rate depreciation.

The counterpart to the non-interest current account improvement was a fiscal adjustment effort that is probably unmatched on a sustained basis in any country. A primary fiscal deficit of 7.1 percent of GDP before the crisis was turned into an outstanding surplus of 5.3 percent in 1987 and an estimated 7.6 % in 1988.And this while revenues from oil exports declined by more than 7 percent of GDP between 1983 and 1988 and GDP growth declined dramatically. Non-interest government expenditure was reduced from the equivalent of 34 % of GDP in 1982 to about 25 % in 1987. The size of such a cut affected severely all areas of public investments, such as in R&D and education.

[1] For detailed analysis see World Bank, Mexico : Towards Growth, Structural Reform and Macroeconomic Stability, volumes I and II, Washington, Dec. 1988.

The fiscal year of 1983 saw an IMF supported stabilization effort during which the fiscal deficit was halved, international reserves recovered and inflation came down. On top of that came the earthquake late 1985 and a major terms of trade deterioration in 1986 due to falling oil prices. In response, the authorities adopted a new stabilization program in July 1986 with a further fiscal and monetary squeeze. In return for such renewed austerity, this program called for a concerted financing effort on the part of Mexico's creditors.

Cutting the public sector investment budget from almost 10 % of GDP in 1982 down to an estimated 3.3 % of GDP in 1988, clearly had major economic and social costs. Government investment has a role to play in areas that heavily complement private investment and in the social sectors. Also, private investment has not made up for the decrease. It is now, more or less, at its pre-oil-boom level of 11 to 12 percent of GDP.

With lower investment, on the one hand, and restrictive demand management, on the other, real growth again stopped. There has been no real growth between 1982 and 1988, and hence a severe decline in per capital income. Also, inflation accelerated, instead of slowing down, towards the end of the period, partially in response to a sharp nominal devaluation. The subsequent de-facto targeting of the real exchange rate, together with an increase in cost adjustments, introduced an element of inherent instability into the system. This became fully apparent towards the end of 1987. The stock market plunge and a temporary opportunity for private debt buy-backs evolving from the 1987 debt rescheduling, triggered a run on the peso. This resulted in reserve losses and eventually to a 37 % depreciation, fuelling inflation and expectations of further exchange rate depreciations. Mexico responded with the Pacto de Solidaridad, a concerted effort to bring down inflation that was then running well into triple digits.

The Pacto was negotiated in December 1987 between Government, labor, farming and industry representatives. The program consisted of further tightening of the fiscal and monetary policies and of renewed structural reform efforts. Trade liberalization was accelerated, credit subsidies were substantially reduced, and the program of public enterprises divestiture was reinforced. These measures were supplemented by a freeze on minimum wages, public sector prices and tariffs. A corner stone of the Pacto consisted in the pegging of the exchange rate against the U.S. dollar.

On almost every target that is under direct or indirect control of the government, performance under the Pact often went beyond what was initially planned. Trade reform has been accelerated. Total government expenditure net of interest expenses has fallen by about ten percentage points of GDP over the past few years, from 28 % in 1982 down to an estimated 18 % in 1988. This effort is the more noteworthy given the negative budgetary impact of further drops in oil prices and increasingly high real interest rates on foreign debt towards the end of the year.

Moreover, this has been achieved in spite of the current extreme level of domestic real interest rates. These have been at around thirty percent in real terms most of the year, and have crept up to a compounded real rate in excess of 40 % towards the end of 1988. Also, exchange rate uncertainty has forced the government to run very restrictive credit policies to avoid reserve losses, and the resulting extraordinary high real rates on internal debt have become a function of capital flight prevention. The whole process, though, has in turn meant that productive investment considerations have been delegated to a lesser priority level in view of the primary focus on monetary disequilibria.

A predominant long term economic problem in Mexico is the continued low growth rate of the Mexican economy. This is an issue of fundamental social concern, given the grave

inequities and highly depressed social conditions affecting major sections of the population. It also presents a major inefficiency and a threat to the success of the short term stabilization programs as well. To this matter, together with the severe external sector constraints, turned its attention the new administration after the transition of political power in December 1988. A comparative presentation of the main government policies over the decade of the 1980's appears in the section which follows. This will serve as a framework so as to understand the evolution and prospects of policies and performance on science and technology in Mexico.

II.1.2. THE EVOLUTION OF MEXICO'S RESTRUCTURING AND STABILIZATION PROGRAMS : 1983-88

The Mexican economic crisis of 1982 made it clear that the import substitution model applied during the previous four decades could not go on, in spite of the fact that it had allowed very rapid economic growth and the creation of an important industrial base. The import substitution strategy had been supported by a highly protectionist policy that promoted "infant industry" through a complex system of import licenses, high import duties, official import prices and a whole set of financial and tax incentives. However, as the years went by, protection extended well beyond the infancy of industries : import substitution became indiscriminate and with few strings attached. This often led to the support of inefficient and uncompetitive product lines and companies, to the detriment of consumer interests and of export competitiveness. Furthermore, the whole process became a disincentive to productive local technological development and quality production that reinforced traditional reliance on foreign sources of technology, machinery and equipment. The exception to the rule were the agriculture and the construction sectors, where local weather and soil conditions inevitably demanded local R&D, as well as the oil and petrochemical sector, where nationalization and the consequent international reaction forced Mexico to undertake its own efforts. [2]

When Miguel de la Madrid became President of Mexico in December 1982, it was clear that spectacular remedies such as nationalization of the banking sector and establishment of foreign exchange controls in September 1982 were not the answer to a crisis that had structural roots. Therefore, beyond a package of drastic short term macroeconomic measures to stabilize the economy, and a program directed to help industry survive and to protect employment in the midst of the prevailing foreign exchange crisis, the new government designed a five year strategy. [3] It was geared towards the restructuring of the economy and the transformation of the traditional import substitution policies into a new industrial and trade strategy more outwardly oriented and more capable of generating the necessary foreign exchange. This was expressed in the National Development Plan 1983-

[2] De Maria y Campos, Mauricio, Restructuracion Industrial y Competitividad, El Caso Mexicano, 1982-88 paper presented at the ECLA Seminar on Industrial Restructuring and Competitiveness in L.A. Santiago de Chile, July, 1989.

[3] See Secretaria de Comercio y Fomento Industrial, El Cambio Estructural en la Industria y El Comercio Exterior, 1982-88 Mexico, Sept. 1988.

88 and, in the case of the industrial sector, in the National Program for Industrial Development and Foreign Trade 1984-88 (PRONAFICE). [4]

Ten programs were defined in PRONAFICE, however, only six of them were structured and implemented : those for the automobile industry, the pharmaceutical industry, the computer and electronic industry, the petrochemical industry, the labor intensive exporting industry - "maquiladoras" - and the small-medium scale industries.

The period covering the years from 1983 to 1987 was one of trial and error in the quest for improved public finances, restructuring and rescheduling of the foreign debt, fighting inflation and overall stabilization of the Mexican economy. The worsening international economic concitions, particularly the foreign debt crisis, deteriorating terms of trade (oil prices in particular) and high interest rates, and the weak and slow response of the Mexican society to the urgency of change, led at the end of the period to a radically different world context and macroeconomic policies that would prevail until 1988. It was not until the end of 1987, when tired of living in crisis and worried about falling into hyperinflation, Mexican society decided to agree on the Solidarity Economic Pact mentioned above. This allowed the Mexican Government to implement a package of orthodox measures and a freeze of prices and incomes.

In the plus side of the macroeconomic balance, the 1983-88 period shows an important reduction of the public deficit (from 15 to 5 % of GDP), a significant increase in national savings as a result of adjustment policies (an average of 25.4 % of GDP), a dramatic reduction of inflation, and an accelerated expansion of non oil exports, - particularly manufactures - that raised the share of exports of goods and services in GDP from 11 % in 1982 to 18 % in 1988 and generated a trade surplus throughout the period, in spite of the fall in oil prices. Such trends were accompanied also by an important process of "privatization" of "non strategic" state enterprises and a de-regulation, that resulted in a leaner public sector and an elimination of much red tape.(Tables I.1 and I.2).

Nevertheless, six years of adverse international and national conditions (the devastating 1985 earthquakes), trial and error and tough adjustment and stabilization policies had a high cost in economic, social and even political terms. Among the more important negative repercussions are the following : [5] (See table I.5)

- zero GDP growth during the six years
- a 30 % contraction in domestic demand
- a decrease of 11 % in GDP per capita
- a fall of 45.3 % in real wages
- a dramatic fall in fixed gross investment - particularly public investment - reducing its share in GDP from 28.5 % in 1981 to 15.6 % in 1988, thus inducing a major fall in investment and maintenance of physical and social infrastructure (education, health, roads, etc),
- an increased gap in employment which by 1988 resulted in 7 million idle workers, in a country where the labor force grows by a million a year,

[4] See Secretaria de Programación y Presupuesto (SPP), Plan Naciònal de Desarrollo 1983-88. Mexico, Mayo de 1983 and Secretaria de Comercio y Fomento Industrial, Programa Nacional de Fomento Industrial y Comercio Exterior, 1983-88, Mexico, Julio de 1984.

[5] See de Maria y Campos, Mauricio, "El cambio estructural en la evolución reciente de la economía mexicana", en varios autores El Cambio Estructural en Mexico y el Mundo, FCE. SPP, 1987.

- a worsening income distribution, in a country where the top 20 % of the population of 80 million has an income 30 times higher than the lowest 20 %.

In short, the macroeconomic context led to putting aside very important objectives and priorities established in the PRONAFICE - such as productive investment, employment and local technological development. On the other hand, it must be pointed out that PRONAFICE did achieve the following objectives :

- exports of manufactures expanded rapidly, from 14.2 % of total exports in 1983 to 56 % in 1988. Morever, the manufacturing sector, which in 1982 generated only 25 % of its foreign exchange requirements, was practically self sufficient by 1987, due to expanded exports and forced reduced imports.

- Foreign direct investment grew at a fast pace, particularly in the automobile, computer and "maquiladora" industry and in tourism.

- In spite of the difficult times, small industry managed to survive, thanks to fiscal and financial incentives, the support of government purchasing power and a process of deregulation which was finally institutionalized by a new Law for the Development of Micro-industry passed by Congress at the end of 1987.

- The medium term sectoral programs implemented for the automobile, computer and pharmaceutical industries, had important effects on the promotion of new investments, exports, efficient import substitution, competitiveness, skill formation and, in the case of the computer and pharmaceutical industry, in local technological development.

- Mexico became a full member of the international trade community by opening up its economy to foreign competition; it undertook successful negotiations to join GATT in 1986 and signed a useful "understanding" with its main partner, the USA, in trade and investment matters, that established a practical framework for consultations and fair application of countervailing duties.

Perhaps, the issue that has been subject to greater debate has been the rapid opening up of the Mexican market to international competition through the elimination of import licensing and tariff reduction. PRONAFICE pointed out that such process would take place on a predictable selective and gradual manner. In practice, import liberalization accelerated at a very fast pace in 1983. It extended, by 1988, to all sectors of the economy, with the exception of automobiles, engines, computers, basic pharmaceutical inputs and a few agricultural products, and exceeded considerably the levels of opening of the economy agreed upon in the GATT negotiations. By 1988 Mexico had, according to some estimates, a relative weighted average tariff of 5.3 % and, according to others, around 8 % - one of the lowest in the world - with a tariff structure of 0, 5, 10, 15 and 20 % as a maximum. Practically few products were under import licensing requirement, in spite of the fact that agreements under GATT allowed until 1993 import licenses for priority industrial sectors and agricultural products and tariffs as high as 50 %.

The suddenness and the magnitude of tariff reduction in many sectors have affected the production, employment and investment levels in most industrial areas. Particularly hurt were the cases of electrical appliances, electronic products, machinery and equipment, toys, wine production, and agricultural products, due to low scale production levels of Mexican plants, very high local real interest rates (25-30 %), intra-firm trade, great product differentiation and often better quality of imported goods, and undervalued "junk imports" from Southeast Asia.

Another important argument expressed by local producers is that the opening of the Mexican economy was totally unilateral and that its severity prevented negotiations for reciprocal concessions by Mexico's trade partners. Steel products, textiles and garments, as well as most agricultural products are pointed out most often as examples. Mexican cloth, for example, faces strict import quotas and duties as high as 37.5 % to enter the US market because of the international textile agreement. Meanwhile, imported cloth from the USA may enter Mexico freely and be subject only to a 15 % tariff.

II.1.3. THE NEW POLICIES OF THE SALINAS GOVERNMENT

The arrival of the Carlos Salinas de Gortari administration has signified the intensification of previous macroeconomic policies and of structural change with severe stabilization practices. A greater emphasis has been placed on market oriented policies, private investment leadership and integration to the global economy, all under the theme of "modernization". Also, in contrast to the previous periods, moderate economic growth has been established as an objective and has been pursued with some success (2.9 % in real terms of GNP).

Despite this reversal in aggregate growth performance, three areas presented disquieting problems directly related to policy choices : agriculture, the current account balance and the rate of fixed investment growth.

Gross agricultural product registered a 3.1 % fall in 1989 not only due to weather conditions, but also due to the opening up of the market of some important products, high real interest rates and the embedded structural problems of land tenancy, organization and productivity. The deficit in the Current Account Balance more than doubled in 1989 (from 2,443 million dollars in 1988 to 5,449 million dollars in 1989) due to debt servicing, but also due to the appearance of a trade account deficit of 645 million dollars (after a surplus of 1,667 million dollars in 1988) linked to recent trade policies. Finally, fixed investment registered a very small increase only in the private sector side, thanks to a more liberal credit policy in 1989 after years of severe restriction. However, real interest rates were kept quite high (between 25 and 30 %) during 1989 and the first quarter of 1990 to prevent capital flight. This constituted a severe disincentive to new productive investment and a stimulus to simply financial investments. The overall investment lag has been clear despite the recent increase in domestic demand patterns.

The Salinas government introduced, as part of its overall policy orientation, a new National Program for Industry and International Trade Modernization (1990-94). A key overall characteristic of the new Program is that the government will not establish priority sectors for industrial development. Instead, priorities are to be defined by the market, comparative advantages and profitability. Also, sectoral programs, when necessary, are not to be defined centrally by the Federal Government but through concerted shared responsibility mechanisms.

The Industrial Modernization Program attaches great importance to the revision of previous laws, decrees and procedures with the aim to eliminate those which established preferential treatments, forced vertical or horizontal integration, set domestic content requirements or granted privileges to national investors, such as the computer and pharmaceutical industry programs. Telecommunications and transportation are specifically targeted for deregulation to encourage "modernization investments". Finally, regulations related to the forest and

fishing sectors are pointed out for reform to promote their potential exploitation and modernization.

As far as technology imports are concerned, the 1990-94 Program envisages an enhanced flow of technology through the elimination of existing controls. There is also an explicit reference to the need to improve the legal framework for industrial property, so that the country may give a similar protection to that offered in industrialized economies. The period of protection for trade marks as well as patents will be extended. Procedures in the registry of trade marks and patents will be simplified.

Technical norms of reference will be established and made available to the industrial sector. Compulsory Official Mexican Standards will be restricted to three areas : health and consumer protection; improved labeling and general information to the consumer; and those concerning environmental protection. The national calibration system will be strengthened and it is intended to promote the creation of private entities to help develop programs of calibration, metrology and quality certification.

Special references are made in the Program for the promotion of free trade zones and industrial labor zones. Imports of capital goods and intermediate products are granted tax exemption from the general import tax, when they are directed to industrial firms established along the border with the US. Border firms will be allowed to sell their products without any restriction in the interior of Mexico once the import tax on the value added has been paid.

The trade regime of these free trade zones will be updated. On this account, commercial firms will be allowed to import goods for consumption in the zone in preferential conditions, substituting individual imports of consumers in border zones. Yet, criticism and concerns still persist in view of the limited domestic linkages (other than labor) induced by the maquiladoras. As far as intermediates and related goods, local suppliers provide only less than 2 % of total inputs in the whole maquiladoras sector.

The overall thrust of the policy directions included in the 1990-94 Program can be grouped into five main areas :

- Economic deregulation and market orientation
- Privatization of public enterprises
- Foreign investment promotion
- Consolidation of the open market economy and integration to the world market
- Restructuring of the agricultural sector.

In the deregulation area, the following main initiatives are of special concern to foreign enterprises :

- Aquaculture was traditionally reserved to fishing cooperatives, which, nevertheless, did not always have the necessary resources, organization and technology to exploit Mexico's broad coastal areas. On December 30, 1989, the Law for Fisheries Development was modified to allow private investors participation, national or foreign.

- Infrastructure lagged behind during the last six years and the government has argued that it does not have the resources to undertake the necessary investments. Various mechanisms have been established so that concessions may be granted to private investors for undertaking such projects.

- The petrochemical industry has been further deregulated to open up sectors to private investment - national and foreign - previously reserved for PEMEX, the state oil company. On August 15, 1989, many products considered in the past as basic - and therefore limited to PEMEX - were classified as secondary and consequently opened to private participation. Simultaneously, an important number of secondary petrochemicals have been put outside the restricted lists and are now open for 100 % foreign investment.

- The new automobile decree of December 11, 1989, foresees the entry of new automobile companies to the market provided they comply with the same requirements as existing companies, eliminates product line restrictions established in the previous decree and allows 100 % foreign investment in automobile components under some conditions.

- The computer industry development policy has been drastically modified, opening up the local market to foreign competition with a 20 % tariff and eliminating previous domestic content requirements. The only incentive left is a reduction in the import tax of components (which is 5 and 10 % anyway) to manufacturers that keep a minimum value added.

- The Pharmaceutical Industry Decrees were eliminated as of May 19, 1990, opening up the Mexican market to free competition of imported basic drugs and cancelling investment incentives and government procurement preferences for Mexican pharmaceutical companies.

- Reforms in the financial sector legislation last January deregulated considerably the banking, leasing and insurance activities, turning the government owned banks more autonomous in their administration.

- The communications sector, previously under strict ownership control by the Ministry of Communications and Transportation and of Telefonos de Mexico, has been opened to private investment. The most important case so far has been cellular telephones, where eight regional concessions were granted to joint Mexican foreign ventures. The purchase of telecommunication equipment previously reserved to companies manufacturing in Mexico (ERICKSON and ALCATEL-Indetels) has been opened up to all world suppliers, with no preference to local manufacturers.

These are the most significant areas which have been subject to deregulation so far. New measures are expected soon such as the revision of the forestry laws, to allow forestry concessions to private enterprise under simplified procedures.

As far as foreign investment promotion is concerned, the May 1989 procedural law not only broadens foreign investment opportunities but, also, allows automatic majority foreign investment in almost all sectors of the economy. This is as long as exports, employment and technology transfer occur. It simplifies authorization and registration procedures. It creates the possibility of establishing 20-year trusts with the purpose of allowing majority foreign investment in those activities that the 1973 law reserves for nationals or where foreign investment is formally limited to 34 %, 40 % or 49 %, such as mining, petrochemicals and automobile components. Such provisions create the possibility of establishing "neutral investment trusts" in Mexican banks, to facilitate foreign investment in Mexican companies registered on the stock market. The foreign investors acquire participation certificates that grant them the patrimonial rights over the stock, though not the voting rights. Finally, the new procedural law creates a Committee for the Promotion

of Foreign Investment that has already started a broad campaign in Mexico and abroad, to identify investment opportunities and induce foreign investors to come to Mexico. [6]

Overall, the consolidation of an open market economy - not only in the trade of goods case, but also in services, capital movements and technology flows - the promotion of the North American Free Trade Area is proving to be of major importance.
Considering Mexico's new open market strategy and traditional predominance of trade, investment and technology links with the U.S., the promotion of closer regional links came as no surprise in the present world context of regional megamarkets. For most of public opinion, a silent integration has been occurring during the last decade. Therefore, a free trade area would be a mere formalization of such realities.

Recent Mexican Senate hearings and public opinion expressed support for the negotiations geared to a North American Free Trade Zone, but at the same time considered important the pursual of complementary options with the EEC, the Pacific Basin and Latin America. One generalized argument is that this should lead to increased foreign investment flows into Mexico, eager to enter the enlarged North American market.

Early June, President Salinas de Gortari and President Bush, in a joint communiqué announced the beginning of conversations on a possible free trade agreement, which should lead to more formal consultations between the U.S., Canada and Mexico, once the Uruguay Round GATT negotiations are concluded. The road will be long and rocky considering the serious interest groups in the three countries.

[6] Subsecretaria de Industria e Inversiones Extranjeras : Promoción de la Inversión Extranjera en Mexico. May 1990.

II.2. TECHNOLOGY INTENSIVE EXTERNAL SECTOR ACTIVITES

II.2.1. TRADE PATTERNS

II.2.1.1. Exports and imports of goods

During the 1983-88 period, forced by the foreign debt servicing burden, Mexico had to accumulate large trade surpluses (U.S. $ 50 billion in total) to be able to cover its obligations to foreign creditors. Together with the mounting export efforts, an important transformation took place in the country's trade composition.

In 1983, non oil exports were only 22.4 % of total exports of which manufacturing accounted for 14.4 %. In 1988, these proportions were 68 % and 56 % respectively (Table II.1). Yet, 1989 was the first year since 1983 when Mexico registered a trade deficit amounting to 600 million dollars. As a result of the opening of the economy, reduced agricultural output and a small increase in investment, imports grew 24 %, while exports increased only 11 %.

One of the most remarkable transformations of the Mexican economy has taken place in the patterns of specialization and international trade. Manufacturing, became as a whole increasingly export oriented - the coefficient of export to demand passed from 2.4 to 11.6 %. Instead of specializing in specific labor intensive sectors and importing products of more capital intensive ones, an important part of Mexico's international trade is undertaken within the same industry. It has been estimated that 50 % of total manufactured exports are intra-industrial and that nearly three quarters of the export increase can be explained by this type of exports. [7]

On the other hand, "traditional" branches have not had such an outstanding performance. This is puzzling since they are also less technologically complex and are more labor intensive. [8] As may be seen from Table II.2, the export share is food and beverages, textile and apparel, footwear, paper and wood has been declining since 1975. The average share during the period 1975-78 was around 40 %, declining to 28.5 % for the period 1979-82 and down to 19.3 % in the period 1983-88.

The most dynamic export growth has occurred in the case of resource based processed goods such as steel (especially pig iron with an increase of more than 68 % between 1983-87), cement, glass, non metallic mineral products, oil derivatives, chemicals and petrochemicals. Also, significant increases took place in the case of assemblying industries such as motor vehicles, components and data processing machinery.

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[7] Jose Casar, Transformacion En El Patron De Especilization y Comercio Exterior Del Sector Manufacturero Mexicano, 1989.

[8] K. Unger and L. Saldana, "Economias de Escale y de Alcance en las Exportaciones mas Dinamicas", El Trimestre Economico, No Vol.LVI, num 222, Mexico, FCE, 1989.

Two main factors explain this pattern of exports :

- the comparative advantage granted by the availability of natural resources as well as by the development of technological capacities in industries where technology is mature.

- intra-firm trade.

In the case of intra-firm trade, undertaken mostly by multinationals, exports are concentrated in very few firms. In the automobile industry, three large American firms exported three quarters of the 1,100,000 m.v engines and of the 195,000 automobiles in 1989. Nissan, Volkswagen and Renault (in the case of engines) represented the other 25 % with growing prospects in the next few years on account of their recent and ongoing investments. [9] Chemical exports are undertaken by US and European firms, particularly German. In exports of data processing electronics machinery two American multinationals account for more than four fifths of trade.

In spite of the successful export results, Mexico's share in international trade is still low and the advantage of the privileged location of the country is far from being fully utilized. Also more disaggregate data show worrying signs :

First, 49 % of industrial exports are concentrated in only 10 products and the number of exporting firms is very reduced. Thus, 80 % of manufacturing exports are concentrated in 300 firms, half of which are multinational corporations.

Secondly, there are signs that suggest that an important share of manufacturing exports may be reduced in the future because of growing local demand, while import liberalization has resulted in increased imports that foreshadow growing trade deficits. The main reason for this is that export activity has not been accompanied by increased capacity and technological modernization but has rather been the result of devaluation, lower wages and the reduction in domestic demand. Investment activity has been concentrated only in some specific branches [10] like motor-vehicles and automobile components, electronics, sugar cane, paper, petrochemicals, fertilizers and non ferrous minerals.

Lastly, it is worrisome that Mexico's trade relations are so concentrated. While the US share in total Mexican exports had been declining since 1978 from 71.8 to 53.4 %, after 1982 the US share increased to reach 66 % in 1988. On the imports side, two thirds of Mexican imports come from the US economy which, similarly, have increased after 1982 (Table II.6).

[9] Dr. de Maria y Campos, Mauricio and Lopez Valadez, Gerardo. Restructuración y Desarrollo de la Industria Automotriz Mexicana en los Ochentas. Unpublished study prepared for the Joint Unit ECLA-CTC. Santiago de Chile. March 1989.

[10] Often this capacity increase has been accompanied by technological restructuring of firms in which the introduction of microelectronic machinery in processes has played an important role. The most prominent example of this has taken place in the automotive industry. See : Lilia Dominguez Villalobos, Microelectronics Based Innovations and Employment in Mexican Industry, Technology and Employment Programme, working paper 183, January, Genera, ILO, 1988.

Japan is Mexico's second largest buyer, with a share of 6 % while Spain is the third with 4.6 %. The EEC's share in Mexico's exports is 13 %, of which Germany's share of Mexican imports is 6.3 %. As a whole, the EEC accounts for 14.4 % of imports.

Mexico's trade with Latin American countries is relatively low (8.3 %). The Latin American Association for Free Trade accounts for almost half. Colombia, Brazil and Argentina are the most important Latin American clients. Imports from Latin America amount to only 3.9 % of total imports of which Argentina and Brazil's share represent more than half.

Total imports have been rather unstable during the eighties. The recession and stabilization adjustment had, as an immediate effect, a dramatic decline in imports after 1981. The 1983 level represented nearly one third of the 1981 equivalent. In 1984 imports observed a mild recovery, remaining stable in the following years up to 1987. In the last two years, due to trade liberalization policies, the economy has witnessed an increasing trend in imports. (Table II.4).

There have been chages in the composition of imports as well. In 1980, 37 % of imports were for the public sector. Consistent with the fall in public expenditure during the period of analysis, this proportion was almost halved in 1989. In terms of the type of goods imported, capital goods represented 27 % of the total in 1980 while in 1989, after a large increase in the previous two years, they were only 19.6 %. Intermediate goods have increased their share by six points, going from 59 % in 1980 to 65 % in 1989, and consumption goods' share in imports increased from 12.7 % of the total to 14.7 %, most of the increase occurring during the last two years. (See Table II.5).

II.2.1.2. Trade with the EEC

The European Economic Community is, as was mentioned above, the second commercial partner of Mexico. While Mexico's trade balance was favorable for 1989 with the USA and Japan, Mexico had a trade deficit of 283 million dollars with EEC countries. (Table II.6).

Trade with the US and Japan has been growing fast in the last four years both in the export and the import side. In the case of the EEC, Mexican exports decreased (-3.5 %), while imports grew 14.1 % in 1989. With the exceptions of Spain, Mexico has reduced its exports to EEC countries, particularly in the case of Germany, France, United Kingdom and Benelux. In 1985 the share of EEC countries in Mexican exports was 18.5 % and in 1989, as was mentioned before, this share was 13 %. [11]

The largest trade deficits took place with Germany and Italy. Ireland, Denmark and France have observed the greater increase in their exports to Mexico.

Mexico's exports to the EEC during the last decade were highly concentrated in oil, which up to the mid eighties represented about 85 % of total exports and allowed a significant

[11] Trade relations of EEC countries with Latin America had been rather modest. In 1958, Latin America's share in EEC imports was 11 % of imports outside the Community. In 1982, with the rise in oil prices, Latin American imports, more than six times greater than in 1958, represented barely 5.6 % of total EEC imports. In 1984, things did not change much : this share was 6.5 %. The situation is even worse in terms of Mexico : between 1982 and 1984, Mexican exports were approximately 15 % of Latin American exports to the EEC. See : Victor Urguidi, "Mexico y la Comunida Economica Europea", Comercio Exterior vol 38, num 4, Mexico, Abril de 1988.

trade surplus. However, in the last six years, the value of oil exports came down so that they represented, during 1988, about 50 % of total exports. On the other hand an important increase occurred in automobile engines and components (basically VW and Renault to the FRG, France, Spain and the Benelux countries) which now account for around 15 % of total exports to the EEC. Coffee, which traditionally represented about 6 % to 10 %, came down sharply in 1989 as a result of the crisis prevailing in world markets. Minerals, some other agricultural products, tuna fish, honey and two growing items, synthetic fibers and computers, complete the picture. (See Table 5).

Trade analysts in Mexico have expressed their concern for the protectionist structure of the EEC market. The four main concerns are the following :

- increasing EEC protectionism through quotas and other non-tariff barriers,
- preferences granted to Mediterranean and African countries, in products of interest to Mexico and other Latin American countries,
- the limited scope of the EEC's General System of Preferences, which excludes agricultural products as well as textiles, garments, steel and other products of interest to Mexico, and
- the Common Agricultural Policy, not only in its restrictive effects on incoming products, but also in terms of the subsidies and supporting mechanisms to production and to the export of surpluses. [12]

Specifically, in the last few years Mexican companies in the steel sector and in the synthetic fiber sector have had to face countervailing duties and other restrictions that have been worrisome, considering Mexico's openness to European exports.

Mexican imports from the EEC are mostly intermediates and capital goods, although the share of consumer goods increased sensibly from 5.6 % in 1988 to 11.5 % in 1989. The share of capital goods imports from the EEC has been above average. In general, it may be said that imports are more diversified in terms of products. The most important are mature technology intensive goods such as machinery and equipment, automobile components, inputs for the pharmaceutical and chemical industry, radio and tv spare parts; However, powdered milk, butyric fat, food and beverages in general, and books still play an important role. (For more detailed descrption of import and export items to and from the EEC, see Tables II.7, II.8 and II.9).

II.2.1.3. Trade activities in consulting engineering and construction services

The export activity of consulting engineering and construction services has been less successful than other areas of trade performance. In 1974 TECNIMEXICO, a consulting consortium was founded to represent affiliated Mexican firms. Information referring to the two largest groups (ICA and Protexa) may be indicative of the reduced export activity of

[12] See de Mateo, Fernando. "Mexico y la Comunidad Economica Europea. Comercio e Inversiones", Comercio Exterior, vol.36, num 7, Mexico, Julio de 1986.

consulting firms. It is estimated that from 1973 to 1986 these two groups undertook two projects per annum equivalent to U.S. $ 2.0 millions. [13] These exports were oriented to South and Central American countries. They were linked with construction contracts of infrastructure works in the areas of civil, structural and hydraulic engineering, in which Mexico has gained reputed technological capability. It is estimated that exports have amounted to only 1 % of total domestic and foreign sales. However, there are signs that exports of consultancy and engineering services have increased notably in the 1985-88 period on account of reduced demand in the Mexican market. More detailed information obtained from TECNIMEXICO and the Ministry of Trade and Industrial Development, shows that in the 1982-1989 period 16 large Mexican companies exported in a systematic manner technology consulting and engineering services, and/or construction services.

On the imports side, the Ministry of Trade and Industrial Development registered only 126 contracts of consulting services from 1983 to 1987, a significant reduction from the booming seventies and early eighties. Two thirds of these contracts corresponded to technological transfer from the US, with 79 contracts. Canada and the U.K. had 10 each, France 7 and Japan 4 contracts. About half of these contracts were related with the manufacturing industry, followed by communal services and mining.

Among the largest world class firms, 33 US firms, 9 European, two Japanese, one Canadian and one Israeli reported having operated in Mexico during 1987. (Table II.10). Mexico is reported as the most important market among Latin American countries, being considered as the seventh largest importing market for such consulting services in the world, according to the number of firms participating in each country.

On the import side only gross estimates are available. Between U.S. $ 12 and U.S. $ 23 million are reported annually, or around 6 % of total domestic sales, as payments for a range of imported consulting services. Considering the estimated exports of Mexican consulting firms (U.S. $ 1.4 million), there is a marked foreign exchange deficit in this item, indicating the definite needs of the Mexican productive sector in obtaining, from foreign sources, important know-how inputs.

II.2.2. FOREIGN INVESTMENT FLOWS AND THE MAQUILADORA INDUSTRY

With the increased flexibility of the respective legal and administrative provisions, foreign direct investment flows have observed a highly dynamic behavior since 1983 and particularly since 1986. As a corollary to the opening of the Mexican market to foreign competition, the joint venture requirements were gradually diminished until 1988, when they practically disappeared. Also starting in 1986 and as a result of the rescheduling of the foreign debt, foreign investments obtained authorization for debt equity swaps, a mechanism that promoted foreign investments particularly in tourism. Also debt capitalization boosted registered foreign investment.

As a result of these policies, during the 1983-88 period, foreign investment authorizations increased in the order of U.S. $ 13.5 billion. This is equivalent to the total accumulated

[13] F. Ochoa y Asociados, Diagnostico De Los Servicios De Ingenieria y Consultoria En Mexico, Informe sobre su potencial de exportación y evaluación de su posible incorporación al Gatt, proyecto Secofi/UNCTAD/PNUD Mex/87/026. p 48.

foreign investments up to 1982. More than two thirds of the approved investments were registered in the 1986-88 period. However, real flows have been estimated at only U.S. $ 6.2 billion during the period - that is, 40 % of the approved amount - due basically to a reduced and later stagnant Mexican market and to the generally unfavorable and uncertain investment conditions that prevailed during those years. Also, as it will be seen below, a very sizeable proportion of the registered investments depended on debt-equity swaps.

During the 1983-88 period, foreign direct investment continued to concentrate in the industrial sector, which normally represented about three quarters of total foreign investment. Diverse services (with about 15 %) and trade (with around 8 %) followed. The primary sector - mining, fundamentally - represented the remaining 2 %.

However, between 1986 and 1988, the industrial sector diminished its share from 78 % to 69 % while the service sector's share grew from 12.7 to 22.7, to a large extent induced by debt-equity swaps in areas such as the tourist sector.

In terms of country of origin, U.S.A.'s investment share has permanently been, by far, the largest representing around two thirds of total foreign investment between 1982 and 1985 and 62 % for 1986-89 (See Table II.12). Japan, which occupied a second place in 1982 with a share of 7.2 %, due to the large investments undertaken during Mexico's oil boom years, slowed down its investments all along the period of reference representing by 1989 6.0 % of total foreign investment.

The EEC countries increased considerably their share from 15 % to about 20 % of total foreign investment. The United Kingdom had the larger European participation, especially in the 1986-88 period, when its total accumulated investment grew from 556 million dollars (3.5 % of f.d.i.) to 1,754 (7.3 % of f.d.i.) as a result of significant tourism investments. It managed to surpass the Federal Republic of Germany, whose share was normally about 8.3 % of total foreign investment up to 1986, but went down in the next three years to represent only 6.3 % in 1989. France is reported with 2.9 % of the total, Spain with 2.6 % and the Netherlands with around 1 %.

Debt-equity swaps played a significant role in the 1986-88 period. During those three years, a total of U.S. $ 3,873 million in swaps were approved and 2.731 million dollars were actually converted, which represented 44 % of real foreign investment flows. This mechanism played an important role in investments related with tourism (31 % of swaps), the motor vehicle sector (16 %), capital goods and other metal-mechanic industries (11.5 %), which added up to 70 % of total swaps. In the motor vehicle industry and maquiladoras they were subject to great criticism, because they represented sizeable subsidies to investments, that were to take place any way.

The country origin of "swaps" is also worth considering. The U.S.A. occupied first place, with a share of 47.6 %. However, the United Kingdom had a share of 13.7 % very large considering its traditional foreign investment participation in Mexico. Other countries' participation in the swaps transactions followed more closely their traditional share in foreign investment in Mexico. The FRG 5.7 %, Japan 3.7 % and Spain 2.9 %. The other unusual "foreign" participation in swaps corresponds to Panama (9 %), which together with some Caribbean tax-havens, constitute the main platform for transactions by Mexican companies, which wanted to profit from swap operations, formerly reserved to foreigners.

II.2.2.1. The labour intensive export assembly industry ("maquiladoras")

As a result of the end of the official Mexican guest workers program to the US in 1965, the Mexican government started a Northern Border Development Program, oriented to the establishment of labor intensive assembly industries in Mexican cities.

This program that has had the support of the US government ever since, in spite of periodic protests from US labour unions. Since then, the "maquiladora" industry has grown at a fast pace, spreading out to other cities away from the border and representing today around 15 % of manufacturing employment in Mexico. As may be observed from Table II.13, the 600 firms already established in 1983 grew up to 1795 in 1989 and the number of jobs increased from 150,867 in 1983 to 427,244 in 1989, while total employment in Mexico had zero growth. Also, the value added generated by this sector has increased by 24 % in the last seven years reaching the level of U.S. $ 3 billion (Table II.13). The reasons for the maquiladora boom in the period were the following :

- The needs of American industry and, more recently, of Japanese and Korean firms for sources of competitive labour force in order to attend the striving American market.

- The declining real wages in Mexico, during the 1983-89 period, went from U.S. $ 3.5 to U.S. $ 2 an hour - in contrast to Southeast Asian countries like Korea and Taiwan where they grew from U.S. $ 2 to U.S. $ 4 an hour in the same period. An undervalued rate of exchange during all these years played also an important role.

In terms of economic activities, maquiladora operations which previously were largely in the garment, furniture, toy and electronics industry, are increasingly concentrated now in the assembly of more technologically advanced operations in electronic and electric materials, automobile components and electronic and electric machinery (Table II.14). These activities concentrate more than 50 % of the total maquiladora value added, almost 45 % of the employment and 55 % of the number of plants.

Maquiladora operations are subject to strong criticism in Mexico in view of their questionable role in the transfer of technology. They usually cover low skilled and low paid activities in isolated sections of the overall manufacturing operations with limited diffusion of not only core but also peripheral process and other know-how. However, in some activities like modern electronics and automobile components and in the cases of total relocation of plants that cover integrated processes, there may be important effects in terms of use of modern technology, training of personnel and entrepreneurial development. Some new locally owned companies in the north of Mexico and Guadalajara are spinoffs of maquiladoras. They have been established by Mexican managers or engineers who, after years of work in the maquiladoras, have decided to go on their own in a similar line of activity or turn into a local supplier.

Presently, the maquiladora industry as a whole purchases almost 9 billion dollars in raw materials and spare parts. Only 1.8 % of this total originates from the domestic industry. The remaining 98.2 % comes from various foreign sources, fundamentally the US, but also Japan and South East Asia. (For sectoral (e.g.food) and geographic (Monterrey, Santillo) exceptions to this general picture of very low local procurement see Table II.15).

At present, the investment structure in the maquiladora industry shows that 48 % of the plants are owned by Mexican subcontractors, 48 % belong to American investors

(accounting for 78 % of fixed investments), 2.4 % to Japanese and 1.2 % to other countries investors.

Although a few European firms have engaged in maquiladora activity, they have been either operated out of American subsidiaries or have been acquired when a European company (e.g. SIEMENS) purchased an American firm with maquiladora operations. European maquiladoras are located in the shoe, garment, house accessories (lamps) and electronic industry, and belong basically to Spanish, French, Dutch, and German investors.

Recently Japanese and to a lesser extent Korean and Taiwanese interest in maquiladoras has grown considerably and became a topic of debate with the US. They are located fundamentally in the electronic industry and in automobile components. Most of them are ventures of US subsidiaries of Japanese parent companies and are therefore legally US owned.

During the 1984-87 period, there was much discussion on whether Japanese companies were avoiding Japan-specific US trade sanctions and whether they should be able to take advantage of US tariff 807. The potential US-Mexican free trade agreement is today triggering greater interest on the Japanese side and should encourage European investors to look more seriously at the convenience of establishing maquiladoras in Mexico to export to the US market and become suppliers of maquiladoras. Table II.16 shows some of these opportunities.

II.2.3. TRADE IN KNOW-HOW AND LICENSING AGREEMENTS

In December 1972, the Mexican Congress approved the first law establishing the obligation to register licensing and technical assistance agreements and for obtaining approval from the Mexican government. A new set of rules was published in January 1990. It explicitly states the need to deregulate technology transfer in order to ensure the inflow of modern technology as part of the modernization objective of economic policy. The negotiation of the terms of acquisition is left to the purchaser or licensee. The role of the authority, as stated by the Director General For Technology Development of the Ministry of Trade and Industry, is one of support and promotion, and no longer one of control and regulation. [14]

In practical terms, the new procedural rules and administration imply, at present, that government authorities will register any agreement no matter what payment levels and conditions are included, as long as the parties involved make a commitment to undertake programs oriented to effective assimilation of the imported technologies, R&D projects, or contributions to the "Programa Mexico" fund.

By 1989, up to 20,000 contracts had been registered. Technology imported through contractual agreements comes mainly from four countries : the USA, particularly in the area of chemical and pharmaceutical products, automobile components, computers and machinery and equipment (65 % of foreign contracts); the Federal Republic of Germany, particularly in chemicals, pharmaceuticals and automobile components (5.1 %); Japan, basically in automobile components, machinery and electrical appliances (3.9 %) and France in food and beverages, cosmetics, machinery and components (5.3 %) (Table II.17).

[14] Villarreal, Roberto, Contexto y Propositos De La Nueva Reglamentacion De La Ley Sobre El Control y Registro De La Transferencia De Tecnologia y Uso y Explotación De Patentes y Marcas, (Mimeo), Febrero de 1990.

Up to 1981, more than 75 per cent of the registered technology contracts were with foreign companies. Out of 4991 such agreements, the US share was 68 %, European countries represented 23.4 % and Japan's share was 2.4 %. Among the EEC countries, Germany (7.5 %), France (4.2 %), the United Kingdom (4.0 %) and Italy (2.4 %) had the larger shares. After 1982 out of 4,062 foreign technology agreements, the US share was 72 %, European countries represented 24 %, (the EEC share was 22 %) and Japan went up to 4 %. Among the EEC countries, the most significant changes were France's rise to the first place with 5.3 % of the total, followed by the F.R.G. with 5.1 %, Great Britain with 3.8 % and Italy with 2.9 %.

It may be noted, as well, that the number of contracts signed with foreign countries declined in absolute terms in most cases or remained stagnant, except for the case of Japan, despite the fast rate of growth of foreign direct investment and investments in the "maquiladoras" in particular.

As far as the stated objectives of the registered contracts until 1982, nearly three quarters of them belonged to three categories : know-how (27.7 %), use of trademarks (23.5 %) and technical assistance (23.0 %). After that year, the share of these three contractual objectives came down to 48 % (i.e. know-how and use of trade marks being reduced almost by half, which in part may be explained, by a reduced number of new productive investment projects as contrasted to registered capital flows). On the other hand managerial services multiplied almost by five their share (24.1 %) and two new items appeared : software (9.4 %) and consulting services (2.5 %). These changes once again resulted from the inclusion of corresponding provisions in the 1982 law and the consideration of managerial services agreements as an expense item for fiscal purposes. Therefore, most of these contracts cannot be included as effectively new technology transfer cases among firms. Once again, if we take away these three items from statistics, a similar pattern to that of the 1973-82 period appears (Table II.18).

Many Mexican companies consider that, during the eighties, it became much more difficult to obtain a technology license than in previous years and that when technology has been available this has happened at higher prices and under more restrictive conditions. [15] This situation has intensified in recent years as a result of the very liberal opening of the Mexican economy to imports. Some Mexican companies have not been able to obtain up-to-date technology from abroad, even from their traditional minority partners, who argue that they would rather export new high-tec products from their home plants or, when investment in Mexico is convenient, to go on their own if possible. This is a frequent complaint of interviewed Mexican companies in the petrochemical specialties, electronic and other technology intensive sectors. The recent 1990 procedural legislation, consistent with the new open market policies, facilitates these trends.

Over the years, patent registration trends have not changed much. Between 1983 and 1987, only 6 % of patents and invention certificates went to Mexicans and local firms. (In the period up to 1982, the equivalent share was less than 8 %). The remaining 94 %, for 1983-87, went to foreign citizens and corporations, out of which the US represented 56.4 %, the Fed. Repub. of Germany 7.9 %, France 6.9 %, Japan 6.5 % and Switzerland and Great Britain 3.6 % each (Table II.20). It is interesting that the US share in total patenting (56.4 %) is much smaller than its share in technology agreements (75 %). The

[15] De Maria y Campos, Mauricio : Areas Estrategicas del Desarrollo Tecnologico de Mexico en el Marco de una Creciente Brecha Tecnologica. Documento preparado para el Foro "Mexico ante la Brecha Tecnologica" organizado por la Universidad Autonoma Metropolitana. Mexico, Novembre, 1989.

relative participation of other countries is higher, especially in the case of Japan, whose patenting had the highest rate of growth along that period.

II.3. THE SCIENCE AND TECHNOLOGY SYSTEM : STRUCTURE, TRENDS AND CHALLENGES

II.3.1. INTRODUCTORY REMARKS

Since the beginning of import substitution industrialization (1940) until the end of the sixties, Mexico relied heavily on the import of technology. With the exception of the oil, the construction and the agricultural sector (where domestic efforts had been forced by international circumstances, local geological and topographic conditions or specific land and climatic requirements) product and process technology as well as machinery and equipment came mainly from foreign sources.

Furthermore, graduate education was virtually non existent and students searching to complete their university studies or to specialize had to seek their educational opportunities in foreign universities, mostly in the US, UK and France. At the end of the sixties, as in other underdeveloped economies, general concern rose regarding this situation and the role of science and technology was revalued. In 1970 the National Council for Science and Technology (CONACYT) was created with the purpose of formulating and coordinating science and technology policy, advising the executive power on all research and development activities (R&D), on the required infrastructure services, on the import of technology and on the development of human resources. The Council was granted executive responsibility in channeling resources to R&D activities related to priority programs and projects as well as in formulating S&T plans and programs.

During the period covering CONCYT's creation up to the end of the oil boom (1982), S&T expenditure increased at a fast rate. Not only existing institutions were strengthened, but new important institutions were created in higher education and basic research, (such as the Universidad Autonoma Metropolitana), in the field of technological infrastructure (i.e. the National Technological Information Center (INFOTEC)), and in various priority areas of applied research (i.e. the Electrical Research Institute, the Steel Research Institute).

II.3.2. THE EVOLUTION OF S&T EXPENDITURES

From 1970 up to 1981 S&T expenditures grew at a fast rate, going from 0.15 % of GDP to 0.46 %, although with significant fluctuations depending on the evolution of overall public expenditure and the pace of economic activity. [16] Following CONACYT's creation in 1970, S&T public expenditures doubled their share, increasing during the next three years up to 0.35 % of GDP. However, after 1974, the pace of increase diminished, falling down to 0.29 % of GDP in 1977. From 1978 to 1981, years of the oil boom, science and technology gained a new impetus being explicitly incorporated in development programs. S&T expenditures increased faster than the growth of public expenditure and of GDP, reaching a peak in 1981 with 0.46 % of GDP (Table III.1).

[16] See : Lustig, Nora. del Rio, Fernando. Franco, Franco. Martina, Esteban. Evolution Del Gasto Publico En Ciencia y Tecnologia 1980-87, Mexico, Academia de la Investigacion Cientifica, Marzo de 1989. We have up dated information for the year 1988, following the lines proposed by this study.

The evolution of S&T expenditure after 1982 has been very much determined by the resource availability problems confronting the Mexican economy. S&T public expenditure declined faster than overall public expenditure, going from 1.06 % of the latter in 1981 to 0.68 % in 1983. Real S&T expenditures declined by one third during those two years. In spite of a 20 % recovery in 1984, the falling trend was maintained. By 1988 S&T public expenditures dropped down to 0.27 % of GDP.

The reasons for the fall in S&T expenditure must be looked for mainly in the evolution of debt servicing, rather than in the redistribution of other expenditures in view of the need to attend other priorities during recession. Relating S&T public expenditure as a proportion of "programmable expenditure" (public expenditures less debt servicing payments, fiscal credits and incentives), as it can be deduced from Table III.1, except for 1988, this relation is quite stable with a tendency to increase. This would suggest that S&T public expenditure has been affected in similar terms as other sectors of the economy and that the decline in real terms is due to the increasing burden of debt servicing payments. [17]

II.3.2.1. Overall description of institutional aspects of S&T

A wide variety of institutions constitue the S&T system : government ministries and decentralized organization, R&D specialized agencies which depend on specific ministries, academic institutions of higher education - both private and public - and firms, also private and public. The share of the publicly financed institutions is by far the largest (more than 80 % of R&D personnel). The following paragraphs present a brief description of the main public agents in the S&T system. Subsequent sections deal extensively with the enterprise sector's involvement in S&T.

The public sector, devoted to S&T activities, can ben divided in two subsectors : one depending on educational institutions and the other on government ministries and decentralized public institutions.

The first comprises those entities coordinated by the Secretary of Public Education, and those dependent on the autonomous universities and institutes of higher education. This subsector accounts for 46 % of all R&D personnel. The most important are : the National Autonomous University of Mexico (UNAM), by far the largest with 14 research institutes and centres in humanities and social sciences (24 % of the research budget) and 23 scientific research institutes and centres (67 % of the research budget in 1989). The Metropolitan Autonomous University, with three main campuses has research activities in engineering, biology, health, social and behavioral sciences. The Centre for Advanced Research of the Polytechnical Institute (CINVESTAV) is specialized in electrical and electronics engineering, biotechnology and bio-engineering, physics, neurological sciences and mathematics. El Colegio de Mexico, specialized in social sciences, is probably the most prestigious institution in that field.

The second subsector includes other government ministries and decentralized public institutions. A group of them undertake activities related to the planning, evaluation and promotion of S&T activities in specific fields, through specialized centres and R&D institutions depending on them. In the case of the Ministries of Agriculture and Hydraulic

[17] N. Lustig, et al., Op. Cit., Mexico, Academia de la Cientifica, 1989, p. 13.

Resources, Energy, Mining and Public Industry, Trade and Industrial Promotion, Fishery, and Health, their R&D centres and technical assistance institutes are oriented to the solution of problems and the supply of S&T services directly related to the administrative field of each ministry. (See in Annex 1 a list of the main institutions and their head ministry).

II.3.2.2. Breakdown of public S&T expenditure by institution, activity and type of cost

A few institutions concentrate most of public expenditure on S&T, as may be gathered from Table III.2. In 1988, three Ministries and 16 institutions represented 76 % of total S&T public expenditure.

The Ministry of Mines and State Industry had a share of 5.9 % in total public S&T expenditure. Most of it goes under the program called : "Coordination of R&D in Energy and the Petrochemical Industry".

The Ministry of Health accounted for 3.4 % of total expenditure. Almost three quarters of this was for capital expenditure dedicated to the development of research infrastructure and the rest went to clinical research, standard and norms and support to research. Finally, the Ministry of Public Education reported a 2.7 % of total expenditure. Almost half of it was dedicated to research and graduate programs at technological institutes and the rest went to applied research in the improvement of curricular.

Looking at the set of 15 institutinos, the four largest (The National Autonomous University, the National Institute for Agricultural, Forestry, Livestock Research, the National Oil Institute, and CONACYT), absorbed 46 % of total expenditure. Next follow 11 middle size institutions with a range from 3.8 % to 1 % of total expenditure.

The breakdown of S&T expenditure by activity was in 1987 as follows : research activities at universities and technological institutes accounted for 34.5 % of total S&T expenditure; research in agriculture, forestry and livestock represented 20.2 %; research in medicine and public health 15.7 %; assessment of natural resource (energetic, mineral, marine) had a share of 9.6 %. (Table III.3).

There have been some changes through time. In 1980 research in technological institutes and universities accounted for 22 % of S&T public expenditure, research in agriculture being first with 29 %. The share of agricultural research declined fast, getting down to 18 % in 1982, whereas medicine and public health took the first place from 1981 to 1984, starting to decline after that date.

Finally, it may be noted that S&T investment expenditure has observed a declining trend from 1980 to 1988. Except for mild increases during 1984, 1985 and 1986, its 1988 level was less than half of the 1980 level equivalent.

II.3.2.3. Human resources in R&D activities

Research on qualified manpower has not received much attention in the last six years in Mexico. The most recent account on human resources involved in R&D activities was

carried out in 1984, ten years after the first one. It is based on a national enquiry carried out among 631 institutions, of which 157 are mainly research centres and the other 474, although not having research as their main objective, have active researchers; it must be noted that only 132 institutions carry 90 % of all research in terms of resource use.

Between 1974 and 1984 the number of institutions passed from 449 to 631 and the number of qualified employees working on research and technological development almost doubled from 8595 to 16604. As in the case of expenditure, R&D personnel tends to be concentrated in few institutions. Fifteen such institutions have 80 % of the qualified personnel reported in the enquiry. [18]

Table III.4 shows that governmental institutions (33 % of total number) have nearly half of R&D personnel. Next come public educational institutions (technological institutes and universities) with 46 % of total R&D personnel. Private educational institutions (6 % of total institutions) have around 7 % of R&D personnel. Unfortunately firms, either public or private account for a very small part of R&D personnel in this inquiry. It must be noted that the low share of R&D personnel among public firms may be explained because the R&D activities in PEMEX, CFE and SIDERMEX are not performed within the firms, but by public independent R&D institutions - which in fact are two of the largest ones. The enquiry includes 37 private firms only. It is thus reasonable to conclude that although R&D activities in private firms are not very significant, they are underestimated in the above noted study.

In 1984, 24 % of R&D personnel was engaged in research in basic and exact sciences, 23 % in social studies and humanities, 22 % in medical sciences, 16 % in engineering and technology, 15 % in research related to agriculture, forestry and livestock. The structural breakdown by scientific field was different 10 years before. In 1974, social studies and humanities had the largest share with 31 %, followed by exact and natural sciences with 26 %, medical sciences with 14 %, engineering with 14 % and finally agriculture with 12 %. Thus, the increase in R&D personnel between 1974 and 1984 was mainly oriented towards more applied R&D activities (Table III.5).

More than half of all R&D personnel who are specialized in agriculture and related sciences and engineering sciences, are employed by public institutions. Public higher educational institutions cover research in exact and natural sciences and in social studies and humanities, employing more than two thirds of qualified personnel in the first and near 60 % in the latter. Private universities put greater emphasis in social studies, humanities and engineering.

In total, it is estimated that 55 % of R&D personnel is engaged in applied research, 31.4 % in basic research and 9 % in experimental research. The survey reported that around 30 % of total R&D personnel had only a BA degree in 1984. Instead, 13 % had undertaken specialized additional studies, 28 % had completed a Master's program or graduated, and 18 % had a PhD. [19]

[18] Estadisticas Basicas Del Inventario De Instituticiones y Recursos Dedicados a Las Actividades Cientificas y Tecnologicas (1984, Serie Estudios 10, Mexico, CONACYT, 1989.

[19] Estadisticas Basicas del Inventario de la Institucióǹes y Recursos Dedicados a las Actividades Cientificas y Tecnologicas, Serie Estudios 10, Mexico, CONACYT, 1989.

In 1974, year of the first survey, R&D personnel was 0.58 per thousand of the total employed labor force. This proportion rose to 0.83 in 1984. If we take into account that there has not been any significant new job generation after 1984, this implies that R&D personnel fell to 0.79 per thousand of labor force in 1988.

II.3.2.4. Research and development by firms

Information on inhouse R&D activities is scant. However, the available information shows that these activities have not played an important role among the majority of Mexican firms. The main exceptions would be the large public sector companies and a select group of private firms in the construction, steel, glass, petrochemical, pharmaceutical and electronics sectors.

A survey undertaken in 1979 covering a sample of 119 large firms reported that 58 of them had a R&D department. However, the activities considered as R&D by some of these firms were dedicated, in fact, to quality control and maintenance. Thus, only 51 of them invested specifically in R&D activities. These firms invested around 1.4 % of total sales (0.9 % among producers of consumer goods and 1.7 % among producers of capital and intermediate goods). The survey found that among the latter some successful results in process innovations had been obtained. Among consumer goods producers, these activities were fundamentally oriented towards small adaptations to local requirements and conditions or changes in order to intensify product differentiation. They could, thus, hardly be considered as real innovations. [20]

Although it is true that there are segments of industry, particularly among firms with consistent export activities, where R&D departments have been created and where investment in technological activities is being promoted, there is no recent study which allows for systematical quantification of the technological effort exerted among export oriented firms or those attending the domestic market. Given the stagnation of domestic demand, it could be argued that the situation has hardly changed in the latter case.

A recent survey, published by a reputed business journal, among 300 firms of different sizes gives useful information on the subject. [21] Altogether a total of 129 firms, or 40.3 % of the sample, stated that they had on a regular basis undertaken some kind of R&D activity. The proportion of firms investing in R&D was 63.5 % in the case of large firms, 27.5 % in the case of small firms, and 43.5 % in the case of medium size firms. It must be noted that most of the technological research financed by the sampled firms was undertaken within the firms, particularly among medium and large size firms.

Two government sectoral programs, that had among their objectives the technological development of enterprises, are worth mentioning. One took place in the pharmaceutical

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[20] Unger, Kurt. Competencia Monopolica y Tecnologica en la Industria Mexicana, Mexico, El Colegio de Mexico, 1985. The sample was constituted by 119 firms selected among the largest firms in the sectors considered as priority by the National Plan of Industrial Development 1979-82.

[21] "Desarrollo Tecnologico en Mexico : En Busca del Tiempo Perdido", Expansion, Vol XXI, No 516, Mexico, 1989. The composition of the survey was as follows : "micro" firms : 12 %; small firms : 17 %; medium size firms : 18.7 %; large firms : 51 %.

industry. Its aim was to promote local investment for the production of active ingredients with the purpose of substituting imports and increasing the market share of local firms in the sourcing of the public health system. With this objective in mind, the Ministries of Health, Trade and Industry and CONACYT, required drug manufacturing companies to make annual investments on R&D equivalent to 5 % on sales and established a supporting financing program. By 1987 it was reported that among 39 suppliers, 25 had established either a R&D laboratory or a pilot plant within the firm and two had a research contract with UNAM. In addition, six of them had participated in the risk-sharing program supported by CONACYT. [22]

This sectoral development program has recently been drastically reformed. Compulsory R&D and related performance requirements have been eliminated, tariff and public procurement practice have been significantly liberalized and product patents will, in the future, be granted in pharmaceuticals. As a result, industry sources expect that very few of the Mexican firms previous involved in R&D will continue doing so in the years to come.

The second program took place in the electronics industry. At the beginning of the eighties this industry consisted mainly of distributors for imported goods, producers of consumer electronics and components which had remained uncompetitive through years of protectionist policies. The 1981 development program, and particularly that of 1985, identified computer electronics technologies and telecommunications as fundamental to modernization efforts. To promote development of local technologies by Mexican companies and to induce subsidiaries to undertake R&D or technological assistance activities in Mexico, companies benefiting from the closed market were required to spend 6 % of their sales in technology related activities. In particular, the program attempted to encourage technology development in microcomputers and peripherals aiming to provide a time and market space in which Mexican firms, or joint ventures, could develop their own technologies. The subsequent and abrupt opening of the economy to foreign competition in electronics components and subassemblies forced many firms to close their doors.

Only a very reduced number of, mainly, U.S. subsidiaries have survived and were able to grow. Three of them made contributions to some R&D activities : [23]

- IBM helped finance the Center for Semiconductor Technology in Guadalajara related to the National Polytechnical Institute.

- Hewlett Packard made improtant technological efforts in Mexico to comply with the requirements of the computer industry program established by the Ministry of Trade and Industrial Development investing in hardware and soft-ware projects with some important Mexican universities. Two particular results may be mentioned. First, its manufacturing division got the worldwide engineering responsibility for the development of one of the new minicomputers families. Second, the firm sponsored an electronics Master's program in the Guadalajara Autonomous University, in a joint effort with Stanford University in California, US.

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[22] Decreto para el Fomento y la Regulación de la Industria Farmaceutica. 22 de Febrero de 1984.

[23] Warman, Jose y Miller, Margaret. "Competitividad de la industrial electrónica Mexicana : estudios de caso", Documentos de Trabajo, Mexico, Fundación Friedrich Ebert y Centro de Tecnología Electrónica e Informática, 1989.

- Tandem has created a center for software technology, sending people to be trained in US plants with an investment of US $ 600,000.

Finally, National Financiera (the national industrial development bank) and FONEI (the government fund responsible for the financing of technological development projects through commercial banks), gave important support to some of these projects.

II.3.2.5. Programa Mexico

When the Ministry of Industry and Trade decided to be more flexible in technology payments in 1985 (allowing subsidiaries of foreign corporations to pay higher royalties), it asked companies in reciprocity to make contributions, on a voluntary basis, to Mexican research and educational institutions.

Up to the middle of 1987, 49 mostly US owned and a few European subsidiaries had made contributions of about 16,000 million pesos to 25 institutions, ranging from universities to public and private research institutions and programs. [24] No Japanese participation was reported. In 1989, 63 projects were counted involving approximately 36 firms and 45 institutions with a total amount down to 5500 million pesos. About 15 firms represented 88 % of these resources. According to a number of participating companies "the program is losing momentum because of lack of interest on the side of the present administration and the complete liberalization of technology payments."

II.3.2.6. Financing technological development in private enterprises

Since the creation of CONACYT in 1970, financing technological development in the private sector has been an important concern of the Mexican government. In order to support this objective, various programs have been created in CONACYT, in some of the national development banks and in special industrial development funds.

The oldest and most important are the "shared-risk" program of CONACYT (1977) and the technological development program of FONEI, the industrial development fund of Banco de Mexico. The first one was conceived as a program to promote the use of research and development facilities in the universities and in the government research laboratories by private or public enterprises, through contractual arrangements. CONACYT contributed 50 % of the necessary resources and granted a loan to enterprises at a very small interest rate for the remaining 50 %.

The second was a program of broader spectrum established by FONEI, with World Bank resources, to finance R&D, technology assimilation and in general any technological development program in manufacturing and service enterprises. FONEI's program, implemented through commercial banks, has not been limited to financing. It has also granted subsidies, when the project has been considered of a priority nature or has shown special novelty characteristics. It has included an insurance policy for companies which

[24] Ballesteros, Carlos. La Promoción Estatal de la Tecnología, Mexico, UNAM y Fundacion Friedrich Ebert, 1989 and Dirección General de Desarrollo Tecnológico, Ministry of Trade and Industrial Development (SECOFI).

acquire new and "risky" Mexican technologies. Moreover, it provided training assistance to consultants and commercial banks involved in technological project evaluation and management.

Besides CONACYT and FONEI, other industrial development funds such as FONEP (financing consultancy and engineering firms), FOMIN (a government venture capital fune), FOGAIN (financing small and medium sized industry) and FOMEX (export financing) supported throughout the eighties technological development, although at a smaller and less systematic scale.

Finally, Nacional Financiera, the industrial development bank, started in 1986 a program to support technological development in enterprises which were undertaking an industrial reconversion program. PROFIRI, had the advantage of operating directly with enterprises as well as through commercial banks, with more attractive and speedier mechanisms for resource disbursement.

More recently, two important events have taken place. FONEI and all the other industrial development funds have been absorbed by NAFINSA and integrated into a single industrial development financial program. Within that program a new integrated financial scheme for the promotion of technological development has been created.

Nafinsa's new program, which will operate through commercial banks under simplified mechanisms, covers every possible type of financing, including risk capital, insurance policies to users of Mexican technology, etc. NAFINSA will grant subsidized financing and attractive fees to intermediary banks, but will only guarantee now up to 50 % of the principal and interests related with the loans. In the case of risk insurance policies, NAFINSA will cover up to 70 % of the net economic loss suffered by the company acquiring a new local technology. Direct subsidies, however, have been eliminated.

On the other hand, CONACYT has recently established an additional program called TIPP - Industrial Technology for Production). This new program is directed to support long term training, research and development programs undertaken by big companies, in coordination with CONACYT and research institutions, in high technology areas such as biotechnology, microelectronics and new materials as well as in food, the environment and informatics. Contributions will be made to this program by the Federal Government and participating companies on a one to one basis. So far 32 large Mexican and foreign corporations have made commitments. Detailed rules will be forthcoming soon. However, it seems clear that significant minimum contributions will be required for the purpose of concentrating in large projects.

Certainly, the most important of the financial programs during the eighties was FONEI's. Since 1978 when it began operating, up to the end of 1988, it had granted 302 loans, amounting altogether to 111,456 million pesos, that is, about 45 million dollars, authorized mainly during the last four years. The average loan amounted to about 150,000 dollars. [25]

The sectoral distribution of the loans shows a large concentration in five branches that represented 87 % of the total financing and 77 % of the 302 loans. The five branches are

[25] Centro para la Innovación Tecnológia / UNAM : Evolución de los Apovos Proportcionados por FONEI para el Desarrollo Tecnológico Nacional. Mexico. Noviembre de 1988.

in decreasing order : metallic products, machinery and equipment, chemicals, non metallic minerals and services - particularly software development.

FONEI's program was rather modest, compared with similar funds in other developing countries. Nevertheless, it grew considerably in the late eighties, not only in quantitative terms, but because of the prestige acquired among the most dynamic industrial enterprises. Perhaps its greatest limitation, according to many of its users, has been that it has not operated directly with enterprises, but rather through commercial banks, which in spite of all the guarantees, fees and technical support granted by FONEI, have often avoided technological development loans, which are not well understood, demand specialized personnel, and are considered risky and not very profitable.

A 1988 evaluation of FONEI's accomplishments recognized these facts and recommended direct allocation of credit to enterprises, particularly small ones. Alternatively, a radical revision of procedures was recommended concentrating credit allocations through three or four banks, instead of using, as before, 18 commercial banks operating in Mexico.

The new NAFINSA program, which absorbed FONEI, has adopted the second option. The recent decision on bank privatization should lead to reconsider the firmst option, at least as a complementary mechanism, since banks were never very keen on these credits in their previous practices.

CONACYT's "shared risk" program has been even more modest. Between 1984 and 1988, it financed an amount equivalent to 10 to 15 % of FONEI's. The average loan was much lower than FONEI's. Financial support was more oriented to applied research than to technological development at a commercial level. Sectoral distribution was similar to FONEI's. However, CONACIT's program also covered some agricultural and agrobusiness projects, as well as research and development linked with social needs : health, housing, community services, etc. The shared risk program suffered much from the reduced budget allocations experienced by CONACYT in the 1983-88 period. The new administration is not succeeding in obtaining additional resources so far, although it is introducing new mechanisms for speedier approval and effective recovery of capital and related interests.

II.3.2.7. Some basic problems and challenges

One of the key conclusions drawn from the previous pages is the realization that macroeconomic problems facing the Mexican economy have gravely affected the amount of resources devoted to the country's S&T system. At the same time, important efforts have been undertaken to rationalize the use of financial resources and to develop new sources so as to counter the decline in expenditures. For example, the Ministry of Programming and of the Budget formulated a strategy towards the consolidation of its S&T institutions. Productivity criteria were established, institutions were organized in such a way as to prevent duplicity of effort and there were important efforts to establish linkages between the productive sector and the research centers. Some of these centers increased their self financing capacity by starting to charge market tariffs for their services.

Moreover, new institutions were created during the last years to attend the technological development needs of private firms. The Centre for Technological Innovation at UNAM and the Centre for Electronic and Informatic Technology (CETEI) jointly sponsored by UNAM and the Chamber of Electronics Industry and Electrical Communications are notable examples.

Nevertheless, S&T infrastructure has severely deteriorated. This has explicitly been recognized in the recent diagnosis contained in the National Program for Science and Technology Modernization which was launched with the announcement by the President of a 20 % increase, in real terms, in S&T expenditure. [26] In this document it is correctly stated that to increase expenditures is not enough and that the performance of these research centres has been sub-standard both in relation to the accomplishment of the objectives for which they were created and in relation to the limited scope of their result. There is a great heterogeneity in the quality of research. Some centres have shown poor results in spite of the great amount of resources allocated to them. It has been widely accepted that part of the resources channeled to the governmental R&D research centres have been incorrectly assigned due to the lack of precise criteria for R&D performance and general evaluation of results.

On the other hand, there are some centers that have had a satisfactory performance and even some that have reached international levels of excellence in specific areas. Among the latter cases are various research units at UNAM, CINVESTAV, the Institute for Electrical Research, the Mexican Petroleum Institute and some regional technological research centers linked to specific industrial sectors such as CIATEG in Leon (leather and shoe), CIATEQ in Queretaro (machinery and equipment), IMMEC in San Luis Potosi (metal mechanics), and CIQA in Saltillo (polymers and plastics). A good model case in terms of quality of research, international cooperation and links with the productive sector is the Institute for Electrical Research. Its particular experience is detailed in the Annex.

In any case, the need to increase S&T expenditure is evident. Taking into account the 1 % of GDP often recommended as a minimum target to developing countries, a simple exercise has been undertaken in estimating the size of new commitments needed under three hypothetical shares of S&T expenditures in GDP. As a base hypothesis a 3 % annual real growth rate of GDP was assumed. The results may be seen immediately below. They show that in order to reach the low target of 0.5 % of GDP in 1994, the real growth rate of S&T public expenditure would have to be 46 % per year while the 1 % of GDP target will require an equivalent growth of more than 61 %.

TABLE M-1 : Growth rates in S&T public expenditure required to increase its % in GDP in 1994

% GDP	Expenditure in 1994 (millions of 1980 pesos)	Rate of growth
1.00	371,973.90	61.16 %
0.75	278,980.49	54.70 %
0.50	185,986.90	46.0 %

[26] "Programa Nacional de Ciencia y Modernización y Modernización Tecnológica 1990-94" El Mercado de Valores Num 6, Marzo 5, Mexico, Nacional Financiera, 1990 p4.

II.3.3. DEVELOPMENT OF QUALIFIED HUMAN RESOURCES

II.3.3.1. Overall evolution of the educational system

After a long and sustained growth period on public expenditures for education, corresponding commitments since 1982 have been unstable and declining : they were reduced by a little less than one third in 1983, mildly recovered in 1984 and 1985 and again declined in 1986 and 1987, although in smaller proportion. In real terms, expenditure in education is today 30 % smaller than in 1982, falling from 3.8 % of GDP in 1982 to 2.5 % in 1988 and from 7.5 % of public expenditure in 1982 down to 6.3 % (Table II.1). However, as also noted above for R&D funding, once the debt servicing is taken into account, educational expenses have maintained a stable proportion of "programmable expenditures". This suggests again that the decline in real expenditure must be explained by the burden of debt servicing and not by a change of priorities. [27]

This reduction in expenditures has not affected so much the enrollment rate as could have been expected. Two factors may be advanced to explain this situation. First, teachers salaries have been dramatically reduced in real and relative terms in relation to other sectors of the economy, particularly up to 1988. [28] Secondly, there has been an effort to improve productivity of resources and to direct them selectively towards specific aims.

It seems that the reduction in expenditures took place differently between the higher levels of education and the lower ones. From Table III.7 it may observed that after 1982 basic education has experienced a greater fall than overall expenditure (-37 %), particularly primary education. The latter has lost more than 7 percentage points in its share of overall expenditures on education. Middle level education observed a smaller reduction than overall expenditure on education (-25 %) thus increasing its share from 12.7 % to 14.3 % in total expenditures. Higher education experienced a comparable fall leading it to maintain the same relative share (20 %). Finally, an increase in expenditure in graduate education is reported, both in real and relative terms. Indeed from 1983 to 1988 graduate expenditure increased by 300 %, passing from .85 % to 3.5 % of total expenditure. This may be partially explained by a reclassification of expenditures in 1984. [29] However, after this date graduate expenditure still reported an increase. Combining the expenditure of undergraduate and graduate education, these two levels were less affected, in relative terms, accounting for 23.4 % of total expenditure compared to 20 % in 1982.

Enrollment reported, also, diverging results (Table II.3). Between 1983 and 1988, primary education observed a negative growth rate of -0.80 % and secondary education, a mild

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[27] Lustig, Nora et al. op.cit., 1980-87, Mexico Academia de la Investigacion Cientlfica, Marzo de 1989. We have up dated information for the year 1988, following the lines proposed by this study.

[28] Real wages have observed a consistently negotive growth rate since 1982 (-7.8 % per annum in average).

[29] Nora Lustig, Fernanco del Rio, Oscal Franco, Esteban Martina, op.cit., 1980-87. Mexico, Academia de la Investigacion Cientlfica, Marzo de 1989, p43.

increase of 2.1 %. At middle education levels, the number of students had been increasing at a fast rate in the period 1979-83 and although the rate of growth was smaller in recent years, it was the second largest in importance (5.1 %), considerably higher than the average (1.6 %).

Enrollment in undergraduate programs at universities and institutes of technology, showed a mild increase per year (1.7 % from 1983 to 1988). Its share in total enrolled students increased from 3.9 % to 4.3 % (from 981.1 to 1085.1 thousand students). The rate of growth in graduate enrollemnt was almost 5 %.

In general, there seems to be a correspondence of behavior patterns of enrollment with the patterns of expenditure at the different levels of education. It was seen that basic, particularly primary, education faced most of the decline in expenditures. Its enrollment was reduced from 64.3 % in 1982-83 to 57.65 in 1988-89. On the other hand, enrollment at higher levels observed a positive increase. It may be gathered that enrollment in post secondary education increased from 11.7 f% to 13.1 % as a proportion of total enrollment (Table III.8).

II.3.3.2. Undergraduate education system

- **Main higher educational institutions**

  Higher education institutions are classified under polytechnical and technological institutes under federal control, state and autonomous universities and private institutions.

  The first have about 177,000 students, accounting for 15.5 % of students enrolled in undergraduate programs. One institution, the National Polytechnic Institute has 60 thousand students in Mexico City. In recent years, as a result of a policy geared increasingly towards regional decentralization, the number of regional technological institutes has increased from 50 to 55 and their registration went up from 57,500 in 82-83 to 86,000 students in 1989-90. This increase is, in relative terms, greater than that occurring among private institutions which, as will be shown below, have expanded rapidly as well. Some of them have gained a good reputation among industry. [30]

  The public university system is constituted by 47 institutions with an enrollment of 781,700 students. The most important ones are : UNAM, the National Autonomous University with 135,000 students and UAM, the Metropolitan Autonomous University (also located in three different campuses in Mexico City) with 50,000 students. The other 45 state universities are institutions founded by the federal and state governments throughout the country.

  In general, there seems to be a consensus in government and in private and academic circles that the quality of education in the public university system has seriously deteriorated during the seventies and the eighties on account of an increasing population, diminishing public resources, low salaries for teachers and the structural

[30] Data on this section are drawn from : Presidencia de la República, Informe del Gobierno, Anexo Estadístico (1989).

problems that characterize free university education, particularly in times of crisis. Some of the science and engineering faculties have been less affected by this situation thanks to private financial efforts undertaken by alumni to equip laboratories and raise teacher standards (as it has happened recently with the chemical engineering faculty of UNAM). Nevertheless, it is recognized that a radical financial and academic reform is urgently needed in public universities. The whole subject constitutes, presently, a very crucial political issue.

Private higher educational institutions have shown a remarkable increase in relative terms to public institutions. From 1983 to 1989, 63 new institutions have been created reaching a total of 190 institutions in 1989. The number of students has also increased from 131,000 to 179,000. The most important institutions are the Instituto Technologico de Monterrey with 16 campuses around the country (more engineering and business oriented), the Instituto Technológico Autónomo de Mexico (business and financial studies) and the Universidad Iberoamericana (with five campuses in different parts of Mexico). It is interesting to note that private universities are normally requested to have a scholarship program equivalent to 5 % of their enrollment fees. Besides, they normally have their own programs of credit-scholarships at the undergraduate level. Although they are small in relation to total enrollment, they may cover in some universities, like the Universidad Iberoamericana, about 15 % of their students, concentrating on the low income, high performing groups.

Private university programs have experienced during the seventies and particularly the eighties a continuous improvement in the engineering, the medical and the economic and management sciences. In the area of management and economics, the quality of their education is so much better than in the public universities, that their graduates are rapidly displacing traditional UNAM graduates in top positions in government and private enterprises.

- **Breakdown of undergraduate education by scientific knowledge fields**

Table III.9 shows that in 1988 the large majority of students were enrolled in social and business studies (463,900 students). Next in importance came engineering studies with 297,000 students, medical sciences with 156,700, agricultural sciences 102,500 last came natural and basic sciences with 32,800 students. It must be noted that important changes have occurred in this breakdown. The student enrollment in agriculture field sciences and social and business studies increased faster than any other field. This increase has been going on since 1979, passing from 7.2 % to 9 % and from 37 % to 42.7 % of total students, respectively. On the other hand, the number of students has declined by almost 50 % in basic sciences fields and in the medical sciences, passing from 6.8 % in 1983-84 to 3.0 % in 1988-89 and from 21 % to 14 % of total students respectively. Engineering studies have maintained their share (27.3 %).

This evolution is due mainly to the low salaries and status that are granted to the majority of professionals graduated in these last two areas. There have been diminishing resources and research posts coupled with the reduced demand for them as a result of a long and dramatic crisis that Mexico has experienced since 1982.

- Additions to the stock of trained human resources relative to aggregate employment

108,000 higher education students completed (not necessarily graduating) their studies (8.2 % of total enrollment) in 1988 (Table III.10). Again, the fall in educational expenditures and the effects of recession over living standards appear to have seriously

affected this overall performance. From 1979 to 1983, the number of students completing their studies increased from 59,800 to 114,000 students. In 1984, the number declined by almost 20 %, recovering afterwards towards the above mentioned figures.

In terms of each thousand of employed labor force, 5.1 students completed their studies in 1988-89. The breakdown of different fields of knowledge was as follows : 463,000 students completed their studies in the business and social sciences, (i.e. 2 students per thousand of employed labor force); 29,000 students completed scientific and engineering studies (1.4 per thousand of employed labor force, involving 10,000 agronomic engineers and veterinaries or 0.48 per thousand of the employed labor force). There were also 3,200 students completing their education in mathematics, physics and biology (0.15 per thousand of the employed labor force).

II.3.3.3. Graduate education

- **The overall situation**

Institutions offering graduate programs are considered as a key linkage of research and education in the national system of S&T. Graduate programs are relatively new. In 1970 there were only 13 institutions offering them. [31] By 1984, the number of institutions reached 125. In terms of enrolment, in 1970 there were 5753 students. By 1984 there were 39,048 and in 1988 45,100, accounting for 4.6 % of the equivalent for undergraduate enrolment (Table II.3.). Together with the quantitative increase there has been a change in regional distribution. In 1970, 60 % of the graduate studies institutions, with three quarters of the enrolment, were in Mexico City. This concentration, though, has changed somehow more recently : in 1984, 30 % of the graduate institutions with 50 % of the enrolment were located in Mexico City. [32]

Economic educational policy on industrial modernization has laid emphasis on the improvement of graduate programs. It has been noted that a heavy dependence on graduate institutions of developed economies is not advisable. [33] First it would be very costly. It is also maintained that the role of graduate institutions is to supply the human resources and generation of new knowledge associated with the needs of the Mexican economy - which is not always fulfilled by foreign graduate programs. Moreover, the improvement of local graduate programs has not been solely justified in economic terms. The need to maintain a national identity and preserve its cultural heritage have also been considered as key considerations for Mexico. Finally, foreign graduate education is closely linked to the serious phenomenon of brain drain.

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[31] D. Barnés, et al, "Fortalecimiento del Posgrado Nacional" Ciencia y Desarrollo, Número especial, Abril, Mexico, CONACYT, 1987, p 13.

[32] Ibidem., p 11.

[33] Barnés, Dorotea y Reséndiz, Daniel "La educación delo posgrado : naturaliza funciones, requisitos y métodos", Ciencia y Desarrollo, Número Especial, Abril, Mexico, CONACYT, 1987, p 10.

On account of the above, CONACYT created in the eighties a program to strengthen local graduate institutions with the following objectives :

- to improve the quality and to increase the number of professors and students
- to promote the better utilization of local research centres, especially those of higher quality
- to promote decentralization
- to improve the physical infrastructure.

The resources channeled to this program have represented around 7 % of CONACYT's budget between 1983 and 1988. The actions taken have included the financing of visits of national and foreign lecturers, the support offered to library stocks and experimental equipment, the incorporation of CONACYT supported graduate students to universities and research centres and some efforts to prevent and recover the brain drain. [34]

- **Graduate enrollment by areas and type of program**

Graduate enrollment has increased by 33 % from 1983 to 1988, accounting for 4.6 % of the equivalent enrollment in undergraduate programs in 1988. As may be gathered from Table II.7, social and administrative studies have the greatest number of students enrolled (14,707) in a similar way as in the undergraduate programs. However, in the case of graduate studies, it is the field of medical sciences with 11,157 students, and not engineering, which follows next with 32 %. Engineering studies have only 4,941 students. It may be noted that business and social studies have decreased in relative terms from 43 % in 1984 to 39 % in 1987, whereas basic and natural sciences increased their share by one point.

Master programs account for nearly two thirds of students while PhD programs have only 3 % of total students. Education in natural and basic sciences account for the greatest part of PhD enrollment (28 %) in 1987-88 (Table III.11).

- Scholarship policy

CONACYT is by far the most important provider of scholarships (including tuition and an allowance equivalent to twice the minimum Mexican wage rate for Master studies). The aim is to promote the formation of highly qualified resources granting subsidized loans mostly for graduate studies (69 % of total scholarships) and technical specialized training programs. Scholarships are granted in different fields of knowledge, but the greatest share is oriented towards sciences and engineering.

During the eighteen year period of the program 42,000 scholarships have been granted. Initially, 80 % of graduate students used to undertake their studies in foreign universities. Presently, only 20 % of them do, on account of the shortage of resources and foreign exchange. Due to the reasons presented above for the support of local graduate programs, scholarship policy for studies abroad has turned highly selective, oriented towards PhD and Post-PhD programs in disciplines and specilties in shortage in the country. The number of scholarships granted in 1988 was 2,235. In comparison,

[34] Barnés, D. Perez Correa, E. y Bravo Sánchez, J. "op. cit. Ciencia y Desarrollo, Número Especial, Abril, Mexico, CONACYT, 1987.

this number was 4,340 in 1981. Understandably, the fall in S&T public expenditure affected this program (Tables III.12 and 13).

Scholarships policy has concentrated particularly in graduate programs of exact and basic sciences. In 1982, these programs received only 16 % of all scholarships against 41 % going to business and social studies. In 1986, the latter got only 13 %, whereas exact and basic sciences received 30 %. Engineering has maintained its share along the period, accounting for 24 % of all scholarships in 1986.

In spite of government efforts directed towards the support of graduate programs and institutions, available resources are totally insufficient. On one side, the fall in real wages has reduced the attractiveness of academic careers. Thus, posts which in other times would have been sought after, are not any longer, particularly those requiring highly qualified personnel. The National System of Researchers Program, created to complement the income of people devoted to research activities and which was heralded initially as an important income "support" effort, covers less than 10 % of researchers. Due to the high rate of inflation, it has played a decreasing role as an incentive to full time researchers.

On the other hand, it has been detected that some important graduate programs face a falling trend in demand. Two factors explain this situation :

- The number of scholarships after a sharp decline in 1983 has remained stagnant since then. Thus, the number of students financed through scholarships has fallen dramatically from 14.3 % in 1981-82 to 6.5 % in 83-84 and to 4.9 % in 1988-89.

- The monthly allowance granted by scholarships is completely insufficient for married students. Moreover, there are other expenses. University libraries usually have very reduced supplies of books, thus, in most cases, students end up having to buy them.

- The number of scholarships granted through foreign cooperation programs, which were very significant in the case of EEC countries during the sixties and seventies, declined considerably during the eighties, particularly in the case of the UK and have only picked up a little in the last two years.

II.3.3.4. Summing up of main issues

In the previous pages we have attempted to show that, in spite of the effects of the recession and the fall of expenditures, there has been an effort to direct resources selectively. Upper levels have been relatively less affected and some sectors like the national graduate educational system have been stimulated. However, it must be pointed out that the evolution of key indicators suggest that this increase has been insufficient. For example, the coverage of the demand for higher education has showed a decreasing trend. In 1982, 84.5 % of the students graduating from preparatory schools enrolled in the first year of the university, while in 1989 only 60 % did. On the other hand, the increase in enrolment in professional technical middle education institutions was insufficient to face the increasing demand. The problem of the final stages in the formal educational system is further intensified by the 60 % decline in the enrolment to education programs (Table III.14).

There are no official targets regarding the number of graduate students required per year. However, from the diagnosis of graduate programs it is possible to detect serious future shortages of specific highly trained personnel. For example, in the case of graduate M.Sc in electronics, it has been estimated that the industry's additional demand will be reaching a level which is about six times larger than the corresponding annual supply of new graduates. Also, significant shortages exist in the case of PhD lecturers and researchers.

In the fields of chemistry and chemical engineering it has been stressed that the number of graduates is insufficient to cope with the growth of the chemical industry and the needs of research institutions. It has been estimated that in order to meet the expected increase in R&D in the petrochemical industry from 0.3 % of sales in 1985 to 1.0 % in the year 2000, demand for graduates in these programs would multiply by 10. This implies an accumulated shortage equivalent to 25 % of industrial demand and 85 % of research personnel in academic institutions. [35]

The above indicators would strongly suggest that the formation of highly qualified resources is insufficient in comparison to the growth of student population and even more so if we take into account the needs of an economy which is expected to grow in the next few years at a rate somewhere between 3 and 6 % a year and confronting global competition. The dimensions of the problem are enlarged by the notable drop in quality standards. As mentioned before, such a decline is due, to a great extent, to the lack of long needed institutional and financial reforms. These require bold actions from the government, yet they also confront great political and social complexities. Also, investment expenditures have been stagnant, research equipment has not been renewed at an adequate rate, nor library stocks have increased in proportion to enrollment. Moreover, salaries of lecturers and researchers have decreased in real terms, stimulating migration to other better remunerated occupations within Mexico. Also, an increasing brain drain has been taking place to industrially advanced countries and their institutions.

Even if the USA is the most important destination of such brain drain, EEC countries play also a significant role, particularly the United Kingdom and France. In these cases, graduate students often pursuing studies abroad, decide to stay in third countries because of lack of jobs, adequate salaries or proper research opportunities in Mexico. These concerns could be the object of S&T cooperation programs with Mexico that should benefit, in the medium and longer term, Mexican-EEC relations in technical, but also in trade and investment matters.

II.3.4. INTERNATIONAL S&T COOPERATION

The first Mexican bilateral technical assistance agreement dates back to 1951 with the USA. The General Direction of Technical International Cooperation, created in 1971 by the Ministry of Foreign Affairs, is the unit in charge of the identification, evaluation, negotiation and follow up of technical cooperation projects in close contact with CONACYT. Besides, each Ministry has an office which is responsible for technical international cooperation in coordination with the Ministry of Foreign Affairs.

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[35] "Educación Superior en Ingeniería Electrónica : el Posgrado" Ciencia y Desarrollo, Número especial, Septiembre, Mexico, CONACYT, 1989, p 47.

The relevance and structure of international S&T cooperation may be appreciated from a comprehensive study undertaken for the period 1979-85. According to this study, there were 1861 international technical cooperation projects involving 121 institutions during that period. These did not include relations between private foreign foundations and Mexican institutions. The latter case is central to the US - Mexican cooperation framework and differentiates the US from the European and Japanese experience in Mexico.

From the 1861 projects reproted in the above mentioned study, bilateral S&T cooperation was by far the most important with 1692 projects and 66 institutions. Considering the areas involved in such cooperation, education and general science and technology obtained the greatest share of projects with 28.5 % of the total. Agriculture, forestry and livestock were second with 22 %, industry had 14 % and health projects 11.8 %. In contrast, multilateral cooperation referred to only 169 projects involving 55 institutions.

The study reports that nearly 70 % of projects were signed with industrially advanced countries. Accordingly, 38 % of the total number of projects were signed with Western Europe, 9 % with the United States, which relied instead on private foundations which were not covered by the study, 18 % with the USSR and Eastern Europe, 4 % with Asia and 28 % with Latin America.

The main characteristics of international S&T cooperation between Mexico and selected countries is as follows :

USA : In general terms, US - Mexican scientific and technical cooperation at the Government level is very scant. Most technical cooperation projects between the two countries take place on an institutional non-governmental basis, through big private foundations. The Ford, Rockefeller, Kellog Foundations, have regularly played important roles, particularly in the fields of education, agriculture, community development and social sciences. More recently, the Hewlett and Mac-Arthur Foundations have begun to play also a significant role in Mexico.

Japan : From 1987 to date, Japan registers 93 technical cooperation projects of which 41 have been finished or are in progress, and 46 are on a preliminary evaluation. In contrast to most of the other countries, the specificity of these contracts is that they generally relate to specific technical cooperation matters. The Japanese counterpart is JICA, the Japanese International Cooperation Agency. Only 15 contracts have, as Mexican counterparts, universities and the rest correspond to Government Ministries and Decentralized Public Institutions, including their research centres. The three most important are : the Communications and Transport Ministry, the Public Education Ministry, and the Mines and Public Industries Ministry.

EEC : The Ministry of Foreign Affairs reports altogether 45 projects. Almost three quarters of these projects are with Mexican universities and, of the total number, most fall under the category of scientific and technological assistance. The most frequent Mexican counterparts are : UNAM, UAM, and CINVESTAV. EEC counterparts are a vast array of universities, of which English universities are the most frequent ones. Other Mexican counterparts are S&T agencies linked with Government Ministries such as the Electrical Research Institute, or public decentralized organizations, like the Mexican Social Security Institute.

United Kingdom : Mexico has 20 registered projects with the United Kingdom, the vast majority falling under S&T assistance. Nine of them were signed by government ministries and their research centres. Four of them were signed by the Electrical Research Institute

with the Universities of Salford, Manchester, the ODA and the Non-Destruction Center. The Mexican institutions include UNAM, the Universities of Yucatán and Chihuahua.

France : France, with 38 projects, has the larger number among EEC countries. Of these, 11 projects have Mexican universities as counterparts, of which UNAM, UAM-I and CINVESTAV are the most frequent. The Ministry of Energy, Mining and Public Industries has seven projects, one under the responsibility of the Nuclear Research Institute and the rest through the Electrical Research Institute. The Department of the Federal District has seven projects. French counterparts are mostly government research agencies. In the industrial cooperation field, French and Mexican industrial enterprises represented in Mexico by CANACINTRA and the National Chamber of Manufacturing Industries, have been operating during the last four years a technical cooperation program with the purpose of promoting French technical assistance and technology transfers to Mexican small and medium sized industries. The agreement has led to 19 ongoing projects, three of them related to the establishment of labor intensive maquiladora projects. There are 53 projects in the pipeline.

Federal Republic of Germany : The FRG's technical cooperation projects are less numerous than France's (19 presently in operation) but more important in size and overall impact. Three significant agreements of technical cooperation have been signed in recent years. One of them, signed in September 1987, aimed to foster cooperation among firms in the export sector, and to promote technology transfer and investment, particularly among small and medium size firms. This agreement has CANACINTRA as a counterpart in Mexico and GTZ on the German side.

The Labor Ministry signed in September 1988 an interinstitutional agreement with BMZ, the German Ministry of Economic Cooperation, with the purpose of a) assisting Mexican firms in training and productivity issues; b) developing programs and educational media for the formation of human resources and c) preparing human resources and instructors for quality improvement programs initially in the textile industry. The executors of this important agreement are, on the German side GTZ, the German entity for technical cooperation and, on the Mexican side, CATEX - the Textile Industry Training Center and CEMAC, the training centre of the Mecian-German Chamber of Industry and Commerce.

Finally, it must also be mentioned that last January, the Mexican Ministry of Education and the German Ministry of Economic Cooperation signed a cooperation agreement in order to improve Mexican scientific and industrial metrology and to unify standards and quality assurance formulation practices. The German counterpart is the PTB - Physikalisch-Technische Bundestadt that will provide assistance, training and equipment to CINVESTAV, which presently houses the National Metrological Laboratories.

Spain : There are 26 projects, all of them in preliminary stages. Five are projects of cooperation between universities and the rest by Government Ministries and State Governments. Generally the Spanish counterpart is AECI, the Spanish Government Agency for International Cooperation. Specific mention must also be made to an agreement undertaken successfully since 1982 between the Spanish and the Mexican assistance and information exchange in the area of patent documentation.

II.4. HIGH TECHNOLOGY SECTORS : CASE STUDIES

II.4.1. ELECTRONICS AND INFORMATICS

II.4.1.1. Size and composition of the Mexican market

There is a notable lack of precise figures concerning the overall size of the electronics market in Mexico. At the latter part of the 1980's, a very rough order of magnitude places the total Mexican electronics market at around U.S. $ 2 billion annually. This figure is close to a quarter of the equivalent for the case of Brazil. Gross production, including imported components, should roughly be between one and one and a half billion U.S. dollars, not counting border assembly industries which service the U.S. market. The rest involves imported goods for the Mexican market.

A subsectoral breakdown will be drawn from a number of diverse sources each covering different populations of firms, yet giving an overall structure of the industry. A government report prepared in early 1985 presented data for 210 firms then registered in the electronics sector (see Table M-2 which follows). These firms reported a total gross output of U.S. $ 770 million and an employment level of 28,000. Imports were valued at U.S. $ 335 million while exports amounted to U.S. $ 92 million. Out of these 210 companies, 178 were producers of equipment, 14 of subassemblies and 26 of components.

TABLE M-2 : Electronics Industry, 1984

Subsector	No. of companies	Employment	Output (1)	Imports (1)	Exports (1)
Equipment	178	22,503	658.6	296.1	85.0
- Consumer	64	8,524	238.0	90.5	15.0
- Professional	114	16,489	493.8	238.5	57.4
- Telecommunic.	34	6,921	222.5	143.0	1.0
- Computing	66	8,785	250	90.0	54.0
- Industrial	13	780	21.3	5.6	2.4
- Biomedical	1	n.a.	n.a.	n.a.	n.a.
Subassemblies	14	1,241	29.8	10.6	7.9
Components	26	4,939	82.8	32.2	11.7
Total (2)	210	28,000	770.0	335.0	92.0

n.a. : not available
(1) Millions of dollars
(2) The data do not necessarily add up to the totals given since the data of some companies are counted in more than one sector.
Source: Subdirección de la Industria Electrónica. 1er. Informe Trimestral (1985) as presented in IDB 1988.

A different aggregate picture is given for 1987 by the manufacturer's association data, which present production levels much lower than those of Table M-2 for 1984. The association's information reports a total gross production value at U.S. $ 540 million for 1987, of which U.S. $ 120 million were exported. They cover 724 firms employing a total of 39,000 workers. It is of interest to note that the industry based data also report a drop in the employment level in the electronics sector by 45 % from 1980 to 1987. Employment and output in the components sector decreased by 70 % during the same period. This was mainly attributed to the economic conditions prevailing since 1982 and to the elimination, since 1985, of previously required imports permits.

On the other hand, it should be mentioned that some figures available from European researchers report a total gross output value of as far up as U.S. $ 1,700 million, (capital goods U.S. $ 660 million, computers U.S. $ 200 million) while the overall employment was in the order of 50,000. Also GATT trade data indicate exports increasing from U.S. $ 910 million in 1979 to U.S. $ 1,940 million in 1985. These two sets of additional data include, though, service and distribution firms plus border exporters based on assembly activities, together with what we call "mainstream" industrial firms.

Table M-3 presents data from the manufacturer's association. From 1980 to 1987 all imports, except component imports, have decreased. Exports of components have been drastically reduced. Computer exports have increased significantly even though the figures reported by this source are lower than the equivalent from other reports.

TABLE M-3 : Electronics industry foreign trade data, 1980-1987 (million $)

	1980		1987	
	Imports	Exports	Imports	Exports
Components	338	131.0	487	14.0
Consumer				
- Electronics	130	8.3	65	1.4
- Computers	229	4.5	100	41.3
- Telecommunic.	64	0.0	41	12.1
Total	980	157.0	839	81.0

Source : Prepared for this report using manufacturers association data.

On the other hand, the participation of electronics in the "maquila" or "border" industry in Mexico is very high. The number of such firms processing electronic goods was 372 and it was estimated that they accounted for 45 % of both employment and value added in the maquila sector. Except for the low-wage labor absorbtion, these activities have registered extremely limited linkages and negligible impact on the overall development of the electronics sector in the rest of the country.

II.4.1.2. Qualitative aspects of the system electronics subsectors

Important structural and performance differences exist according to the distinct subsectoral categories. The consumer electronics subsector started in the 1960s. During 1970s, it was described as oligopolistic, overprotected and inefficient. It seems to have mostly included foreign affiliates which following government requirements, were producing expensive goods with high local integration. The situation changed progressively with the entry of Japanese and South Korean firms, selling in the internal market or being established for export to the U.S. Also, illegal imports are reported as having contributed to the lowering of prices. Some local firms own and operate modern plants which basically concentrate, though, in the assembly of imported SKD and CKD kits.

The telecommunications sector has traditionally been concentrated in a few multinational firms (ITT, Ericsson, Standard Electric, and recently NEC and GTE). Production in Mexico during the mid 1980s was still mostly electromechanical, but quite reasonably integrated and not greatly inefficient. The digitalisation of the telephone system started at that time, two satellites were acquired but were far from being fully utilised, rural telephone programs were established and data transmission networks were also developed.

Performance of the computer sector followed a different pattern. Data presented above show a dynamic growth under the often cited, yet never published government "Program on Informatics". The Program is said to have improved the negotiating position of local firms enabling them to obtain technology or components from internationally established producers instead of just continuing as mere distributors of foreign goods. Gross export growth has also been very significant; yet, there is no significant local development and production deepening, although local value added seems to have grown. Production still means, basically, assembly operations. Some signs of technological adjustment and advance could though be claimed, based on the shortening of time lags in local assembly of new international standard models of microcomputers from one generation to the next. Most exports, though, are carried out by foreign transnational enterprises.

Nevertheless, in spite of the general lack of depth of local production, there exists a small group of local firms active in some product areas with successful projects, such as in the design and production of LANs (local area networks). On the other hand, it must be mentioned that reported exports by local firms include items such as printer ribbons or paper, thus overstating their performance as electronics producers and exporters. Part of the business of local firms consists in producing subassemblies for transnational affiliates.

Local research and development has not really taken off, although in certain cases formal commitments existed, during the mid 1980's, for spending amounts of 3 % to 6 % with respect to sales. To improve the situation the manufacturers association and the Mexican Autonomous University (UNAM) support CETEI, a coordinating center aimed at bringing together firms and university researchers for product development. Also, CINVESTAV (Center for Advanced Studies and Research) has some activities in microelectronics while the IIE (Institute for Electrical Research) has a wide range of research activities in data acquisition, remote control, development of simulators for training the operators of large (including nuclear) power stations, communication networks and control software. IIE has two commercial spin-offs producing control equipment and aircraft simulators for training.

II.4.1.3. The policy background

The current situation of electronics and informatics (or computing) in Mexico could, in principle, be summarized quite succintly : at the end of a long period of various degrees of protectionism, no barriers to trade are left except for a tariff on finished goods (20 % for computing equipment) and parts (5 % to 10 %). It is important, however, to note that this state of affairs is not the result of a progressive process linked to productivity improvements, but instead the outcome of a complete and sudden reversal of past industrial protection policies.

The two most prominent areas of electronic industry activity in the 1960's and 1970's were the consumer electronics sector and the off-shore or border industries. Consumer electronics developed as an import-substitution industry, with a prominent role played by foreign firms and imported technology. As the government required local integration of components, such activities increased and spread in diverse areas of the consumer electronics goods industry without, however, promoting a professional electronics sector. According to various appraisals, the resulting consumer goods industry had high costs and low quality products. As a result, at the end of the 1970's, the government authorized lower levels of integration to reduce costs. From 1979 to 1982, promotional measures in the professional goods subsectors (communications and office machines) were also implemented.

At the same time, all through the 1960's, off-shore assembly activities developed independently and with very limited linkages with the internal market. Mexico was then a significant site for assembly of semi-conductors and of television sets for the U.S., later losing ground to other sources.

In the first half of the 1980's, there emerged the only, more or less, coherent and determined strategy to develop a subsector in the electronics industry in Mexico. The consumer electronics sector was not chosen, allegedly because of the awareness that an efficient export orientation would have been required so as to avoid the repetition of past problems. This approach was apparently not considered feasible. Instead, the computing area was chosen on the basis of a subsectoral program prepared by industrial promotion specialists of the Mexican government and resisted by a number of foreign and some national business/commercial representatives. The overall approach took, finally, the form of some basic and agreed guidelines for the development of the sub-sector of minicomputers, microcomputers and peripherals.

In spite of its weak institutional status the "Program" was in operation for most of the 1980's. It combined aspects of an import substitution and export promotion strategy based on voluntary registration of firms interested in preferential import conditions for parts and other inputs, plus some additional benefits such as tax credits. In practice, the system of import controls guaranteed a market reserve for locally produced (or assembled) microcomputers.

The participating companies were initially restricted to no more than 49 % foreign ownership. In several cases, though, this was overruled in favor of 100 % ownership, authorized for firms which combined strategies offering local development such as the promotion of local suppliers or special export programs. Also, foreign pressures, exercized in the context of Mexico's debt and overall external sector management, diluted the ownership requirements. All firms, involved in the Program were required to spend between

3 % to 6 % of sales in local R&D according to whether they were producers of peripherals, microcomputers or minicomputers.

Over 70 firms registered up to 1986/1987 with the Program administration authority, at least eight of them foreign wholly owned and fifteen joint ventures. During the 1981 to 1985 period the Program offered some effective advantages. By 1985/1986, though, the general trend towards an overall liberalization of imports eliminated such advantages and effective protection for registered firms steadily decreased thereafter. At present, the conditions being discussed with entrepreneurs just before the beginning of the total liberalization period, starting in April 1990, include "open borders" for imports plus some fiscal rebates as the only promotional advantage to be kept available for participating companies.

In conclusion, the Mexican electronics sector did not develop on the basis of a sustained and efficient set of policies. Instead, it confronted a series of partial initiatives of questionable impact on different "mainstream" subsectors during the 1960-80 period. Within the border industry, several waves of Mexican labor-intensive operations were integrated to semiconductor, television sets and other production activities of the U.S. industry and market, generating very limited, if any, linkages with the rest of the Mexican productive structure, yet inducing an important direct employment effect.

Strategic for both local and foreign owned firms willing to continue production under the current liberal economic policies is the commitment to become more export oriented and competitive. Yet, Mexico does not offer a low cost integrated production structure to supply foreign markets nor is there a solid local foundation for autonomous development or design. Also, it must be noted that components must be imported either from countries that are direct competitive suppliers, or from advanced country firms with world wide sourcing operations. Responses by national and transnational firms to this situation, cannot yet be anticipated. The only main new and differentiating consideration at the present time is the extent to which the North American Free Trade Agreement is likely to provide a preferential entry platform to the U.S. market from Mexico.

II.4.2. BIOTECHNOLOGY : APPLICATIONS IN PRODUCTIVE ACTIVITIES - SOME COMPARATIVE EXPERIENCES IN MEXICO AND BRAZIL

II.4.2.1. Biotechnology in the pharmaceutical and health sector

The development and application of biotechnology may represent a key technological breakthrough for the solution fo major problems in the Brazilian and Mexican health and pharmaceutical sectors. Besides, they are among the larger markets in the world for pharmaceutical products : by the year 2000 Brazil will rank third and Mexico fifth in importance in the western world, (UNIDO 1984).

A distinguishing feature of the pharmaceutical sector in both countries concerns the dominant presence of foreign transnational corporation (TNC's). In Brazil they account for 83 % of total pharmaceutical sales. Also, 68 % of the input value of drugs used for domestically produced medicines are imported from transnational corporations. If raw materials other than drugs are taken into account, the import dependence of the

pharmaceutical industry is even greater, reaching 77 % of the inputs used in the production process. Comparable figures are also reported for the case of Mexico (Bifani/IDB 1989).

In the health sector it is important to distinguish :

(i) the pharmaceutical industry proper;
(ii) the production of sera and vaccines, and finally,
(iii) the production of reagents for diagnosis and treatment of infectious and parasitic diseases.

Brazil is presently the seventh national market for pharmaceuticals in the western world. Although final product imports have been largely substituted, the local market is dominated - as noted above - by TNC's through a combined process of direct foreign subsidiaries entry and a progressive acquisition of national firms by foreign companies. This situation has important consequences for the domestic development of pharmaceutical innovations, including those through biotechnology.

Antibiotics represent about 58 % of the Brazilian market for pharmaceutical products while in Mexico the corresponding figure is around 66 %. Both cases are particularly high compared to the world average which is approximately 30 %. Among the antibiotics, the most important group concerns the case of penicillins which account for 47 % of the total production of biopharmaceutical products of Brazil (Bifani op.cit). Only 50 % of penicillin production is estimated to be used for direct human and animal consumption while 43 % goes to the production of 6-APA - an intermediate product in the production of semisynthetic penicillins (ampicillin). The rest is mainly used for synthesizing cephalosporin derivatives.

Despite the growing local production, both countries are still dependent on imports of antibiotics. In turn, domestic production is undertaken through traditional chemical technologies which have environmental and economic disadvantages as compared to the new enzymatic proceses.

Vitamins are the second most important pharmaceutical market in these two countries. One of the best prospects for expansion in the future is believed to be in the use of vitamins in animal feeds. As in the case of antibiotics, the production of vitamins is carried out by classical chemical methods, although microbial production has been shown to be more efficient as in the vitamin B complex. In Mexico the only company producing vitamins by fermentation (vitamin B12) withdrew in 1981 because of problems connected with the availability of efficient strains.

It is in the production of drugs where biotechnology is expected to have an early important development. Technical aspects, greater simplicity in the manipulation and the fact that they are products of a relatively high added value explain the priority assigned to this group of products by private firms. In Brazil, the BIOBRAS group, a private owned national company with past experience in the production of insulin and enzymes using traditional synthetic methods, is exploring the possibilities of producing human insulin by biotechnological methods, and monoclonal antibodies and leucocyte interferon in a joint agreement with the Argentinian firm BIOSIDUS.

The presence of transnational corporations is less dominant in the area of sera and vaccines. The production of immunological agents is of paramount importance in countries like Brazil and Mexico that have to overcome serious problems in public health. Infectious and parasitic diseases are still a major cause of mortality and large sections of the

population are exposed to tropical parasitic diseases. Some of Brazil's regions report among the world's highest cases of malaria incidence. Half of the Brazilian population is exposed to schistosomias, while leishmaniasis shows high incidence in Mexico. In its turn, the chagas disease (the Latin American variant of tripanosomiasis) is widespread all over Latin America. Leprosy is also a major disease in tropical areas, particularly in certain zones of the Amazon bassin.

Immunological agents are a fundamental component of the government responsibility in the context of public health plans. As a consequence the governmental presence is reported as very high not only in the corresponding distribution activities but also in production. In this case and for a number of technological reasons related to health considerations and their corresponding social and economic implications, both recombinant DNA and monoclonal antibody technologies have an enormous potential in Latin America.

II.4.2.2. Biotechnology in agricultural activities

Biotechnology application in the Brazilian and Mexican agriculture is not new. Both countries have a large experience in the application of breeding and selection of plant varieties and, more recently, in the application of techniques like tissue culture. In addition, Brazil has advanced certain experiences in the production and use of biopesticides. A more detailed account of the present situation and the prospects for biotechnology applications in priority product areas appears immediately below.

II.4.2.2.1. Natural nitrogen fixation

This is an area in which important activities concentrate both in Mexico and Brazil. In the former a specialized center has been created : The Nitrogen Fixation Research Center at the National Autonomous University of Mexico and located in Cuernavaca. Also active in this field in Mexico are the University of Chapingo and CINVESTAV. In Brazil, the State owned Empresa Brazilera de Pesquisa Agropecuaria (EMBRAPA) has actively worked in the R&D and dissemnation of results concerning nitrogenous fixation through its programme on Biologia do Solo.

One crop for which the natural fixation of nitrogen has proved to be an important economic activity is that of soybeans. Just over 20 years ago Brazil introduced the soybean as a culture suitable for the opening of the "cerrado" (savannaha) and the expansion of agricultural frontier. In the years following 1965 nearly 4 million ha were planted with soybeans. The native rhizobium strains are identified and reproduced at the laboratories of EMBRAPA which supply them to seven factories. The latter have been approved by the Ministry of Agriculture for the production of about 9 million doses of inoculants equivalent to the inoculation of 8 million ha of soybean per year.

Furthermore, the great demand for forestry products and the on-going reforestation programmes can generate an enormous potential for rhisobium and ectomycorrhizal inoculum. The first has already been successfully applied in the case of soybeans in Brazil, while the second, ectomycorrhizal inoculum, is still at an experimental stage. It is estimated that the development of such techniques will permit to increase at least by 20 % the

efficiency of phosporous intake equivalent to the saving of one million tons of phosphate for Brazil or US $ 600 million on fertilizers expenses, (J.O. Siqueira a A.A. Franco, 1988).

The present biotechnological market for fertilizers in both Mexico and Brazil can be multiplied with the expansion of leguminous culture and the development of mycorrhizal inoculation. The potential economic impact of these two areas of biotechnological application is huge including the reduced dependency on energy and industrial inputs, the reduced capital investment and the beneficial impact on the natural environment.

II.4.2.2.2. Tissue culture

Tissue culture technique is being applied in several areas both in Brazil and Mexico, particularly for the rapid multiplication of disease-free and homogeneous ornamental plants, the production of flowers for export, the production of fruits for direct consumption in domestic and foreign markets, or for industrial purposes.

In Brazil, two firms, Equilabo in Campinas and Floranica in Niteroi, apply the technique for the production of orchids for exports. In the fruit growing sector important developments have been achieved after the creation of the Center for Research on Temperate Climate Fruit Trees. Meristem culture is widely applied for the production of disease-free cultivars. In 1983, twenty million units of six different cultivars of strawberries, one for processing and five for table fruit were produced inducing significant increases in productivity per hectare. The same technique is applied for the production of some varieties of thornless blackberry bush (10,000 units in 1984), pears, citrus fruit, etc.

In the case of Mexico, tissue culture is an important activity at a number of diverse institutions. The latter include the Universidad Autonoma Agraria, the Universidad de Chapingo, CINVESTAV-Irepuato, UNAM, the Instituto Nacional de Investigaciones Agricolas de Zacatepec, the Programa Nacional de la Papa in Toluca, etc.

II.4.2.2.3. Biopesticides

The high consumption of pesticide, particularly insecticides and herbicides, present a great potential for substitution by biotechnological products (biopesticides). For example, in the State of Sao Paulo in Brazil, pesticides account for 26.8 %, 19.5 % and 15.1 % of the total sales revenue of cotton, soybean and orange crops respectively. The advantages of biopesticides (in selectivity, possible all year around use and the saving of energy) make the development of this product line at an industrial scale particularly important.

Since 1972 different institutions have been involved in biopesticide R&D in order to control some of the major biological constraints encountered by the Brazilian agriculture. The National Soybean Research Center in Parana, which is attached to the EMBRAPA, isolated in 1972 the virus "baculovirus anticarsia" to combat a major problem caused by the insect know in Brazil as "lagarta de soja" and scientifically as "anticarsia gemmatalis". This is responsible for about 40 % of the overall losses caused by insects on soybean culture. During 1984-85 more than 300,000 ha were treated with this biopesticide, the cost of soybean protection using biopesticide was equivalent to nearly 75 % of the traditional chemical method. By the middle of the 1980s the production of the virus was undertaken,

under the supervision of EMBRAPA, by five cooperatives in the State of Parana, one in Santa Catarina, five in Rio Grande do Sul and one in Sao Paulo.

Another insect, the "duatrea saccharalis" which attacks sugar-cane, soybean, millet and also garden vegetables could be controlled by a virus : the DsGV. It has been isolated and its virulence increased by genetic engineering at the Genetics Department of the University of Campinas, in the context of a programme supported by the national Sugarcane Improvement Program. The industrial scaling up of the process is presently being developed.

Although 43 active principles of insecticides, herbicides and fungicides are synthesized in Brazil, in addition to the bio-pesticides, the domestic production is still largely insufficient covering only a small fraction of the domestic needs of pesticides. The overall potential market is relatively large and expanding. For example, in 1984 the total sales of pesticides in Brazil amounted to more than US $ 800 million of which US $ 240 million were for insecticides. At the same time, as noted above, pest control represent an important proportion of the selling price of most agriculture products.

II.4.2.2.4. Livestock sector, food and feed

Biotechnology has a great potential in three main areas of animal agriculture, namely : animal disease diagnosis, prevention and control; animal nutrition and health; and genetic improvement of animal breeds.

The main efforts for the application of biotechnology in the livestock of Brazil and Mexico concentrate on the techniques of embryo transfer, freezing, superovulation and division of embryos with the purpose to improve the quality of livestock, both bovine and porcine, and to increase meat and milk yields work for animal feed production and improvement.

In Brazil, biotechnology development for animal agriculture is mainly oriented to artificial insemination and embryo transfer. Since 1975 artificial insemination techniques are used by private firms particularly for bovine production. In 1983 more than 24 centers of artificial insemination were operating, although the larger part of the market is controlled by only five firms. By the middle of the 1980s these centers were producing and commercializing nearly 1.6 million doses.

Animal improvement techniques are also applied for swine and poultry production. Concerning swine improvement, a joint venture exists between AGROCERES and the British group Pig Improvement Co. (PIC). Concerning poultry, the basic problem faced by Brazilian farmers is the oligopolistic character of the international market dominated up to 80 % by two firms : Arbor Acres and Hubbard. Domestic firms depend upon the import of the genetic material from these two corporations. To overcome this dependence AGROCERES has initiated a programme for the genetic improvement of poultry. The objective is to identify and to develop the type of poultry best adapted to Brazilian conditions and its market. For this purpose Agroceres Ross Melhoramento Genetico, a joint venture between AGROCERES and Ross Breeders of Scotland (subsidiary of Hillsdown Holding), has been created.

Artificial insemination and embryo transfer in Mexico is less developed than in Brazil and the available information shows relatively few projects in this area. Results have not been disseminated and, in general, activities are still at initial stages. A project, though, that has

received great attention in Mexico is the development of a genetic engineered bovine variety. The latter has one third of the equivalent size and weight of the normal species, its growth period is nine months instead of three years and the space requirements are less than one third. Thus, on the area required for a normal cow of 700 kg it is possible to grow ten units of a dwarf variety weighing 150 kg each. The project has been developed at the Facultad de Medicina Veterinaria y Zootecnia of the UNAM.

The improvement of animal nutrition and growth have high priority in both countries. Mexico, in particular, has a large short-fall of proteins and has to import substantial volumes in the form of soybeans and fishmeal. In 1988 it was estimated that by 1990 Mexico will be importing more than 1.6 million tons of pure vegetable protein (soybean), or 73.5 % of its total requirements of proteins (Bifani/IDB 1989). To overcome this problem two solutions have been envisaged both based on fermentation technology. The first is the use of organic agricultural residues for the production of non-conventional feed. The second is the production of single cell protein as animal feed.

Two industrial processes have been developed on the basis of the first approach : the BIOFERMEL and the DESA processes. The former has been developed in Mexico by the Departamento de Biotechnologia of the Instituto de Investigaciones Biomedicas of the UNAM. It is based on fermentation using molasses, maize stubble, urea, manure and water. The product is in the market since 1985 and is used as a substitute for traditional balanced feed prepared on the basis of sorghum, soybean and maize. The DESA process (for "desechos animales enriquecidos en acidos organicos"), has been developed by the Instituto Mexicano de Technologias Apropiadas and it is based on the use of manure and starch for the production of a low cost feed.

Single cell protein, SCP, production is pursued at CINVESTAV in Mexico. It is still, however, in the pilot plant stage. Technical problems associated with the decomposition of the sugar cane bagasse, which is used as a feed stock, together with financial requirements have postponed the scaling up of the process.

Finally, the application of biotechnology for the diagnosis, prevention and control of animal diseases has not yet reached the commercial stage, although several R&D institutes and private firms are actively involved in their development. Basic economic limitations of biotechnological development in these areas are similar to those confronted in developed countries. These involve the low value added of individual farm animals which limits veterinary cost and veterinary medicine sales per animal, and consequently the funding for veterinary R&D. Moreover, the new biotechnological developments are not always well adapted to current husbandry practices that require skilled labor. On the other hand, veterinary developments in the area of diagnosis (monoclonal antibody, vaccines, antibiotics and vitamins) are closely associated with their development for human health. Therefore, investments on R&D in biotechnology for pharmaceutical and human health are likely to have important spillovers on animal agriculture.

II.4.2.3. Equipment and materials for biotechnology

The application of biotechnology requires the development of new equipment and the demand for specific materials. Moreover, the sophistication of such equipment and instruments to be used for the application of biotechnology requires specialized manpower. At the beginning of the 1980s the annual expenditure on the purchase of biotechnology equipment was growing, internationally, at rates of at least 15 % annually. This growing

demand has two main components : laboratory equipment and machinery for scaling up the new processes.

Since new biotechnology is still an emerging industry, many of its practical applications are difficult to anticipate accurately. Thus, lags in the supply of specialized equipment appear quite often. This situation can be more acute in new industrializing countries which do not have large and diversified manufacturing sectors for such types of equipment.

ANNEXES

ANNEX 1 - PUBLIC RESEARCH INSTITUTIONS BY MINISTERIAL CATEGORY

ANNEX 2 - STATISTICAL TABLES

ANNEX 1 : PUBLIC RESEARCH INSTITUTIONS BY MINISTERIAL CATEGORY

1. Ministry of Agriculture and Hydraulic Resources : National Institute for Agricultural, Forestry and Livestock Research, and the Water Research Institute, depending on the Ministry of Agriculture and Hydraulic Resources. This ministry coordinates three minor institutions which undertake research activities, although to a much smaller scale for particular crops and the academic institutions specialized in agriculture (Universidad de chapingo, Universidad Francisco Narro).

2. Ministry of Energy, Mining and Public Industry : the Mexican Oil Institute, the Electrical Research Institute, the Nuclear Research Institute, National Institute for Siderurgical Research, the Mining Development Commission and the R&D activities undertaken by public firms like : Altos Hornos, Fertimex, etc.

3. Ministry of Trade and Industrial Promotion : the National Industrial Research Laboratories (LANFI).

4. Fishery Ministry : the National Fishing Institute.

5. Ministry of Communications and Transport : the National Institute of Communications, the National Institute of Transport and the R&D activities of TELMEX, the Mexican Telephone Company.

6. Ministry of Health : coordinating more than 12 national institutes and hospitals with various research specialities. (The National Nutrition Institute, the National Cardiology Institute, etc.).

7. Ministry for Programming and the Budget (SPP) : Given its new commanding role in the S&T system since 1985, we shall expand on its activities.

This Ministry has assumed the coordination of science and technology entities whose incidence is of a multisectorial character like the CONACYT, the 16 R&D centres and scientific institutions depending on CONACYT's coordination and INFOTEC. SPP assigns the funds for these institutions and has, since 1985 by law, the responsibility for the overall formulation, coordination and administration of the S&T policy with the assistance for CONACYT.

These R&D centres are located in different regions of the country specialized in one or two lines of research often linked to the industrial activities of the region. For instance, there is a leather and shoe R&D institute servicing the shoe industry concentrated in the Leon, Guanajuato area; two machinery and equipment R&D institutes operating in the metal mechanic industry area located in the states of Queretaro and San Luis Potosi; the Research and Technological Assistance and Design Centre in Jalisxo is specialized in food technology; the Centre of Applied Chemical Research in the Northern state of Coahuila.

The scientific institutions depending on CONACYT, and hence on SPP are increasingly located in different regions of Mexico in order to promote decentralization of S&T. Of these

the most important are the following : Centre for Scientific Research and Higher Education in Ensenada, Baja California; the Biologic Research Centre in Baja California Sur; Centre for Optical Research in Guanajuato and Biotic Resources Research Centre in Veracruz.

CONACYT, as was mentioned, is in charge of the coordination of the national plan on S&T. The promotion and support of R&D, represents 34 % of its budget and the development of highly qualified human resources represents 40 %. While it is true that through its actions CONACYT can potentially exert leadership, its reduced budget limits its functions to a marginal role because it is less than 10 % of total public expenditure allocated to S&T activities by the Ministry of Planning and the Budget.

TABLE I : Country data

Area	Population	Density (1985)
Total : 1,973 km2	80.4 million (1986)	39.5 per km2
(000s)	Rate of growth : 2.3 % p.a. (1980-1985)	

Population characteristics (1984)		Health	
Crude Birth Rate (per 1,000)	33.2	Population per physician (1983)	1,200
Crude Death Rate (per 1,000)	6.6	Population per hospital rool (1980)	1,780
Infant Mortality (per 1,000 live births)	50.6		
Income distribution (1978)			
% of national income, highest 20 %	57.7		
lowest 40 %	2.9		
Access to safe water (1981)		Access to electricity (1982)	
% of population - urban	61.4	% of population	74.6
- rural	51.0		
Nutrition (1983)		Education	
Calorie intake as % of requirements	125.9	Adult literacy rate % (1980)	83.0
Per capita protein intake (gms/day)	72.4	Primary school enrollment % (1983)	119.0

GNP per capital in 1985 (US $ 2,080)

Gross domestic product in 1986			Annual rate of growth (%, constant 1970 prices)	
	US $ Mln.	%	1976-1980	1981-1985
GDP at market prices	128,109	100.0	6.7	0.8
Gross domestic investment	22,931	17.9	9.4	-5.5
Gross National Saving	21,266	16.6	10.8	-4.6
Current account balance	-1,700	1.3	-	-
Exports of goods, NFS	21,300	16.6	12.2	7.6
Imports of Goods, NFS	16,200	12.7	13.6	-10.0

Output, labor force and productivity in 1984

	Value added		Labor force		V.A. per worker
	US $ Mln.	%	Ths.	%	US $
Agriculture	14,772	9.6	5,342	26.6	2,765
Mining (1)	17,214	11.2	271	1.3	63,520
Industry (2)	51,057	33.1	3,897	19.4	13,102
Services	71,125	46.1	10,582	52.7	6,721
Total/average	154,168	100.0	20,092	100.0	7,673

.. Not available for a recent year
(1) Including petroleum
(2) Including manufacturing, utilities, and construction

TABLE I : Country data (continued)

Government finance	General Government (1)			Public sector		
	(Mex $ B)	(% of GDP)		(Mex $ B)	(% of GDP)	
	1985	1985	1980-84	1985	1985	1980-84
Current revenues	9,043.4	19.9	19.6	14,684.0	32.2	31.2
Current deficit	-1,411.9	-3.1	-1.0	-1,412.3	-3.1	-1.5
Capital expenditures	2,087.2	4.6	5.8	2,733.5	6.0	9.6

Money, credit and prices	1981	1982	1983	1984	1985	1986
(Banking system)	(Millions of Mex$ outstanding at end of period)					(oct.)
Money and Quasi Money	1,940	3,311	5,398	9,012	13,136	19,240
Bank Credit to Public Sector	1,025	2,883	4,498	6,048	10,136	19,342
Bank Credit to Private Sector	1,020	1,366	2,030	3,709	5,777	9,165
(Percentages or Index Numbers)						
Money and Quasi Money as % of GDP	33.0	35.2	31.5	31.4	28.8	26.5
Consumer Price Index (1980=100) (2)	127.9	203.3	410.2	679.0	1,071.2	1,994.9 (Dec.)
Annual Percentage changes in :						
- Consumer Price Index (2)	27.9	59.0	101.8	65.5	57.8	86.2 (Dec.)
- Bank Credit to Public Sector	54.5	181.3	56.0	34.5	78.7	101.0 (3)
- Bank Credit to Private Sector	45.9	33.9	48.6	82.7	55.8	73.9 (3)

Balance of payments - US $ B.	1974	1979	1984	1986
Exports of goods, NFS	5.2	13.7	30.1	21.3
Imports of goods, NFS	7.4	16.2	16.2	16.2
Resource balance (deficit = -)	-2.2	-2.5	13.9	5.1
Interest payments(net)	-0.7	-3.0	-9.7	-7.0
Worker's remittances	0.2	0.2	0.3	0.3
Other factor payments (net)	-0.3	-0.4	-0.7	-0.6
Net transfers	0.1	0.2	0.4	0.5
Balance on current acc.	-2.9	-5.5	4.2	-0.7

Merchandise exports (averages)	(US $ B.) 1980-86	%
Petroleum products	13.5	66.8
Mach.&Equipment	1.7	8.4
Garden vegetables	1.3	6.4
Mining ores & metals	0.9	4.5
Agro-industrial prods.	0.8	4.0
Chemicals	0.6	3.0
Coffee	0.5	2.5
Manuf.non-ferr.metals	0.4	2.0
Others	0.5	2.4
Total	20.2	100.0

(1) Including the Federal Government, the Federal District, and the Social Security system
(2) Annual average
(3) Annualized rate

TABLE I : Country data (continued)

					External debt, December 31, 1986	
						US $ B.
Direct foreign investment	0.7	1.3	0.4	1.0	Public debt, incl.guaranteed	76.5
Net MLT borrowing (public)	1.2	1.1	2.0	0.6	Non-guaranteed private debt (6)	23.7
- (Disbursements) (4)	(1.4)	(5.2)	(8.2)	(7.1)	Total outstanding & disbursed	100.2
- (Amortization) (5)	(0.2)	(4.1)	(6.2)	(6.5)		
Other MLT (net)	1.2	2.7	0.7	-0.5		
Subtotal	3.1	5.1	3.1	1.1	Debt service ratio for 1986	% (7)
ST public capital (net)	-	-	0.2	0.7	Public debt, incl.guaranteed	..
Private ST & errors & omis.	-0.1	0.7	-4.5	0.2	Non-guaranteed private debt	..
Changes in net reserves (- = increase)	-0.1	-0.3	-3.0	1.1	Total outstanding & disbursed	47.9

Rate of exchange, 1986 average	IBRD/IDA LENDING, (Dec. 31, 1986) (US $ Mln.)		
		IBRD	IDA
US $ 1.00 = Mex $ 611.8	Outstanding and disbursed	6,934.7	-
Mex $ 1.00 = 0.00163	Outstanding incl. undisbursed	9,359.1	-

.. Not available for a recent year
(4) Including refinancing
(5) Including postponements and restructuring
(6) Including US $ 7.8 billion owed by nationalized domestic commercial bank
(7) As a share of exports of goods and non-factor services.

TABLE I.1. : Mexico's economy 1982-1989 - Aggregate indicators

	1982	1983	1984	1985	1986	1987	1988	1989
1.Economic growth								
Real GDP (%)	(0.6)	(4.2)	3.5	2.5	(3.7)	1.5	1.1	2.9
Primary sector (%)	(2.0)	2.2	1.5	2.9	(1.4)	1.1	(1.6)	(3.1)
Industrial sector (%)	(2.1)	(8.9)	4.7	4.8	(5.9)	2.7	1.2	4.8
2.Inflation								
Consumer prices (%)	98.9	80.8	59.2	63.7	105.8	159.2	51.7	19.7
Retail prices (%)	93.5	80.2	60.1	61.1	102.3	166.5	37.3	15.6
3.Exchange rate								
Controlled (DEC)	96.5	143.9	192.6	371.5	923.5	2198.5	2257.0	2637.0
Variation (%)	267.8	49.2	33.8	92.9	148.5	138.2	2.7	16.8
Free (DEC)	148.5	161.4	210.0	447.5	915.0	2227.5	2297.5	2680.8
Variation (%)	466.2	8.7	30.1	113.1	104.5	143.4	3.1	16.7
4.Interest rates								
CPP (average)	40.4	56.7	51.1	56.1	80.9	94.6	67.6	44.6
CPP (DEC)	46.1	56.4	47.5	65.7	95.3	104.3	45.5	40.1
5.Salaries								
Minimum urban salary								
Nominal growith (%)	73.8	44.8	56.6	54.0	105.5	144.9	31.9	12.7
Real growith								
at 1970 prices (%)	(9.8)	(19.5)	(4.1)	(4.3)	(3.3)	(1.6)	(14.4)	(6.1)
6.Public finances								
Financial deficit								
Financial deficit as % of GDP (%)	16.9	8.6	8.5	9.6	16.0	16.1	12.0	5.8
7.Financial saving								
Total financial assets (banks & not banking)								
Nominal growth (%)	78.3	67.4	69.1	47.4	104.2	159.7	63.4	53.7
Real growth (%)	12.0	(7.4)	6.2	(10.0)	(0.8)	(0.2)	7.7	28.4
8.External sector (billion dlls)								
Trade balance	6.8	13.8	12.9	8.4	4.6	8.4	1.7	(0.6)
Current balance	(6.2)	5.4	4.2	0.5	(1.7)	3.9	(2.9)	5.8
International reserves								
Variation	(4.7)	3.3	2.2	(3.4)	0.9	6.9	(7.1)	(0.4)

Parenthesis = negative sign E/ estimated data
Source : Official government statistics

TABLE I.2. : Selected economic indicators of Mexico, 1978-88

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
GDP (millions of 1970 pesos)											
- Total	711982.3	777162.6	841854.5	908764.8	903838.6	856173.6	887647.4	912334.1	874200.0	893100.0	903600.0
- Manufacturing	176816.5	195613.7	209681.9	224326.2	217852.2	202026.3	211683.5	223886.1	211200.0	216600.0	221200.0
- Investment goods	35075.0	40566.7	44455.7	49161.8	42970.1	33168.3	35246.8	39864.8	33219.6	34830.9	37951.2
Investment	142799.3	171714.2	197364.5	226427.4	190312.8	137240.7	144815.0	154024.5	135233.5	133205.0	140797.7
Employment (thousands of workers)											
- Total	16844.0	17676.0	20280.0	21548.0	21482.0	20995.0	21482.0	21967.0	21590.0	21609.4	21607.3
- Manufacturing	2133.0	2291.0	2441.0	2557.0	2505.0	2326.0	2374.0	2451.0	2375.0	2410.6	2453.4
- Maquiladora	90.7	111.3	119.5	130.9	122.4	173.1	202.0	217.5	270.8	305.2	369.4
Exports (thousands of dollars)											
- Total	6063.0	8818.0	15512.0	20102.0	21230.0	22312.0	24196.0	21664.0	16031.0	20656.0	20658.0
- Manufacturing	2119.0	2372.0	3571.0	4098.0	3386.0	5448.0	6986.0	6428.0	7782.0	9907.4	11611.5
- Maquiladora v.a.	448.02	637.85	772.5	977.3	811.0	828.2	1160.9	1265.8	1295.0	1598.1	2337.4
Investment goods imports (million U.S. dlls.)	2041.8	2730.0	4926.0	7433.0	4389.0	2114.0	2452.0	2908.0	2767.0	2472.0	3787.1
New foreign investment (million U.S. dlls.)	383.3	810.0	1622.6	1701.1	626.5	683.7	1442.2	1871.0	2420.9	3877.2	3157 *
External debt (million US dlls)	36401.0	41118.0	49032.0	74353.0	56732.0	89827.0	96585.0	96567.0	100991.0	107452.0	100384.0
Exchange rate (peso per US $)	22.3	22.8	23.3	24.0	53.0	151.0	210.0	450.0	920.0	2198.0	2257.0
Consumer price index (1980 = 100)	71.9	85.3	100.0	128.0	207.3	410.6	679.2	1071.5	1995.4	4626.0	9907.2

Source : Instituto Nacional de Estadistica y Geografia, Secretaria de Programacion y presupuesto (SPP) : Cuentas Nacionales, (Mexico city, 1988) and Direccion General de Inversiones Extranjeras, Secretaria de Comercio y Fomento Industrial.

Notes : * preliminary

1. Investment goods imports = value of imports of machinery, equipment and metallic products
2. Exports and imports by the maquiladoras are not included in total exports and imports while their employment and value added are part of the total.

TABLE I.3. : Mexico : recent macroeconomic trends - Mexico-basic data

	1988	1989
Area and population		
Area	1,958,201 sq Km	
Population (in millions)	82.7	84.3
Annual rate of population growth (percent)	1.9	1.9
Life expectancy at bith	69 years	
Economic activity by sector (annual changes in percent)		
Agriculture, livestock, forestry and fisheries	-3.2	-3.1
- Agriculture	-4.4	-2.1
- Livestock	-2.2	-4.1
- Forestry	2.2	-9.8
- Fisheries	-1.4	0.3
Industrial activity	1.9	4.8
- Mining (including petroleum)	0.4	-0.9
- Manufacturing industry	3.0	6.0
- Construction	-2.5	3.0
- Electricity	6.2	8.0
Services	1.8	2.7
- Financial services	1.7	1.2
- Communications	7.6	15.3
Ratios of GDP (percentages)		
Exports of goods, services and transfers	18.5	18.2
Imports of goods, services and transfers	91.9	20.9
Current account balance	-1.4	-2.7
Budgetary public sector revenues	27.7	28.9
Public sector financial deficit	12.8	5.8
Public sector primary surplus	6.4	8.3
Public sector operational balance	-4.1	-1.6
Public sector operational balance (adjusted)	-0.7	2.0
Money supply (MI)	4.5	4.6
Money and quasi-money (M4)	28.5	33.3

Source : Banco de Mexico, the Mexican economy 1990.

TABLE II.1. : Foreign trade (percentages)

Concept	1982	1983	1984	1985	1986	1987	1988
Exports	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Oil	77.6	71.8	69.0	68.2	39.4	41.8	32.5
- Crude oil	73.6	66.3	62.2	61.4	34.8	38.1	28.5
- Other	4.0	505	6.8	6.7	4.5	3.6	4.0
Non oil	22.4	28.2	31.0	31.8	60.6	58.2	67.5
- Agricultural and livestock	5.8	5.3	6.1	6.5	13.1	7.5	8.1
- Mining	2.4	2.3	2.2	2.4	3.2	2.8	3.2
- Manufactures	14.2	20.5	22.7	23.0	44.4	48.0	56.2
Imports	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Private	62.6	49.5	57.5	66.8	70.8	77.3	81.2
- Consumer goods	6.1	2.5	2.8	4.0	3.9	3.9	8.1
- Intermediate goods	35.9	33.3	39.8	45.8	49.2	58.1	56.2
- Capital goods	20.5	13.7	14.8	17.0	17.7	15.2	16.9
Public	37.4	50.5	42.5	33.2	29.2	22.7	18.8
- Consumer goods	4.4	4.6	4.7	4.2	3.5	2.3	2.1
- Intermediate goods	22.4	33.9	29.8	22.0	17.6	14.1	12.3
- Goods	10.7	12.0	8.1	6.9	8.2	6.3	4.4

Source : Banco de Mexico : Foreign sector indicators

TABLE II.2. : Export share of selected industries

	Rate of growth					
	75-78	79-82	83-88	75-78	79-82	83-88
Food and beverages	29.20	21.20	12.07	5.40	-4.00	13.57
Footwear and textiles	9.40	5.60	4.00	-3.50	-11.40	24.36
Wood	2.20	1.80	1.40	28.90	-12.50	17.29
Paper and print	2.90	2.40	2.60	10.50	0.0	33.0
Subtotal	40.80	28.60	19.3	10.27	-9.30	17.91
Steel	3.10	2.80	5.49	3.10	2.80	18.96
Chemical products, plastics, oil derivates, etc.	12.20	12.30	10.85	0.80	7.10	17.35
Non metallic minerals	5.50	4.00	6.37	30.30	-8.80	21.00
Metallic products and mach	24.50	27.60	38.07	20.20	-0.70	25.43
- Finished automobiles	11.80	14.80	12.10	32.80	2.30	38.36
- Engines	0.80	0.70	12.89	159.00	-35.00	17.78
- Computers	0.40	0.60	13.53	36.60	6.10	83.98

Source : Unger and Salda,"Economias de Escala y de Alcance en Trimestre Economico Vol. LVI(2), Num.222. Mexico, Fondo de Cultura Económica 1989.

TABLE II.3. : Manufactured exports - Total and by groups exports (millions of dollars)

Concept	1982	1983	1984	1985	1986	1987	1988
Total	3,017	4,582	5,452	4,978	7,112	9,907	11,616
Food, beverages and tobacco	707	725	822	751	937	1,313	1,369
Textile, apparel and leather industry	150	191	275	195	333	566	626
Lumber industry and products	52	82	98	72	100	134	182
Paper, paper products, editorial and printing	78	75	97	86	138	222	324
Chemical substances, oil products, plastic and rubber products	468	672	821	715	908	1,206	1,554
Non metallic mineral products, except coal and oil products	140	210	289	313	375	447	527
Basic metallic industries	490	881	888	641	917	1,260	1,577
Metallic products, machinery and equipment	888	1,663	2,074	2,129	3,283	4,618	5,300
Other manufacturing industries	43	83	88	76	120	140	157

Source : Banco de Mexico - Inducadores del sector externo

TABLE II.4. : Mexico : Main export products (January-November 1988-1989) - Millions of dollars

Products	1988		1989		89/88 (%)
	Value	(%)	Value	(%)	(%)
Total of Mexico	18,954	100.0	20,933	100.0	+ 10.4
Agriculture and forestry	1,293	6.8	1,360	6.5	+ 14.2
Cattle and fisheries	236	1.2	231	1.1	
Crude oil	5,372	28.3	6,628	31.2	+ 23.4
Metal minerals	300	1.6	263	1.3	-12.3
Non metal minerals	311	1.6	298	1.4	- 4.2
Manufactures	11,388	60.0	12,065	57.6	+ 5.9
Frozen shrimps	294	1.6	395	1.4	+ 3.8
Beer	178	0.9	149	0.7	- 15.9
Fruits and vegetables	103	0.5	145	0.7	+ 40.9
Sugar	155	0.8	79	0.4	- 48.9
Artificial and synthetic textile fibers	198	1.0	187	0.9	- 5.6
Leather manufactures	108	0.5	104	0.5	- 3.9
Lumber manufactures	170	0.9	182	0.9	+ 7.2
Fuel oil	149	0.8	101	0.5	- 32.5
Propane and butane gas	112	0.6	84	0.4	- 24.9
Petrochemical products	188	0.9	151	0.7	- 19.7
Plastic and synthetic resins	203	1.1	206	1.0	+1.2
Acids	172	0.9	201	1.0	17.1
Prepared varnishes and colors	101	0.4	113	0.6	11.5
Plastic manufactures	67	0.3	88	0.4	31.3
Glass and crystal manufactures	218	1.1	217	1.0	-0.2
Hydraulic cement	134	0.7	144	0.7	+7.0
Iron and steel manufacture	678	3.6	795	3.8	+17.2
Iron and steel manufacture	182	0.9	225	1.1	+19.1
Iron bars	159	0.8	202	1.0	+26.1
Silver bars	292	1.5	373	1.8	+27.8
Copper bars	128	0.7	196	0.9	+52.5
Automotive spare parts	1,303	6.9	1,451	6.9	+11.4
Automotive motors	1,275	6.7	1,269	6.1	-0.4
Other automotive spare parts	414	2.2	367	1.8	-11.4
Motor spare parts	89	0.4	99	0.5	+44.5
Electricity cables	177	0.9	165	0.8	-6.7
Information process equipment	302	1.6	349	1.8	+15.7
Industrial machinery spare parts	174	0.9	247	1.2	+41.7

Source : Bancomext.

TABLE II.5. : Mexico : Main import products (January-November 1988-1989)
- Millions of dollars

Products	1988		1989		1989/88
	Value	(%)	Value	(%)	(%)
Total of Mexico	17,174	100.0	21,457	100.0	+ 24.9
Manufactures	15,194	88.5	19,016	88.6	+ 25.1
Food and beverages	1,083	6.3	1,842	8.6	+ 70.1
- Milk powder	223	1.3	453	2.1	+ 104.0
- Fresh and frozen meat	216	1.3	259	1.2	+ 19.8
- Animal and vegetable oil and fat	137	0.8	199	0.9	+ 45.5
Textile and apparel	367	2.1	639	3.0	+ 74.3
Cellulose pulp	365	2.1	366	1.7	+ 0.4
Paper and carton	141	0.8	222	1.0	+ 57.8
Fuel oil	213	1.3	243	1.1	+ 13.9
Polypropelene	131	0.8	134	0.6	+ 3.0
Chemical mixed preparations	301	1.8	344	1.6	+ 14.4
Natural and synthetic resins	170	1.0	239	1.1	+ 40.4
Pharmaceutical preparations	161	1.0	183	0.9	+ 13.2
Plastic manufactures	421	2.4	567	2.6	+ 34.9
Non metallic mineral manufactures	145	0.8	206	0.9	+ 41.9
Iron and steel sheet	275	0.6	362	1.7	+ 31.8
Pads, rowlocks, arrows and pulleys	145	0.8	196	0.9	+ 34.9
Iron and steel waste	110	0.6	76	0.4	- 31.1
Automobile assembly parts	944	5.5	882	4.1	- 6.5
Automobile replacement parts	482	2.8	600	2.9	+ 24.6
Automobile engines	133	0.7	160	0.7	+ 20.1

Source : Bancomext.

TABLE II.6. : Mexico : Geographic distribution of foreign trade (main partners) (1987-1988) - Millions of dollars

Country	1987					1988					1988/1987	
	Exports (%) value	%	Imports (M) value	%	Balance of trade (X-M)	Exports (X) value	%	Imports (M) value	%	Balance of trade (X-M)	X	M
Mexico's total	20,656	100.0	12,223	100.0	+8,433	20,658	100.0	18,903	100.0	+1,755	+0.01	+54.7
United States	13,322	64.5	7,876	64.4	45,446	13,626	66.0	12,617	66.7	+1,009	+2.3	+60.2
Japan	1,349	6.5	295	6.5	+554	1,231	6.0	1,125	6.0	+106	-8.8	+41.5
EEC	3,007	14.6	1,980	16.2	+1,027	2,690	13.0	2,783	14.7	-93	-10.6	+40.6
Spain	1,232	6.0	174	1.4	+1,058	981	4.7	208	1.1	+773	-20.4	+19.5
Fed.Rep.Germ.	325	1.6	835	6.8	-510	440	2.1	1,187	6.3	-747	+35.4	+42.2
France	581	2.8	344	2.8	+237	562	2.7	437	2.3	+125	-3.3	+27.0
U.K.	313	1.5	214	1.8	+99	195	0.9	359	1.9	-164	-37.7	+67.8
Belgium-Luxemb.	250	1.2	107	0.9	+143	229	1.1	159	0.8	+70	-8.4	+48.6
L.A.Integration Association	807	3.9	272	2.2	+535	887	4.0	566	3.0	+271	+3.7	+108.0
Argentina	169	0.8	45	0.4	+124	125	0.6	135	0.7	-10	-26.1	+200
Brazil	164	0.8	166	1.4	-2	116	0.6	296	1.6	-180	30.3	+78.3
Canada	316	1.5	355	2.9	-39	277	1.3	338	1.8	-61	-12.3	-4.8
Central America	336	1.5	22	0.2	+194	334	1.6	41	0.2	+293	5.7	+86.4
COMECON	45	0.2	10	0.3	+15	141	0.7	54	0.3	+87	+213.0	+80.0
EFTA	113	5.5	345	2.8	-233	114	0.6	454	2.4	-340	+0.9	+31.2

TABLE II.7. : Mexico : Principal exports to EEC (January-June 1988-1989)
- Millions of dollars

Products	1988		1989		89/88	Country of destination
	Value	(%)	Value	(%)	(%)	
Mexico's total exports	12,353		11,531		-6.7	
Exports to EEC	1,609	100.0	1,393	100.0	-3.4	
Selected products	1,110	64.8	1,006	72.2	-9.4	
Crude oil	814	50.6	694	49.8	-4.8	Portugal, Netherlands, France, Spain, Italy, Benelux, U.K.
Motors with cylinders more than 1000 cm3	110	6.8	205	14.7	+86.4	F.R. Germany, Benelux, France
Crude coffee	105	6.5	12	0.1	-89.6	France, F.R. Germany, Italy, UK, Spain
Natural honey	18	0.2	20	1.4	+11.0	UK, F.R. Germany, Benelux
Tuna fish	13	0.1	11	0.1	-5.4	Italy, Spain
Copper minerals and concentrates	12	0.1	9	0.1	-5.0	F.R. Germany, Spain
Zinc minerals and concentrates	10	0.1	8	0.1	-20.0	UK, F.R. Germany, Benelux, Italy
	8	0.1	8	0.1	0.0	UK
Refined lead	8	0.1	7	0.1	-2.5	Italy, Benelux, F.R. Germany, UK
Lead minerals and concentrates	6	0.1	5	0.1	-6.7	Spain
Sugar	6	0.1	27	1.9	+350.0	UK

Source : SECOFI-BANCOMEXT

TABLE II.8. - Mexico : Main imports from EEC (January-June 1988-1989)
- Millions of dollars

Products	1988		1989		1989/88	Country of origin
	Value	(%)	Value	(%)	(%)	
Mexico's total imports	8,970		11,182		+24,7	
Exports from EEC	1,291	100.0	1,545	100.0	+19.7	
Selected products	45	3.5	253	16.4	+556.2	
Automobile spare parts	-	-	48	3.1	+47,000	F.R. Germany
Milk powder	2	0.1	41	2.7	+18,500	Ireland, UK, F.R. Germany
Tractors spare parts	1	-	19	1.2	+14,000	UK, F.R. Germany
Butyric dehydrated fat	4	0.3	14	0.9	+2,500	Benelux, France, Netherlands
Electronic (telephone,telegraphy, radio & TV) spare parts	1	-	19	1.2	+15,000	Benelux, Netherlands, France, F.R. Germany
Textile machinery	2	0.1	14	0.9	+6,000	Benelux, F.R. Germany, Spain
Spanish books	8	0.6	12	0.8	+50	Spain
Air and liquid pumps	16	1.3	9	0.6		Italy, F.R. Germany
Steam turbine	-	-	10	0.6	+500	F.R. Germany
Fuel oil	-	-	8	0.5	+500	France, UK, Netherlands
Motor spare parts	-	-	8	0.5	+400	UK, FRG
Laminated plate iron	2	0.1	8	0.5	+300	Spain, UK
	-	-	3	0.2	+200	Italy, Spain
Centrifugal machines	-	-	3	0.2	+200	Spain
Nobovissin	-	-	3	0.2	+200	France
Cassein	-	-	3	0.2	+200	France
Fiber treatment machinery	-	-	3	0.2	+200	Spain
Railroads	-	-	3	0.2	+200	UK
Iron cables	-	0.3	5	0.3		Belgium-Luxemb.
Bencimidasol	1	-	3	0.2		Belgium-Luxemb.
Piperazin	1	-	3	0.2		Belgium-Luxemb.
Butadien	-	-	1	-		Netherlands
Printing paper	1	-	3	0.2		France
Electric transformers	-	-	2	0.1		France
Chemical preparations	3	0.2	4	0.2		France
Paper machinery	1	-	4	0.2		Spain, F.R. Germany

Source : SECOFI-BANCOMEXT

TABLE II.9. : Mexico : Imports of technology intensive products from EEC (January-June 1988/89) - Thousands of dollars

Products	1988		1989		1989/88
	Value	(%)	Value	(%)	%
Mexico's total imports	8,970.000	100.0	11,182.000	100.0	+ 24.7
Mexico's imports from EEC	1,291.000	14.4	1,545.000	13.8	+ 19.7
Selected products					
Ireland					
- Indometasin	4	0.0	183	0.02	+3666.0
- Chloral-hydrates	59	0.0	113	0.01	+ 91.0
- Noboviossin	93	0.0	77	-	- 17.0
United Kingdom					
- Tractor spare parts	139	0.0	9,455	0.8	+67,000.0
- Plunger motor parts	-	-	4,911	0.4	-
- Rails	-	-	2,449	0.2	-
- Tractor transmissions	298	0.03	1,814	0.2	+508.0
- Potasic penicilin	1,102	0.1	1,445	0.1	+ 31.0
- Tractor pumps	449	0.05	1,332	0.1	+1,966.0
- Noboviossin	676	0.08	956	0.09	41.0
- Wheel tractors	766	0.08	839	0.09	+ 10.0
Netherlands					
- Electric spare parts	-	-	3,815	0.3	-
- Butadien and isopren	-	-	1,000	0.09	-
- Potasic penicilin	-	-	801	0.08	-
- Pumps and compressors	30	0.0	431	0.03	+1,337.8
France					
- Noboviossin	1,547	0.2	3,343	0.3	+116.0
- Automotive spare parts	-	-	1,437	0.1	-
- Propylen	129	-	1,399	0.1	+982.0
- Blocks of nitrocellulose	1,089	0.1	1,222	0.1	+ 12.0
- Dibromeotenil	1,029	0.1	1,056	0.09	+ 2.7
Italy					
- Motor pumps	489	0.05	1,234	0.1	+152.4
- Injection machines	495	0.05	1,129	0.09	+128.0
Temperature measurement and control	445	0.05	1,046	0.09	+135.4

TABLE II.9. : Mexico : Imports of technology intensive products from EEC (January-June 1988/89) - Thousands of dollars (continued)

Products	1988		1989		1989/88
	Value	(%)	Value	(%)	(%)
Denmark					
- Rowlocks	-	-	475	0.04	-
- Liquid pumps	4	-	316	0.03	+6,315.0
- Oxalic acid	12	-	187	0.02	+1,382.0
- Animal fat extraction machinery	-		138	0.01	-
Belgium and Luxemburg					
- Electronic spare parts	-	-	10,844	1.0	-
- Piperydin	266	0.03	1,300	0.1	389.7
- Wheel tractors	-	-	1,088	0.09	-
Fed. Rep. of Germany					
- Textile machinery	948	0.1	7,339	0.7	+674
- Steam turbines	2	-	5,945	0.5	-
- X-ray equipment	2,192	0.2	2,924	0.3	+ 33.4
- Tractor's spare parts	-	-	5,777	0.5	-
- Automotive spare parts	-	-	45,107	4.0	-
- Data processing automatic machines	-	-	2,101	0.2	-
- Printing machinery	567	0.96	1,613	0.1	+184.5
- Machine tools	6,936	0.7	2,992	0.3	- 55.9
- Chemicals (*)	2,356	0.3	2,802	0.3	+ 18.9

Source : BANCOMEXT

(*) This category includes the high technology groups of products which are difficult to identify in current trade statistics : Petrochemical, basis drugs for pharmaceutical products and other fine chemicals.

TABLE II.10. : Main exporter firms in the area of technology and construction engineering services

Name of firm	Type of service exported	Destination
HYLSA, S.A.	Technology and technical assistance for the reduction of sponge iron	USA, Germany, Japan, Middle East
MYLON, S.A.	Technology and technical assistance for the production of non-woven materials	Central and South America, England
PIPSA	Technology for extraction	The Netherlands, Central and South America
VIDRIERA MONTERREY	Technical assistance for the manufacturing of glass tableware (1988)	Central America
VITROCRISA CRIMESA	Technical assistance for the manufacturing of glasses and glass containers 1988	USA
INGENIEROS CIVILES ASOCIADOS	Services of construction engineering (damps, roads, markets) (1976-1989)	Central and South America
CONSTRUCCIONES PROTEXA, S.A.	Engineering and construction gasoducs	South America
PERFORACIONES MARITIMAS MEXICANAS	Oilwells drilling services (1985)	India
CONDUX, S.A. DE CV	Engineering and construction (Gasoducts) (1985-1989)	South America
BUFETE INDUSTRIAL DISEÑOS Y PROYECTOS	Detailed Engineering, Technical Assistance and construction	Bulgaria and Central America
SERVICIOS ESPECIALIZADOS PARA CONSTRUCCION	Engineering and construction services (1977)	Central America
MASECA	Technical assistance and use of patents for comflour - manufacturing	
INGENIEROS Y ARQUITECTOS	Engineering and construction (1989)	Belize
CONSTRUCTORA URBEC	Technology (1989)	Panama
CONSTRUCCIONES CONDUCCIONES Y PAVIMENTOS	Engineering and construction services (1980)	El Salvador
E.P.N. INGENIERA CONSTRUCCION Y PERFORADORA LATINA	Engineering drilling for geothermic wells	Central and South America, Indonesia

Sources : Tecnimexico, Secretaria de Industria y Comercio y entrevistas directas.

TABLE II.11. : Direct foreign investment 1983-1988 (millions of dollars)

DFI	1983	1984	1985	1986	1987	1988	TOTAL
Authorized	684	1,442	1,871	2,421	3,877	3,157	13,452
- New investment	684	1,442	1,871	1,324	2,029	2,229	9,579
- Swaps *	-	-	-	1,097	1,848	928	3873**
Total real flow	70	543	270	720	2,600	2,031	6,234
- New inversion	70	543	270	357	1,100	1,163	3,503
- Swaps *	-	-	-	363	1,500	868	2,731

Source : Direccion General de Inversiones Extranjeras. SECOFI.

TABLE II.12. : Direct foreign investment in Mexico (Millions of dollars)

	1982	1983	1984	1985	1986	1987	1988	1989
New	626	684	1,442	1,871	2,421	3,877	3,157	1,814
Accumulated (1)	10,786	11,470	12,900	14,629	17,050	20,927	24,084	16,772
(country of origin)								
1. U.S.A.	68.0%	66.3%	66.0%	67.4%	58.6%	65.5%	62.1%	63.0%
2. U.K.					3.3%	4.7%	7.3%	6.7%
3. F.R.G.	8.0%	8.5%	8.7%	8.0%	8.2%	6.9%	6.6%	6.3%
4. Japan	7.2%	6.8%	6.3%	6.1%	5.2%	5.6%	5.9%	5.0%
5. Switzerland	5.3%	5.1%	5.0%	5.3%	4.8%	4.4%	4.2%	4.5%
6. France					3.3%	2.8%	3.1%	2.9%
7. Spain					2.8%	2.9%	2.6%	2.6%
8. Others	11.5%	13.3%	14.0%	13.2%	17.3%	17.6%	8.6%	9.0%

(1) Adjustment of 12.4 to the accumulated item of 1984 and of 142 million dollars to 1985, because of partial and total mexicanizations, mergers, bargains.

Source : Foreign investment general direction SECOFI.

TABLE II.13. : Mexico : Main indicators of maquiladora industry (1983-1989)

Years	Number of plants	Employment (persons)	Value added (million dollars)
1983	600	150,867	829
1984	672	199,864	1,250
1985	760	211,958	1,300
1986	891	249,833	1,394
1987	1,125	305,253	1,573
1988	1,500	390,422	2,600
1989	1,795	437,064	2,954
Annual rate of growth, 1983-89 (%)	20.0	19.4	23.6

Source : SECOFI, INEGI.

TABLE II.14. : Mexico : Main activities of the maquiladora industry, according to the value added generated (percentages)

Economic activity	(%)
Mexico's maquiladora industry	100.0
Electronic and electric materials	27.7
Automotive parts and equipment	23.5
Electronic and electric machinery	12.5
Textile and apparel	6.3
Metal and lumber furniture	5.4
Services	3.3
Sport articles and toys	2.2
Other activities	19.1

Source : SECOFI.

TABLE II.14a : Mexico : Foreign investment by economic activity and country of origin in maquiladora industry, 1989 (percentages)

Economic activity	Total number of plants	Investment structure			
		100 % Mexican	100 % USA	100 % Japan	100 % other countries (*)
Mexico's total	2,047 (100.0)	48.4	48.0	2.4	1.2
Food	61 (100.0)	47.5	45.9	4.9	1.7 (1)
Textiles	363 (100.0)	48.5	49.9	-	1.6 (2)
Leather and shoe	75 (100.0)	48.0	48.0	-	4.0 (3)
Metal and wood furniture	329 (100.0)	48.3	47.4	3.3	1.0 (4)
Chemical products	154 (100.0)	48.0	48.7	3.2	-
Automotive parts and equipment	174 (100.0)	48.9	47.1	4.0	-
Machinery, tools and equipment	29 (100.0)	48.3	48.3	3.4	-
Electric and Electronic machinery	39 (100.0)	48.7	46.1	12.8	5.1 (5)
Electric and Electronic materials	461 (100.0)	48.6	47.5	3.3	0.6 (6)
Sports articles and toys	60 (100.0)	48.3	48.3	-	3.4 (7)
Other manufacturing industries	215 (100.0)	48.4	47.9	2.8	0.9 (8)
Services	87 (100.0)	48.3	48.3	1.1	2.3 (9)

(*) Includes the following countries :

(1) Panamá (1 plant)
(2) Panamá (4 plants) Switzerland and Argentina (1 plant each one)
(3) France (2 plants), Bahamas (1 plant)
(4) Spain (1 plant), Cayman Island (1 plant), Hong Kong (1 plant)
(5) S.Korea and the F.R. of Germany (1 plant each one)
(6) F.R. of Germany (2 plants), Netherlands (1 plant)
(7) Belize and Philippines (1 plant each one)
(8) Panamá and Spain (1 plant each one)
(9) Canada and Finland (1 plant each one)

Source : SECOFI.

TABLE II.15. : Mexico : Maquiladora industry domestic and imported supply by economic activity, 1989 (percentages)

Economic activity	Total inputs	Domestic inputs	Imported inputs
Mexico's total	100.0	1.8	98.2
Border zone	100.0	1.1	98.9
Food	100.0	26.0	74.0
Textiles	100.0	0.2	99.8
Leather and shoe	100.0	2.9	97.1
Metal and lumber furniture	100.0	2.9	97.1
Chemical products	100.0	2.2	97.8
Automotive parts and equipment	100.0	0.8	99.2
Machinery, tools and equipment	100.0	1.1	98.9
Electronics and electric machinery	100.0	0.1	99.9
Electronic and electric materials	100.0	0.9	99.1
Sport articles and toys	100.0	0.1	99.9
Other manufacturing activities	100.0	1.3	98.7
Services	100.0	2.1	97.9
Rest of the country	100.0	5.8	94.2
Textiles	100.0	2.4	97.6
Leather and shoe	100.0	9.1	90.9
Chemical products	100.0	52.9	47.1
Automotive parts and equipment	100.0	3.0	97.3
Electronic and electric machinery	100.0	8.0	92.0
Electronic and electric materials	100.0	1.3	98.7
Other manufacturing industries	100.0	12.8	87.2
Services	100.0	2.7	97.3

Source : SECOFI.

TABLE II.16. : Mexico : market opportunities for suppliers of maquiladora industry

Inputs by activity	1988 inputs supplied (millions of dollars)	1988 percentage of Mexican value added maquiladora industry
Textiles/Appareil	391.9	1.0
- Clothes - Leather yarn - Zippers - Clasps - Security clothes - Gloves		
Packing materials	306.9	4.8
- Isolated paper - Paper swarm - Carton boxes - Bubble packs - Corrugated carton - Adhesive ribbon - Plastic package - Labels		
Materials management equipment	2,261.3	0.7
- Tractors - Transporters - Stowage platforms - Shelving - Plastic tray - Batteries - Goods lifts		
Chemical products	16.9	33.1
- Moulded parts - Vinyl - Glasses - Gum - Epoxy adhesives - Welding - Lubricants - Resins - Solvents		
Metal mechanic	397.1	0.5
- Zinc casting - Aluminium casting - Iron - Replacement rings, valves, bullets & packs - Tools - Blocks - Stamped metals - Fasteners (joint pins, rivets, nuts, screws)		
Electronic	3,061.8	0.4
- Capacitors - Pressed circuits tables - Magnetic wire - Harness wire - Isolated wire		

Source : Elaborated with data from SECOFI and BANAMEX.

TABLE II.17. : Origin of technology transfer contracts

Country	1973-81			1982-89		
	Number	As % of Total Agts.	As % of Foreign A.	Number	As % of Total Agts.	As % of Foreign A.
USA	3424	52.1	68.6	2944	20.74	72.47
Mexico	1531	23.3	-	10141	71.43	-
F.R.G.	322	4.9	6.4	208	1.46	5.12
France	210	3.2	4.2	217	1.52	5.34
G.B.	197	3.0	3.9	153	1.08	3.77
Switzerland	151	2.3	3.1	94	0.66	2.31
Italy	118	1.8	2.4	117	0.82	2.88
Japan	118	1.8	2.4	161	1.14	3.96
Spain	85	1.3	1.7	0.8	1.1	1.80
Netherlands	28	1.2	1.6	33	0.24	0.81
Other	338	5.1	6.6	62	0.4	1.53
Total foreign contracts	4991	100.0	100.0	4062	100.0	100.0

Source : DGTT, SECOFI.

TABLE II.18. : Contractual object in technology transfer contracts

Contractual	1973-1982 %	1983-1987* %
Technical assistance	23.0	21.5
Basic engineering	5.2	4.1
Technical knowledge	27.7	12.4
Detail engineering	3.7	4.0
Industrial designs	0.1	0.1
Consulting services	-	2.5
Computing software	-	9.4
Copyrights	1.4	3.5
Trade marks licencing	23.5	14.1
Patents licencing	9.0	2.0
Administrative services	5.5	24.1
Franchises	0.7	2.3
Total	100.0	100.0

Source : Dirección General de Transferencia de Tecnologia - SECOFI.
Departamento de Estadistica.

* The coverage of administrative services agreements was broadened considerably by the 1982 Law.

TABLE II.19. : Contracts by economic sector

Economic sector	1973-1982	1983-1987*
Agriculture, forestry and fishing	0.18	0.28
Mining	2.33	3.09
Manufacturing industry	71.18	53.33
Construction	1.48	1.27
Electricity	2.54	6.14
Trade, restaurants and hotels	14.54	13.90
Transp.communications	0.73	1.17
Insurance and realty	2.96	8.80
Communal social, and personal services	0.63	11.50
Non classified	2.83	0.52
Total	100.00	100.00

Source: Dirección General de Transferencia de Tecnologia - secofi. Departamento de Estadistica.

TABLE II.20. : Share of investment, technology and industrial property in Mexico (1983-87)

Origin	Amount of investment		Technology contracts Certs.		Patents & Invent.		Trade marks	
Total	100.0		100.0		100.0		100.0	
Local	91.0		67.8		6.0		48.0	
Foreign	9.0	100.0	32.2	100.0	94.0	100.0	52.0	100.0
- U.S.		65.5		75		56.4		51.2
- F.R.G.		6.9		3.1		7.9		8.7
- Japan		5.6		2.3		6.5		4.4
- Switzerland		4.4		1.3		3.6		4.8
- G.B.		4.7		2.2		3.6		5.3
- France		2.8		3.4		6.9		8.8
- Sub-total		89.9		87.3		84.9		83.2
- Other		10.1		12.7		15.1		16.8

Source : Banco de Mexico and Secretaria Ejecutiva. CNIE

TABLE III.1. : Domestic product, total public expenditure and SC&T public expenditure

	Millions of pesos 1980				
	1979	1980	1981	1982	1983
GDP	3947070	4470077	4862219	4831689	4628937
Public expenditure	1506495	1711745	2098905	2421944	2173859
Programmable public expenditure	987540	1159760	1431294	130508	1099751
SC&T public expenditure	14135	19193	22268	20243	14679
SC&T public expenditure/GDP	0.36	0.43	0.46	0.42	0.32
SC&T PE/public expenditure	0.94	1.12	1.06	0.84	0.68
SC&T PE/programmable PE	1.43	1.65	0.56	0.55	1.33
	1984	1985	1986	1987	1988
GDP	4796050	4919905	475277	4792936	4854497
Public expenditure	2172601	2089499	2431234	2587062	1963986
Programmable public expenditure	1162326	1097764	1023923	960823	906271
SC&T public expenditure	17648	17432	16543	16535	13154
SC&T public expenditure/GDP	0.37	0.35	0.35	0.34	0.27
SC&T PE/public expenditure	0.81	0.83	0.68	0.64	0.67
SC&T PE/programmable PE	1.52	1.59	1.62	1.72	1.45

Sources: Lustig, del Rio, Franco and Martina, EVOLUCION DEL GASTO PUBLICO EN CIENCIA Y TECNOLOGIA 1980-87, Academia de la Investigación Cientifica, Marzo de 1989, SPP, Cuenta de la Hacienda Pública 1988.

TABLE III.2. : Public expenditure in science and technology - main institutions (1988)

Thousands of millions		%
UNAM	153500	14.6
National Inst. of Agric research	123513	11.8
Mexican Petroleum Institute	102300	9.7
CONACYT	110285	10.5
Ministry of Mines & Public Ind	62190	5.9
Ministry of Health	35571	3.4
National Siderurgy Research Inst	30319	2.9
UAM	38888	3.7
CINVESTAV	34949	3.3
Public Education Ministry	27873	2.7
Fund for the support of research	27418	2.6
Electrical Research Institute	21807	2.1
Graduate School of Agriculture	20714	2.0
National Nuclear Research Inst.	16514	1.6
National Politechnical Institute	14597	1.4
Colegio de Mexico	16282	1.6
Mexican Social Security Institute	11622	1.1
National Fishing Institute	10723	1.0
Subtotal	796875	75.8

Source : SPP, Cuenta de la Hacienda Publica Federal, 1988, tomo 10.

TABLE III.3. : Breakdown of public S&T expenditure by activity (in percent)

	1980	1981	1982	1983	1984	1985	1986	1987
Agriculture, forestry and livestock	28.9	23.9	17.9	18.6	18.9	20.8	19.3	20.2
Evaluation and exploitation of natural resources	10.3	8.1	8.4	9.6	7.4	7.9	9.6	9.6
Medicine and public health	21.0	27.3	27.0	25.4	22.6	18.6	18.5	15.7
Communications and transport	0.5	0.1	0.3	0.8	0.7	0.2	0.5	0.4
Fishery	2.8	2.2	2.0	1.0	0.9	1.0	1.1	0.9
Manufacturing industry	4.1	7.1	6.3	5.2	4.6	4.2	5.5	5.3
Universities, technologicals, research in education	21.8	23.2	26.3	27.6	33.4	36.1	33.5	34.3
Housing & ecology	0.0	0.0	0.0	0.5	0.1	0.2	0.2	0.3
Other	10.6	8.1	11.8	11.2	11.5	11.1	11.9	13.2
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Sources: Lustig, Del Rio and Martina, EVOLUCION DEL GASTO PUBLICO EN CIENCIA Y TECNOLOGIA, (1980-87), Academia de la Investigación Cientifica, Mexico, 1989.

TABLE III.4. : Breakdown of R&D by type of institution

Type of institutions	Institutions		R&D personnel	
	number	%	number	%
Public educational	318	50.4	7535	45.9
Private educational	47	5.9	343	7.4
Governmental : federal & state	210	33.3	8088	49.3
Private firms	37	5.9	122	0.74
State owned firms	3	0.8	79	0.5
International	3	0.5	123	0.7
Other	13	3.2	114	-4.54
Total	631		16404	100

Source : Estadísticas Básicas del Inventario de las instituciones y recursos dedicados a las actividades científicas y tecnológicas", SERIE ESTUDIOS 10, México, CONACYT, 1989.

TABLE III.5. : Breakdown of R&D personnel by scientific field

Scientific field	1974		1984	
	number	%	number	%
Exact and natural sciences	2245	26.1	3951	24.0
Agricultural science and tech.	1061	12.3	2543	15.4
Engineering science and tech.	1175	13.7	2589	15.8
Medical and health sciences	1195	13.9	3542	21.6
Social studies and humanities	2662	30.9	3799	23.1
Non response	259	3.1	-	-
Total	8595	100	16404	100

Source : "Estadisticas Básicas del Inventario de la instituciones y recursos dedicados a las actividades cientificas y tecnológicas", SERIE ESTUDIOS 10, México, CONACYT, 1989.

TABLE III.6. : Expenditure on education

	millions of pesos 1980				
	1980	1981	1982	1983	
Expenditure on education	139971	174567	181759	126565	
Expenditure on education/GDP	0.031	0.036	0.038	0.027	
Ex.on education/Public expenditure	0.082	0.083	0.075	0.058	
Ex.on education/Programming expenditure	0.121	0.122	1.393	0.115	
	1984	1985	1986	1987	1988
Expenditure on education	134556	138307	125792	123323	123570
Expenditure on education/GDP	0.028	0.028	0.265	0.026	0.025
Ex.on education/Public Expenditure	0.062	0.066	0.052	0.048	0.063
Ex.on education/Programming expenditure	0.116	0.126	0.123	0.128	0.136

Sources: Lustig, del Rio, Franco and Martina, EVOLUCION DEL GASTO PUBLICO EN CIENCIA Y TECNOLOGIA 1980-87, Academia de la Investigación Científica, Marzo de 1989. Presidencia de la República Informe de Gobierno, 1989 Anexo Estadístico.

TABLE III.7. : Expenditure on education (thousands of millions)

	1980	1981	1982	1983	1984	1985	1986	1987	1988
Total	139971	174567	181759	126565	134556	138307	125792	123323	123570
Basic	70429	93165	92443	57765	56790	60827	55576	59502	58431
Middle-higher	15402	19543	23166	17133	14471	17919	21004	16509	17629
Undergraduate	30181	32025	35604	27694	22854	23699	23933	24862	24529
Graduate	1099	1211	1209	1073	3811	4137	4096	4430	4363
Other	22682	28215	57120	22527	36212	30613	20756	13820	22606

Source : Presidencia de la República, Informe de Gobierno 1989, Annexo Estadístico.

TABLE III.8. : Enrollement by educational level

	Thousands										Growth rates	
	79-80	80-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	79-83	84-88
Total	20114.6	21464.9	22673.3	23682.8	24455.3	24756.2	25253.8	25436.7	25444.7	25444.7	4.17%	0.66%
Pre-school	854	1071.6	1376.2	1691	1893.7	2147.5	2381.4	2547.3	2625.7	2668.6	18.62%	5.88%
Primary	14126.4	14666.3	14981.1	15222.9	15376.2	15219.2	15124.2	14994.6	14768	14656.4	1.89%	-0.80%
Capacitation	254.4	369.3	395.2	407.3	435.9	427	407.7	445	446.6	440	12.49%	0.16%
Secondary	2818.6	3033.9	3348.8	3583.3	3841.7	3969.2	4179.5	4294.7	4347.2	4355.3	6.18%	2.11%
Subtotal:Basic education	18053.4	19141.1	21101.3	20904.5	21547.5	21762.9	22092.8	22821.6	22187.5	22120.7	3.73%	0.44%
Technical middle education	97.3	122.4	220.8	301.5	316.6	317.1	359.1	408.7	462.2	427.7	32.68%	5.14%
Preparatory	942.9	1057.7	1142.9	1233.9	1310.9	1427.8	1538.1	1527.4	1586.1	1642.8	6.96%	3.83%
Subtotal:Middle-education	1042.2	1180.1	1363.7	1534.4	1627.5	1744.9	1897.2	1936.1	2048.3	2070.5	10.2%	4.09%
Education	290.8	332.5	332.7	324.1	299.2	226.5	191.1	151.5	132.1	126.7	2.75%	-13.34%
Universit.& Technology Inst.	760.2	811.2	875.6	918.8	981.1	1021.9	1072.7	1025	1071.4	1085.1	4.85%	1.69%
Subtotal:Higher education	1051.0	1143.7	1208.3	1242.9	1280.3	1248.4	1263.8	1176.5	1203.5	1211.8	4.28%	-0.91%
Graduate			30.179		33.735	39.048		42.5	41.4	45.1	n.d.	4.96%
Main educational levels as % of total enrollement												
Primary	70.20	68.3	66.1	64.3	62.9	61.5	59.9	58.9	58.0	57.6		
Secondary	14.0	14.1	14.8	15.1	15.7	16.0	16.5	16.9	17.1	17.1		
Postsecondary	10.4	10.8	11.5	11.7	12.0	12	12.5	12.4	12.9	13.1		
Education	14.0	15.0	15.0	14.0	12.0	9	8.0	6.0	5.0	5.0		
Undergraduate & graduate	3.8	3.8	4.0	3.9	4.2	4.1	4.2	4.2	4.4	4.4		
Graduate	n.a.	n.a.	1.0	n.a.	2.0	n.a.	n.a.	2.0	2.0	0.002		

Source : Presidencia de la República, Informe de Gobierno de 1989, Anexo Estadístico.

TABLE III.9. : Breakdown of undergraduate university education enrollement by field of study

	Thousands										Growth rate per annum	
	78-80	80-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	79-83	84-88
Total	760.2	811.3	875.6	918.8	981.1	1021.9	1072.7	1025	1074	1085.1	4.85%	1.69%
Natural and basic sciences	44.2	47.2	50.9	53.4	67.4	30.9	32.4	31	32.5	32.8	4.84%	-11.31%
Medical sciences	159.6	170.3	183.8	192.9	205.9	147.6	154.9	148	154.7	156.7	4.85%	-4.45%
Agricultural sciences	55.3	59	63.7	66.8	70.9	96.5	101.3	96.8	101.2	102.5	4.84%	6.34%
Engineering & technology	208.9	222.9	240.6	252.5	270	279.7	293.6	280.6	293.2	297	4.85%	1.60%
Social & business studies	284	303.2	327.2	343.3	366.8	436.8	458.5	438.1	457.9	463.8	4.85%	3.99%
Education & humanities	8.2	8.7	9.4	9.9	0.1	30.4	32	30.5	31.9	32.3	4.82%	161.94%
Graduated students	59.8	69.751	77.437	88.812	114.266	92.401	97.496	99.011	113.341	108.332		
Attention to demand	90.3	88.6	82.1	84.6	78.5	70	77.4	63.7	63.8	57.7	-1.62%	-5.00%
Graduation/total enrollement	0.079	0.086	0.088	0.097	0.116	0.090	0.091	0.097	0.106	0.100		
Percentages												
Natural & basic sciences	5.81	5.82	5.81	5.81	6.87	3.02	3.02	3.02	3.03	3.02	5.81	3.66
Medical sciences	20.99	20.99	20.99	20.99	20.99	14.44	14.44	14.44	14.40	14.44	20.99	15.53
Agricultural sciences	7.27	7.27	7.28	7.27	7.23	9.44	9.44	9.44	9.42	9.45	7.27	9.07
Engineering & technology	27.48	27.47	27.48	27.48	27.52	27.37	27.37	27.38	27.30	27.37	27.48	27.38
Social & business studies	37.36	37.37	37.37	37.36	37.39	42.74	42.74	42.74	42.64	42.74	37.37	41.83
Education & humanities	1.08	1.07	1.07	1.08	0.01	2.97	2.98	2.98	2.97	2.98	1.08	2.48
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source : Presidencia de la República, Informe de Gobierno 1989, Anexo Estadístico.

TABLE III.10. : Graduated students from universities and technological institutes in relation to occupied labour force

	79-80	80-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89
1.Graduated students (thousands)	59.8	69.751	77.437	88.812	114.266	92.401	97.496	99.011	113.341	108.332
2.Basic and natural sciences	3.477	4.058	4.502	5.162	7.850	2.794	2.945	2.994	3.430	3.275
3.Agriculture and pecuary sciences	4.350	5.072	5.634	6.457	8.258	8.726	9.207	9.351	10.680	10.233
4.Engineers	16.433	19.164	21.278	24.407	31.446	25.291	26.685	27.105	30.942	29.651
5.Business and social sciences	22.340	26.067	28.937	33.184	42.720	39.496	41.672	42.319	48.323	46.304
6.Medical sciences	12.555	14.641	16.255	18.646	23.981	13.346	14.079	14.296	16.326	15.644
7.occupied labour force (thousands)	17722	18050	18400	18760	19130	19500	19890	20300	20680	21090
1/7	3.374	3.864	4.209	4.734	5.973	4.739	4.902	4.877	5.581	5.137
2/7	0.196	0.225	0.245	0.275	0.410	0.143	0.148	0.148	0.166	0.155
3/7	0.245	0.281	0.306	0.344	0.432	0.447	0.463	0.461	0.516	0.485
4/7	0.927	1.062	1.156	1.301	1.644	1.297	1.342	1.335	1.496	1.406
5/7	1.261	1.444	1.573	1.769	2.233	2.025	2.095	2.085	2.337	2.196
6/7	0.708	0.811	0.883	0.994	1.254	0.684	0.708	0.704	0.789	0.742

Source : Presidencia de la República, Informe de gobierno 1989. Labour force figures : Nacional Financiera, LA ECONOMIA MEXICANA EN CIFRAS, 10a edicion.

TABLE III.11. : Graduate registration

	83-84				87-88				83-84	87-88
	Spec.	Master	Phd	Total	Spec.	Master	Phd	Total	%	%
Total	11725	21099	911	22735	12652	23579	1208	37439		
%	0.35	0.63	0.03		0.34	0.63	0.03			
Agricultural	109	836	22	967	82	1017	26	1125	0.03	0.03
Natural sciences	84	2124	301	2509	150	2512	339	3001	0.08	0.07
Medical sciences	9552	1215	151	10918	9818	1147	192	11157	0.30	0.32
Social & business studies	1554	12545	380	14479	1978	12264	465	14707	0.39	0.43
Engineering & technology	426	4379	57	4862	527	4354	60	4941	0.13	0.14
Education & humanities					97	2285	126	2508	0.07	

Source : ANNUIES, Anuario del Posgrado, 1984 and 1988, México.

TABLE III.12. : Scholarships granted by CONACYT

Year	Total
1979-80	3378
1980-81	4618
1981-82	4340
1982-93	1801
1983-84	2540
1985-86	2033
1986-87	2608
1987-88	1843
1988-89	2220
1989-90	2235

Source : Presidencia de la República, Informe de Gobierno, Anexo Estadístico, 1989.

TABLE III.13. : Scholarships by field of knowledge

	1982 (%)	1986 (%)
Basic Sciences	15.7	29.8
Engineering	24.5	24.2
Social and business studies	41	13.3
Agricultural	9.3	18.8
Health sciences	6.5	8.4
Earth sciences	3	5.5
Total	100	100

Source : DADRHY, CONACYT quoted by : Barnés et al. "El Programma de Fortalecimiento del Posgrado Nacional," CIENCIA Y DESARROLLO. Número especial, Abril, Mexico, CONACYT, 1987.

TABLE IV.1. : Mexican technological institutions

Sector of activity or service	Technological capabilities G	S	I	Mexican institutions	Priority	EEC technical cooperation projects
1.Agriculture	2		7	Instituto Nacional de Investigaciones Agricolas Forestales y Pecuarias (INIFAP) - Univ.Autónoma de Chapingo, Instituto Antonio Narro, Centro de Instituciones de Maiz y Trigo (CIMYT)	II	STD:tropical & subtropical agriculture. AGRICULTURAL RESEARCH PROGRAMME : competitiveness management of agricultural resources
02.LIVESTOCK	1	5	3			
03.FORESTRY		1	7	INIFAP	II	FOREST
04.FISHERY AND AQUACULTURE		7	2	Instituto Nacional de Pesca	II	FAR : fisheries & aquaculture
MINERIA (05.07-10)minerals 06.oil	 6	 7 2	 2	Mining Develpment Commission Council for Mineral Resources Industrias Petroles I Industrial Minera Mexicana I PEMEX and Instituto Mexicano del Petroleo (IMP)		CECA-CHARBON
MANUFACTURE						
11-19. Food	1	8		CIATEJ (Jalisco) UNAM, Facultad de Quimica CINVESTAV Inst.Tecnológico de Durango Univ.Autónoma Metropolitana (UAM-I) Universidad Iberoamericana Laboratorios Nacionales de Fomento Industrial (LANFI)	II	FLAIR PROGRAMME: agroindustrial research (enhancement of quality, hygiene,etc)
20-22. Beverages		8	1			
23. Tobacco	1	6	2			
24-26. Textiles	1	4	4	Centro de Diseño y Moda de la Indust.Textil y del Vestido MYLON I		SPRINT : Strategic
27. Apparel		4	4	Centro de Diseño y Moda de la Indust.Textil y del Vestido		Program for innovation and technology transfer
28. Footwear		5	4	CIATEG (Guanajuato)		FOREST
29-30. Wood		4	5			
31. Paper	1	7		LANFI		
32. Printing & editorial	1	5	2			
33. Oil derivates	7	2		PEMEX IMP		BOR : community bureau of reference Applied Metrology and Chemical analysis
34. Basic petrochemical	6	3				
35. Basic chemicals	1	7	1	Centro de Invest.Quimeca Applicada (CIQA) - Saltillo LANFI		
36. Fertilizers	1	6	2	FERTIMEX I		
37. Resins & fibres	4	4	1	RESISTOL, ALFA, CYDSA I		
38. Pharmaceuticals		6	3	UNAM, Facultad de Quimica CINVESTAV UAH-1 NOVOM, SILANES I		
39. Soaps, deter.cosmet.		3	4	Inst.Mexicano de Investigaciones Tecnológicas (IMIT)		
40. Other chemical prod.	1	4	4	IMIT		
41. Rubber		7	2	NEGROMEX I		
42. Plastic products		6	3	CIQA (Saltillo)		

Sector of activity or service	Technological capabilities G	S	I	Mexican institutions	Priority	EEC technical cooperation projects
43.Glass & products	8		1	VITRO I		
44. Cement	7	2		CEMENTOS MEXICANOS I		
45. Other non met.min.		6	2			
46. Basic steel	2	6		HYLSA, SIDERMEX I IMIS (INST.FOR STEEL R.)		OBCA-ACIER
47. Metallurgy	1	3	4			Revolving of Waste R & D
48. Metallic furniture		3	5			
49. Structural steel		7	2			
50. Other except machinery		1	4			
51. Non electrical mach.&equip. a)Construction b)mining & petroleum c)agricultural machinery		3 4 3 4	2 3 5 5	Instituto de Manufacturas Metalmecánicas (IMMEC)		
52. Mach.&elect.equip.		7	2	IMMEC		
53. Elect.appliances	1	6	2			
a)Consumer electronics		5	4	CETEI CINVESTAV		ESPRIT Microelectronics and peripherals Information processing systems II application technologies
54.b)professional electronics		2	7	UNAM.-Instituto de Fisica - Instituto de Fisiologia Cellula		
55. Electr.mach&equip.	1	4	4			
56. Automobiles		8	1			
57. Auto-components		8	1	CONDUMEX, METALSA I, SPICER I		
58. Transport equip & mach.		6	3			
59. Instruments & measurement equip.	1	5	3	UNAM. Instituto de Instrumentos		
60. CONSTRUCTION	6	2		UNAM, Inst.de Ingeniera ICA, PROTEXA I		
- biotechnology	2	4	4	INIFAP UNAM. Centro de Invest.Sobre Ingeniera Genetica y biotechnologia	II	BRIDGE : biotechnology research innovation ECLAIR : European linkage of agriculture & Industry through research
- new materials		4	5	UNAM. Instituto de recursos Materiales Instituto de Fisica Instituto de Investigaciones Electricas (IIE) IMP	II	BRITE-EURAM: Cost shared program concerning advanced severals technology, design technology & assurance for products & services
- petroleum	6	2		IMP	II	RADIOACTIVE WASTE MANAGEMENT TELEMAN:REMOTE HANDLING OF HAZARDOUS ENVIRONMENTS JOULE:joint opportunities for unconventional sources of energy supply
- geothermics	4	4				
- electrical	3	5	1	IIE EPN I		

Sector of activity or service	Technological capabilities G	S	I	Mexican Institutions	Priority	EEC technical cooperation projects
- nuclear	1	1	6	Instituto Nacional de Investigaciones Nucleares (ININ),CINVESTAV (solar),IIE(solar),UNAM, Instituto de Ciencias del Mar (sea)		
BASIC SERVICES						
housing		7	2	Ministerio Desarrollo Urbano y Ecologia INFONAVIT	II	
medicine & health				Specialized Research Institutions & hospitals of the Ministery of Health Mexican Social Security Institute (IMSS)		AIM program for advanced informatics in medicine MEDICAL RESEARCH PROGRAM: improve efficiency of medical research efforts
water & drainage	1	6	2	National Water Commission DDF UNAM. Instituto de Ingeniera	II	
environment protection				Inst.de estudios Ecológicos of the M.of Urban Development & Ecology Instituto de Ecologia, UNAM, Instituto de Geologia ECODESARROLLO Instituto Nacional de Investigaciones sobre Recursos Bióticos (INIREB), CFE		STEP: research into environment and health Risks associated with chemicals EPOCH:research & past climates, climatic & seismic hazards
education		3	6	Ministry of Public Education Instituto Nacional para la Educación de los Adultos Instituto de Investigaciones educativas UNAM, UAP CONACYT	II	DELTA:development of European Learning through technical advance. Support R&D to be used for the of teaching and learning
transport		2	7	Ministry of Communications & Transports Mexican Inst.of Transport	II	EURET:optimum network exploitation logistics & reduction of harmful externalities
communications		2	7	Instituto Mexicano de Communicaciones (INC) Teléfonos de México (TELMEX)	II	RACE:integrated broad bord communicators INSIS:new technologies for information eectronic transmission of papers, teleconference, data base
trade and storage		4	5			
engineering consultancy	4	5		EPN I ICA I PROTEXA I BUFETE INDUSTRIAL I		

Sector of activity or service	Technological capabilities			Mexican Institutions	Priority	EEC technical cooperation projects
	G	S	I			
S&T activities				CONACYT Colegio de México UNAM, UAM, CINVESTAV Private Universities (Part.Instituto Tecnológico de Estudios Superiores de Monterrey & Universidad Iberoamericana) Large government and regional research institutes	II	Science Program SPES PROGRAM Monitor SAST:strategic analysis in the field of S&T FAST:forecasting & assesement in S&T SPEAR:support program for the evaluation activities in the field of research VALUE:ease and acceleration of the circulation of results COMET II linkages between univ.& industry

I firms
II priorities

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