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IMPACTS OF LIBERALIZATION AND ECONOMIC INTEGRATION ON MEXICO'S COMPUTER SECTOR

Short Title: Liberalization of Mexico's Computer Sector

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I. INTRODUCTION

Trade liberalization, privatization and deregulation are the fundamental elements of neoliberal economic prescriptions for boosting growth and productivity in developing countries. The basic premises of neoliberal doctrine revolve around the idea that "Efficiency and transparency led by markets are better than inefficiency and opaque systems led by government" (Kagami and Tsuji, 1999). On that basis, "state-owned enterprises have been privatized and deregulation in social and economic activities has been going on in developing countries as well as in advanced countries. This market-oriented approach has become the main economic philosophy in the contemporary world" (Kagami and Tsuji, 1999, pp. 1–2).

As the key correlate of neoliberal theory, free trade has become the guiding principle and the programmatic backbone of the policies implemented by the top international financial institutions. In the words of an International Monetary Fund report (1997), "With open trade, domestic prices reflect world prices, thereby promoting the efficient allocation of resources. Open trade and capital account policies not only allow a country to exploit its comparative advantages in production, but they also promote the importation of lowest-cost products, often with embedded advanced technology… such spillovers of advanced technology into developing countries provide a key mechanism for productivity catch-up with advanced economies."

If the above is true, the computer industry is a case in which significant benefits from open trade could be expected, as it embodies advanced technologies that can be applied by virtually all economic sectors. In keeping with such expectations, developing countries around the world have been opening up their computer markets to foreign trade and investment for the

past decade or more. One example of this trend is Mexico. In the 1980s, the Mexican computer industry was governed by policies that limited participation of foreign companies and tightly restricted imports of computer equipment. However, in 1990 most restrictions on trade and foreign investment were lifted as part of a broad program of economic liberalization. Mexico further opened its computer market in the mid-1990s as it signed and implemented the North American Free Trade Agreement (NAFTA).

Mexico's case is therefore most relevant for examining the process of liberalization and its impacts on both computer production and use. Using data on production, use, imports and exports, as well as information gathered in interviews with major computer companies and related business organizations, government officials and computer users, we analyze how liberalization has affected both company-level decisions and broader industry-level trends. The result is a mixed, nuanced set of findings, showing that liberalization has indeed led to some of the benefits expected by its proponents, but not without significant costs for the local industry. We also find that the lack of sectoral policies to support investment and enhance national capabilities has kept Mexico from capitalizing on its unique geographical location and membership in NAFTA.

This paper is organized as follows: first we discuss the economic environment and the process of liberalization at the macroeconomic level. Next we detail Mexico's policies for the computer industry, from the protectionist approach of the 1980s to the liberalization measures of the 1990s. Then we analyze the impacts of liberalization on trade, investment, production, use, and the local market in the computer sector. Finally we draw conclusions from the case and discuss its implications.

II. ECONOMIC ENVIRONMENT AND LIBERALIZATION[1]

Beginning in the 1940s, Mexico embarked on an era of growth and prosperity that lasted over 30 years, with annual economic growth rates of over 6 per cent in real terms, and more than 3 per cent on a per capita basis.   These achievements helped solidify the political rule of the Institutional Revolutionary Party (PRI), which has governed Mexico since 1929.

The policies behind this success were dubbed *desarrollistas* (developmentalist), as they had rapid growth as their overriding concern. Mexico's impressive industrialization was based on an aggressive import substitution strategy, as both Mexican and foreign companies developed manufacturing capacity to serve the protected domestic market. However, the economy began to slow in the 1970s, as import substitution opportunities became exhausted and Mexico felt the impacts of global economic shocks.

The discovery of large oil reserves in 1976 changed the picture dramatically. During the oil boom of the late 1970s, Mexico's GDP grew by over 8% per year as oil exports soared. The government borrowed heavily to expand production and invest in other development projects. However, by 1981 oil prices were falling and world interest rates rose dramatically, raising the cost of servicing Mexico's foreign debt. The trade deficit grew, and investors began to move capital out of the country. In 1982 the situation became critical, and the government took drastic steps to protect its dwindling foreign reserves, including nationalizing the banking system, adopting foreign exchange controls, suspending principal payments on foreign debt, and devaluing the peso.

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[1] This review of Mexico's economic history draws on Roger Hansen (1974) and Nora Lustig (1992), and the work of Lustig and John Adams, Jr., as summarized by Leithe (1997).

Mexico suffered from a severe shortage of capital as a result of the crisis. From 1983 on, the Mexican government began to re-privatize commercial banks. In 1984, it began to open up its economy by replacing import permits with tariffs in the General Importation Tax Tariffs and reducing both tariff levels and the number of tariff categories: from 16 in 1982 ranging from zero to 100%, to 11 in 1986 ranging from zero to 45% (Palacios, 1992, p. 35). In 1986 Mexico joined the General Agreement on Tariffs and Trade (GATT), agreeing to a program of further liberalization, privatization, and deregulation. After winning a disputed victory in the 1988 presidential election, president Carlos Salinas further accelerated the ongoing economic reform process.

The changes were dramatic. Tax reforms were enacted and public spending was cut to reduce the fiscal deficit. Major state enterprises were privatized, including Teléfonos de México (Telmex), the country's two airlines, mining companies, sugar refineries, and a large number of manufacturing firms. Bank re-privatization was completed and restrictions on foreign ownership were removed or relaxed in key sectors such as telecommunications, mining, transportation and petrochemicals (although the oil company, Pemex, remained in government hands). Restrictions to foreign investment were largely lifted under a New Foreign Investment Law in 1993. In the same year, trade barriers were further lowered under a new Foreign Trade Law. The process was so rapid that only 20% of the economy was protected by tariffs or import licenses in 1988, compared to 75% in 1985. Thus the opening up of the Mexican economy was swift and unilateral vis-à-vis major trade partners, especially the United States.

As a result of these changes, investor confidence in the Mexican economy was restored, leading foreign investment inflows to grow from US$3 billion in 1989 to US$12.2 billion in

1991.[2] Inflation was brought under control and the economy began to grow again. From 1990

on, the Salinas administration sought to anchor its liberalization policies by negotiating a free

trade accord with the United States and Canada. The North American Free Trade Agreement

(NAFTA), tying the three countries into a continental free trade zone, entered into force in

January 1994.

NAFTA, on top of the earlier economic restructuring, attracted more foreign investment

into Mexico. However, in 1994, investor confidence was shattered by the Chiapas rebellion and

the assassinations of presidential candidate Luis Donaldo Colosio and PRI secretary general José

Francisco Ruiz Massieu. These events led to a capital outflow that at one point totaled one-third

the value of Mexico's outstanding stocks.

The Mexican government was forced to allow the peso to float freely in December of that

year, and it immediately lost 40% of its value. The economy fell into a deep recession in 1995,

with GDP falling by 6.2%, but unlike the 1980s crisis, this one was short-lived. Exports grew

rapidly, foreign investment returned, and economic growth resumed in 1996.   Table 1

summarizes Mexico's economic performance since 1980.

INSERT TABLE 1 HERE

The decade-long process of liberalization and economic integration into NAFTA has

changed the Mexican economy substantially. The process opened Mexico to the winds of

foreign competition, creating new opportunities for some, while causing economic and social

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[2] It is worth noting that part of the capital that flows into and out of Mexico each year corresponds to Mexican

capital, which is moved back and forth largely between Mexico and the U.S. in response to investment risk,

opportunity, and expectations.

dislocation for others.   These changes have been felt keenly in the computer sector, as it was liberalized abruptly, ending a decade of protection for the domestic industry.

III. LIBERALIZATION IN THE COMPUTER INDUSTRY

The first major policies affecting the computer industry were a series of foreign investment laws passed in the early 1970s aimed at increasing national self-sufficiency in technology. These laws enhanced the state's role as an industry regulator and promoter, matching the country's nationalistic economic ideology at the time.

The development of a national technology strategy was put into the hands of the National Council on Science and Technology (CONACyT), created in 1970. CONACyT was made responsible for coordinating science and technology policies and is the leading source of research funding even today. During the late 1970s and early 1980s, bureaucratic control over technology and foreign investment policies shifted among several agencies.   In 1983, the functions were centralized under the Ministry of Commerce and Industrial Promotion (SECOFI).

Policies in the 1980s: Computer industry protection and promotion

During the 1980s the Mexican government adopted policies specifically aimed at the computer industry for the first time. In 1981, SECOFI's forerunner, SEPAFIN, formulated the so-called "Program to Promote the Manufacture of Electronic Computing Systems, their Central Processing Units and their Peripheral Equipment," more commonly referred to as the Computing Program in English and the PC (Programa de Computadoras) in Spanish. This program was never published in the official government gazette as some in the government were concerned about reaction from the U.S., while others were uncomfortable with SEPAFIN's expanding power. Instead, the government implemented the plan for about nine years, without formally promulgating it. The key goals of the plan were (Borja, 1995):

- To generate local production of mini- and micro-computers, parts and components,

- To promote computer exports,

- To achieve greater technological autonomy in computer technologies.

The following policies were adopted to achieve these objectives:

- *Trade*: Access to the domestic computer market was limited to companies that would produce according to the Program's provisions.

- *Foreign investment*: Foreign ownership was limited to 49 per cent in the production of PCs and peripherals.

- *R&D*: Foreign companies were required to invest a fixed percentage (between 3% and 6%) of gross sales in R&D, and to fund the creation of research centers and training programs.

- *Government procurement*: Preferential treatment was given to companies registered in the Program.

- *Domestic content*: A minimum proportion of domestic parts and components was required in final products (45 per cent for PCs and 35 per cent for minicomputers).

- *Fiscal and credit incentives*: New companies in the computer industry could receive fiscal credits and soft loans from government development funds.

According to José Warman, considered its key architect, the Computing Program aimed to move Mexico away from import substitution to a more balanced strategy that included export promotion and the creation of domestic technological capabilities. The PC was seen at the time as offering a new opportunity for Mexico to develop a domestic computer industry supported by a broader electronics industry.

Almost as soon as the computer program was in place, the environment began to change substantially. First, the debt crisis of 1982 shifted the government's emphasis from industrial policy to financial policy, with the balance of payments becoming the critical concern. Second, the introduction of the IBM-PC led to the standardization of the PC industry on the IBM architecture and the creation of a global production network for high-volume PC production (Dedrick and Kraemer, 1998).

These two developments led to a shift in strategy in 1985 when IBM asked permission to produce PCs in Guadalajara, but balked at the joint venture requirement in the Computing Program. IBM had already abandoned India rather than give in to demands that it enter a joint venture there, and it had been fighting with the Brazilian government over Brazil's market reserve plan.

The Mexican government was opposed to granting an exemption to IBM, especially since other foreign firms such as Unisys, Apple, Hewlett-Packard and Wang had already formed joint ventures with Mexican partners. But IBM was not only the biggest computer maker in Mexico and the world, it was now the dominant PC maker and a global industry was growing around its standard. Keeping IBM out of Mexico's PC market would isolate the country at a time that it hoped to become more integrated into the emerging industry.

In the end, IBM and the Mexican government came to an agreement that gave IBM the right to retain full ownership of its new plant, which opened in 1986. Soon thereafter, Hewlett-Packard also received permission to take 100% control of its Mexican operations, while Apple decided to pull out of the Mexican market.

IBM did offer a number of concessions to get permission for 100% ownership of its plant. It invested $11 million in a new Center for Semiconductor Technology in Guadalajara. It

also agreed to develop local suppliers, and most importantly agreed to export a large share of the

plant's output, helping Mexico reduce its trade deficit in computers. IBM's PC exports helped

lower the trade deficit in PCs from $200 million in 1985 to $78 million in 1987 (Borja, 1989).

The IBM decision marked a turning point in the Computing Program. SECOFI shifted its

emphasis from industry protection to export promotion and encouraging the use of information

technology (IT) throughout the economy. In 1987, computer makers were allowed to import

components for assembly with a 13% tariff and to operate outside the Computing Program, an

option taken by some Mexican PC makers who simply did final assembly of Asian PCs. PC

prices dropped but Mexico failed to develop a domestic supply base for parts and components.

Policies in the 1990s: Liberalization and economic integration

In 1990, the Salinas administration opened up the Mexican computer market to imports,

eliminating import permits and retaining only a 20% maximum tariff. R&D requirements were

dropped and all companies were given access to government procurement contracts. The

Computer Program was now a thing of the past, leaving in its place a largely free market in the

computer sector. NAFTA further liberalized the computer sector, by lowering tariffs on PCs

from 12% in 1994 to zero in 1998.

Mexico's liberalization of the computer sector took a "big bang" approach of opening the

sector all at once and letting the industry adjust to the new environment. Policies since then have

been based on the belief that liberalization of the sector would ensure the best results and that

there should be only a limited role for the government in promoting or regulating the sector.

While laissez-faire has been the general trend, there have been some scattered attempts at

industry promotion in the 1990s. When Ernesto Zedillo became president in December 1994, he

explicitly called for the development and exploitation of information technology as a national

goal. This goal was given form in the Plan for the Development of Informatics (PDI), which targets: (1) promotion of IT use; (2) human resource development; (3) research and development; (4) development of a local IT industry to exploit niche opportunities; (5) improvement of the telecommunications infrastructure; and (6) creation of the necessary legal framework to support IT (e.g. intellectual property rights).

However, the PDI has had little impact, for two reasons. First, there are no funds set aside to pay for new projects, so funding must come from the relevant government agencies' already tight budgets. Second, there is little coordination among the institutions involved, and no pilot agency to ensure that policies are designed so as to complement each other.

The government is also encouraging development of local production, mostly through creating a supplier base to support the multinationals producing in Mexico. The organizations involved are the Mexican Investment Board, the foreign investment office of SECOFI, and two development banks—Banco Nacional de Comercio Exterior (Bancomext) and Nacional Financiera (NAFIN). SECOFI also operates local supplier development programs in its offices in most of Mexico's states.   In addition, the national electronics, telecommunications and informatics industry chamber (CANIETI) has implemented a strategy to develop a local supply base for the computer and electronics industries. In Jalisco, a separate organization was created in early 1998 named Electronics Industry Production Chain (CADELEC), which is specifically devoted to promoting the development of local suppliers to the large electronics companies operating in that state. However, there is little coordination of efforts, limited funding, and no overarching strategy aimed at developing long-term capabilities.

A pre-liberalization policy that has facilitated the growth of the computer and electronics industries in Mexico is the decades-old maquiladora program, which allows components to be

imported duty free as long as they are re-exported in finished products. A complementary U.S.

policy allows imports from maquiladoras with duties paid only on the value added in Mexico.

IV. IMPACTS OF LIBERALIZATION ON THE COMPUTER SECTOR

To analyze the impacts of liberalization on Mexico's computer sector, it is important to keep in

mind that there were two major processes at work. The first was market liberalization, marked

by the one-time elimination of most trade barriers in 1990. The second was NAFTA, the terms

of which were agreed upon in 1992, but which did not go into effect until January, 1994. The

impacts of liberalization were felt quickly, as computer prices dropped and new companies

entered the Mexican market. The reactions to NAFTA were more gradual, as some companies

responded after the agreements were made, in anticipation of their ratification, while others were

more cautious, waiting until after NAFTA had been in effect for some time.

Sorting out the impacts of liberalization is complicated by the peso crisis and ensuing

recession of 1995, but by looking at trends over the whole decade we get a clearer idea of the

impacts of liberalization and NAFTA on trade, computer production, the local market, and

computer use.

Trade

Computer imports started to grow quickly in 1990, immediately after the market was liberalized

(Figure 1). This is not surprising, as liberalization led to lower prices and brought more

competitors into the domestic market.

Computer exports have shown high growth rates since 1992, growing sixfold to over $3

billion in 1996 according to Reed Electronics (Figure 1). SECOFI states that the value of the

PCs exported increased nearly sevenfold from only $553 million in 1990 up to $3.8 billion in

1997 (SECOFI, 1998).   The growth in exports took off around the time that NAFTA was successfully negotiated and has continued since.

For several years, Mexico was running substantial trade deficits in computer hardware. This situation was reversed after the peso crisis of 1994–1995, which created a sharp recession and cut into the buying power of the peso.   Since 1995, Mexico has run a trade surplus in computers, mirroring a shift from deficit to surplus in its overall trade balance.

INSERT FIGURE 1 HERE

Trade between the U.S. and Mexico shows a similar pattern.   Figure 2 shows that trade in both directions was growing steadily before NAFTA was implemented in 1994, with the U.S. running a stable trade surplus.   In 1995, however, Mexico's imports declined while its exports continued to grow, due to the peso crisis.   Since then, trade has again continued to grow in both directions, but now with Mexico running a surplus.

INSERT FIGURE 2 HERE

Computer production

In the 1990s computer production in Mexico expanded rapidly, from $916 million in 1991 to $2.9 billion in 1997, not including production by maquiladoras (SECOFI, 1998).   When maquiladora production is included, computer hardware production topped US$4.5 billion in 1997 (Figure 3).   Computer production appears to have been influenced by the signing of NAFTA, which was agreed to by the three countries in 1992 and implemented in January, 1994.

INSERT FIGURE 3 HERE

Industry structure

Mexico's computer industry has evolved into being primarily an export platform for the U.S. market, thanks to Mexico's location and membership in NAFTA.   Geographically, the computer

industry is not clustered along the border like the consumer electronics industry and other maquiladora industries. Only Acer operates a major PC plant on the border, in Ciudad Juárez. Most of the industry is concentrated in Guadalajara, the capital of Jalisco state in western Mexico, where companies sacrifice immediate proximity to the U.S. in return for lower wages, a more stable work force, and a good pool of engineers and IT professionals.

Mexico's role as an export platform is associated with an industry structure that mirrors other export platforms such as Malaysia and Ireland. First, the industry is dominated by foreign MNCs, with little participation by locally-owned firms. Second, the industry concentrates on assembly activities, since components and equipment can be easily imported from the U.S. Third, the industry consists mostly of large foreign computer makers, such as IBM, Hewlett-Packard and Acer, plus a few Asian companies such as LG Electronics and Tatung which make both TV sets and computer monitors, and large contract manufacturers such as Solectron and SCI. Very few locally-owned companies are involved in the production of computer hardware.

Mexico's computer industry has grown in size and diversity in the past few years. The passage of NAFTA encouraged foreign companies to supply their Mexican operations from Mexico, rather than bring in parts from Asia. In addition, the short product cycles of the computer industry have forced computer makers serving the U.S. market to shorten their supply chains to improve their speed to market. The result has been a rapid growth in production of circuit boards, cables, connectors and other parts, although there is still almost no production of major components such as semiconductors and hard disk drives.

Firm activities

The impacts of liberalization on individual companies is illustrated by the top computer producers and vendors in Mexico—IBM, Hewlett-Packard—and by local PC companies.

IBM

IBM de México began manufacturing typewriters in 1957 in Mexico City, moved to Guadalajara in 1975, and began producing minicomputers in 1982. The Guadalajara plant began producing PCs in 1985 and disk drive components in 1986. Output grew rapidly, and by 1988 IBM's total exports from Mexico were over US$300 million.

Since the liberalization of Mexico's computer market in 1990, IBM has diversified its production in Guadalajara. Production decisions are no longer based on meeting government requirements for exports or local content, but rather on filling a role in IBM's global production network. IBM now produces desktop and notebook PCs, PC servers, and disk drive components. Employment at the Guadalajara plant was estimated at around 8,000 workers in 1998.[3]

Not only is IBM the biggest producer and seller of IT products and services, it has also been a leader in developing local suppliers. IBM Guadalajara uses 25 Mexico-based suppliers (including foreign-owned contract manufacturers) among its total of 200 suppliers. IBM's goal is to develop local suppliers who can produce for IBM's global operations, not just for its Mexican facilities.[4]

In June, 1999, IBM announced a $200-million expansion of its Manufacturing and Technology Plant near Guadalajara. The company said 2,750 jobs would be created as a result of the expansion (*Dow Jones International News*, 1999). Later that month, IBM announced it was eliminating 1,100 jobs at its San Jose, California facilities and moving production of tape

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[3] Information on IBM's present activities in Mexico draws on interviews with IBM managers in Guadalajara, Mexico City, and in San Jose, California.

[4] An interesting example is in disk drive components, where IBM outsources head assembly to a locally-owned company called CompuWorld. IBM taught the company how to set up clean-room operations that mirror IBM's own facilities. Now CompuWorld provides extra capacity to balance IBM's production with demand fluctuations.

drives and server drives to Guadalajara, Hungary and Fujisawa, Japan.[5]   The company explained
that the move was part of a restructuring intended to cut costs and reduce the time it takes IBM
to move storage products to market (Ha, 1999).

In addition to its hardware activities, IBM also develops software in Mexico. A team of
150 software engineers develops software for the AS/400 product line in Guadalajara. In 1998,
IBM bought a software developer in Mexico City called TecnoSys, which is developing custom
applications for IBM customers in Mexico.

Hewlett-Packard[6]

Hewlett-Packard established its Guadalajara Manufacturing Solutions (GMS) operation in 1982.
From 1982 to1985, it manufactured products such as minicomputers, PCs and printers in order to
meet requirements for market access under the Computing Program. HP had a joint venture for
PCs with a domestic Mexican company called DESK Fomento Industrial. After IBM started
producing PCs in Guadalajara with 100% ownership, HP dissolved the joint venture.

In 1987, HP started exporting from Mexico to North America and Latin America. In
1988, HP's GMS operations were given engineering responsibilities for minicomputers, and in
1989 it gained worldwide responsibility for line impact printers. In 1994, coincident with the
implementation of NAFTA, HP expanded its high-volume manufacturing in Mexico for the
North American market, and enhanced Mexico's role as a regional manufacturing center. By

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[5] IBM's disk drive operations in Guadalajara assemble sliders and head stacks, which are sent to plants in Thailand,
China and Hungary for final disk drive assembly. Final drive assembly is not done in Mexico because the other
locations offer a range of financial incentives not available in Mexico. IBM's executives in Guadalajara and in the
U.S. say that the plant is highly competitive with other IBM plants, owing to the high quality of local workers,
engineers and technicians.

[6] Information on Hewlett-Packard from interviews with HP managers in Guadalajara and San Diego, CA.

1998, HP GMS consisted of four operations, with a total of about 500 employees. These operations included paper handling solutions, an international procurement office, hard copy manufacturing (Deskjet and All-in-One printers), and an optical electronic division that manufactures LEDs.

In 1992, HP established its Latin American Distribution Operation (LADO) in Guadalajara. LADO has about 1,000 employees, doing final assembly and distribution of PCs for Latin American markets.

HP began doing R&D in Mexico in the 1980s to meet government requirements, but now continues to do R&D there because it makes business sense. The company has an engineering team of 35 people in Guadalajara, which has generated 15 patents and seven products for five different printer platforms.

To summarize, since liberalization, HP's activities in Mexico have evolved from producing for the protected local market to supporting North American manufacturing operations with worldwide responsibility for R&D, engineering, and manufacturing for specific product lines.

Local PC companies

Local PC makers were hit hard by liberalization and NAFTA, which put many of them out of business. Liberalization brought in a flood of imported PCs, creating stiff competition in the domestic market. Meanwhile, none of the local companies has the resources to take advantage of potential opportunities created by NAFTA to sell in the U.S. or Canada.

Several locally-owned Mexican PC companies have survived in the post-liberalization environment. The leading holdover is Lanix, a company established in 1990, which sold 32,000 PCs in 1997. Headquartered in Hermosillo, Sonora, the company's annual revenues are around

$35 million a year. Another local company that has survived liberalization but in a diminished capacity is Printaform. During the 1980s, Printaform was the leading PC vendor in Mexico, but its PC market share dropped dramatically after liberalization.   Printaform has survived by producing office equipment, but has only a minor role in the PC market.

The final segment of the PC industry consists of non-branded "white-box" assemblers. The wide proliferation of these faceless competitors that has occurred in Mexico in the last decade has become a serious challenge for both multinationals and local branded assemblers. According to CANIETI, there are about 3,000 of those white-box companies spread throughout the country. "Non-branded" assemblers include hundreds of distributors and retailers that offer the customer either parts and components, or a completely assembled PC.

Emergence of a Regional Production Cluster: Guadalajara

The computer industry in Mexico is highly concentrated in Guadalajara, Jalisco, which produces nearly two thirds of the nation's computer output (*El Informador*, 1998). Electronics exports from the state of Jalisco topped $7 billion in 1998, according to the state government's Department of Economic Promotion (SEPROE).

There has been a large inflow of investment into the Guadalajara region's electronics industry in recent years. Between March 1995 and September 1998, foreign direct investment in electronics amounted to $1,295 million. According SEPROE, 25 new electronics companies were established in Jalisco between 1995 and 1997, and 40 more opened during 1998. Presently there are about 120 companies employing over 50,000 people.

The rapid flow of new investment in Guadalajara's computer and electronics industry since 1995 can be attributed in part to NAFTA, which facilitated foreign investment and encouraged companies to locate production in Mexico for the North American market. It can

also be attributed to the sharp devaluation of the peso, which reduced the cost of producing in Mexico relative to alternative locations.

The main computer makers in the area are IBM and Hewlett-Packard. There also are a number of large MNCs in the communications industry, including Lucent, NEC, and Motorola. However, most of the rapid growth of the region's computer industry in recent years is related to a new phenomenon—the sudden arrival of major contract manufacturers (CMs). SCI Systems was the pioneer, setting up its first plant in Guadalajara in 1987. However, in just two years, between 1996 and 1998, another six CM plants were established in different locations in Guadalajara's metropolitan area. The newcomers include Solectron, Flextronics, Jabil Circuit, NatSteel, Dovatron and Avex Electronics.

As to the economic interconnections of CMs with the local economy, the plants have developed linkages among themselves and with other companies operating locally. For example, Flextronics has assembled printers for HP Guadalajara, and NatSteel's local plant has supplied PCBs for those printers. Philips has produced answering machines with PCBs made by NatSteel, Flextronics, and by Philips itself.

What lured six of the world's largest CMs to Mexico in such a short time? Certainly the presence of leading customers such as IBM, Hewlett-Packard, NEC and Lucent Technologies has been a strong attraction by itself. In fact, an HP manufacturing manager in the U.S. said that he encouraged Solectron to locate in Guadalajara in order to support HP's ink jet printer operations for North America. However, the presence of major MNCs does not fully explain the simultaneous arrival of so many CMs in the past few years. The explanation may be that CMs are coming in response to demand from computer and electronics companies which need to have some products assembled in a NAFTA-member country.

Alternatively, as some CM executives pointed out, CMs have come to Mexico not to follow their customers, or to take advantage of NAFTA, but rather in response to the lowest landed cost logic that governs the location decisions of multinational corporations in general. In this case, Mexico's proximity to the U.S. market gives it a cost advantage in transportation that may exceed the labor cost advantages of some Asian locations. Also, PC makers serving the U.S. market increasingly employ build-to-order production which requires short lead times for delivery of components and partially-finished products. Shipping from Mexico to the U.S. takes less than a day by truck, while Asia is closer to a month away by ship.[7]

IT market

The reduction in tariffs and restrictions on PC imports attracted new vendors to the Mexican market and led to more competition and lower prices. As a result, PC diffusion has spread and overall IT investment has grown rapidly.

PC penetration in Mexico remained very low in the 1980s, with annual sales totaling about 250,000 units in 1990. The PC market began to grow rapidly after the market opening in 1990, however, with unit sales growing around 20% per year from 1990–1994 (Figure 4). After a downturn caused by the economic crisis of 1995, sales grew rapidly in the late 1990s to reach an estimated 1.37 million units in 1999.

INSERT FIGURE 4 HERE

After liberalization, foreign companies such as Acer, Compaq and AST entered the Mexican market, and quickly took the lead. Acer was the top PC vendor from 1991 to 1996,

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[7] For instance, two members of Taiwan's Acer Group have manufacturing operations in Mexico. Acer Computer Inc. has opened a plant in the border city of Ciudad Juárez to produce PCs on contract for IBM. Acer Peripherals Inc. makes computer monitors in another border town, Mexicali (LaPedus, 1998). Each of these operations was set up for mass production for the North American market, to shorten delivery times and take advantage of NAFTA.

before being surpassed by Compaq in 1997. By 1998, the top five PC brands were Compaq, Acer, IBM, HP and Alaska (Table 2). Earlier local leaders Lanix and Printaform saw most of their market share disappear. Newcomer Alaska and the combined forces of the white-box makers accounted for most of the locally-owned industry.

INSERT TABLE 2 HERE

Liberalization had an impact on the market for white-box clones. At the end of the 1980s, white boxes accounted for 70% of the market, due to large price gap between them and branded PCs. The gap was reduced after liberalization in 1990 and further closed in 1992 when Compaq cut prices aggressively. By 1998 clones had an estimated 21% of the market, serving mainly the small business and consumer markets with a combination of low cost hardware and add-on services.

Overall investments in information technology have quadrupled from US$1.1 billion in 1989, the last year of the Computing Program, to over US$4.1 billion in 1998, in spite of a deep decline during the 1995 peso crisis (Figures 5 and 6).

INSERT FIGURE 5 HERE

INSERT FIGURE 6 HERE

Software and Services

Packaged software sales totaled $542 million dollars in 1998 (Table 3)[8] while the customized software market was estimated at $186 million dollars (Table 4). Over 90% of the packaged software sold in Mexico is imported, almost all of it from the U.S. This is probably not so much a function of NAFTA integration as the simple fact that U.S. companies dominate the global

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[8] Select-IDC estimates a slightly lower figure of $467 million, as shown in Figure 6.

market for packaged software. Mexico's software industry is still small, and most companies have only one or two products, and a few employees. Few packaged software makers have been able to develop a stable product line and achieve success in the domestic market.

On the other hand, most customized software is developed in Mexico (Table 4). This is common in most countries, as custom software usually is developed on-site in close collaboration with the customer. As a result, the more successful local companies are those that provide custom programming and other IT services. The largest custom programming firm is Softek, based in Monterrey, which has over 2,000 employees and over US$50 million in sales in 1997, including a significant business serving U.S. clients. Another firm, EDM, based in Ciudad Juárez, has 2,000 employees providing a range of services including data entry, telemarketing, software development and systems consulting. GE Capital acquired 80% of EDM in 1998 (Jastrow, 1998).

INSERT TABLE 3 HERE

INSERT TABLE 4 HERE

By working on a contract basis, companies such as these avoid the problems of developing distribution channels and raising capital to support product development. Their business is not directly affected by liberalization, as they do not import or export components and finished products. However, the more open economic environment in Mexico and closer economic integration through NAFTA has surely helped these companies to develop business relationships with U.S. companies and has increased the demand for IT services in the Mexican market.

IT Use

During the run-up to NAFTA, companies invested more heavily in hardware, but during the peso crisis, many firms shifted their emphasis to enterprise software and systems integration services

in order to get more value from their existing hardware stock (note in Figure 6 that hardware spending declines most steeply in 1995). By 1997–1998, the trend was toward outsourcing of IT functions, as companies restructured and focused on core business activities. As one executive put it, "the crisis forced companies to rethink who they are, and where they want to be."

Computer use is heaviest in the financial sector, which has invested in IT as a competitive tool as the sector has been privatized and opened to foreign participation. Under NAFTA, U.S. banks have entered the Mexican market through joint ventures, bringing with them their advanced information systems, and Mexican banks have responded by increasing their own IT investments to keep up.

A similar trend can be seen in other sectors. In retailing, companies such as Wal-Mart and Price Club have entered and expanded rapidly in Mexico, bringing their powerful information systems with them. In manufacturing, Volkswagen installed a new factory information system in its Puebla plant that enables it to produce Beetles, Golfs, and Jettas custom-configured to customer requests at a rate of 850 vehicles per day (King, 1998).

Still, IT spending in Mexico is less than one percent of GDP, much lower than countries such as Singapore, Korea and Malaysia (Table 5). While multinationals and some large Mexican firms are heavy IT users, small companies lack the financial and human resources to support IT investment. This situation is changing gradually as younger people with computer skills enter family businesses, and as lower-cost PCs make IT affordable even for small businesses. As for home use, Mexico's highly skewed income distribution limits the number of households that can afford to buy a PC, and poor quality, though rapidly improving, Internet service limits the benefits from owning a computer. Select-IDC estimates that about 600,000 Mexican households had a PC in 1998 (out of about 18 million).

INSERT TABLE 5 HERE

Internet use

Internet service in Mexico began in the early 1990s at educational institutions such as the National Autonomous University (UNAM), and Monterrey Tech (ITESM). They had links to the U.S. and sold access to both the public and private sectors in Mexico. Now there are many Internet service providers (ISPs), ranging from large companies such as Telmex and CompuServe to small local providers.

After a slow start, the Internet has been catching on rapidly, with Mexico being the second largest Internet user in Latin America (Table 6). Select-IDC estimated that there were about 400,000 Internet users in Mexico in 1997, and predicts that the number will reach 2 million by 2000. Internet use is hampered by poor-quality telephone lines in much of the country, which limit users to connection rates of 14.4 Kbs at best. And while long-distance phone rates have gone down, local service rates have gone up since the telecommunications market has been liberalized. The average cost of an Internet connection in Mexico is about $35 per month, compared to $20 in the U.S.

INSERT TABLE 6 HERE

Despite the relatively high telecommunications costs and low bandwidth currently available for the Internet, growth in Internet use is expected to increase considerably, extending further into the commercial, educational and government domains. Demand for Internet access should fuel further growth in computer use in Mexico.

CONCLUSIONS

The impacts of liberalization on Mexico's computer sector have been mixed, but generally positive. Liberalization of the industry in 1990 removed most barriers to imports, lowered PC

prices and computing costs, and helped spur the diffusion of information technology throughout the economy. On the other hand, it led to the demise of much of the local PC industry, as domestic companies were overwhelmed by large foreign PC makers who entered the market.

NAFTA's impacts are harder to quantify, especially as the inauguration of NAFTA was followed closely by the peso crisis of December 1994. But NAFTA sent a powerful message to foreign investors and removed most of the remaining barriers to foreign capital, thus creating a more stable investment environment. NAFTA also made it more advantageous for companies to treat North America as a single market and locate production for that market in Mexico rather than Asia or elsewhere. This factor was amplified by the trend in the PC industry toward faster product cycles, greater emphasis on time-to-market, and build-to-order production, all of which favored locating production closer to the final market in North America. One of the most visible results was the flood of contract manufacturers into Mexico, particularly Guadalajara, from 1996 to 1998.

The combination of NAFTA and the trend toward regional production helped bring thousands of new assembly jobs to Mexico and created demand for higher-skilled technicians, managers and engineers. While Mexico's computer hardware industry is still small compared to countries such as Taiwan or Singapore, it has grown rapidly and is likely to continue to expand.

So far, the industry still mainly imports components, then assembles and exports completed circuit boards, semi-finished PCs, or complete PCs. What is missing is production of key components such as semiconductors, disk drives, CD-ROM drives or power supplies. What is also missing is locally-owned companies serving as suppliers, subcontractors or service providers to the big multinationals. With a few exceptions, Mexican entrepreneurs have not been attracted to the computer industry or its supporting industries, in spite of potential opportunities

created by liberalization and the presence of so many foreign MNCs. Instead, most Mexican entrepreneurs have focused on more traditional industries such as broadcasting, publishing, commerce, manufacturing, and real estate.

The software and services industries have seen fewer impacts from liberalization and NAFTA. Packaged software companies have had some success targeting specialized markets, but lack the capabilities and capital needed to commercialize their products widely in Mexico and abroad. On the other hand, companies providing IT services such as custom programming control most of the domestic market and in some cases have become contractors serving the U.S. market.

Perhaps liberalization and NAFTA have had their greatest impacts on computer use in Mexico. Lower prices have spurred PC diffusion and given Mexicans the tools for Internet access. NAFTA has brought foreign competition to industries such as banking and retail, and U.S. companies in particular have brought advanced information systems to their Mexican operations. Mexican companies are increasingly investing in IT in order to do business with foreign companies or to compete with them. These investments are necessary to improve productivity and provide the infrastructure needed for Mexican companies to compete in the global economy.

Mexico's location next to the world's largest IT market and producer, as well as its membership in NAFTA, give it an advantage that most other countries would envy, yet it has done little to develop policies to capitalize on its position. This is partly due to a prevailing laissez-faire ideology that guides government policy, and partly due to concerns that Mexico should not be seen as pulling jobs out of the U.S. Also, there has been no emphasis placed on IT by top government leaders.

The result is that there is no coordinated national strategy to develop the infrastructure, human resources or technology base to support computer production and use. The lack of investment incentives is blamed for Intel's decision to locate an assembly facility in Costa Rica (which offered incentives) rather than Guadalajara, in spite of Guadalajara's superior supplier base and human resources. In addition, the lack of venture capital has limited the growth of domestic companies.

Mexico is lacking not only a national IT policy but also an overall industrial policy, as called for by many analysts and private sector leaders. The absence of such policy framework is hurting Mexico's workers and companies who might benefit even more from the opportunities created in the computer sector. Compared to successful IT producers and users such as Singapore, Taiwan, Ireland and Malaysia (Dedrick and Kraemer, 1998; Tallon and Kraemer, 1999; Palacios, 1995), Mexico has failed to develop policies in several areas. Some of these are as follows:

- support for local software and service companies, through low-cost loans, export assistance, management advice, and small business incubators (although a project in this latter regard is in progress in Jalisco);

- new roles for universities through more support for computer science, technical training, joint industry-university cooperative research, and co-location of business incubators (there are promising initiatives, though, such as the Technopolis project run by the University of Guadalajara to offer incubators for the development of new business);

- incentives and funding for government agencies to use IT and the Internet innovatively;

- targeted incentives to attract suppliers of components and materials and to encourage MNCs to expand their activities in Mexico.

Mexico also lacks a pilot agency with the authority and resources to coordinate the efforts of different agencies. In the absence of such an agency with high level support, even a modest program such as the PDI has lacked the resources and cooperation necessary to succeed.

Some might argue that the Mexican experience has few implications for other countries, due to Mexico's unique position vis-à-vis the U.S. However, the actual impacts of computer industry liberalization have been about what might be predicted, given Mexico's existing industry structure, location, and technological capabilities. It is not surprising that Mexico has developed into an export platform for MNCs with limited involvement of local capital, given the limited involvement of domestic entrepreneurs and the lack of government policies to support them. The lesson of Mexico's case for other developing countries is that liberalization is a necessary step to participating in the global computer industry, but it is not sufficient to realize the full range of opportunities present in that industry.

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## ***TABLES AND FIGURES (IN THE ORDER THEY APPEAR)***

Table 1. Trends in economic performance (US$ billions unless noted)

Variable	1980–1992	1993	1994	1995	1996	1997	1998
GDP growth (%)	1.5	2.0	4.4	-6.2	5.2	7.0	4.9
Inflation (%)	62.4	9.8	7.0	35.0	34.4	20.6	16.7
Exports		51.9	60.9	79.5	96.0	110.3	
Imports		65.4	79.3	72.5	89.5	106.9	
Merchandise trade balance		13.5	-18.4	7.0	6.5	3.4	
Current account balance		-23.4	-29.7	-1.6	-1.9	-11.4[a]	

[a]First three quarters.

Sources: IMF, *International Financial Statistics Yearbook, 1998.* IMF *World Economic Outlook, May 1999.* World

Bank, *World Development Report 1999/2000.*

Figure 1. Mexico's trade in computer hardware, 1989–1996
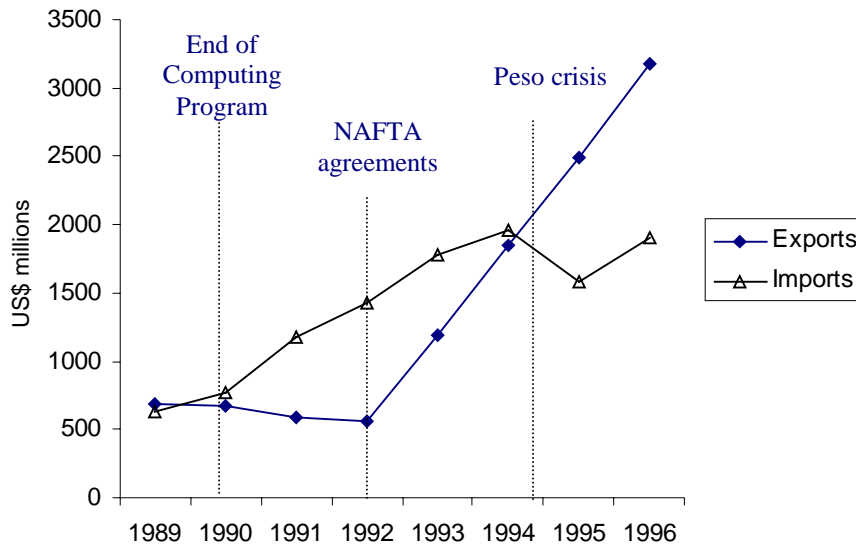
Source: Reed Electronics Research, *Yearbook of World Electronics Data,* various years.

Figure 2. Mexico-US trade in computers and office equipment
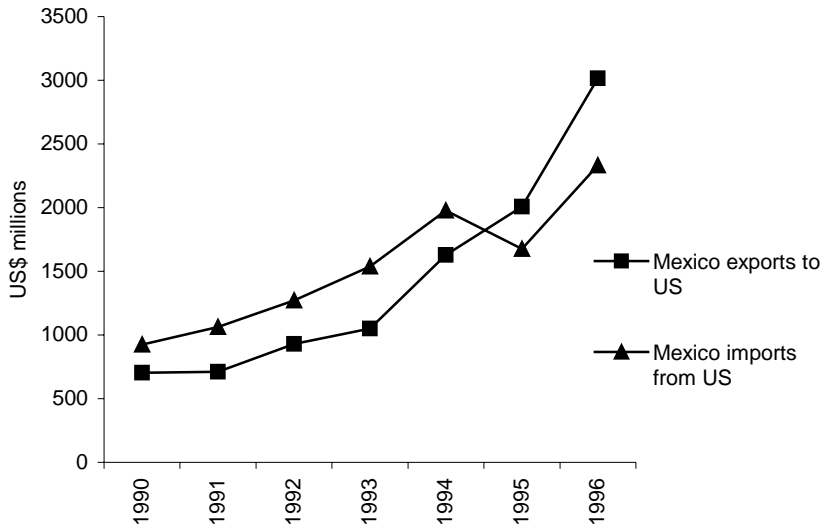
Source: AEA and NASDAQ, 1997.

Figure 3. Computer hardware production in Mexico, 1989–1997
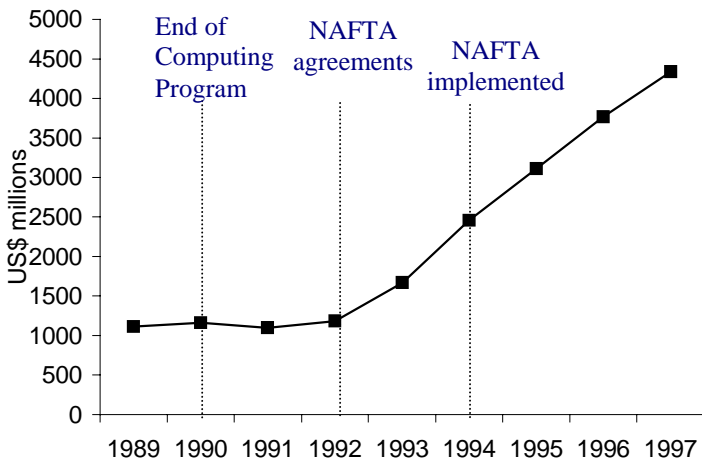
Source: Reed Electronics Research, *Yearbook of World Electronics Data,* various years.

Figure 4. PC sales in Mexico, in units
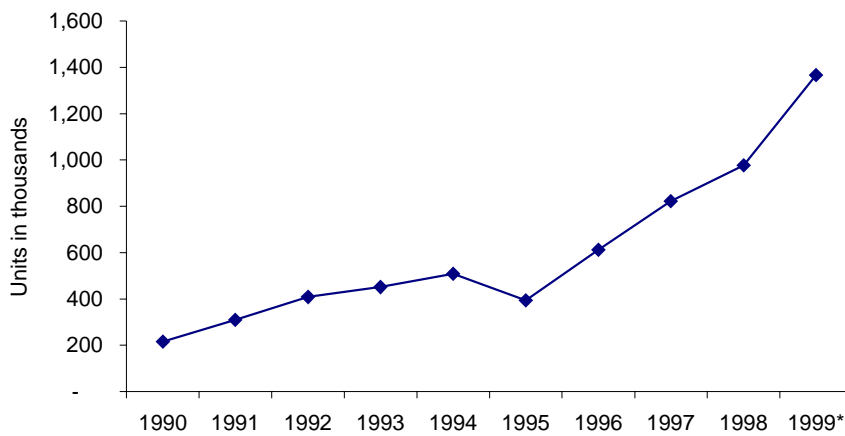
*Estimate.

Source: Select-IDC, data provided to authors.

Table 2. PC market share in Mexico, 1997 and 1998

Vendor	Share 1997	Share 1998
1 Compaq	17.2%	20.9%
2 Acer	18.7%	11.3%
3 IBM	13.7%	12.8%
4 HP	12.2%	10.2%
5 Alaska		8.9%
6 Lanix	4.0%	2.9%
7 Dell	3.0%	3.8%
8 Toshiba	2.5%	2.4%
9 Apple	3.0%	2.3%
# Printaform	0.5%	0.4%
# Other brand international	4.7%	2.8%
# White boxes	20.5%	21.3%
	100.0%	100.0%

Source: Select-IDC, data provided to authors.

Figure 5. Total IT spending in Mexico, 1985–1998
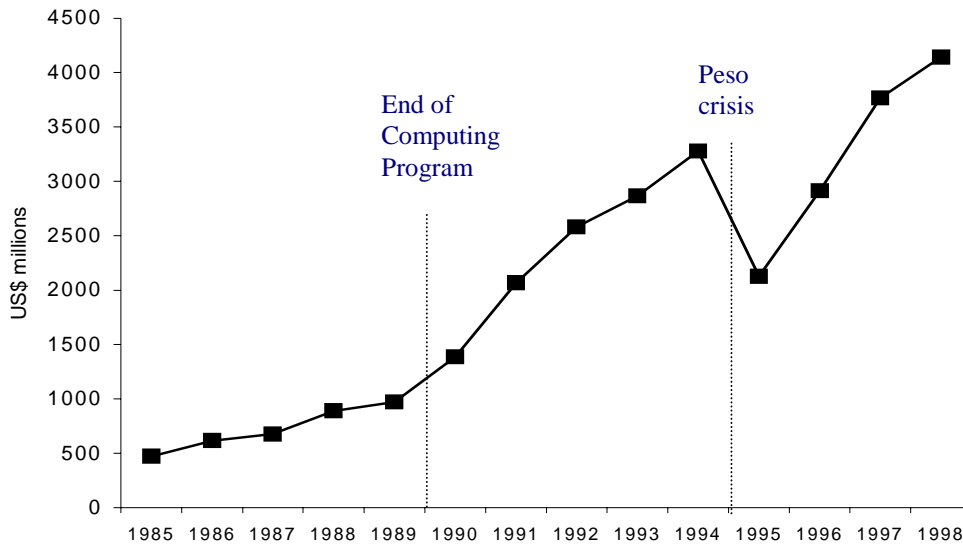
Source: Select-IDC, data provided to authors.

Figure 6. IT spending by category, 1989–1998

Source: Select-IDC, data provided to authors.

Software is packaged software; customized software is included in services.

Table 3. Mexico's packaged software market (US$ millions)

	1997	1998
Imports	406	515
Local production	22	28
Exports	1	1
Total market	428	542
Imports from U.S.	391	494

Source: U.S. Department of Commerce, 1998

Table 4. Mexico's customized software market

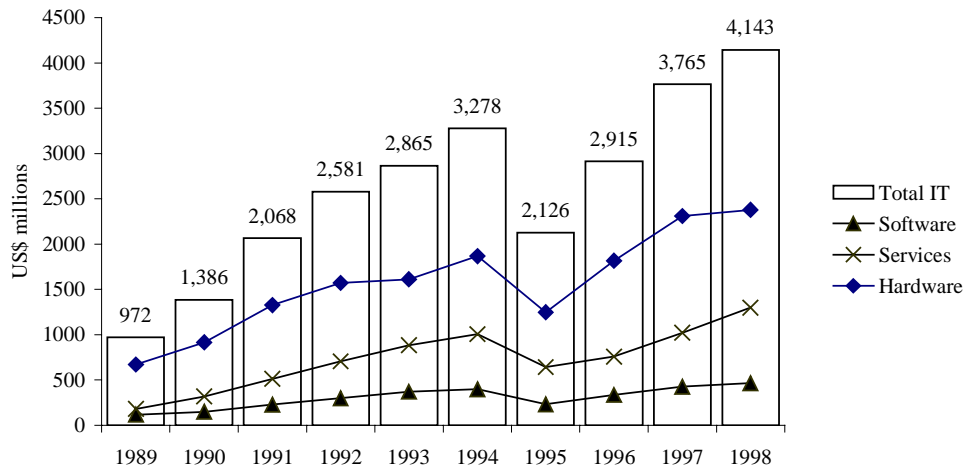|	1997	1998
Imports	4	6
Local market	130	184
Exports	3	4
Total market	132	186
Imports from U.S.	4	5

Source: U.S. Department of Commerce, 1998

Table 5. IT use indicators

	IT/GDP (%) (1997)[a]	PCs per 100 people (1997)[b]
Mexico	0.9	3.73
Brazil	1.3	2.63
Malaysia	1.7	4.61
Thailand	0.6	1.98
Korea	1.8	15.07
Taiwan	1.0	11.82
Singapore	2.6	33.74
Hong Kong	1.3	23.07
United States	4.0	40.69

Sources:

a. Calculated from IDC data presented in WITSA, 1998, *Digital Planet: The Global Information Economy.*

b. ITU, 1999, *Challenges to the Network, Internet for Development.*

Table 6. Internet statistics for Latin America

Country	Hosts per 10,000 people, 1999	Hosts per 10,000 people, 1996	Annual growth rate, 1996-99 (%)
Brazil	17.8	4.9	53.7
Mexico	**13.8**	**3.2**	**62.7**
Chile	23.1	11.0	28.1
Argentina	25.9	3.6	93.0
Colombia	7.5	2.3	48.3
Venezuela	11.5	1.0	125.7

Sources: ITU World Telecommunications Development Report, 96/97; Internet Software Consortium, 1999.