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# THE AUTOMOBILE INDUSTRY AND THE MEXICO - US FREE TRADE AGREEMENT

## ABSTRACT

This paper considers the likely effect on the automobile industry of a free trade agreement between the U.S. and Mexico. As there are currently large restrictions on imports into Mexico, one important outcome of a free trade agreement would be the opening of the Mexican market to U.S. producers. This is consistent with the history of the international auto industry and the fact that the U.S.-Canada Auto Pact opened a new, large market to U.S. manufacturers. The current state of the Mexican auto industry is considered in great detail, suggesting that the Mexican industry will continue to prosper, increasing output but also relying heavily on production from U.S. owned plants and on inputs imported from the U.S. and Canada. However, much of the existing domestically oriented industry is likely to be replaced by other North American producers. Finally, an econometric demand analysis implies that economic growth together with declines in prices to world levels could rapidly expand the size of the Mexican auto market. The free trade agreement represents an opportunity for product diversification and rationalization in the auto industry.

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## I. Introduction

The recent growth of automotive imports from Mexico and the prospect of a new North American free trade agreement have raised fears of a massive movement of North American automobile production to low wage Mexican plants. In common with many other industry observers, we argue that such a movement is unlikely.[1] In brief, the primary current impediments to North American trade in autos consist of restrictions on imports into Mexico. Thus, the primary long term effect of a free trade agreement will be the opening of the (potentially large) Mexican market to North American producers, rather than a movement of production to Mexico.

We begin with a discussion of the world automobile industry and of prior experience with free trade in automobiles. We note that the automotive sector is now a world industry that escapes the narrow limits of national boundaries. In analyzing the international position of US, European and Japanese firms, we show that US firms have the greatest involvement abroad. However, despite the relocation of production across the world, the ratio between the output of foreign affiliates of US firms and the domestic output of US firms changed little during the 1980's. During this same period, the overseas competitors of US firms followed very different strategies. While Japanese manufacturers demonstrated an

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[1]See also Womack 1991 for a useful discussion of many of the issues discussed below. While Womack relies heavily on interviews with industry participants, we rely more on government and trade association data and, in our final section, on econometric analysis.

unprecedented willingness and ability to move production abroad, European companies have retrenched inside the European Community.

To identify the consequences of a possible free trade agreement, we analyze the effects of the Auto Pact of 1965 on both the Canadian and the US auto industry. We show that the Canadian industry enjoyed spectacular growth after the Auto Pact, mostly fuelled by exports to the US. However, the most relevant aspect of this episode for the Mexican case is that the Auto Pact opened a new, large market to US manufacturers.

Mexico, however, with its very low wages, is clearly a different case from Canada. We therefore turn to a discussion of the history and current structure of the Mexican auto industry. We note that this industry is increasing its integration into the world market and is particularly integrated into the operations of US manufacturers. Current policies, however, prohibit most imports of finished automobiles and give indirect subsidies to exports. Both Mexican exports and imports have been increasing, with many exports coming from "Maquiladora" plants near the border. We provide new data on Maquiladoras that is consistent with claims that these plants specialize in labor intensive production unlikely to take place in the US. We conclude that the export oriented sector of the Mexican auto industry will continue to prosper, relying heavily on production from US owned plants and on inputs imported from the US and Canada. However, much of the existing domestically oriented industry is likely to be replaced by other North American producers.

Finally, via an econometric demand analysis, we consider the potential size of the Mexican market that could be opened up to US producers. This demand analysis treats recent changes in Mexican national income and government policy as experiments that help to reveal underlying

demand elasticities. While the Mexican market is currently small, we find that declines in prices to world levels and, even more importantly, economic growth, could rapidly expand its size.

## II. THE WORLD AUTO MARKET: SOME STYLIZED FACTS.

**World-wide Trends.** It would be beyond the scope of this paper to analyze in depth the world-wide evolution of the automobile industry. However, to put the issue of the free trade agreement in its proper perspective, it is important to recall some essential features of the automotive sector. After the 1980-82 recession, world-wide motor-vehicle production experienced several years of sustained growth. Between 1982 and 1988 motor-vehicle production grew by 33%, and by 1988 it was 13% higher than the previous peak of 1978.

More importantly, the recent history of the industry is characterized by increased globalization of both production and markets. The increasing multinational nature of most car producers makes it difficult to draw clear national boundaries for the industry. With few exceptions, auto companies continued to diversify the location of their production in the 1980s. As shown in Figure 1, the major auto companies typically produce between 10% and 50% of their total output abroad. American companies still exhibit the largest share of production manufactured at foreign affiliates, but European and Japanese companies have increased their foreign activity in the last decade. The changes in the location of production of Japanese companies have been especially remarkable. For

example, while Honda's production in 1981 took place completely inside Japan, by 1988 almost a quarter of it took place abroad, mainly in the US. Typically, changes in the international location of production are guided by a desire to move manufacturing closer to end markets, thus saving on transport costs and, more importantly, avoiding local protectionist measures. With few noticeable exceptions, mentioned below, the bulk of production at foreign affiliates is not reimported for sale in the home market.

It is important, therefore, to keep in mind that the relevent definition of, say, the American auto industry depends on the issue to be addressed. For example, if we are concerned with the profitability of US companies, the relevant criterion is the nationality of the manufacturer, independently of where it operates. On the other hand, if we are concerned with the effects of the industry on domestic employment and output, what is important is the production location and not nationality. As shown in Figure 2(a)-2(d), the two criteria do not always suggest similar conclusions. In 1988, American car manufacturers had the largest share of world production (34.1%), followed by Japanese (28.8%), and European (24%) manufacturers. Perhaps surprisingly, Japanese and European Community shares decreased from 1981, while the American share actually increased.[2]

If we consider the location of production, the situation is reversed. The European Community has the largest world share (31.1%), followed by Japan (27.7%) and the US (24.4%). Both the European and American

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[2]Of course, the increasing share of U.S. production is in large part a result of the robust recovery of the U.S. economy over exactly these years. A peak-to-peak comparison of, for example, 1978-1988, would produce somewhat different results.

shares increased from 1981, while the Japanese share fell slightly. A major cause of this pattern is the relocation of Japanese production from Japan to the US and Europe.

**The US Industry.** Data on world-wide employment and foreign direct investment of US firms are not available at the auto industry level, so we first analyze data referring to the whole transportation equipment sector. Between 1983 and 1988, world-wide employment of US multinationals in transportation equipment increased by 20% (from 2.7 million to 3.2 million employees). The increase in employment, however, occurred only at US parents where it rose by 32%. In contrast, the aggregate employment of foreign affiliates decreased by almost 10% in the same period, although this employment displayed substantial cross-country variation. As shown in Figure 3(a)-3(b), employment in European affiliates dropped from 63% to 45% of total foreign employment. Conversely, considerable growth took place in Canada, where employment increased from 111,000 to 137,000 and in Japan, although by a smaller extent. Similarly, the share of employment in Latin America almost doubled, with Mexico enjoying the largest growth. Because of this increase, US multinationals in transportation equipment now employ almost 83,000 in Mexico, comparable to their Brazilian employment of 89,000.

Similar trends are present in the pattern of the US direct investment position. After a decline between 1980 and 1983, the US foreign investment position in transportation equipment increased sharply and more than doubled between 1984 and 1989 (Figure 4). This period was characterized by a marked shift away from Europe toward Canada and

Japan (Figure 5(a)-5(b)). While the direct investment position in Latin America increased by almost 70% between 1980 and 1989, its world share decreased, although this decrease largely stems from divestment in Argentina (Figure 6(a)-6(b)). Both Brazil and Mexico, in fact, experienced a rapid growth, higher than the world average. In Mexico, as we will see, this growth is largely due to the expansion of the "maquiladora" sector.

We will now turn from the transportation equipment sector to data on the automobile industry alone. Between 1981 and 1988, production in the US automotive industry increased by 42%, a rate of growth greater than in the European Community (32%) and Japan (13.6%).[3] As shown in Figure 7(a), foreign manufacturers' production has increased from 2.6% to 8% of total output. The upward trend in foreign producers' output is entirely due to the commencement of Japanese production.[4] Since 1984, output of Japanese transplants has been growing at an annual average rate of 55%. Although far from Japanese performance, the US production of American manufacturers displayed a considerable growth, increasing by 34% between 1981 and 1988. This contrasts with the behavior of European producers whose output more than halved in the same period, due to the closure of VW's plant in 1988.

We now turn to the nationality of producing firms. As shown in Figure 7(b), world-wide production of American manufacturers increased by 34.5% between 1981 and 1988. The figure also shows that the increase

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[3]Once again, this is influenced by cyclical factors.

[4]Honda started its US operations in 1982, and was soon followed by Nissan (1983), Toyota (1986) and Mazda (1987) and Subaru-Isuzu (1989).

in production was a global phenomenon.[5] The largest increases took place in Canada (43.5%) and in the European Community (39%). To a lesser extent, production also increased in Latin America (21.7%).

In summary, it is important to stress that American foreign investment and production in transportation equipment is quite considerable. In 1988, more than 37% of the American production of motor-vehicles took place abroad. This ratio remained almost constant during the eighties, despite the considerable changes in the degree of involvement of American manufacturers across different world regions. In comparison, the production of foreign companies in the US is small, but increased sharply in the eighties, mainly because of the operations of Japanese transplants.

**The European Community, Japan, and Latin America.** The situation in the European Community is almost opposite from the US. The production of foreign manufacturers in the Community is large, a quarter of total production in 1988, up from 22.5% in 1981 (Figure 8(a)). European production in the US decreased by almost 60%, between 1981 and 1988. In contrast, US production in the European Community increased by 39%, well above the 28% growth rate of the European manufacturers. Japanese companies have also begun production in the Community, a process started with Nissan's factories in Spain (1983) and the UK (1988). Japanese production in Europe, however, is less than one sixth of their production in the US. In contrast to their American counterparts, European manufacturers produce relatively little outside the Community and such

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[5]Only in Australia (included under "others") did American automobile output decrease in this period.

production decreased in the eighties from 10.2% in 1981 to 7.4% in 1988 (Figure 8(b)). The only sizable foreign production takes place in Latin America, mainly because of the VW and FIAT plants in Brazil and VW's operation in Mexico. It should be kept in mind, however, that a substantial part of the production of European manufacturers occurs within the Community but in countries other than the country of residence of the parent company. Also, this production diversification within the Community showed an upward trend in the eighties, increasing from 9.2% in 1981 to 12% in 1988.

Until the early eighties, Japanese automobile production was isolated from the rest of the world. No foreign production of motor vehicles took place in Japan, and virtually all of Japanese manufacturers' output was produced in Japan. While foreign producers have not established a noticeable presence in Japan, Japanese manufacturers have shifted their production abroad at an increasing rate. Between 1981 and 1989 they opened new fronts in the US, Canada, the European Community and Australia, while increasing their production in Latin America by almost 40%. In 1988 production of foreign affiliates represented 8.6% of total production, higher than that of the European Community (Figure 9).

In section 3, we analyze in detail the recent evolution of the automobile sector in Mexico. It is worthwhile, however, to put the Mexican case in the wider context of the Latin American market. While some assembly plants operate in Columbia, Chile, Peru and Venezuela, the bulk of the Latin American production takes place in Argentina, Brazil and Mexico. As shown in Figure 10(a)-10(b), Brazil is the largest producer, manufacturing in 1988 over 60% of Latin American motor-vehicles. Brazilian share of Latin American production has increased considerably in

the eighties, while the opposite was true for both Mexico and Argentina. In fact, between 1981 and 1988, production in Brazil increased by 37%, while in Argentina it decreased by 6% and in Mexico it decreased by 4.5%. However, while production in Argentina never recovered from the contraction of the early eighties, Mexican production has displayed a positive trend since 1983, with particularly significant gains in the most recent years. By 1988, US manufacturers were the largest producers in Latin America, with 45.8% of total output. European Community producers, which had the largest share up to 1987, decreased to 43.8% from 50.4% in 1981. Looking across countries in Latin America, in 1988 US companies produced the majority of motor-vehicles in Mexico (68%,), while Japanese companies produced 20% and European companies 12%. In Argentina and Brazil, however, European manufacturers still had the lead in 1988, with 59% and 41.8% of total production respectively. That year, US companies produced only 39% of Brazil's output and 19.8% of Argentina's output.

One crucial issue in view of a possible trade liberalization is the current degree of openness of the sector in Latin America, especially in Mexico. All three countries under consideration have a high degree of protection against foreign-produced autos and consequently imports have remained negligible. As shown in Figure 11(a)-11(b), Argentina's production is almost completely absorbed by the domestic market and exports have been very small. However, both Mexican and Brazilian export patterns have changed dramatically in recent years. While in 1970 exports represented less than 1% of Brazilian production, they increased to 13% in 1980 and 30% in 1988 (Figure 12(a)). While most exports are directed to other Latin American countries and Europe, about 20% of

exports were shipped to the US in 1988 (Figure 12(b)). We will analyze the Mexican case in more detail in the next section. At this point, however, it is worth mentioning that Mexican exports increased by a factor of 10 in the eighties. Moreover, 86% of exports were directed to the US in 1990 (Figure 13(a)-13(b)).

These developments in Latin America raise the central issue of whether a free trade agreement with Mexico will induce American firms to relocate across the southern border, in an attempt to reduce their production costs. Some useful information in debating this issue can be derived by analyzing the recent history of the trade relationship between Canada and the US. We turn to this issue next.

**The Canadian-US Auto Pact.** Looking at the recent history of the US-Canada market is instructive for several reasons. First, the type of free trade agreement now negotiated between Mexico and the US has many points in common with the Free Trade Agreement (FTA) signed in 1989 between Canada and the US. Moreover, it is most likely that a Mexico-US agreement would not even be an issue now without the successful conclusion of the previous Canada-US negotiations. Second, the common geographical proximity to the US makes several aspects of the Canadian experience relevant to understand the likely consequences of a free trade area with Mexico. Finally, there are unavoidable interactions and spillovers between trade relationships north and south of the US border. The Canadian experience, however, should be interpreted with caution since there are obvious differences between the Canadian and Mexican cases. Probably the most important difference is the dissimilar stage of economic

development in which the two countries are entering the free trade area. Later in the paper, we will argue that the particular growth position of Mexico is an essential element in evaluating the medium-long run consequences of a free trade agreement.

The relevant episode for our purposes is not, however, the Canada-US FTA of 1989, but the Canada-US Auto Pact of 1965. The FTA, in fact, has not changed the basic car industry environment created by the 1965 Pact. Compared with the scope of the 1965 Auto Pact, the FTA introduces only minor modifications. It calls for the phasing out (to be completed by 1998) of the remaining duties on Canada-US automotive trade, and it changes the procedure for computing the North American content requirement (now 50% of direct manufacturing costs instead of 60% of invoice value). More important is the provision that prevents new manufacturers from enjoying the privilege of free trade import into Canada from third countries.

The 1965 Auto Pact eliminated most of the tariffs between the US and Canada. The Auto Pact also introduced the 50% minimum North American requirement for products flowing from Canada to the US, as mentioned above. Canada took a more global approach to trade liberalization than the US, granting free entry to all imports (not just from the US) as long as they satisfied a number of production safeguards. These safeguards were designed to guarantee a minimum ratio of Canadian production to total Canadian sales and value added.

The effects of the Pact on the Canadian Auto industry were enormous. Production more than doubled between 1965 and 1970, and almost tripled by 1979 (Figure 14(a)). Most of the increase in production has been exported, mainly to the US. As shown in Figure 15(a), before the

Auto Pact Canadian exports were negligible and were mostly directed to countries other than the US. The Pact changed the situation dramatically. By 1970, over 70% of Canadian production was exported to the US (Figure 15(b)). Importantly, however, trade has not been one-sided. As shown in Figure 14(b), before 1965 Canadian imports of motor-vehicles were small and came primarily from outside North America. After the Auto Pact, imports increased sharply, mainly because of the acceleration of imports from the US. While, prior to 1965 US imports represented around 5% of Canadian sales, by 1971 this ratio surpassed 40% and it is now over 50% (Figure 16(a)). Exports to Canada represented less than 1% of US production before 1965 and are now over 7% (Figure 16(b)).

The Auto Pact thus profoundly changed the Canadian auto industry. Production rose spectacularly and a major component of this surge in production was exported to the US. But the most important lesson for the US-Mexican trade agreement is that the Auto Pact created a new, large market for US manufacturers. In the next section we will consider the Mexican auto market in greater detail. We will then turn, in section, to the potential size of this market under a free trade agreement.

## III. THE MEXICAN AUTO INDUSTRY IN RELATION TO THE UNITED STATES.

In this section, we will analyze in some detail the history and current structure of the Mexican automobile industry. We will emphasize that, despite years of avowedly protectionist policies, the Mexican industry is dominated by foreign producers and has remained a large importer from

the US In considering the current structure of the industry based in Mexico, we will show that Mexican auto exports to the US are concentrated in products typically imported by the US from low wage countries. But in contrast to similar products imported from overseas, the Mexican products are frequently manufactured by US based firms and contain a high percentage of US made parts.

**The Initial Relationship.** The automobile industry represents one of the most important examples of industrial integration between the US and Mexico. The multiple backward and forward linkages of automobile manufacturing have captured the attention of both governments in the last three decades, and the relationship has been influenced by world trends and country-specific regulations on both sides of the border. In this section, we will look at the series of Mexican "Automobile Decrees" as a mechanism to promote sectoral growth and, more importantly, as a response to the overwhelming automobile trade deficits since the 1950's.

The growing Mexican market led Ford to open the first Mexican assembly plant in 1925. In the following years, all the other US producers as well as some foreign and domestic firms started assembling vehicles. Nevertheless, by 1960, 53% of domestic demand for passenger cars was still supplied by imports, while close to 80 percent of the value of parts used in domestic assembly was also imported. Exports amounted to a little over $200,000, producing a sectoral deficit of more than $119 million, almost 85% with the US alone (Table 1).

These facts motivated the Mexican government's 1962 Automotive Decree, establishing a new regulatory framework intended to foster

domestic production and reduce the trade deficit. Other countries (such as Brazil and Argentina) employed protectionist policies, but because of its links with the US industry, Mexico's rules were far less restrictive. The decree included a 60% domestic content regulation, price controls and production quotas. Foreign investors faced no restrictions in vehicle production, but were limited to 40% ownership of component plants.

The government envisioned an industry consisting of only four domestically owned companies. However, in 1964 the final outcome allowed 7 producers: General Motors, Ford, American Motors, Fabricas Automex (with Chrysler participation), Nissan, Volkswagen and DINA, a government-owned firm.

US-Mexican sectoral relations continued to deepen. To meet the domestic content requirement, US subsidiaries, led by Ford, linked US component producers with Mexican capital to create auto part companies. Tremec and Spicer are the result of these efforts, supplying most of the domestic market for transmissions (and several other components) since then. Other US-based parts companies like Eaton made substantial direct investments in the components industry.

Nonetheless, the sector's significant trade imbalance persisted; in 1970 the deficit with the US alone represented $170 million dollars or close to 17% of the nation's 1970 trade deficit. After numerous disputes between domestic and foreign producers, the government opted for an export promotion policy formalized in the 1972 automotive decree. Imports were to be balanced by growing exports containing at least 40% of auto parts not made by the car manufacturer. This policy strongly favored foreign auto makers. Automex faced Chrysler's opposition to its US exports, leading to

financial difficulties and acquisition by its US partner.[6]

Private domestic (i.e. Mexican) capital in vehicle production disappeared. Exports of auto parts increased as the Big Three implemented globalization strategies, but the deficit persisted. In 1975, imports from the US were almost three times larger than exports from Mexico (figure 17.)

The 1977 Auto Decree created a new balance-of-payments mechanism, requiring each auto maker to increase exports in order to balance its imports and payments abroad by 1982. This provided an additional incentive for multinationals, especially the Big Three, to focus on Mexican export strategies instead of investing in other developing countries like Brazil. By 1981, General Motors increased its "maquiladora" operations (discussed further below), and opened two new plants for the production of engines and vehicles. Chrysler also started engine production operations, joined by Ford's Chihuahua plant two years later (Table 2).

The growth of auto parts companies, supplying the rapidly growing domestic market with high quality components, was the outcome of a second wave of joint ventures between US auto makers and large Mexican industrial groups. In 1981, Ford joined with Grupo Alfa to open Nemak, still one of the largest suppliers of aluminum engine heads. A few months later, General Motors and Grupo Condumex together created Condumex Autoparts, supplying wire harnesses. Two other Ford ventures with Grupo Vitro and Grupo Visa created Vitroflex, the largest auto glass producer, and Carplastic, producing plastic boards. The multinational auto makers benefitted in several ways from such associations. They could produce and

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[6]For a good description of the negotiation process between manufacturers and the Mexican government consult Bennet and Sharpe (1985).

supply the domestic market with higher quality products, profit from the comparative advantage of their Mexican partners, meet export requirements, and even source their US based plants, reducing production costs.

The 1977 decree also increased maquiladora incentives allowing up to 20% of the compensating exports of car producers to accrue through the value added of maquila plants. US auto makers, and in particular General Motors, increased their involvement in this sector with electrical components assembly.

The significant growth of the domestic market, peaking at 600,000 units in 1981, also entailed the worsening of the sector's trade balance and made it impossible for producers to meet the "balanced-growth" goal of 1977. In 1981, the auto deficit with the US alone was close to 27% of Mexico's total trade deficit (Table 1).

The 1983 Auto Decree followed shortly, undertaking stronger measures aimed at a zero trade balance for each company. Three main policies were outlined: stringent domestic content rules for vehicles and parts, required balance-of-payments (allowing no deficits), and limits to one line and a maximum of five models per car maker by 1987. The more restrictive rules and a decline in the domestic market convinced Renault and American Motors to stop vehicle production.[7] The Big Three, Volkswagen and Nissan, all 100% foreign owned, are the sole remainders of 20 years of "protectionist" policies in the passenger car segment.

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[7]See Lopez-de-Silanes (1991) for a more detailed analysis of the past Automotive Decrees and their effects on the Mexican industry.

**The 1989 Auto Decree.** We will now turn to the recent evolution of the Mexican auto industry and its integration with the US. We will begin by explaining the present regulatory framework in Mexico, which has not only altered the tone and thrust of the previous two decades of industrial policies, but also led to an enormous increase in imports ending the period of sectoral trade surplus.

By 1989, Mexico was already embarked on a path of stabilization, trade liberalization and structural change, but the automotive industry remained isolated from these movements, ranking third in protection after oil and tobacco. To find a solution to this imbalance, all industry players were involved in consultations, resulting in three 1989 Decrees designed to promote the industry's development in both domestic and foreign markets.

The Mexican automobile market is almost 1/25th of the US size, and the ratio of cars per consumer is eleven times lower in Mexico. These issues were addressed in the 1989 "Auto Popular" Decree. Tax exemptions were granted to popular cars subscribing to the program, which required the auto maker to reduce its profit margin as well. The general idea was to provide consumers with a small car at more reasonable prices. Only the Volkswagen Sedan model (the "Beetle") embraced the scheme. By the end of that year, VW had become the leader in domestic sales with a 70% increase in the Sedan's production and sales. In 1990, monthly sales of this car had quadrupled, capturing 24% of total passenger car sales in the country.

In December, two other decrees followed. One pertaining to buses, trucks and other similar vehicles established, for the first time since 1962, a clear path for the elimination of trade and entry barriers (to be

achieved by 1994.) Finally, new rules pertaining to the manufacturing of passenger vehicles and light trucks were outlined in a third decree that significantly relaxed the restrictions on foreign-owned producers and broke with a closed market for imports. The third decree became effective in November, 1990 with the 1991 year models.

Auto makers established by 1989 now have some freedom to choose the lines they wish to produce in Mexico and those to import from the same manufacturer abroad. However, imports of vehicles are restricted to 15% of total domestic production (this increases to 20% in 1993.) To gain permission to import, manufacturers must still maintain a positive trade balance, with diminishing proportions of exports to imports. Auto parts imports continue to be open to trade with an average tariff rate close to 10 percent.

Individual automobile, truck, and auto parts domestic content requirements have been eliminated. A more flexible 36% of the National Value Added for all the auto makers' production must still come from the National Value Added of the domestic auto parts industry, or from other domestic suppliers.[8] The general deregulation of the sector includes the elimination of: limits in lines and models, the compulsory list of domestic autoparts to be included in each vehicle, the mandatory gasoline engines on medium-sized trucks, and the restrictions on the proportion of base vehicles marketed.

The previous balance-of-payments requirement was replaced by a

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[8]This constitutes a significant change since the previous 60% content rule was measured at production costs. Further discussion of this issue is also found in Lopez-de-Silanes (1991).

less restrictive trade-balance mechanism eliminating the need to compensate for payments abroad. Trade surpluses can accumulate beginning with the 1992 car model year. Even the transferability of trade-surplus rights among manufacturers is allowed.

The pricing of imported vehicles is said to be closely watched by the authorities. A manufacturer could lose its temporary "import exclusivity rights" if its listed price exceeds international public prices for equivalent vehicles.

**Resulting Industry Structure.** Today's Mexican automotive industry is the result of regulations in the series of decrees just outlined, the macroeconomic conditions of the country in the 1980's and intense international market competition. These three factors have created a two-tiered industry and, until recently, defined separate trends for domestic sales and exports.

An important reason for the failure of the 1969-1982 measures in promoting exports was the stream of incentives favoring the opposite: production for the domestic market. This has created a relatively inefficient domestic assembly industry, which frequently relies on outdated production techniques and short production runs. This industry is unlikely to survive a free-trade agreement in its present form.

Trade liberalization measures starting in 1983 have eliminated some of the anti-export bias; indeed the strict balance-of-payments rules can be seen as an implicit export subsidy. The US auto manufacturers, as well as some large component companies, are among the most favored by the implementation of special export programs. The new, globally oriented

sector of the Mexican auto industry is likely to flourish under a free-trade pact. This industry, typically located in Northern Mexico to take advantage of its close links with the US, can be roughly divided into three parts: engine plants, Maquila auto parts plants and a high-tech auto assembly sector. We will examine these sectors in some detail, arguing that exports to the US from this sector largely compete with imports from other (often low wage) countries, rather than with US production. The North American industry is aided by the relatively low-cost and high quality of the Mexican products and (perhaps more importantly to US and Canadian producers) the Mexican exporters are large demanders of inputs from the rest of North America.

Of the three sectors, production in the engine and high-tech assembly plants most resembles similar US based production. However, production in the famed Maquiladora sector is concentrated in highly labor intensive stages of production. This sector takes US inputs and creates products which would otherwise might otherwise be produced in other areas of the world.

A detailed analysis of the manufacturers' installed capacity per plant is provided in Table 2. We show the data for 1983 and 1988, covering the period of one of the most important investment waves in the industry. Installed capacity and announced investment plans with their possible consequences for exports are also shown. After reviewing the various export-oriented sectors, we will turn to a discussion of the prospects for the domestically oriented industry.

**The Engine Plants.** The engine export take-off in 1982-1984 marks a first stage in the export movement. Triggered by the intense competition from Japanese imports, US producers searched for low-cost production bases in Third World countries. The new market for smaller engines and front-wheel drives was reoriented to these countries, among which Mexico presented appropriate cost-saving conditions for engine production. In 1981, General Motors and Chrysler opened new high-technology engine plants in Saltillo, significantly increasing their installed capacity to 570,000 and 395,000 units respectively. Ford's 1983 Chihuahua plant uses advanced technology and a skilled labor force. The engines produced in this plant have quality comparable to US manufactured engines and require similar labor input. Another example of the quality and high productivity of this segment is Renault's engine plant in Center-North Mexico. Renault's Mexican operations, after withdrawing from the passenger car market in 1986, consist solely of an engine plant in Torreon producing nearly 150,000 units per year; this plant produces some of the best quality engines of the French manufacturer.

Total engine exports quadrupled in value in two years and reached over 1.4 million units by 1988. Practically all of the Big Three exports are directed to the US. Nevertheless, they still constitute less than 14% of the total amount of engines used every year in the US based production. The satisfactory results of these plants in world markets has led Ford to announce increased investments to double its capacity in its Chihuahua engine operations (Table 2).

**High Tech Vehicle Plants.** The second stage in export growth began in 1987 with the high-tech vehicle plants. Ford's Hermosillo plant, one of the most advanced in the world, became operational that year and was to annually assemble, largely from Japanese parts, 130,000 units of Mercury Tracers for export to the US. However, due to the appreciation of the yen the units became more expensive than expected, halving actual production to 65,000 per year. Originally, about 65% of components were Japanese, 3% from the US and 32% Mexican, but with time the input composition has dramatically changed. The 1990 model contained nearly 75% US parts, 15% from Japan and only 5% from Mexico. In this new phase, after a partial shutdown of the plant in 1989 that nearly halved exports, the new Ford-Mazda Escort model is being produced with exports reaching over 40,000 units in 1990.

Exports from General Motors since 1986 have been erratic, with total units fluctuating between 20,000 and 40,000. Chrysler's vehicle exports include an almost constant 22,000 units of the D-150 light truck and, until 1989, mostly compact K-models. More recently, Volkswagen's shutdown in the US (due to reduced demand) resulted in its operational shift to Mexico, thus creating a flow of small car exports to the US. Finally, Nissan's exports, steadily growing since 1987, are almost completely directed to other Latin American countries.

In summary, total vehicle units exported jumped from 20,000 in 1983 to 278,000 seven years later. In 1983, Volkswagen was responsible for 90% of exports and only 1% of vehicles was directed to North America, while in 1990 86% were sent to the US alone. Of these, 87% represented exports of the Big Three back home (Table 3).

**Maquiladoras and Autoparts.** The maquiladoras ("in-bond" plants) are another recent component of North American automobile integration, exemplifying a cost-efficient combination of inputs between the two countries. The basic operation of a maquila plant consists of the import of components and assembly in Mexico for later export. These plants are exempt from Mexican majority ownership rules governing the auto parts industry, and are able to import components free from duties as long as they export at least 80% of their output.

These plants have experienced dynamic growth in the past decade, especially since 1984. From about 12,000 workers in 1982, transportation equipment maquiladoras employed about 100,000 workers in 1990. That year, their total value added represented an average of 23% of exported value and had multiplied seven fold since 1982. Automotive maquiladoras are the second most important maquila group following electronic materials and accessories. They contribute 1 out of 5 workers in the total maquiladora operations located in Mexico (Table 4).

In order to clarify the sometimes misrepresented nature of this industry, we will study a sample of 178 maquiladora plants out of the total of 187 transportation plants in May 1991 (Table 5). Because of the paucity of available data on the maquiladoras, we provide fairly detailed information about these plants. Our results show that one out of four of these plants is engaged in the production of wire harnesses, an extremely labor intensive activity. In 1990, Mexico was the most important exporter to the US of this product, followed by Taiwan and the Philippines. Japanese data also show large imports of these products into Japan from

other Asian countries like Taiwan. From our data, almost all components used in Mexican wire harness plants are imported from the US, representing close to 70% of Total Production Value. Presumably, the proportion of US made components is much less in east Asian production.

Seat covers and interior trim constitute another 8% of maquiladora plants. Chromizing and shining of rims takes 5 percent, followed by various other components. Mexico is the main supplier to the US of seats, safety belts and windshield wipers. All of these operations are labor intensive; lower Mexican wages are obviously of great benefit to US producers. Japan similarly uses neighboring Taiwan and Singapore, and more recently Thailand, for producing such components.[9] If US producers were denied access to the Mexican labor market for these production stages, they would be at a disadvantage relative to Japanese access to neighboring low wage countries. (Presently, European producers may gain similar access to labor markets in Eastern Europe.)

To explore this issue further, we looked at the US Import Tariff by item from 1982 until 1990, covering the period of the Mexican automotive export surge. We chose a sample of 17 of the highest US imports from Mexico, which are almost completely supplied by maquiladoras.[10] Table 6 presents the participation of Mexican imports in total US imports as well as

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[9]Data is from United Nations trade statistics.

[10]Most of these products were chosen from the Automotive products chapter in the US Tariff Schedule (Chapter 87). Nonetheless, we also looked at all those products which are identifiable as pertaining for the most part to the automobile sector but find themselves classified in other chapters of the Tariff Schedule. We included some of these items since several of them constitute a large part of US imports from Mexico.

Mexico's ranking among exporters to the US in each product analyzed. Similarly we also show the percentage of US imports coming from the first, second or third countries in the ranking. In 9 of the products analyzed imports from Mexico rank lower than those from Japan, Taiwan, Korea or Hong Kong among others. These other countries constitute a high percentage of the US import bill in these items. As noted, a difference may be found in the US content of imports from such nations versus imports from Mexico.

Our study also shows that 65% of the plants have US ownership of more than 90% of capital, and 10 more constitute US-Mexican joint ventures with Mexican participation below 50% (Table 5). Only 8 plants in the sample have ownership interests from other countries, half of these with Japanese participation. The maquiladoras are thus in large part a US operation, sourcing components with large US inputs for North-American based plants.

For a total of 36 maquiladoras we obtained more detailed data. Our criterion for this sample included choosing all the operations of the Big Three, and all other producers with non-US capital in their structure (excluding Mexico). General Motors is the assembler most involved in maquiladoras, employing close to 38 thousand workers. Wire harnesses represent most of its plants; it also engages in other activities of maquiladoras as described above. Ford's and Chrysler's participation is significantly smaller (Table 7).

With the exception of Honda's plant, Mexican components represent at most 4.8% of production value with a mean of 0.3 percent. The total Mexican value added in this sample constituted on average 22% of total production value. The Big Three employ a total of 5300 workers in

all their analyzed maquiladora operations. For this sample of US auto makers, close to 80% of total production value is represented by imported materials, while Mexican components represent less than 1 percent. The wage bill is about 10% of the total value of production. This is relatively good news for US labor, given that these ratios would differ significantly in overseas operations.

Other US component imports from the Mexican auto parts industry outside the maquiladora sector have shown significant growth but their future is not certain, at least in their present condition. Between 1982 and 1989, auto parts exports multiplied five times in value. North America represented nearly 80% of total Mexican auto part exports in 1990, but the Mexican share of total US imports trails the share of several other countries. Parts exports are concentrated among a small number of companies and include very labor-intensive products and those in which Mexico has some other competitive advantage. There is an absence of firms exporting high-technology parts, and a lack of international competitiveness in medium-technology parts. It seems that most of these exports constitute low-technology products.

To further explore this issue we undertook the same type of analysis as with the maquiladoras looking at highly exported Mexican autoparts in the US Import Tariff (Table 8). We can confirm the above observations. With the exception of safety glass, Mexican imports represent around 5% of US total imports. Mexico ranks significantly lower than Japan or Canada for most of these. Absent further foreign investment in the autoparts industry, most of the autoparts sector which produces for the domestic Mexican market is likely to be replaced by imports from the US

**Prospects for the Domestic Market.** The oil bonanza period between 1977 and 1981 significantly benefitted the Mexican automobile production. Passenger car production grew at an average of 25% per year. Total vehicle production peaked in 1981 at close to 600,000 units, with automotive GDP representing 7.1% of total manufacturing GDP. Nonetheless, as in the previous 20 years, increased production was tied to higher imports and a sectoral trade deficit which in 1981 explained close to 40% of the national deficit. The period of high inflation and fall in per capita real income until 1988 seriously affected the domestic market. From 1981 to 1983, total passenger car sales dropped 43 percent. A slight recovery in the following two years was followed by two worse years, leaving domestic passenger car sales at a ten-year low of 154,152 units in 1987.

The stabilization of the economy since 1988 and special policy measures, such as the "Auto Popular" Decree and certain price controls, have created a significant recovery in domestic sales, more than doubling the 1987 sales figure with 352,608 passenger cars and 550,000 vehicles in 1990. This year was the third in a row with a growth rate above 30 percent.

Automotive imports closely followed the production swings of the 1980's, reflecting domestic sales and exports (Figures 13 & 17). Nonetheless, the introduction of the less restrictive automotive decrees in 1989 marked the end of six years of trade surplus in this sector. The partial deregulation and increased openness of the auto industry made imports of components alone jump from $1.7 billion in 1988 to $4.6 billion

two years later. The data seems to suggest a fragile trade surplus and an inevitable dependence on imports of components for both exports and the growing domestic market.

Although Mexican nominal imports have somewhat changed over time, we see an almost constant proportion of imports from the United States. Comparing the import structures of 1982 and 1990 we find a nonsignificant variation of proportion of materials used in the production of autoparts, engine components, and autoparts themselves. All of these numbers are above 70% (Table 9).

As for passenger car imports themselves, manufacturers have been mostly importing luxury cars during this period of adjustment (Table 3). Partial explanations are the actual limits on the amount of imports, and the higher profit margin obtainable from these cars, which would otherwise not be produced in the country in such short runs. In 1990, the Big Three accounted for 68% of the imported units sold, equivalent to 88% in value. However, in thinking about these numbers, we should consider possible uncertainties about the final terms of the Free Trade Agreement and the fact that the period of observation is still very short in relation to production decisions.

The likely bright future of the export-oriented sector is not shared by the rest of the parts and vehicle plants in Mexico. These plants are the result of decades of import-substitution policies, oligopolistic protection and restricted entry conditions, all of which impeded technological progress. These vehicle assembly plants operate in very short runs, far below world scale (around 250,000 units), aiming at a small closed market with scarce opportunities for competition. Levels of technology are low, there is little use of robotics and antiquated equipment dominates the environment. The

organization of production and labor-management relations are far from current lean production techniques or their closest equivalents in non-Japanese firms[11].

Nevertheless, for a variety of reasons which include Volkswagen's shutdown and the strategic decisions of US producers responding to some changes in demand, these plants have exported some models in recent years. Contrary to expectations, some plants have achieved higher productivity and quality performance levels than similar plants in other developing countries. It is nonetheless clear that the arrival of a free trade area will create extraordinary pressure on these plants, which will need to undergo substantial restructuring in order to remain open. Among several possibilities is the specialization of some of them on particular models which are produced in small runs, due to their own characteristics or to market demand conditions. This may be happening already, with some luxury models produced and exported in 1990 (Table 3). Substantial growth and enlargement of the plants is another option. This is unlikely, as it would entail the modernization of the whole infrastructure of the plant when their location near Mexico City in the geographical center of the country makes exports more difficult.

## IV. The Potential Demand for Automobiles in Mexico.

The Mexican export boom discussed above is made possible by the relatively open US economy. Since the trade barriers to Mexican autos

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[11]An analysis of current production processes and techniques is provided in Altschuler et.al. (1985).

entering the US are small, while the barriers to US finished vehicle exports to Mexico are large, the opening of the Mexican auto market to US producers will be one of the largest effects of a free-trade agreement. The inefficient operations of the traditional plants in the center of Mexico suggest that the "new" Mexican market will be largely served by existing plants in the rest of North America.

In this section we consider the potential size of the Mexican market by examining the current demand for automobiles in Mexico. We estimate a simple demand system, depending on prices and national income, for various types of autos in Mexico. The estimated model parameters allow us to predict the demand for autos in Mexico as prices fall and as income rises under a free-trade agreement. While the current size of the Mexican market is small, our parameters are consistent with a prediction that a fall in prices to world levels, together with a rise in national income, will produce a substantial increase in Mexican auto demand. If the free-trade agreement is restricted to North American producers, then this substantially increased market will be an important source of revenues for these firms.

The partial equilibrium approach of this section contrasts with the related general equilibrium work of Hunter, Markusen and Rutherford (1991). That paper attempts to solve out for all of the equilibrium responses to a free trade agreement, including new demand levels, output prices, input choices and industry wages. Such an ambitious undertaking necessitates heroic assumptions on the nature of production and demand. Also, the parameters of that model are selected by a combination of arbitrary guesses and calibration to a very small amount of data. For example, the authors treat all automobiles as a homogeneous good and assume a constant demand elasticity equal to one.

Our approach is strictly partial equilibrium, but we allow for product differentiation and provide econometric estimates of demand elasticities. The econometric approach provides a clear path from the data to the results and allows us to calculate standard errors for model parameters and for projected demand. Rather than attempt to solve out for new equilibrium outcomes, we provide a series of projections for Mexican automobile demand under alternative hypotheses about post free trade prices and growth in income. The approach of Berry, Levinsohn and Pakes (1991) could be used to extend to partial equilibrium approach of this paper to include a much richer model of product differentiation and an explicit calculation of new (partial) equilibrium outcomes under free trade.

The data for our analysis are constructed from a monthly series of product-level prices and sales for the eleven year period 1980-1990. These data were kindly made available to us by the Mexican automobile dealers association. The Mexican auto dealers group their autos into four categories, "popular" (which at the end of 1990 includes the Volkswagen beetle and a local version of the Nissan Sentra), "compact" (which includes the VW Jetta and Ford Topaz), "sports" (such as the Ford Thunderbird) and "large" (or "luxury" which includes the Ford Taurus, GM Century and Chrysler New Yorker, but no US style luxury cars such as Cadillac or Mercedes.) As mentioned above, until 1990 Mexican law required that all of these automobiles be produced in Mexico, and only very limited imports are now allowed.

For the purposes of this study, we have aggregated the product-level monthly data into quarterly data on three product groups: popular, compact and a combined "luxury" category, including both large and sporty cars. We combined the two more expensive types of cars because of the

relatively small sales and sporadic production of the sporty models. For 1990, average prices (in US dollars at 1990 exchange rates) and unit sales of these three types of cars are as follows (note that these sales figures differ slightly from the production numbers above):

| | Popular | Compact | Luxury | Total |
|---|---|---|---|---|
| Sales | 174,704 | 127,674 | 27,618 | 329,996 |
| Price $ | 15,824 | 30,574 | 45,383 | 23,191 |

Relative to the US, these figures are notable for the high level of prices and for the extremely low level of demand (about 0.34% in annual per capita auto sales.) Both of these factors suggest the potential for a much larger market under free trade.

To consider this potential market, we suppose that the demand for autos of a particular type depends on the average prices in the three classes, on national income, and on the prices of alternative uses of income. We posit two broad alternative uses of income: savings and the consumption of other goods. Other goods are treated as the numeraire, as prices are adjusted for the Mexican consumer price index (CPI). We include as the "price" of savings the real rate of interest on three month Mexican treasury bills (RATE). National income is proxied by Gross Domestic Product (GDP.)

**Estimates of Demand.** As a particular functional form for demand, we adopt a constant elasticity framework in which the demand for product type j at time t, $q_{jt}$, depends on the prices of all the product types,

$p_{jt}$, and on aggregate demand factors, $x_t$:

$$\ln(q_{jt}) = x_t\beta_j + \sum_k \eta_{jk} \ln(p_{kt}) + \epsilon_{jt}, \qquad (1)$$

where $\eta_{jk}$ is the elasticity of demand for product j with respect to the price of product k and $\epsilon_{jt}$ represents unobserved demand factors which are assumed to be uncorrelated with $x_t$. Consistent with the discussion of the last paragraph, the terms included in $x_t$ are a constant, the logarithm of real quarterly GDP (indexed with 1980 GDP equal to 100) and the real three month T-bill rate. Over the course of the sample, the GDP index varies from 96.3 to 128.5 with a mean of 109.8.

Table 10 presents OLS estimates of the parameters in (1) for each of the product classes, with the cross-price elasticities all constrained to be zero. These results are consistent with priors, in that an increase in GDP is associated with increases in demand, while increases in interest rates and prices appear to decrease demand. For each product class, price elasticities of demand are estimated to be either inelastic or approximately unit elastic. However, these OLS estimates ignore the time-series nature of the data, the effect of cross-price elasticities and the correlation of prices with the unobserved demand characteristics, $\epsilon_j$. This latter feature of the data will tend to bias our results in the direction of inelastic demands.

Instrumental variables methods are the well-known solution to the correlation of prices with demand errors. The choice of instruments describes the "experiments" which reveal movements along a given demand curve; a question naturally arises as to the availability of such instruments. Luckily for our econometric analysis, in the 1980's the Mexican government itself conducted a sequence of "experiments" (or policy changes) which altered input prices and competition in the auto industry. We take variables proxying for these experiments as our instruments.

We consider two types of relevant policy changes. For much of the 1980s, the government set a special "controlled" exchange rate, which was available for many commercial transactions. (Toward the end of our data, the controlled exchange rate coincides with the market exchange rate.) Changes in this exchange rate affect the input costs of auto producers by altering the cost of imported inputs. (The exact nature of the change in perceived input costs is complex, as for much of this period auto firms may import only by exporting in equivalent amounts.) The controlled exchange rate is therefore one instrument for prices. Also, as outlined in section III, during the time period of our analysis the government announced two new decrees affecting automotive production and competition. These decrees took effect in 1984 and 1990. Furthermore, at the end of 1987, the government launched a new "stabilization" effort under which it tried to reduce the real prices of automobiles.

Thus, as proxies for different government policy regimes, we use as instruments four time-specific dummy variables. These dummy variables cover the periods 1980-1983, 1984-1987, 1988-1989 and 1990 respectively. The first of these is omitted to avoid collinearity with the constant in x. In addition to the x vector, we therefore use four instruments for prices: three time dummies plus the controlled exchange rate.

We will not present a dynamic model of automobile demand in Mexico, but we will acknowledge the time series nature of the data with an assumption on the serial correlation of the unobservables. In particular, we assume that $\epsilon_{jt}$ follows a linear first-order autoregression:

$$\epsilon_{jt} = \rho\epsilon_{jt-1} + \nu_{jt}, \qquad (2)$$

where $\nu_{jt}$ is assumed to be independently distributed across time and to be mean independent of exogenous data, z (consisting of x and the four

instruments described above.) Our estimation method requires no further assumptions on the properties of the unobservables, such as homoskedasticity or assumptions on the correlation of the errors across product types at a given time.

Estimating the demand system with an unrestricted matrix of price elasticities yields very imprecise estimates of the elasticities. Table 11 provides a set of estimates which impose symmetry on the matrix of elasticities and constrain the cross-price elasticities between luxury autos and other autos to be zero. This restriction is not rejected by the data and, given that some restrictions are necessary for precise estimates, appears relatively reasonable. These estimates indicate once again that demand increases in GDP and decreases as interest rates raise. A one percent increase in GDP is associated with a greater than three percent demand increase for each product type. The estimated own-price elasticities are negative, as required, and are significantly different from zero. In contrast to the OLS results, the estimates imply elastic demands for each product type. The large value of the own-price elasticity for "popular" cars is consistent with the large sales response to recent price cuts for the Volkswagen Beetle, as discussed above. The estimated cross-price elasticity between popular and compact autos is positive, although not precisely estimated. As expected with quarterly data, the estimated serial correlation parameter (of 0.47) is positive and significantly different from zero.

**Implications of the Estimates.** These estimates imply a large effect of price decreases and of increases in national income. Post free-

trade demand will depend on aspects of the industry which we have not addressed (such as production parameters and the nature of competition) and on the details of the free trade agreements. We will therefore present estimates of demand under several hypotheses about prices and income.

Hunter, Markusen and Rutherford (1991) note that producers may price discriminate across different countries if consumers are not allowed to trade across borders (and thereby arbitrage away any price differentials.) They suggest that, depending on the terms of the free trade agreement, this may limit any decline in Mexican prices. However, the own-price demand elasticities estimated here are considerably higher than the unit elasticities assumed by these authors; this will limit the size of producer markups and thus limit the size of price differentials across countries.

Table 12 presents results for predicted unit quarterly sales under different scenarios. The first row of the table gives actual 4th quarter of 1990 sales. The second and third rows of the table consider the effect of a decrease in prices to US levels. For the purposes of these policy experiments, we use prices which approximate the prices of similar automobiles sold in the US, $8,000 for "populars", $12,000 for compacts and $18,000 for large and sporty cars. The second row assumes that the Mexican government retains tariffs and taxes sufficient to raise Mexican prices 20% above US levels, while the third row assumes that prices fall to match their US counterparts. We see that a price decrease to US levels more than doubles total Mexican demand.

Increases in Mexican GDP will further increase demand. Rows four and five of the table present two scenarios. The first is that GDP continues to grow at recent rates of about 3% per year for five years. The second is that the free trade agreement accelerates growth to 5% per year

for five years. Of course, the effects of such a large increase in GDP are difficult to measure precisely, as indicated by the large standard error of estimated demand in the last row. However, the point estimates suggest that under the optimistic assumptions of 5% growth and US prices, Mexican demand could reach more than 7 times its present level. Even the relatively conservative estimates in the third row imply total annual sales in excess of 1.6 million, which is roughly 15% of US annual demand. This may be a reasonable number for a country with a population one third the population of the US However, the standard errors of these estimates indicate a wide range of possible outcomes.

**Some Caveats and Possible Extensions.** The analysis of the preceding section could be improved in several directions. The constant elasticity demand framework is relatively simple and could be extended to consider product level information in the manner of Berry, Levinsohn and Pakes (1991). In an application to the US auto industry, that paper shows how to combine explicit models of consumer utility with product level variables to estimate a much richer set of cross-price elasticities. The lack of attention to product level detail has possible empirical implications; for example, we may underestimate demand increases by leaving out the effect of increases in product variety.

The framework of the present paper does not distinguish consumer perceptions of short versus long run changes in GDP and prices; adding this distinction would be quite difficult, but could alter interpretations of the income elasticity parameter. A related point is that we have not modelled the durable nature of automobiles, which implies that past sales influence

current demand. Also, the policy experiments of the last section do not attempt to solve out for a new pricing equilibrium, but rather assume that current North American price levels will prevail. This assumption becomes less realistic as the Mexican market increases in size and is problematic if producers are allowed to price discriminate across countries. Once again, the methods of Berry, Levinsohn and Pakes (1991) could be used to solve out for new pricing equilibria with and without price discrimination.

The demand analysis of this section makes no attempt to estimate the location of the plants which will service the growing Mexican market. While some new plants may locate in Mexico to produce models which have particular appeal in Mexico, we should note that apart from the VW Beetle the models currently produced and sold in Mexico are very similar to other North American models. Therefore, much if not most of the increased Mexican demand could be served from plants which serve the overall North American market. As we argue above, if these plants were likely to move en masse to Mexico, they would have done so already.

Finally, we should comment briefly on the possible role of used automobiles. If free trade in used cars is permitted, the relatively poor Mexican consumers would become a major source of demand for used cars from the US and Canada. This would substantially drive up the price of used cars and lead wealthier consumers (in all countries) to trade in their old cars more frequently. In this case a more complicated trading pattern might emerge, with the increase in North American demand for new cars coming largely from US and Canadian consumers, while a large portion of Mexican demand is satisfied by used cars. A large supply of recent vintage used cars could easily supplant any new vehicle production geared expressly for the low-priced Mexican market, particularly the VW Beetle. However,

as noted, free-trade in used cars need not fundamentally alter our conclusion of a large increase in North American sales, but only the distribution of new cars sales across different groups.

## V. Conclusion.

We have argued that well-established exporting activities, with high levels of technology, product quality and productivity, are likely to remain on both sides of the border. On the Mexican side, this sector will probably be formed by the engine plants, the high-tech assembly plants, the US-Mexican joint ventures in auto parts and a few other auto parts producers with high efficiency levels. The maquiladora industry in Mexico will continue to provide a useful cost reducing mechanism for all North-American based plants, although their current justification, avoiding tariffs, is likely to disappear under a Free Trade Agreement. Highly labor intensive components will continue to be produced in plants similar to current operations.

There are several factors that make Mexican production difficult, which explains why most production activities will not simply move to "the other side". Mexico's industrial infrastructure is weak in several areas. There is a shortage of suppliers of maintenance parts, which increases the risk of a partial halt in operations for long periods. Transportation systems, such as rail and highways are still unreliable, disrupting supply lines and final product delivery. Skilled labor is not abundant, at least in the medium run, and additional training will be required for some tasks.

Mexico's role for the US automobile industry could involve the

opening of production activities of small models that compete directly with the large number of similar cars imported from Japan or East Asia, sometimes even by Ford or General Motors themselves (Kia, Geo). The benefit from this strategy consists in the additional sourcing of components with high percentages (close to 80 percent) from the US itself. Ford's restructuring of its Hermosillo plant points in this direction. Most importantly, Mexico, as Canada with the implementation of the Auto-Pact, offers the opportunity for production diversification and rationalization.

Finally, the dynamics of the domestic Mexican market itself, expected to reach 1.5 million units of annual sales in 6 to 10 years, represents an important possibility for export growth from US-based plants. As Canada did in the sixties, Mexico could offer the opportunity for the creation of a large new market just next door.

## Appendix

The model defined by equations (1) and (2) can be rewritten in terms of the model parameters, $\theta$, and the data as,

where,
$$\nu_{jt}(q,x,p,\theta) = \epsilon_{jt}(q,x,p,\theta) - \rho\epsilon_{jt-1}(q,x,p,\theta),$$

$$\epsilon_{jt}(q,x,p,\theta) = \ln(q_{jt}) - x_{jt}\beta - \Sigma_{k=1}^{3} \eta_{jk}\ln(p_{kt}).$$

Note that the model parameters are $\theta = (\beta,\eta,\rho)$ where $\eta$ is a vector with up to nine elements. Estimation is based on the moment condition

$$E(\nu_{jt}(q,x,p,\theta) \mid z) = 0,$$

where z is the seven vector of instruments discussed in the text. We simplify our use of instruments by first regressing observed prices on the seven instruments and creating predicted prices from the estimated coefficients. These predicted prices, $\hat{p}$, would be the optimal instruments for the elasticities if expected value of price, conditional on z, were linear and if the $\nu$'s were i.i.d. (see White, 1984). In any case, they will provide consistent and asymptotically normal estimates. Let the constructed instrument vector be

$$\hat{z}_t = (x_t,\hat{p}_t).$$

We then choose the value of the parameters which minimizes the sample

correlation between the errors and the instruments. The objective function is therefore

$$\min_{\theta} \frac{1}{T}\sum_{t} v_t(q,x,p,\hat{\theta})\otimes z_t$$

The asymptotic variance, $V(\theta)$, of the resulting estimator is standard from White (1984).

The outcome of each of the "experiments" in table 12 can be written as the linear combination of the estimated parameters for some $\delta$. The variance of the estimator of log quantity is therefore

$$\ln(\hat{q}_j) = \ln(q_j) + \delta'\theta,$$

$$Var(\ln(\hat{q})) = \delta' V(\theta)\delta.$$

By the usual first-order expansion, the variance of the predicted quantity is

$$Var(\hat{q}) \approx \hat{q} Var(\ln(\hat{q})).$$

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**Figure 1**

# PRODUCTION AT FOREIGN AFFILIATES
## % OF WORLDWIDE PRODUCTION

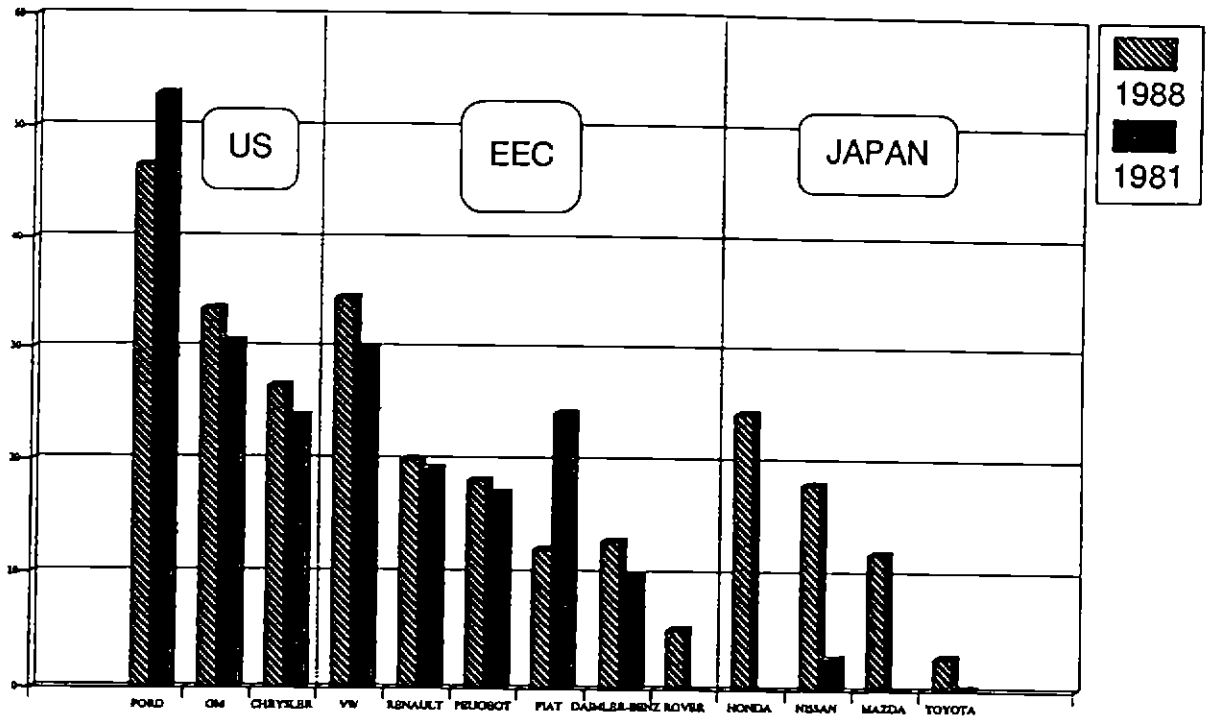
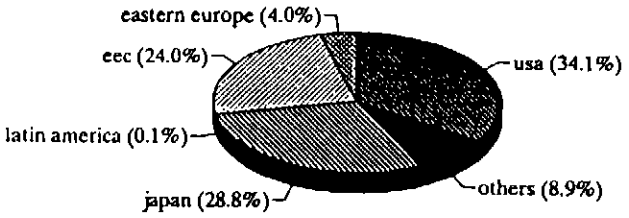


**Figure 2**

(a)

## WORLD AUTO PRODUCTION, 1988
by nationality of manufacturer

world production: 48,119,607




(b)

## LOCATION OF AUTO PRODUCTION
1988

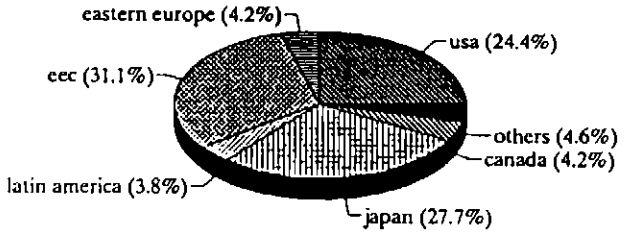
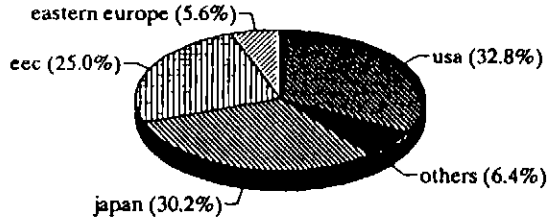



**Figure 2**

(c)

## WORLD AUTO PRODUCTION, 1981
by nationality of manufaturer

world production: 37,225,058




(d)

## LOCATION OF AUTO PRODUCTION
1981

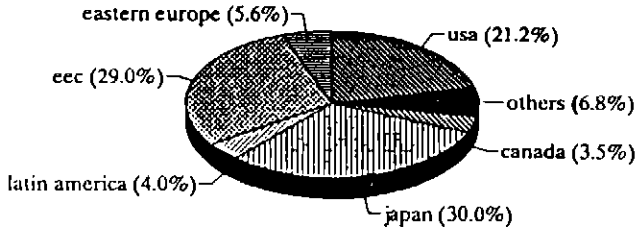
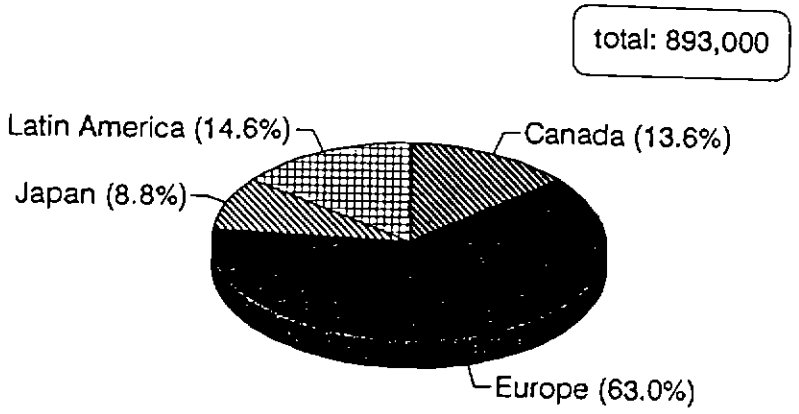


**Figure 3**

(a)

US MULTINATIONALS: FOREIGN AFFILIATES
EMPLOYMENT IN TRANSPORTATION EQUIPMENT

1983




(b)

US MULTINATIONALS: FOREIGN AFFILIATES
EMPLOYMENT IN TRANSPORTATION EQUIPMENT

1988

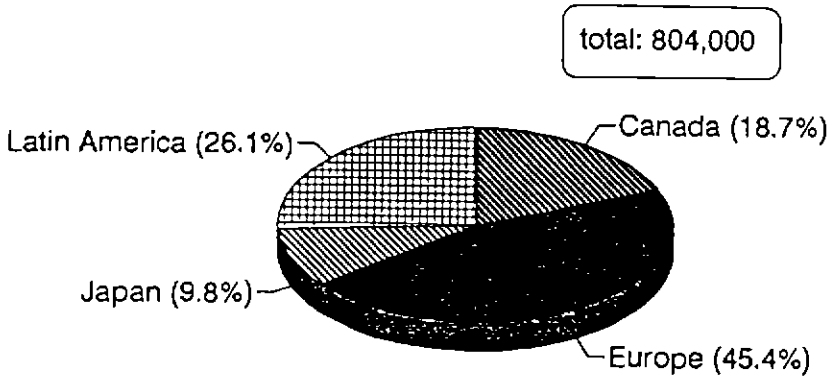


**Figure 4**

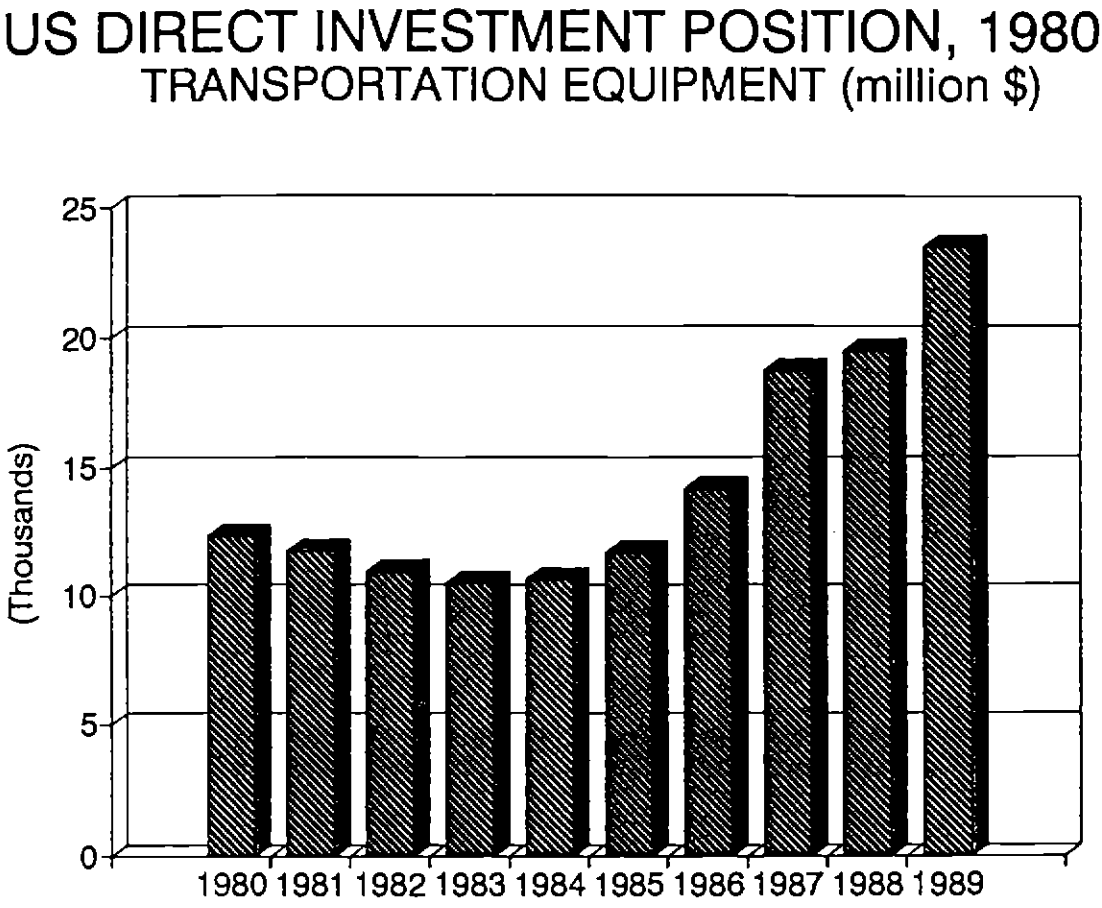
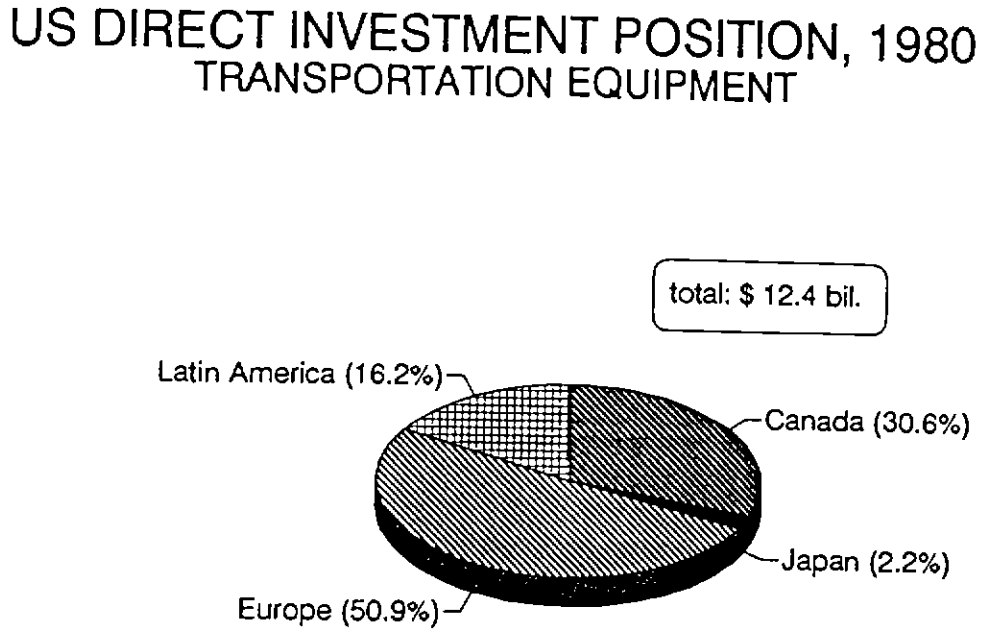

US DIRECT INVESTMENT POSITION, 1980-89
TRANSPORTATION EQUIPMENT (million $)
(Thousands)
25
20
15
10
5
0
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989

**Figure 5**

(a)


US DIRECT INVESTMENT POSITION, 1980
TRANSPORTATION EQUIPMENT
total: $ 12.4 bil.
Latin America (16.2%)
Canada (30.6%)
Japan (2.2%)
Europe (50.9%)

(b)

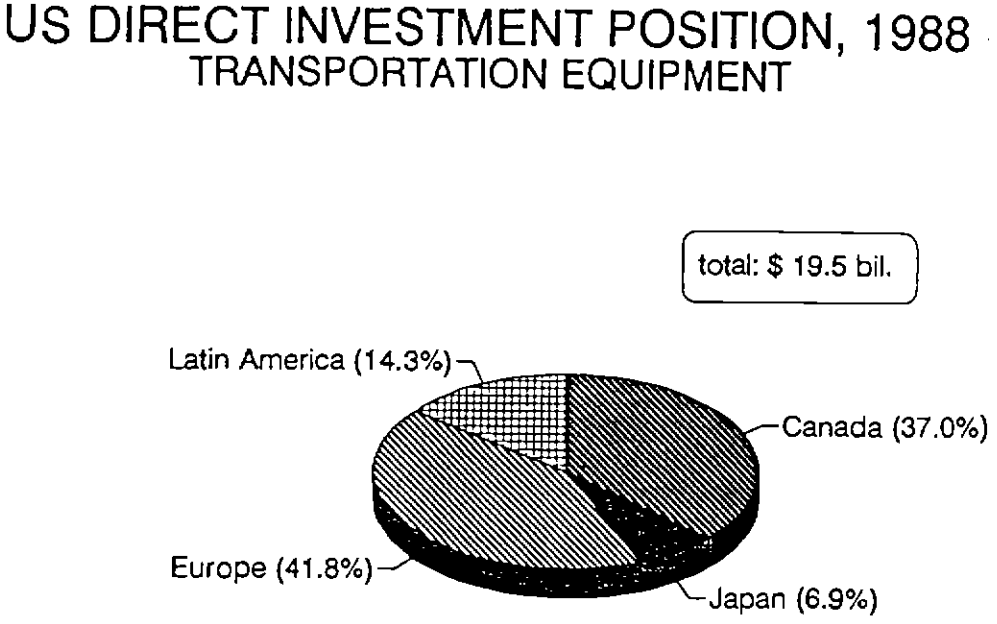
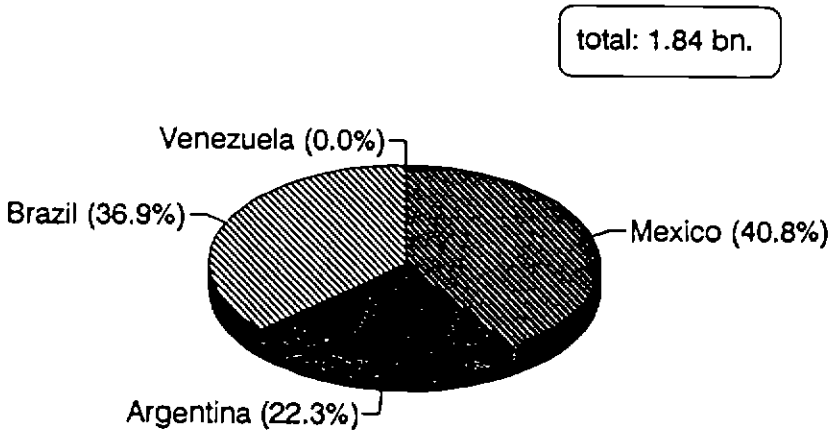

US DIRECT INVESTMENT POSITION, 1988
TRANSPORTATION EQUIPMENT
total: $ 19.5 bil.
Latin America (14.3%)
Canada (37.0%)
Europe (41.8%)
Japan (6.9%)

**Figure 6**

(a)

## US DIRECT INVESTMENT POSITION, 1980
### TRANSPORTATION EQUIPMENT




(b)

## US DIRECT INVESTMENT POSITION, 1989
### TRANSPORTATION EQUIPMENT

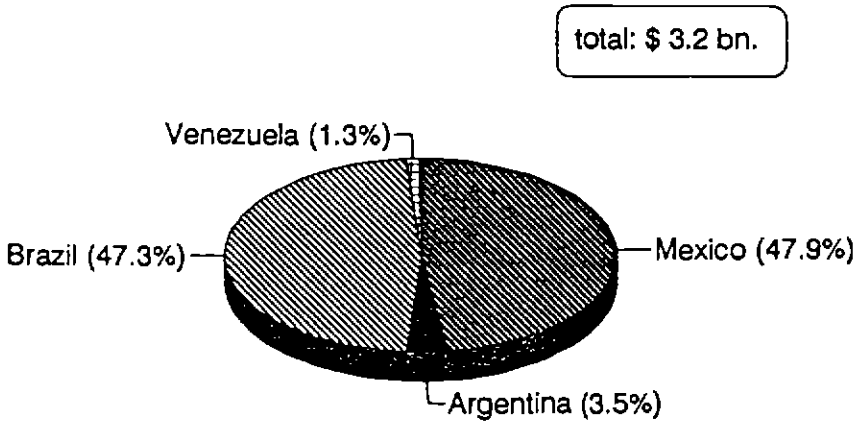
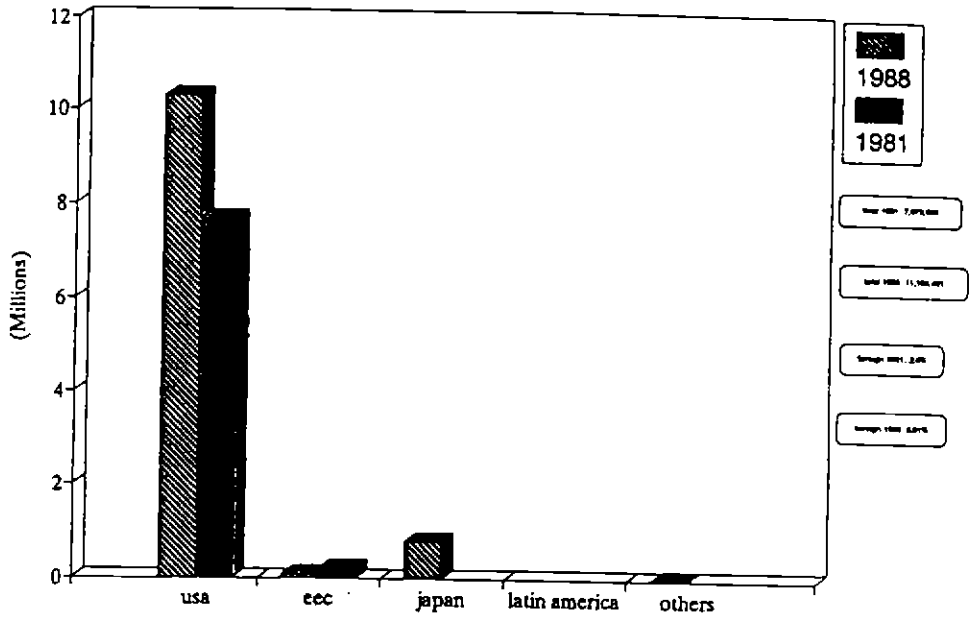


**Figure 7**

**(a)**

AUTO PRODUCTION IN THE US




**(b)**

LOCATION OF US AUTO PRODUCTION

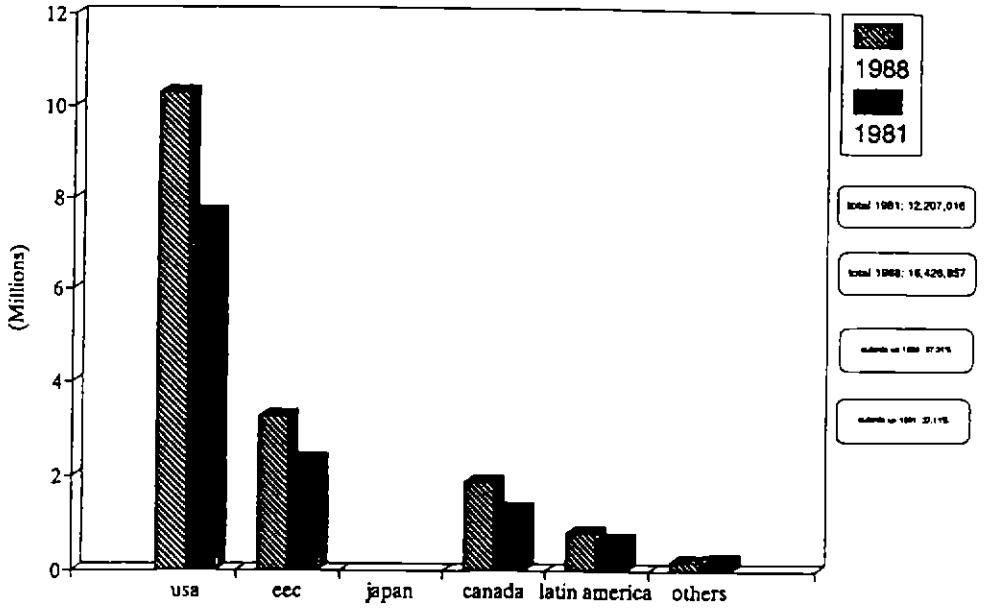
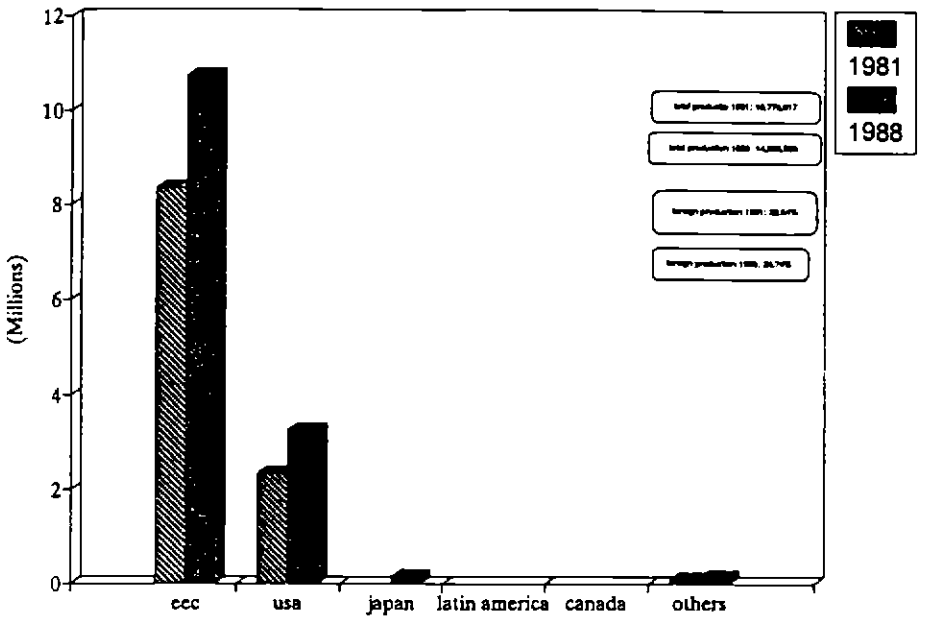


Figure 8

(a)

AUTO PRODUCTION IN EEC




(b)

LOCATION OF EEC AUTO PRODUCTION

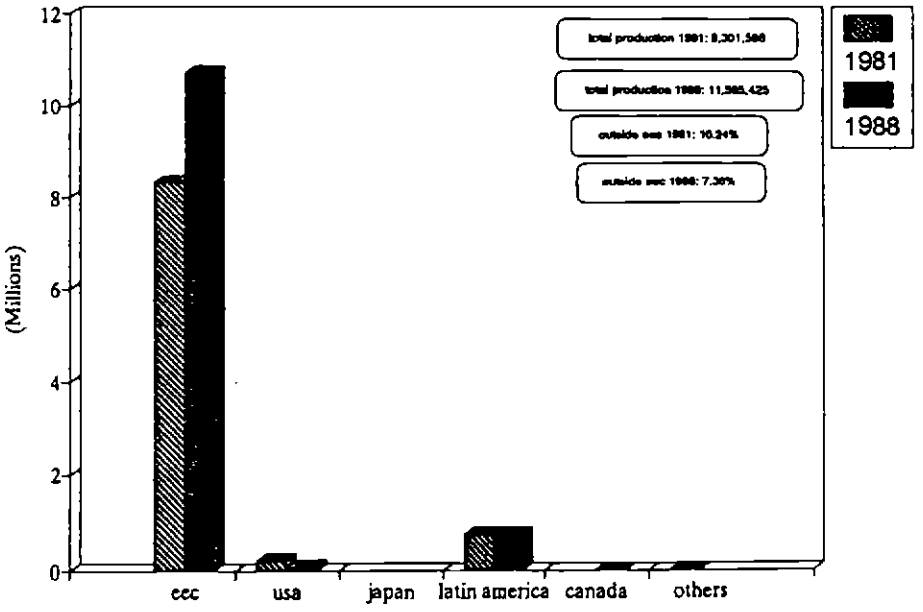


Figure 9

# LOCATION OF JAPANESE AUTO PRODUCTION

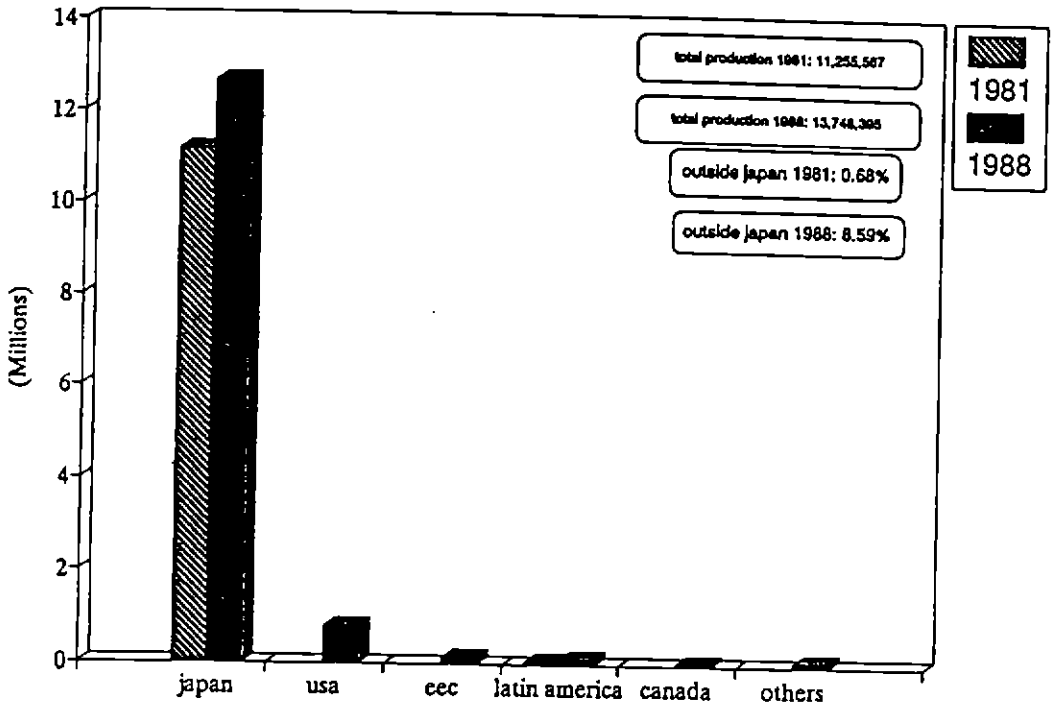
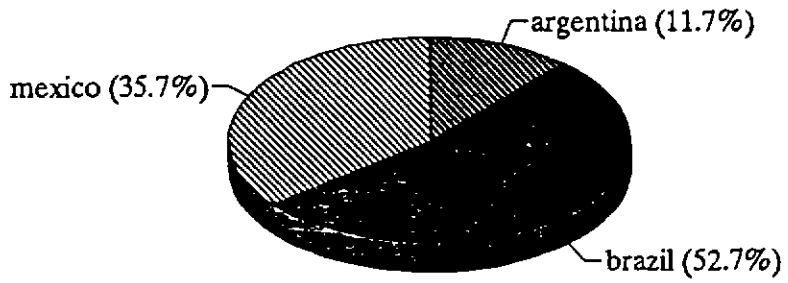


**Figure 10**

(a)

AUTO PRODUCTION IN LATIN AMERICA
1981




(b)

AUTO PRODUCTION IN LATIN AMERICA
1988

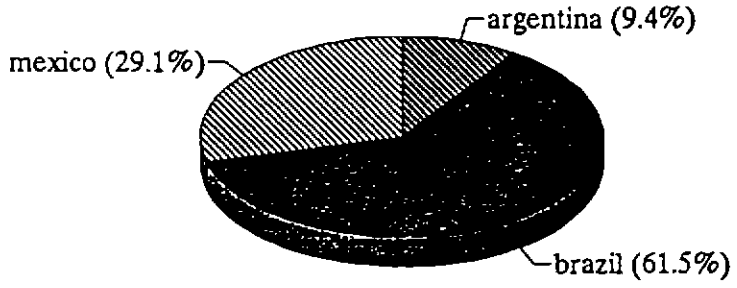
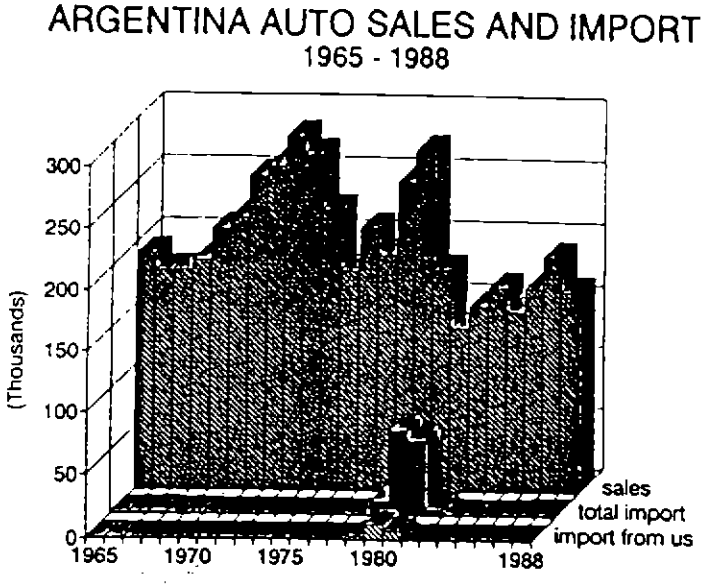


**Figure 11**


ARGENTINA AUTO SALES AND IMPORT
1965 - 1988
(Thousands)
300
250
200
150
100
50
0
1965
1970
1975
1980
1988
sales
total import
import from us

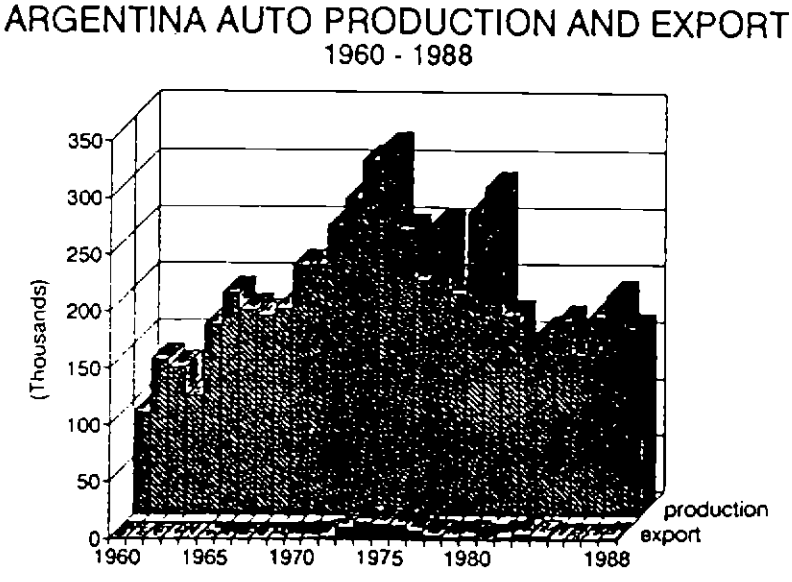
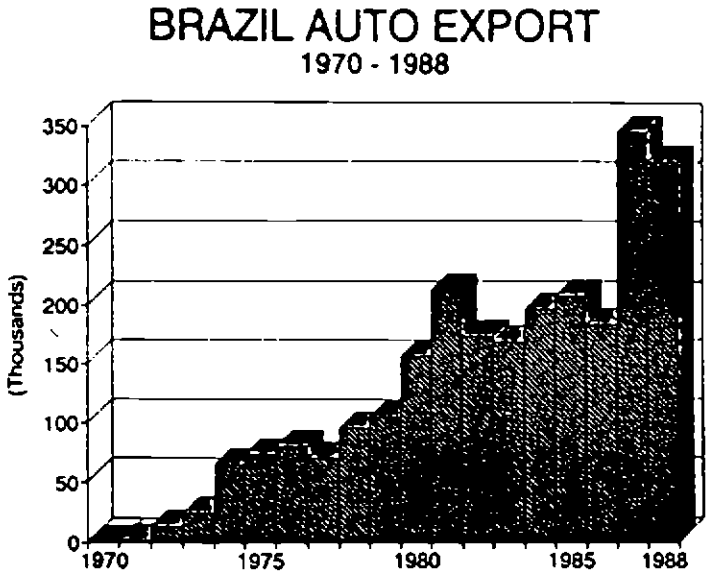

ARGENTINA AUTO PRODUCTION AND EXPORT
1960 - 1988
(Thousands)
350
300
250
200
150
100
50
0
1960
1965
1970
1975
1980
1988
production
export

**Figure 12**


BRAZIL AUTO EXPORT
1970 - 1988
(Thousands)
350
300
250
200
150
100
50
0
1970
1975
1980
1985
1988

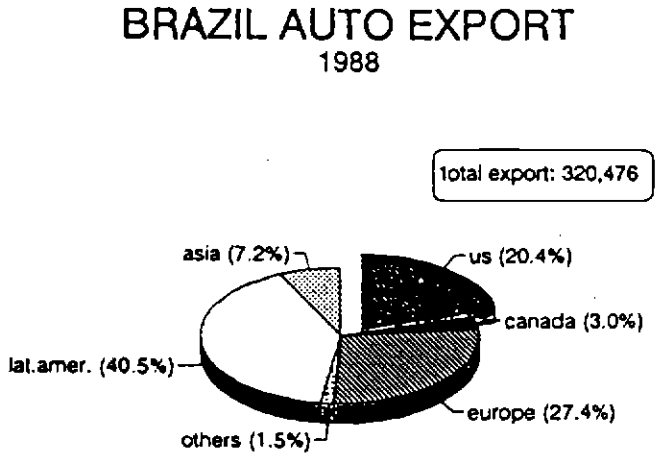

BRAZIL AUTO EXPORT
1988
total export: 320,476
asia (7.2%)
us (20.4%)
canada (3.0%)
lat.amer. (40.5%)
europe (27.4%)
others (1.5%)

**Figure 13**

# MEXICO AUTO PRODUCTION AND EXPORT
## 1980 - 1990

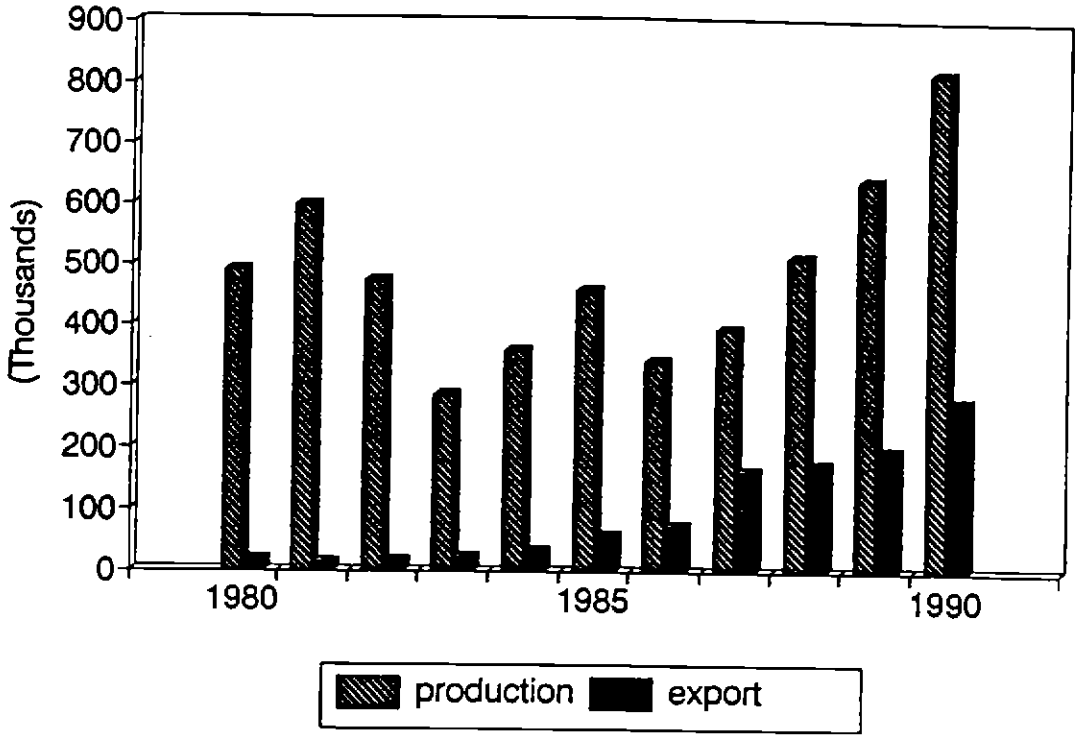
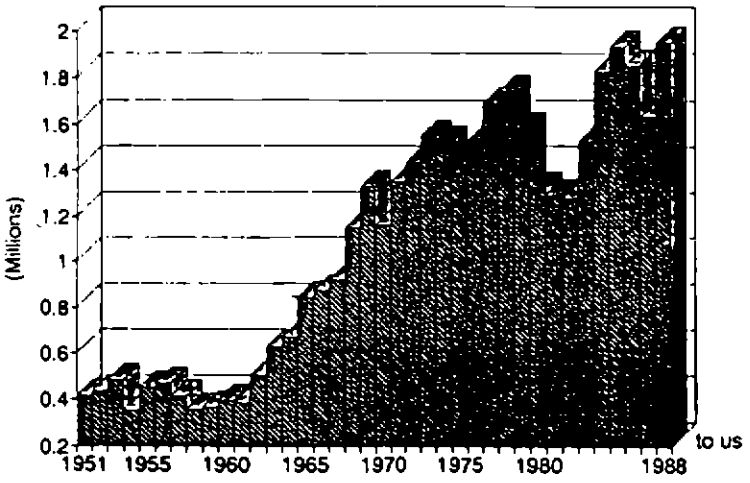


**Figure 14**

CANADIAN AUTOMOBILE PRODUCTION
1951 - 1988




CANADIAN AUTO IMPORT FROM US
% OF US AUTO PRODUCTION (1953-1988)

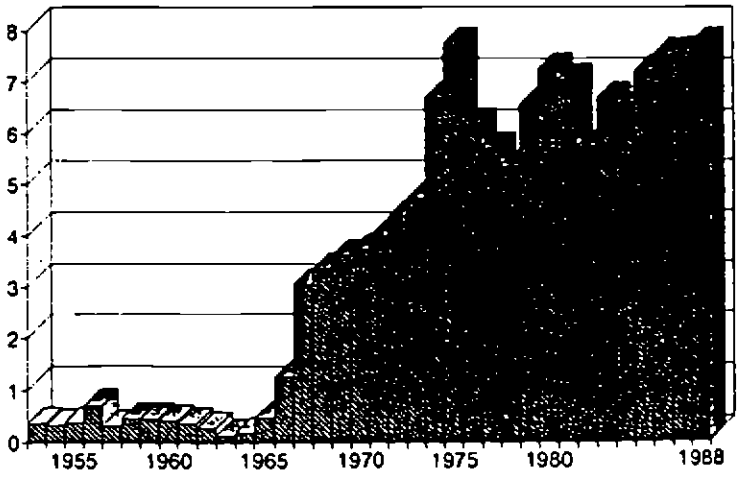
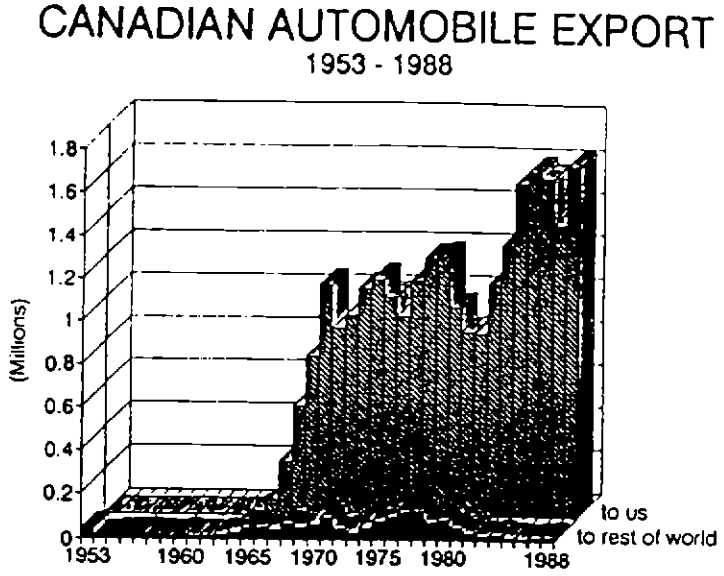


**Figure 15**


CANADIAN AUTOMOBILE EXPORT
1953 - 1988
(Millions)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1953
1960
1965
1970
1975
1980
1988
to us
to rest of world

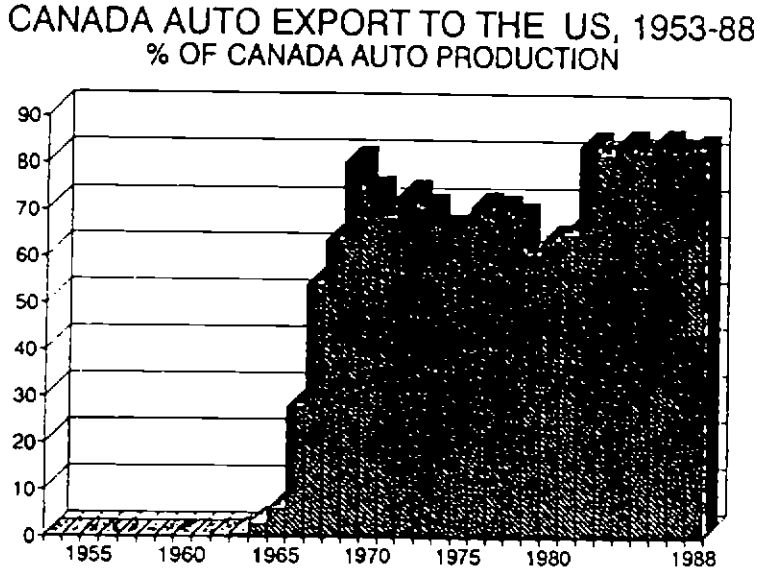
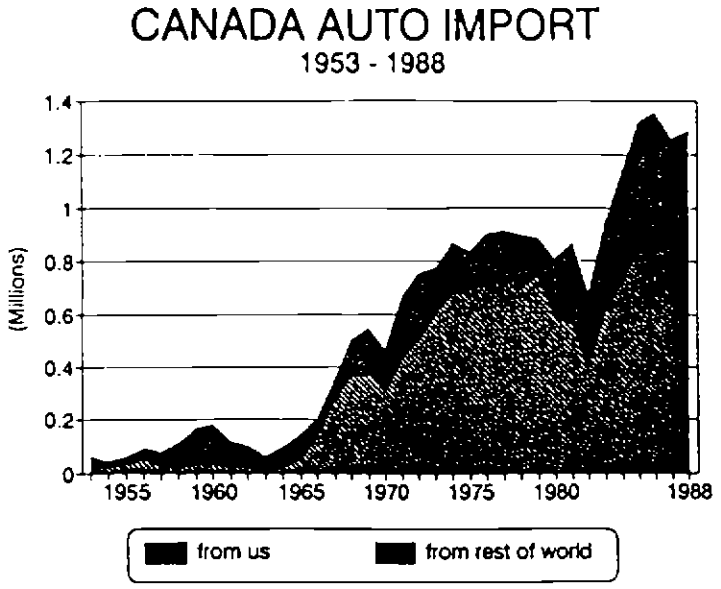

CANADA AUTO EXPORT TO THE US, 1953-88
% OF CANADA AUTO PRODUCTION
90
80
70
60
50
40
30
20
10
0
1955
1960
1965
1970
1975
1980
1988

**Figure 16**


CANADA AUTO IMPORT
1953 - 1988
(Millions)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1955
1960
1965
1970
1975
1980
1988
from us
from rest of world

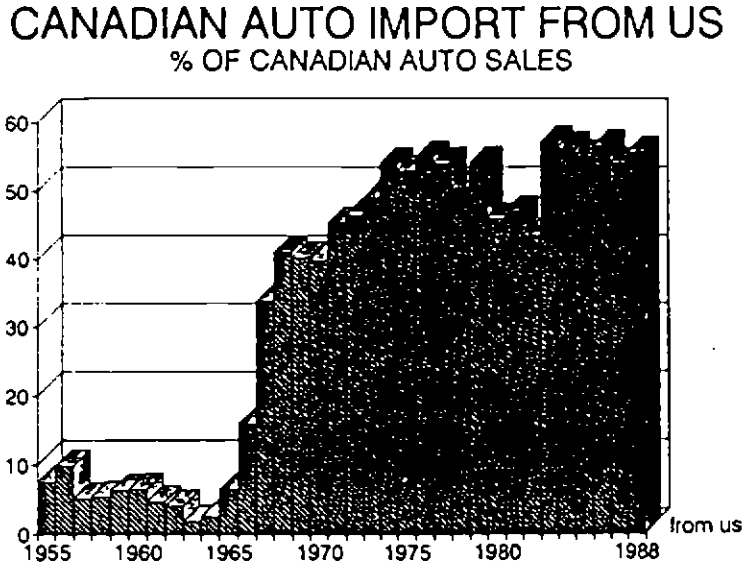
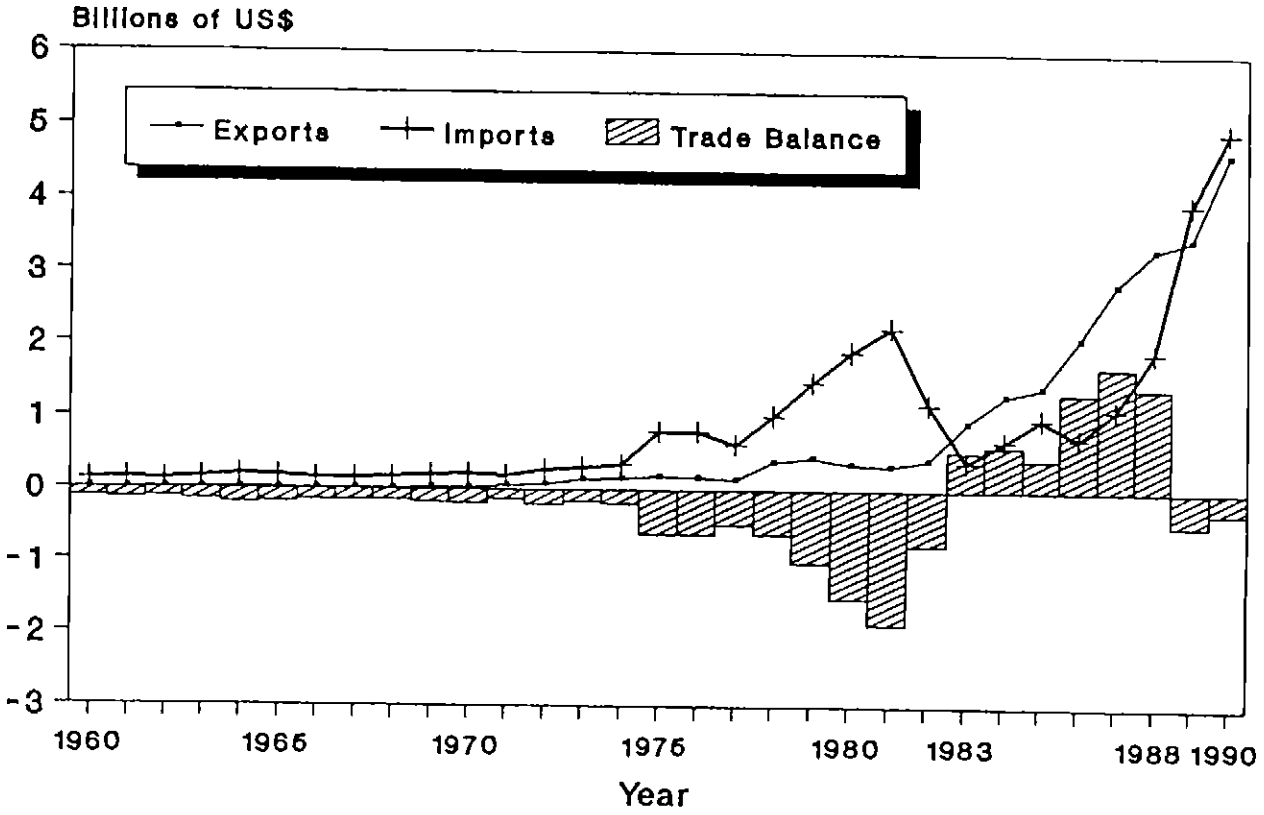

CANADIAN AUTO IMPORT FROM US
% OF CANADIAN AUTO SALES
60
50
40
30
20
10
0
1955
1960
1965
1970
1975
1980
1988
from us

Figure 17

# MEXICAN AUTOMOTIVE TRADE
(1960-1990)




Source:Calculated with data from
INEGI, Banco de Mexico and SECOFI.

## Table 1

MEXICAN AUTOMOTIVE TRADE BALANCE, 1960-1990

(Millions of US dollars)

| YEAR | AUTOMOTIVE EXPORTS | | | | AUTOMOTIVE IMPORTS | | | AUTOMOTIVE | U.S.A. / TOTAL | | AUTOMOTIVE / NATIONAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TOTAL | Vehicles | Engines | Autoparts | TOTAL | Vehicles | Autoparts | TRADE BALANCE | Exports to | Imports from | Exports | Imports | Balance |
| 1960 | 0.2 | 0.0 | | 0.2 | 119.3 | 86.5 | 32.7 | -119.1 | 65.4% | 86.4% | 0.0% | 10.1% | 26.6% |
| 1965 | 0.8 | 0.1 | | 0.8 | 182.6 | 131.7 | 50.9 | -181.7 | 63.8% | 87.1% | 0.1% | 11.7% | 39.7% |
| 1970 | 26.6 | 0.2 | | 26.4 | 219.7 | 166.4 | 53.3 | -193.1 | 67.7% | 88.8% | 2.1% | 9.4% | 18.6% |
| 1975 | 184.0 | 9.6 | 35.4 | 139.0 | 807.3 | 189.6 | 617.6 | -623.3 | 73.9% | 65.4% | 6.0% | 12.0% | 17.1% |
| 1980 | 366.2 | 128.7 | 32.7 | 204.8 | 1,896.7 | 657.7 | 1,239.0 | -1530.4 | 66.9% | 66.3% | 2.4% | 10.1% | 41.4% |
| 1981 | 339.5 | 113.8 | 61.5 | 164.2 | 2,219.4 | 681.6 | 1,537.8 | -1879.9 | 69.1% | 73.5% | 1.7% | 9.3% | 41.7% |
| 1982 | 420.2 | 79.2 | 191.3 | 149.6 | 1,192.8 | 213.4 | 979.4 | -772.6 | 62.8% | 77.9% | 1.9% | 6.1% | NS |
| 1983 | 940.6 | 124.2 | 602.8 | 213.6 | 397.9 | 33.5 | 364.5 | 542.7 | 72.4% | 68.1% | 4.4% | 5.4% | 3.9% |
| 1984 | 1,303.6 | 145.9 | 840.2 | 317.5 | 684.6 | 97.5 | 587.1 | 619.0 | 74.2% | 68.5% | 5.8% | 7.1% | 4.8% |
| 1985 | 1,426.8 | 140.7 | 1,039.2 | 246.9 | 993.2 | 135.0 | 858.2 | 433.5 | 85.5% | 72.0% | 6.6% | 7.1% | 5.8% |
| 1986 | 2,083.1 | 545.8 | 1,152.7 | 384.6 | 728.9 | 91.3 | 637.7 | 1,354.2 | 86.4% | 75.0% | 12.8% | 5.0% | 32.0% |
| 1987 | 2,839.2 | 1,207.0 | 1,179.6 | 452.5 | 1,135.8 | 108.6 | 1,027.2 | 1,703.4 | 87.7% | 75.1% | 14.7% | 8.9% | 23.0% |
| 1988 | 3,335.3 | 1,452.0 | 1,371.9 | 511.4 | 1,909.7 | 225.8 | 1,683.9 | 1,425.6 | 81.8% | 81.1% | 15.5% | 9.9% | 78.6% |
| 1989 | 3,477.7 | 1,674.4 | 1,335.9 | 467.4 | 3,951.1 | 161.3 | 3,789.9 | -473.4 | 84.1% | 75.9% | 15.3% | 15.6% | 18.2% |
| 1990 | 4,635.0 | 2,691.0 | 1,478.4 | 465.7 | 4,936.8 | 345.3 | 4,591.5 | -301.8 | 89.8% | 77.5% | 17.2% | 15.9% | 7.3% |

NOTE: NS = Non significant

SOURCE: Calculated with data from INEGI, Banco de Mexico and SECOFI.

## Table 2

PLANTS AND INSTALLED CAPACITY OF THE AUTOMOBILE ASSEMBLY INDUSTRY IN MEXICO
(1983 - 1991)

| AUTOMAKER | PLANT LOCATION (year) | Region | PRODUCT | INSTALLED CAPACITY (Units/Yr.) 1983 | 1988 | 1990 | ANNOUNCED INVESTMENT PLANS: 1990-1991 AMOUNT | PURPOSE | RESULTING PLANNED EXPORTS TO U.S. |
|---|---|---|---|---|---|---|---|---|---|
| CHRYSLER | 1) Mexico City | Center | Light Trucks | 73,440 | 73,440 | 73,440 | | | |
| | 2) Toluca | Center | Passenger cars | 120,960 | 120,960 | 150,000 | | | |
| | | | Engines (6, 8 cil.) | 137,088 | 169,646 | 90,000 | | | |
| | | | Condensers | 806,400 | 806,400 | 806,400 * | | | |
| | | | Automatic Transmission | --- | 60,480 | 60,480 * | | | |
| | 3) Saltillo (1981) | North | Engines (4 cil.) | 270,000 | 270,000 | 270,000 | | | |
| FORD | 1) Cuautitlan | Center | Passenger cars | 59,280 | 61,900 | 61,900 | | | |
| | | | Light Trucks | 44,640 | 49,700 | 49,700 | 1)$840 million | 1)Expand Hermosillo from 130,000 to 170,000 units. | 1)All units from its Hermosillo plant. |
| | | | Engines (4, 6 cil.) | 60,000 | n.a. | 90,000 | | | |
| | | | Engines V8 | 120,000 | n.a. | n.a. | | | |
| | | | Forge | 33,225 | n.a. | n.a. | 2)$700 million | 2)Double Chihuahua's engine cappacity. | 2)500,000 engines/Yr. |
| | 2) Chihuahua (1983) | North | Engines (4 cil.) | 400,000 | 400,000 | 400,000 | | | |
| | 3) Hermosillo (1986) | North | Passenger cars | --- | 130,000 | Expanding | | | |
| G. M. | 1) Mexico City | Center | Light Trucks | 71,300 | 60,480 | 60,480 | | | |
| | | | Spark Plugs | 5,520,000 | 5,520,000 | 5,520,000 * | $50 million | Increase in Wire Harnesses. in the maquiladora segment. | |
| | 2) Toluca | Center | Engines (4,6,8 cil.) | 118,750 | 142,538 | 142,538 | | | |
| | | | Forge | 33,500 | 33,500 | 33,500 * | | | |
| | 3) Saltillo (1981) | North | Passenger cars | 87,500 | 103,156 | 120,000 | | | |
| | 4) Saltillo (1981) | North | Engines (6 cil.) | 451,200 | 451,200 | 451,200 | | | |
| NISSAN | 1) Cuernavaca | Center | Passenger cars | 78,000 | 78,000 | 100,000 | | | |
| | | | Light Trucks | 48,000 | 48,000 | 48,000 | $1 billion (1990-1994) | 1)Shift component from Japan to Mexico. | 1)1992: $120 million in components |
| | | | Engines (4 cil.) | 84,000 | 144,000 | 144,000 | | | |
| | 2) Lerma | C-N | Gray Iron Forge | 30,000 | 40,000 | 40,000 * | | 2)By 1994: 200,000 vehicles | 2)1993: 32,000 Sentras 1995: 64,000 Sentras |
| | 3) Aguascalientes (1982). | C-N | Engines (4 cil.) | --- | 192,000 | 192,000 | | | |
| | | | Aluminium Forge | n.a. | n.a. | n.a. | | | |
| | | | Transaxes | n.a. | 150,000 | 150,000 * | | | |
| | 4) Aguascal. II (1990) | C-N | Passenger cars | --- | --- | Construction | | | |
| VW | 1) Puebla | Center | Passenger cars | 168,000 | 129,800 | 200,000 | | | |
| | | | Light Trucks | 24,000 | 22,000 | 22,000 | $1.5 billion (1991-1994) | Expand vehicle production to 300,000 units by 1991, and 450,000 units by 1993. | By 1993 up to 310,000 vehicles. |
| | | | Engines (4 cil.) | 540,000 | 440,000 | 440,000 | | | |
| | | | Gray Iron Forge | 64,800 | 64,800 | 64,800 * | | | |
| | | | Aluminium Forge | 21,600 | 21,600 | 21,600 * | | | |
| | | | Magnesium Forge | 14,400 | 14,400 | 14,400 * | | | |
| RENAULT/ JEEP | 1) Mexico City | Center | Light Trucks | 17,500 | Closed | --- | | | |
| | 2) Cd. Sahagun | Center | Passenger cars | 40,000 | Closed | --- | | | |
| | | | Engines (4 cil.) | 40,000 | Closed | --- | | | |
| | 3) Torreon | C-N | Engines (6 cil.) | 40,000 | 200,000 | 300,000 | | | |

* Represents own estimate drawn from previous production or cappacity data.
n.a. Information not available.
C-N Stands for Center-North

SOURCE: AMIA, several issues.

# Table 3

MEXICAN BASED PASSENGER CAR PRODUCTION FOR DOMESTIC SALES AND EXPORTS
(Before and after the 1989 Auto Decree)

| AUTOMAKER | MODELS | (Type) | 1988 Production | 1988 For: Domestic Sales | 1988 Exports | 1988 Exports US (%) | 1990 Production Imports | 1990 For: Domestic Sales | 1990 Exports | 1990 Exports US (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| CHRYSLER | Dart/Aries | (C) | 21,385 | 14,406 | 6,960 | | 0 | 0 | 0 | |
| | Volare/Reliant | (C) | 21,930 | 13,159 | 8,725 | | 0 | 0 | 0 | |
| | Shadow | (C) | 19,029 | 15,005 | 3,980 | | 29,344 | 23,703 | 4,714 | |
| | Sundace | (C) | 3953 | | 4,220 | | 0 | 0 | 0 | |
| | Spirit | (C) | | | | | 32,494 | 23,941 | 8,640 | |
| | Acclaim | (C) | | | | | 8,618 | | 8,612 | |
| | Phantom | (L) | 8,021 | 3,191 | 4,587 | | 35,053 | 2,009 | 33,389 | |
| | New Yorker | (L) | 2,162 | 2,152 | 2 | | 2,862 | 2,850 | | |
| | Magnum | (S) | 819 | 819 | | | 0 | 0 | | |
| | Imperial | (L) | | | | | 77 | 77 | | |
| | TOTAL | | 77,299 | 48,732 | 28,474 | 92.6% | 108,371 77 | 52,580 | 55,355 | 99.2% |
| FORD | Topaz | (C) | 19,512 | 19,116 | | | 28,664 | 35,355 | | |
| | Tracer | (C) | 66,361 | | 66,361 | | 47,702 | | 47,702 | |
| | Escort | (C) | | | | | 40,902 | | 40,902 | |
| | Gula | (C) | | | | | 3,670 | 3,470 | | |
| | Taurus | (L) | 6,974 | 6,855 | | | 3,502 | 4,073 | | |
| | Cougar | (L) | 2,919 | 2,961 | | | 5,647 | 6,553 | | |
| | Thunderbird | (S) | 3,049 | 3,069 | | | 4,504 | 5,431 | | |
| | Lincoln Town | (L) | | | | | 940 | 940 | | |
| | TOTAL | | 98,815 | 32,001 | 66,361 | 97.8% | 134,591 940 | 55,822 | 88,604 | 100.0% |
| G. M. | Celebrity | (C) | 40,449 | 4,080 | 36,385 | | 0 | 267 | 0 | |
| | Cavelier | (C) | | | | | 15,024 | 13,212 | | |
| | Cutlass | (C) | 9,012 | 9,152 | 3 | | 13,676 | 13,686 | | |
| | Century | (L) | 2,016 | 2,050 | | | 45,075 | 4,084 | 40,993 | |
| | Cadillac | (L) | | | | | 789 | 789 | | |
| | Corvette | (L) | | | | | 313 | 313 | | |
| | TOTAL | | 51,477 | 15,282 | 36,388 | 99.7% | 73,775 1,102 | 32,351 | 40,993 | 100.0% |
| NISSAN | Tsuru | (P) | 71,201 | 60,247 | 12,319 | | 98,430 | 79,945 | 18,737 | |
| | Maxima | (L) | | | | | 438 | 438 | | |
| | 300 ZX | (L) | | | | | 119 | 119 | | |
| | TOTAL | | 71,201 | 60,247 | 12,319 | 0.0% | 98,430 557 | 80,502 | 18,737 | 0.0% |
| VW | Sedan | (P) | 19,008 | 19,348 | 51 | | 84,930 | 84,265 | 83 | |
| | Golf | (P) | 17,380 | 16,988 | 286 | | 58,482 | 27,948 | 29,075 | |
| | Jetta | (C) | 12,879 | 12,293 | 24 | | 39,494 | 21,390 | 17,074 | |
| | Corsar | (C) | 3,095 | 3,996 | 75 | | 0 | 49 | | |
| | Passat | (C) | | | | | 1,129 | 1,129 | | |
| | TOTAL | | 52,362 | 52,625 | 436 | 9.3% | 182,906 1,129 | 134,761 | 46,232 | 77.4% |
| TOTALS | POPULARS | (P) | 107,589 | 96,583 | 12,656 | | 241,862 0 | 192,138 | 47,895 | |
| | COMPACTS | (C) | 217,605 | 91,207 | 126,733 | | 259,588 1,129 | 136,202 | 127,644 | |
| | LUXURY | (L) | 22,092 | 17,209 | 4,589 | | 92,139 2,476 | 22,245 | 74,382 | |
| | SPORTS | (S) | 3,868 | 3,888 | 0 | | 4,504 0 | 5,431 | 0 | |
| | TOTAL | | 351,154 | 208,887 | 143,978 | 85.7% | 598,093 3,805 | 356,016 | 249,921 | 86.8% |

NOTE: The letters in parenthesis represent the type of car as classified in Mexico:
Populars: (P)
Compacts: (C)
Luxury : (L)
Sports : (S)

SOURCE: AMIA, several issues.

# Table 4

AUTOMOTIVE MAQUILADORA INDUSTRY, 1979-1988

| YEAR | TRANSPORTATION EQUIPMENT | | | | | | | TRANSP.EQUIP. / NATIONAL TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Plants | Workers | Imported Inputs | Value Added | Exported Value | V.A./ Imp.Inputs (percent) | V.A./ Exp.Value (percent) | Workers | Value Added (percent) | Exported Value |
| | | | (Millions of US$) | | | | | | | |
| 1980 | 53 | 7,500 | -- | 62.2 | -- | -- | -- | 6.3% | 8.1% | -- |
| 1981 | 44 | 10,999 | -- | 125.5 | -- | -- | -- | 8.4% | 13.0% | -- |
| 1982 | 44 | 12,288 | -- | 130.7 | -- | -- | -- | 9.7% | 17.0% | -- |
| 1983 | 47 | 19,048 | -- | 171.8 | -- | -- | -- | 12.8% | 21.1% | -- |
| 1984 | 51 | 29,079 | -- | 222.8 | -- | -- | -- | 14.6% | 19.4% | -- |
| 1985 | 62 | 39,848 | -- | 329.5 | 1,438.8 | -- | 22.9% | 18.8% | 26.0% | 28.2% |
| 1986 | 76 | 48,140 | 1,313.9 | 307.9 | 1,621.8 | 23.4% | 19.0% | 19.6% | 23.8% | 28.7% |
| 1987 | 107 | 59,278 | 1,704.5 | 381.6 | 2,082.2 | 22.4% | 18.3% | 19.4% | 23.9% | 29.3% |
| 1988 | 131 | 83,290 | 2,253.5 | 596.3 | 2,849.8 | 26.5% | 20.9% | 21.4% | 25.5% | 28.1% |
| 1989 | 149 | 87,813 | 2,664.2 | 725.1 | 3,389.3 | 27.2% | 21.4% | 20.1% | 23.8% | 27.1% |
| 1990 | 187 | 100,461 | 2,989.2 | 908.3 | 3,897.5 | 30.4% | 23.3% | 22.5% | 25.2% | 27.7% |

SOURCE: INEGI and Banco de Mexico, several issues.

# Table 5

SURVEY OF THE MEXICAN AUTOMOTIVE MAQUILADORA INDUSTRY
(May 1991) *

| PRODUCT | NUMBER OF PLANTS | CAPITAL OWNERSHIP | | | | LOCATION | |
|---|---|---|---|---|---|---|---|
| | | U.S. (above 90%) | US-MEXICO 2/ JOINT VENTURES | MEXICO (above 50%) | OTHER NATIONS | Northern States | Other |
| Wire Harnesses | 43 | 34 | 2 | 5 | 2 (Japan) | 43 | |
| Other Electrical Components | 9 | 4 | | 4 | 1 (Jap-Mex) | 8 | 1 |
| Radio receivers | 3 | 2 | | | 1 (Panama) | 3 | |
| Seat Covers, Interior Trim & Parts | 14 | 12 | 1 | | 1 (Canada) | 13 | 1 |
| Seat Belts | 5 | 5 | | | | 5 | |
| Plastic parts & Boards | 9 | 8 3/ | | 1 | | 9 | |
| Windshields or safety glass | 5 | 2 | | 3 | | 3 | 2 |
| Air Conditioners & Air Compressors | 7 | 4 | | 3 | | 7 | |
| Bumpers & Body Parts | 7 | 4 | 1 | 1 | 1 (US-Jap) | 6 | 1 |
| Metallic Structures for trailers | 8 | 2 | 1 | 4 | 1 (Canada) | 7 | 1 |
| Body repairs and modifications | 6 | 3 | 1 | 2 | | 5 | 1 |
| Golf Cars | 2 | | | 2 | | 2 | |
| Reconstruction of Parts | 7 | 2 | 1 | 4 | | 6 | 1 |
| Chromizing & shining of Rims | 11 | 6 | 1 | 4 | | 11 | |
| Rims | 2 | 2 | | | | 2 | |
| Wheel components | 2 | 1 | | 1 | | 2 | |
| Radiators | 3 | 2 | 1 | | | 2 | 1 |
| Hidraulic mechanisms | 3 | 3 | | | | 3 | |
| Assembly of Gear boxes | 3 | | | 3 | | 3 | |
| Assembly of aluminium parts | 2 | | | 2 | | 2 | |
| Brake components | 6 | 4 | 1 | 1 | | 4 | 2 |
| Mufflers | 2 | 2 | | | | 2 | |
| Other small components 1/ | 13 | 9 | | 3 | 1 (Panama) | 12 | 1 |
| TOTAL | 172 | 111 | 10 | 43 | 8 | 160 | 12 |
| | | 64.5% | 5.8% | 25.0% | 4.7% | 93.0% | 7.0% |

Notes:
* This reflects a survey of 180 Transportation Equipment Maquiladoras. Here we only include those engaged in automotive related activities.
1/ It includes (1)Speedometers; (1)Ceramic Magnets; (1) Catalytic Converters; (2) Metallic components; (1) Transmission components; (1) Windshield Wipers.
2/ With US percentage ownership below 90 % but above 50 %.
3/ It includes 1 US-German Joint Venture with 96 % US capital ownership.
SOURCE: Direction of the Maquiladora Industry, SECOFI Mexico.

## Table 6

THE HIGHEST U.S. IMPORTS FROM THE MEXICAN MAQUILADORAS
(1982-1990)

| PRODUCT | 1982 MEXICO IMPORTS / TOT.US IMPORTS | 1982 MEXICO RANKING | 1982 OTHER COUNTRIES COUNTRY | 1982 OTHER COUNTRIES RANKING | 1990 MEXICO IMPORTS / TOT.US IMPORTS | 1990 MEXICO RANKING | 1990 OTHER COUNTRIES COUNTRY | 1990 OTHER COUNTRIES IMPORTS / TOT.US IMPORTS | 1990 OTHER COUNTRIES RANKING |
|---|---|---|---|---|---|---|---|---|---|
| Locks of base metal | 3.4% | (6) | Japan | (1) | 13.7% | (2) | Japan | 59.6% | (1) |
| | | | West Germany | (2) | | | Taiwan | 13.6% | (3) |
| Nickel-cadmium storage batteries | 49.7% | (1) | Japan | (2) | 25.2% | (2) | Japan | 59.7% | (1) |
| | | | Hong Kong | (3) | | | Hong Kong | 5.7% | (3) |
| Windshield wipers | 0.0% | * | Canada | (1) | 77.3% | (1) | West Germany | 8.8% | (2) |
| | | | | | | | Japan | 4.2% | (3) |
| Radio-tape player combinations | 0.0% | * | Japan | (1) | 40.6% | (1) | Japan | 29.5% | (2) |
| | | | Hong Kong | (2) | | | Korea | 14.0% | (3) |
| Radiobroadcast receivers | 24.2% | (2) | Brazil | (1) | 64.1% | (1) | Singapore | 14.9% | (2) |
| | | | Japan | (3) | | | Japan | 12.8% | (3) |
| Insulated ignition wiring sets | 74.0% | (1) | Taiwan | (2) | 73.7% | (1) | Philippines | 6.7% | (2) |
| | | | Japan | (3) | | | Taiwan | 5.3% | (3) |
| Safety seat belts for bodies | 10.3% | (4) | Japan | (1) | 64.5% | (1) | Japan | 24.9% | (2) |
| | | | Canada | (2) | | | Canada | 9.3% | (3) |
| Radiators, for motor vehicles | 2.5% | (5) | Japan | (1) | 22.4% | (2) | Canada | 49.3% | (1) |
| | | | West Germany | (2) | | | Japan | 9.2% | (3) |
| Mufflers and exhaust pipes, for vehicles | 0.1% | * | Canada | (1) | 31.3% | (2) | Japan | 32.8% | (1) |
| | | | West Germany | (2) | | | Canada | 8.0% | (3) |
| Steering wheels, steering columns | n.a. | | | | 22.6% | (2) | Japan | 44.5% | (1) |
| | | | | | | | Canada | 20.9% | (3) |
| Parts of trailers and semi-trailers | 13.7% | (2) | Japan | (1) | 9.3% | (3) | Taiwan | 22.4% | (1) |
| | | | West Germany | (3) | | | Canada | 15.2% | (2) |
| Accesories for automatic regulatos | n.a. | | | | 16.3% | (2) | Japan | 33.7% | (1) |
| | | | | | | | West Germany | 9.3% | (3) |
| Seats of a kind used for motor vehicles | n.a. | | | | 60.8% | (1) | Canada | 32.8% | (2) |
| | | | | | | | Japan | 13.0% | (3) |
| Parts of seats of a kind used for vehi. | n.a. | | | | 14.3% | (3) | Canada | 64.1% | (1) |
| | | | | | | | Japan | 18.2% | (2) |
| Other parts of seats | n.a. | | | | 20.6% | (2) | Canada | 34.1% | (1) |
| | | | | | | | West Germany | 11.0% | (3) |
| Lighters | 0.0% | * | Canada | (1) | 51.4% | (1) | Taiwan | 14.1% | (2) |
| | | | | | | | Korea | 13.4% | (3) |

Notes:
* Below 7th. place as a US source of imports of this product.
n.a. The exact match for this product to the Harmonized Tariff System in 1990 was not found.

SOURCE: Data base provided by SECOFI from the US Tariff System.

# Table 7

SURVEY OF MEXICAN AUTOMOTIVE MAQUILADORA PLANTS
(Data for May 1991)

| OWNER & PRODUCTION | PLANTS SURVEYED | NUMBER OF EMPLOYEES | MEX'N COMP./ PRODN.VALUE (%) | VALUE ADDED/ PRODN.VALUE (%) 1/ | IMPORT.COM./ PRODN.VALUE (%) |
|---|---|---|---|---|---|
| BIG THREE | 27 | 53,509 | 0.2% | 20.9% | 79.1% |
| Wire Harnesses | 14 | 29,458 | 0.5% | 27.7% | 72.3% |
| Seat Covers, Vinyl boards & Interior Trim | 5 | 9,336 | 0.0% | 28.5% | 71.5% |
| Gasoline Inyectors & Engine Controls | 1 | 2,931 | 0.0% | 23.5% | 76.5% |
| Radios | 1 | 4,137 | 0.0% | 4.8% | 95.2% |
| Bumpers | 1 | 1,224 | 2.3% | 58.2% | 41.8% |
| Ceramic Magnets | 1 | 771 | 0.0% | 90.6% | 9.4% |
| Windows, Glass | 1 | 380 | 1.0% | 60.8% | 39.2% |
| Climate Controls & Radiators | 1 | 1,301 | 0.0% | 22.5% | 77.5% |
| Steering Columns | 1 | 2,764 | 0.1% | 14.5% | 85.5% |
| Catalytic Converters | 1 | 1,207 | 0.0% | 61.0% | 39.0% |
| U.S.- JOINT VENTURES | | | | | |
| KOREA-USA: Metallic Structures | 1 | 6 | 0.0% | 40.0% | 60.0% |
| GERMANY-USA: Plastic springs | 1 | 53 | 0.4% | 4.4% | 95.6% |
| OTHER COUNTRIES | | | | | |
| JAPAN: | | | | | |
| Wire Harnesses | 2 | 4,381 | 0.2% | 59.5% | 40.5% |
| HONDA, Seat Covers & Body parts | 1 | 236 | 27.9% | 48.1% | 51.9% |
| JAP-MEX: Electrical Components | 1 | 52 | 1.7% | 80.7% | 19.3% |
| PANAMA: | | | | | |
| Cassete Players | 1 | 13 | 0.0% | 1.2% | 98.8% |
| Speed Counters | 1 | 44 | 0.0% | 54.3% | 45.7% |
| CANADA: Leather wheel covers | 1 | 663 | 0.4% | 21.0% | 79.0% |
| TOTAL OF SAMPLE | | 58,957 | 0.3% | 22.0% | 78.0% |

Notes:
Total Production Value is defined as the sum of Value Added plus Imported Components.
1/ It includes Mexican Components.

SOURCE: Own calculations based on data provided from SECOFI.

## Table 8

SOME OF THE HIGHEST U.S. IMPORTS FROM THE MEXICAN AUTOPARTS INDUSTRY
(1982-1990)

| PRODUCT | 1982 MEXICO IMPORTS / TOT.US IMPORTS | 1982 MEXICO RANKING | 1982 OTHER COUNTRIES COUNTRY | 1982 OTHER COUNTRIES RANKING | 1990 MEXICO IMPORTS / TOT.US IMPORTS | 1990 MEXICO RANKING | 1990 OTHER COUNTRIES COUNTRY | 1990 OTHER COUNTRIES IMPORTS / TOT.US IMPORTS | 1990 OTHER COUNTRIES RANKING |
|---|---|---|---|---|---|---|---|---|---|
| Toughened (tempered) safety glass | 0.2% | * | Canada | (1) | 28.8% | (2) | Canada | 36.2% | (1) |
| | | | Japan | (2) | | | Japan | 14.5% | (3) |
| Windshields of laminated safety glass | 53.2% | (1) | Canada | (2) | 37.9% | (1) | Canada | 31.1% | (2) |
| | | | West Germany | (3) | | | West Germany | 5.9% | (3) |
| Bodies (including cabs) | 0.2% | * | Canada | (1) | 2.1% | (6) | Canada | 56.6% | (1) |
| | | | Japan | (2) | | | Japan | 12.1% | (2) |
| Bumpers and parts thereof | 36.3% | (1) | Japan | (2) | 5.2% | (4) | Canada | 62.3% | (1) |
| | | | West Germany | (3) | | | Japan | 18.2% | (2) |
| Brakes, servo-brakes and parts | 1.9% | (6) | Canada | (1) | 3.6% | (5) | Canada | 43.5% | (1) |
| | | | Japan | (2) | | | Japan | 25.7% | (2) |
| Gear boxes for vehicles | 12.9% | (4) | Canada | (1) | 0.3% | (6) | Japan | 52.6% | (1) |
| | | | Japan | (2) | | | Canada | 23.7% | (2) |
| Road wheels and parts and accessories | 10.2% | (6) | Taiwan | (1) | 5.3% | (5) | Canada | 34.4% | (1) |
| | | | | (2) | | | Japan | 20.1% | (2) |
| Clutches and parts thereof | n.a. | | | | 3.9% | (7) | Japan | 51.2% | (1) |
| | | | | | | | Canada | 12.3% | (2) |
| Parts and accessories of bodies | 0.0% | * | Canada | (1) | 5.0% | (4) | Japan | 61.1% | (1) |
| | | | | | | | Canada | 16.8% | (2) |

Notes:
* Below 7th. place as a US source of imports of this product.
n.a. The exact match for this product to the Harmonized Tariff System in 1990 was not found.

SOURCE: Data base provided by SECOFI from the US Tariff System.

# Table 9

MEXICAN AUTOMOBILE IMPORT STRUCTURE

| IMPORTS | 1982 US/TOTAL (%) | 1990 US/TOTAL (%) |
|---|---|---|
| COMPONENTS USED IN PARTS PRODUCTION | 71.6% | 73.0% |
| Liquids,glass,metal parts,wheels,etc.. | 72.3% | 72.5% |
| Engines,bombs,filters,mechanical systems | 70.9% | 72.4% |
| Metalic structures, "pullers" | 92.4% | 97.8% |
| ENGINE COMPONENTS & PARTS | 82.3% | 83.7% |
| AUTOPARTS | 76.0% | 73.6% |
| Parts in Chapter 87 (Automobiles) | 75.8% | 74.7% |
| Boards, seats & interior trim | 77.6% | 67.7% |
| CHASIS & BODIES | 98.5% | 88.9% |
| VEHICLES | 96.4% | 86.1% |
| TRACTORS | 100.0% | 91.3% |
| BUSES | 36.5% | 85.7% |
| PASSANGER VEHICLES | 99.4% | 87.9% |
| TRUCKS | 90.5% | 98.5% |
| SPECIAL VEHICLES | 96.7% | 64.8% |

SOURCE: Data Basa provided by SECOFI from the US Tariff System.

## Table 10

OLS Demand Results, by type
Dependent Variable is: ln Qty
(Standard Errors in Parentheses)

| | POPULAR | COMPACT | LUXURY |
|---|---|---|---|
| Const | 2.14 | -6.60 | 2.07 |
| | (2.32) | (4.13) | (4.02) |
| LnGDP | 2.60 | 4.14 | 2.95 |
| | (0.64) | (1.12) | (1.13) |
| Rate | -0.75 | -1.01 | -0.89 |
| | (0.14) | (0.21) | (0.23) |
| LnPrice | -0.67 | -0.45 | -1.08 |
| | (0.21) | (0.27) | (0.29) |
| R-SQ | 0.63 | 0.52 | 0.59 |

## Table 11

Demand System Results
Instrumental Variables
(Standard Errors in Parentheses)

| | POPULAR | COMPACT | LUXURY |
|---|---|---|---|
| Const | 3.30 | -5.69 | -2.64 |
| | (4.81) | (5.05) | (4.29) |
| lnGDP | 3.40 | 3.98 | 4.55 |
| | (1.33) | (1.51) | (1.26) |
| Rate | -0.17 | -0.87 | -0.51 |
| | (0.39) | (0.19) | (0.36) |
| lnPrice Popular | -2.80 | 1.08 | -- |
| | (0.91) | (0.62) | |
| lnPrice Compact | 1.08 | -1.49 | -- |
| | (0.62) | (0.51) | |
| lnPrice Luxury | -- | -- | -1.55 |
| | | | (0.44) |
| serial correlation | 0.47 | | |
| | (0.22) | | |

## Table 12

Actual and Projected Mexican Auto Sales
(standard errors in paentheses)

| | POPULAR | COMPACT | LUXURY | TOTAL |
|---|---|---|---|---|
| Actual 4th QTR 1990 Sales | 53,027 | 24,263 | 7,964 | 85,254 |
| U.S. Prices + 20% Tariff | 98,458<br>(36,678) | 50,302<br>(21,183) | 27,422<br>(13,949) | 176,182<br>(56,642) |
| U.S. Prices No Tariff | 139,093<br>(66,743) | 54,644<br>(28,742) | 37,432<br>(23,833) | 231,169<br>(95,976) |
| 5 Yrs 3% Growth (U.S. Prices) | 239,141<br>(161,916) | 103,091<br>(78,008) | 77,266<br>(64,230) | 419,497<br>(245,933) |
| 5 Yrs 3% Growth (U.S. Prices) | 356,080<br>(297,019) | 164,338<br>(154,184) | 131,587<br>(130,084) | 652,004<br>(468,290) |