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THE WELFARE EFFECTS OF TRADE LIBERALIZATION: EVIDENCE FROM THE CAR INDUSTRY IN COLOMBIA

JORGE TOVAR*

Abstract

In this paper I examine the effects of trade liberalization on firms' performance and consumers' welfare. Using product level data, I study firms' performance in the Colombian automobile industry. Given my disaggregated data I can estimate pre and post-reform price-cost margins, as well as calculate the results by origin of production. Before the reforms were implemented, imported cars had prohibitively high tariffs, on average 200%, and were essentially unavailable. After the reforms such tariffs were reduced to 38% on average. I find that as the industry restructured prior to the liberalization process, price-cost margins dropped from 33% to 24%. After the reforms, margins increased because of the associated lower costs, but then again started to fall, reaching a low 23% for domestic cars. The behavior of price-cost margins is explained by increasing domestic competition prior to the reforms, the associated decrease in costs after the reforms and the relatively unchanged market structure. On the consumer side, the approach I follow allows me to estimate the monetary gains due to the liberalization process. I find the post-reform gains in consumers' welfare to be, as a consequence of declining prices and increased variety, over three thousand dollars per purchaser. A counterfactual simulation, where it is assumed that no foreign cars were available after the reforms, suggests that the gains achieved by consumers are due, for the most part, to increased variety rather than to price competition.

Keywords: Trade Liberalization, Price-Cost Margins, Consumer Surplus, Demand Estimation, Automobiles, Colombia

JEL classification: D43, F13, F14, L13, L62

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CONSECUENCIAS SOBRE EL BIENESTAR ECONÓMICO COMO CONSECUENCIA DE LA LIBERALIZACIÓN COMERCIAL: EL CASO DE LA INDUSTRIA AUTOMOTRIZ EN COLOMBIA

Resumen

Este artículo estudia los efectos que un proceso de liberalización comercial tiene sobre el desempeño de las firmas y sobre el bienestar de los consumidores. Utilizando información a nivel de producto, se examina el desempeño de las empresas del sector automotriz colombiano. Gracias al tipo de información disponible, es posible estimar los márgenes de ganancia antes y después de las reformas comerciales, así como calcular los resultados por origen. El arancel para importar carros, antes de las reformas, alcanzaba niveles prohibitivos, en promedio 200%, haciendo prácticamente imposible su presencia en el mercado Colombiano. Al implementarse las reformas, cuando el arancel cayó a un promedio del 38%, se encuentra que los márgenes de ganancia cayeron de niveles alrededor del 33% al 24%. Cabe anotar que inmediatamente después de entrar en vigor la reforma comercial los márgenes crecieron por los menores costos asociados, para después caer hasta niveles del 23% para los carros domésticos. El comportamiento de los márgenes de ganancia se explica por la mayor competencia interna observada antes de las reformas, por la caída en los costos después de las reformas y por la, relativamente estable, estructura del mercado. Por el lado del consumidor, la metodología utilizada permite estimar en términos monetarios las ganancias fruto de la liberalización comercial. Se encuentra que dichas ganancias son, como consecuencia de menores precios y mayor variedad de producto, de alrededor de tres mil dólares por consumidor. Mediante ejercicios de simulación, y asumiendo que después de la reforma no ingresaron carros importados al país, se encuentra que la mejora en el bienestar de los consumidores es fruto de la mayor variedad de producto disponible y no tanto de la competencia en precios.

Palabras clave: Liberalización Comercial, Márgenes de Ganancia, Excedente del Consumidor, Estimaciones de Demanda, Automóviles, Colombia

Clasificación JEL: D43, F13, F14, L13, L6

I. Introduction

The introduction of theories of trade under imperfect competition challenged the idea that gains from tariff removal were always positive. Since then, much of the empirical work has focused on determining the possible gains from trade policy (Feenstra, 1995). Previous evaluations of trade liberalization have focused primarily on cross-industry regressions. In a recent survey, Tybout (2001) concludes that certain protected sectors, when exposed to foreign competition, tend to have lower price-cost margins. This result is typically interpreted as evidence of an increase in competition.[1] However, the causes remain unclear and the effects over the market structure are uncertain.[2]

In this paper, I use different data to study the effects of trade reforms on firms' performance and consumers' welfare. My objective is to estimate the economic effects of a trade liberalization process in the context of an oligopolistic market with differentiated products. I use product-level data from the Colombian automobile industry to estimate product-level demand and unobserved marginal costs. By looking at the automobile market in Colombia, prior and after the 1990s trade reforms, the effects of such reforms on price-cost margins can be evaluated. Moreover, using this approach it is possible to directly take into account the effects of foreign competition as well as to estimate (in monetary terms) the effects on consumers' welfare.

The Colombian case offers an excellent opportunity to study the effects of a liberalization process given the way the reforms were implemented. These reforms were initially planned in the last quarter of 1990 and scheduled to be gradually implemented over a four-year period. However, by the second half of 1991, policy makers did not observe the projected effects of the reforms and decided to immediately (and unexpectedly) reduce tariffs to the levels expected in 1994. This unique feature, the fact that prior to 1992 no foreign cars were available and that the number of domestic firms remained constant over the entire sample period, allows me to examine the effects of such liberalization process free of possible restrictive endogeneity issues.

As mentioned above, previous evaluations of trade policy, for the most part, have been done using plant or industry-level data. Product-level data has also been used to evaluate the

[1] See for example Grether (1996), Harrison (1994), Roberts (1996) or Tybout (1996).

[2] Tybout (2001) points out other possible explanations for such price-cost margins behavior. It might be that domestic firms are relatively efficient and thus better able to compete against potential imports or that sunk entry costs are so large that low margins (originated from unanticipated foreign competition) prevent firms from covering their entry costs.

effects of trade policy.[3] With the exception of Brambilla (2003), who estimates the economic effects of adopting a customs union between Brazil and Argentina, none of these papers study a trade policy reform as the one analyzed in this paper. Moreover, Brambilla's dataset spans only for four years, 1996-99, before the customs union actually took place, a period when the tariff for outside vehicles was increasing.[4] The difference between Brambilla (2003) and the present study relies not only in the way demand is estimated and in the length of the available data, but crucially in that unlike the MERCOSUR case, Colombia faced a one-shot (essentially unanticipated) tariff reform. I can therefore estimate observed changes, and calculate the effects of certain counterfactual simulations.

Using prices, characteristics, and sales for cars sold in Colombia between 1986 and 1998, I adopt a discrete choice random utility model to econometrically estimate demand. A GMM framework allows me to deal with the potential correlation between prices and unobserved car characteristics and thus to obtain consistent demand estimates. The instruments I use exploit increasing competition, the fact that many cars are imported and that, even if domestically produced, up to 70% of their components are imported. My first set of instruments is based on the idea that for a given car the number and the observed characteristics of competing models are correlated with this car's price, but uncorrelated with its unobserved characteristics. As a second set of instruments, I use the real exchange rate, the import tariffs, and the sales tax. These variables are correlated with the price, but not with the unobserved characteristics.

Once the demand model is estimated, I compute own- and cross-price elasticities for each car in the sample and consumer surplus over the thirteen-year period. The data show that as tariffs decline, the number of models sold in Colombia increased, and prices dropped. The estimates suggest that the increased variety and lower prices of cars improved consumers' welfare by approximately three thousand dollars per purchaser compared to the pre-reform period. Moreover, counterfactual simulations show that most of the consumers' welfare improvements were due to increased variety rather to price competition. Specifically, when I compare the consumers' welfare under the assumption that no foreign cars entered the market, relative to the observed consumers' welfare, the model shows that the sole

[3] Examples are Feenstra (1988), Goldberg (1995) and Berry, Levinsohn and Pakes (1999), who study the effect of VER on the 1980's U.S. – Japan relations. Berry, Grilli and López (1992) study the effects of the NAFTA formation on the Mexican car industry.

[4] Vehicles imported from outside Argentina and Brazil.

existence of imported vehicles reported gains of more than three thousand dollars per purchaser.

On the supply side, I characterize the behavior of firms as an oligopolistic competition. I derive the first order condition under the assumption of existence of a Nash-Bertrand equilibrium. With these conditions and the demand parameters estimated following the above procedure, I can recover the (unobserved) marginal cost of production for each car model. These estimates allow me to calculate price-cost margins as well as changes in firms' performance.

Theory predicts that lower tariffs and increased competition should reduce these price-cost margins. Indeed I find evidence of this, but I detect that existing domestic competition before the reforms also had an effect on margins. My estimates show that price-cost margins declined from an average of 33% in 1986 to 24% in 1991. Despite the fact that only three firms existed in Colombia prior to the reforms, anecdotal evidence suggests that in this period domestic firms began to compete intensively. Changes in the ownership of such firms and in the contractual relationship with the government seem to explain such behavior.

In the last quarter of 1991, tariffs of the main imported input used in assembling domestic cars was reduced from an average of 20% to 3%.[5] Similarly, for imported cars, tariffs dropped from an average of 200% to 38%. This decline in tariffs implied a drop in costs, and therefore a significant increase in price-cost margins in 1992. Once new firms entered the market, this extra competition drove price-cost margins to slightly lower levels than those observed before the reforms were implemented.

With prices going down, to keep margins stable, costs must have fallen. These lower costs are a direct result of the lower tariffs and the real appreciation process observed in the years that followed the reforms. In 1992, the first year after the reforms were implemented, I find the marginal costs for domestic vehicles to be 22% lower than the previous year.

The reforms pushed both prices and cost downwards. Domestic firms took advantage of these reductions in costs while improving efficiency in order to maintain their price-cost margins and to compete against imports.

My results support previous findings that price-cost margins fall as tariffs are removed. However, I find that, even in a protected sector, given certain conditions, margins prior to liberalization measures are not necessarily high. Moreover, my results suggest that as the

[5] This input, known as the "completely knocked down" (*CKD*) unit, represents about 70% of the cost of assembling a domestic car.

initial reform shock passes, its effects tend to vanish. Specifically, as competition increased, domestic firms lost around 50% of the market. However, their production increased and as time passed they recovered much of the market power lost with the initial shock. Lower cost pass-through, the small scale of imported cars competition and the remaining protection explains the prevalence of the three domestic firms. [6]

I find, not surprisingly, that domestic firms are less sensitive to external shocks in large part because they have are owned by multinational corporations and therefore have a very strong link with the respective headquarters. Foreign importers, on the other hand, are independent firms with no direct link to their respective international headquarters. This explains in part that domestic firms are less dependent to external shocks, such as fluctuations in the exchange rate. The effect of this pass-through is found to be incomplete, on average 0.50. Notably, the average pass through is higher and more volatile for imported cars (0.62) than for domestically produced cars (0.42).

The remainder of the paper is organized as follows. Section II reviews the existing literature. Sections III and IV presents the specifics of Colombia's trade reforms and its auto industry. Section V lays out a model of supply and demand. Section VI describes the data while section VII and VIII discuss the estimation strategy. Section IX and X reports and discusses the results. Finally section XI runs some specification checks while section XII concludes and discusses directions for future research.

II. Empirical Literature on Trade Reforms

Theory tends to predict that trade liberalization leads to efficiency gains. However, an overview of the existing empirical literature suggests that although such gains may actually exist, it is not clear that trade reforms are the cause. The literature on the effects of trade on growth, productivity and welfare can be divided into three general categories: Cross country regressions, cross industry regressions and product level analysis.

A thorough survey of cross-country regressions is out of the scope of this paper. However, it is worth noting that a major issue in this literature is how to measure openness. Once the decision is made on whether trade volumes, quotas (or tariffs), price differentials or artificially constructed indices (such as the Sachs-Warner index) are to be used, the main

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[6] Tariffs for imported cars remained relatively high, 38%, while tariffs for the inputs used in assembling a domestic car (*CKD*) were set to be only 3%. Further, in 1996 the sales tax for domestic cars, under 1.4 liters, was set to be 20%, while for an imported car this tax was 35%.

result in most papers is that trade reforms seem to have an effect on growth (and productivity), but results are not robust, and no strong policy conclusions can be extracted from such literature.[7]

Cross industry regressions use primarily manufacturing industry data, whenever possible disaggregated at the plant level. Tybout and Westbrook (1996) claim that industry or plant level data is preferred because country level data cannot be used to distinguish scale economies from changes in market share allocation across heterogeneous plants, or from technological progress.

Despite the volume of empirical work that addresses the correlation between trade and firms performance, efforts to measure gains from trade at the micro level have been inconclusive. For example, Harrison's (1994) results suggests, analyzing the 1985 trade reforms in Cote d'Ivoire, that price-cost margins fall only in few sectors. However, the period of analysis for her paper is 1979-1987 not enough to actually test for long term effects of the reforms. Harrison has access to tariffs data and finds that productivity increased after liberalization took place, but sector-by-sector, the net results are inconclusive.

Haddad, de Melo and Horton's (1996) and Tybout's (1996) results for Morocco and Chile respectively raise doubts on whether exposure to international trade affects market power when using import penetration as trade proxy.[8] Haddad et al. (1996) show that entering firms consistently locate in exporting sectors but find no clear pattern of correlation between trade flows and price-cost margins.

Roberts (1996) studies the Colombian manufacturing industry over the period 1977-85, during which no major trade reform took place. He finds no statistical significant effect between import penetration and price-cost margins in Colombia. However, he does find some effect over relatively more concentrated industries. For the late 1980s Mexican reforms, Grether (1996) results suggest that foreign competition reduced price-cost margins. Having access only to industry level data Foroutan (1996) analyzes the early 1980's Turkish trade reforms. He finds that, depending on the specification used, import penetration varies from little impact to none. He argues that the little impact of reforms may be due to the fact that export oriented industries were already the most competitive and efficient firms.

[7] See for example Renelt and Levine (1992), Harrison (1996), Frankel and Romer (1999) or Rodriguez and Rodrik (2000).

[8] Haddad, de Melo and Horton (1996) study the 1983-84 trade reforms in Morocco. Tybout (1996) studies the 1979 trade reforms in Chile with 1979-1985 plant level data. As Grether (1996), Haddad, de Melo and Horton (1996) and Roberts (1996) do for several other countries, Tybout analysis is performed using industry and plant level data. In general, results are very week when using industry level data.

Recent work by Pavcnik (2002) and Muendler (2002) based on the Olley and Pakes (1996) methodology, use Chilean and Brazilian plant level data respectively to analyze the evolution of productivity in those countries manufacturing sectors.[9] Pavcnik finds no evidence that firms in export competing sectors increase performance, but her results suggest that, for import competing sectors, liberalized trade did in fact enhanced plant productivity. Muendler concludes that foreign competition improved productivity while eliminating inefficient firms.

The above review, though far from exhaustive, suggests that the effect of trade liberalization still remains an empirical question. As argued by Tybout (2001), it seems that there is a tendency for mark-ups to fall with import competition, but the link between trade reforms and the observed performance is not yet clear.

The third category of trade liberalization related literature; product level analysis is also the most recent. This approach has been widely used in the industrial organization literature in the past.[10] The use of such models for trade related questions is much more scarce. Among the latter, Berry, Grilli and López (1992) forecast the expected growth of the Mexican car industry in an attempt to anticipate the effects of NAFTA. They conclude that economic growth together with declines in price to world levels would expand the Mexican auto market.

The imposition of voluntary export restraints (VER) from Japan to the U.S. was the focus of Goldberg (1995) and Berry, Levinsohn, and Pakes (1999). The former finds that the VER were binding in the first years after they were imposed, while the latter finds the opposite. Brambilla (2003) measures the effect of adopting a customs union in the automobile market in Argentina and Brazil. She finds that under a customs union, prices in Argentina will be lower, while consumers were better off. The opposite is true for Brazil.

III. Trade Reforms in Colombia

Following international trends, many Latin American countries undertook international policy changes in the early 1980s. However, not until the early 1990s did Colombia decide to engage in such changes. For years, Colombia was an inward-looking economy, and remained such even until the late 1980s. Though some very timid liberalization measures

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[9] Pavcnik focuses her research on the period 1976-86. Muendler uses Brazilian plant level data for the period 1986-98.

[10] See Feenstra (1988), Berry, Levinsohn and Pakes (1995), Goldberg (1995), Nevo (2001) or Petrin (2002)

where taken in the early 1980s, it was not until 1991when deep structural fiscal, labor, monetary and trade reforms were actually implemented.[11]

The outgoing government took initial steps around 1989, but different internal and external events prevented any serious reform from being implemented. Therefore, it was not until 1990, when the recently elected Gaviria Administration designed a four-year program to gradually lower tariffs. However, in October 1991 the gradual program was terminated and Colombian policy makers decided to abruptly lower tariffs, breaking the program designed months earlier.[12] Tariffs were set, in the last quarter of 1991 to the 1994 expected levels. Among other reasons, the stagnation of both imports and exports induced government analysts to believe that economic agents where postponing any investment decision until the moment when tariffs were at their lowest levels.

IV. The Colombian Car Market

Over the period 1986-1998, three companies were the sole assemblers (not producers) of cars in Colombia. The three companies are *Compañía Colombiana Automotriz* (CCA), assembler of Mazda; *Sociedad de Fabricación de Automotores S.A.* (Sofasa), assembler of Renault and General Motors Colmotores S.A. (GM Colmotores), assembler of General Motor vehicles. [13]

The oldest firm is Colmotores, which was founded in 1956. Chrysler owned the company until 1979, when General Motors bought the production plant. In 1991 the name was changed to its current name. As part of GM, the company assembles and sells in Colombia Chevrolet's, Opel's and Suzuki's models under the Chevrolet make. Historically, Colmotores has been the largest of all three firms.

CCA, the second oldest firm, was founded in 1960. In 1973, Fiat and the government Industrial Investment Institute (IFI) bought the company. Fiat models were produced until 1983 when the company was authorized to switch and produce Mazda's instead. In 1988 IFI sold its share to Colombian private investors who in turn sold its part to Japanese investors. By 1993, the entire company was owned by Mazda.

[11] See Garay et. al 1998.

[12] The program aimed to lower tariffs from an aggregate average level of around 25% in 1990, to a level of 11% in 1994.

[13] Originally and up to 1991 it was known as *Fabrica Colombiana de Automotores S.A.* As a GM partner, Colmotores sells Chevrolet, Suzuki and Opel among others.

Sofasa was established in the late 1960's by the creation of a joint society between IFI and Renault. In 1989 Renault bought IFI's share and offered 24% to Toyota Motor Corporation. Colombian private investors bought 52% of the company in 1994, remaining the rest at equal shares in the hands of Renault and Toyota. Finally, in 2003 the Colombian investors sold its share of the company to Renault, Toyota and Mitsui.[14]

Given that domestic firms assemble but do not produce cars in Colombia, most of its inputs are imported. The imported materials known as CKD, which stands for Completely Knocked Down, represent around 70% of a fully assembled car.

Throughout the period of analysis (1986-1998), the main regulation changes were related to the 1991 structural reforms. Prior to the reforms, the government intervention in the car market began to be relaxed, particularly in the second half of the 1980's. In 1988 a new contract unifying the operational conditions of all three firms in the market was signed. Each firm was authorized to assemble no less than three models per year. They had to produce each model for at least 5 years and provide spare parts for at least 10 years. A 3% tax on the value of CKD imports in order to support the auto-parts sector was also established. Prior to this new contract competition was distorted as each firm had a different contract with the government giving artificial advantage to the firms depending on the contract conditions. Up to 1985 prices of taxis, commercial vehicles and small cars were regulated. This type of regulation was terminated early 1986.

In 1991 the government authorized the entry of new firms willing to assemble, it eliminated the import license requirements for CKD units and reduced the tariffs for both CKD and imported or *completely built up* (CBU) cars. Firms were allowed to freely assemble as many models and versions as they wanted, as long as they guaranteed the supply of auto parts and service for each model for a period of at least 10 years. Other legal changes had to do with the domestic components requirements for Colombian produced or assembled cars. Despite these changes, no new company has yet established a plant in Colombia.

V. The Model

As mentioned above, the estimates of the demand model using product-level data are later combined with a supply model in order to determine the effects of the Colombian trade liberalization process. The use of disaggregated data offers several advantages. First, I

[14] Today Renault owes 60% of the company, Toyota 28% and Mitsui 12%.

observe physical output as opposed to the revenue observed when using industry (or plant) level data. Second, competition is not inferred, but directly observed as imported cars flood into the market. Third, the approach is flexible enough to allow the researcher to actually measure (in monetary terms) the effects of such trade policy, and finally, it is possible, via simulations, to infer the effects of foreign competition on consumers' welfare. The obvious drawback is that I am only looking at one particular market. It is common, however, for trade agreements to give a different treatment to certain sectors, particularly the auto sector. For example, the free trade agreement signed in the mid 1990s between Colombian, Mexico and Venezuela treated differently this sector. While cars tariff were not initially included in the agreement, they expected fall to 0% in 2007.

V.i. Demand Model

I will use a discrete choice random utility model to estimate the demand parameters. The demand model described below is derived from McFadden's (1978) generalized extreme value model as developed by Bresnahan, Stern and Trajtenberg (1997).

The product differentiation general extreme value (PD GEV) model allocates each alternative to one nest along each of pre-selected dimensions, which characterize attributes of the product. It is based on the notion that markets for differentiated products exhibit increased cross-elasticity due to nesting relative to dimensions. In this paper I differentiate cars along two dimensions: origin (domestic vs. foreign) and size as perceived by engine displacement (small, medium, large).

The most commonly used version of GEV models is the nested logit. Motivated by different questions, Goldberg (1995) and Goldberg and Verboven (2001) use a multi-level and a two-level nested logit respectively to estimate demand for cars.[15] Similarly, also for cars, Berry, Levinsohn and Pakes (1995, 1999), Petrin (2002) and Brambilla (2003) use a random coefficient logit approach to determine demand estimates.

The main advantage of the PD GEV model over the nested logit model is that while in the latter the order of the nests matters, in the former it does not. The nested logit model implies that all alternatives are grouped into pre-determined mutually exclusive nests. This means that given two categories, origin and size, a change in price on say, a small Colombian

[15] Goldberg and Verboven also attempts to estimate their model using a PD GEV, but they report that this model did not find support in their data.

car, will have the same effect on shares on a medium Colombian car, than over a large Colombian car. The PD GEV overcomes this limitation.

In principle, the random coefficient logit model allows for flexible substitution patterns without *a priori* segmenting the market. As argued by Nevo (2000), this advantage comes at a cost. First, as shown below, the expression for the share function is solved via simulation as opposed to the close form of the PD GEV model. Second, detailed information about consumer heterogeneity is required to compute the market shares. More important, Petrin (2002) notes that a very rich dataset set is required in order to obtain precise estimates. Given the limitations of my dataset, only 926 observations and no consumer heterogeneity available beyond income, I choose to use the PD GEV model.

Assume that the conditional indirect utility function for consumer *i* for product *j* in market (period) *t* depends on observed product characteristics (x_{jt}), unobserved (to the researcher) product characteristics (ξ_{jt}), income (y_{it}), price (p_{jt}), and unknown parameters θ_{jt}. Building on a Cobb Douglas utility function, Berry et al. (1995) showed that the following functional form may be used to study the consumers' decision problem:

$$
\begin{aligned}
&U_{ijt} \equiv \alpha \ln(y_{it} - p_{jt}) + x_{jt}\beta + \xi_{jt} + \varepsilon_{ijt} \\
(1) \qquad &\delta_{jt} = x_{jt}\beta + \xi_{jt} \\
&i = 1 \ldots I,\ j = 1 \ldots J, t = 1 \ldots T
\end{aligned}
$$

where ε_{ijt} is defined below. The δ_{jt} term is common to all consumers and is therefore referred to as the mean utility, α is the marginal utility from income and β represents specific taste characteristics.

Correlation between the price and the unobserved product characteristics is expected because when the price is set, the producer takes into account these (observed by the firm) characteristics. When estimating the model, this endogeneity issue will be taken in consideration.

Consumer *i* will buy car *j* if he/she reports a higher utility, i.e.:

$$U(x_{jt}, \xi_{jt}, p_{jt}, \varepsilon_{ijt}; \theta) \geq U(x_{rt}, \xi_{rt}, p_{rt}, \varepsilon_{irt}; \theta) \text{, for } r=1 \ldots J$$

The model must take into account the possibility that consumers may not want to buy a new car. Ignoring this possibility would imply that an even change in the price of all cars will have no effect over demand and so, the substitution patterns would be biased. Let A_{jt} be the set of values for ε such that the consumer decides to buy good *j*.

$$A_{jt} = \{\varepsilon : U(x_{jt}, \xi_{jt}, p_{jt}, \varepsilon_{it}; \theta) \geq U(x_{rt}, \xi_{rt}, p_{rt}, \varepsilon_{it}; \theta),\ for\ \ r = 0,1,\ldots J\}$$

The mean utility from the outside option cannot be identified separately from a constant term in equation (1) and therefore is normalized to zero as is common in the literature, i.e.

$$u_{iot} = \alpha \ln(y_{it}) + \xi_{ot} + \varepsilon_{iot} \equiv 0$$

Assuming ties occur with zero probability, and given $P_0(\varepsilon)$, the density of ε in the population, the market share of the j^{th} good as a function of the $J+1$ goods competing in the market is:

(2)
$$s_{jt}(x_{.t}, p_{.t}, \xi_{.t}; \theta) = \int_{\varepsilon \in A_{jt}} P_o(\varepsilon)$$

where $x_{.t}=(x_{1t},\ldots,x_{Jt})$. Similarly for p and ξ.

Dropping the t subscript, and defining M to be the size of the market, the J-vector of demands is $Ms_j(p,x,\xi;\theta)$.

The integral in (2) can be computed either analytically or numerically depending on the distribution assumption made for ε_{ij}. If ε_{ij} is assumed to be independently and identically distributed (i.i.d.) across choices, if its believed multivariate extreme value and if no additional heterogeneity (beyond the ε_{ij} term) is assumed, then the integral can be solved analytically. Specifically, letting $V_{ij}=\alpha ln(y_i-p_j)+\delta_j$ and making use of McFadden (1978) the share function can be derived. This paper specifies that if $F(\varepsilon_{io},\ldots\ \varepsilon_{iJ})$ denotes the $J+1$ dimensional CDF of ε, and $G(y_0,\ldots,\ y_J)$ is a nonnegative, homogeneous of degree one function satisfying certain restrictions,[16] then

$$F(\varepsilon_{io},\ldots,\varepsilon_{iJ}) = \exp(-G(e^{-\varepsilon_{io}},\ldots,e^{-\varepsilon_{iJ}}))$$

is the multivariate extreme value distribution, and

$$S_{ij} = \frac{e^{V_{ij}} G_j(e^{V_{io}},\ldots,e^{V_{iJ}})}{G(e^{V_{io}},\ldots,e^{V_{iJ}})}$$

defines the market share equation of product j, where G_j is the partial derivative of G with respect to $e^{V_{ij}}$.

I therefore define $G(.)$ to be the weighted sum of two one-level nested multinomial logit $G(.)$ functions, as follows:

[16] Specifically $G(.)$ has to be non-negative, homogenous of degree r, (where $r\geq 0$), $lim.\ G(.)\to\infty$ as $e^{V_j}\to\infty$, for $j=0\ldots.J$, and mixed partials of $G(.)$ must alternate in sign with first partial nonnegative.

(3) $$G(e^{V_i}) = a_O\left[\left(\sum_{j\in d} e^{V_{ij}/\rho_O}\right)^{\rho_O} + \left(\sum_{j\in f} e^{V_{ij}/\rho_O}\right)^{\rho_O}\right] + a_S\left[\left(\sum_{j\in s} e^{V_{ij}/\rho_S}\right)^{\rho_S} + \left(\sum_{j\in m} e^{V_{ij}/\rho_S}\right)^{\rho_S} + \left(\sum_{j\in l} e^{V_{ij}/\rho_S}\right)^{\rho_S}\right] + e^{V_{io}}$$

$$a_O = \frac{(1-\rho_O)}{(2-\rho_O-\rho_S)}; a_S = \frac{(1-\rho_S)}{(2-\rho_O-\rho_S)}$$

where *O* denotes origin (domestic *(d)* or foreign *(f)*) and *S* stands for size (small *(s)*, medium *(m)* or large *(l)*). Under the conditions stated above, the model is consistent with random utility maximization for all possible values of the explanatory variables as long as ρ_O and ρ_S lie in the unit interval.[17]

Letting *O(j)* and *S(j)* denote the groups to which product *j* belongs, and using *G(.)* from equation (3), the following share equation is derived:

(4) $$s_{ij} = \frac{a_O e^{V_{ij}/\rho_o}\left(\sum_{k\in O(j)} e^{V_{ik}/\rho_o}\right)^{\rho_o - 1} + a_S e^{V_{ij}/\rho_s}\left(\sum_{k\in S(j)} e^{V_{ik}/\rho_s}\right)^{\rho_s - 1}}{G\left(e^{V_i}\right)}$$

Equation (4) is the probability that consumer *i* buys car *j* and is composed of two terms, one for origin and one for size. It implies that for any product *j*, a change in the price or characteristics of any other product located in the same cluster will have a stronger impact on product *j* than on any other product located in a different cluster.

The parameter ρ is a measure of the degree of independence in unobserved utility among the products in nest *n*. That is, as ρ tends to zero, the dependence across products that share a particular nest become stronger. Conversely, if $\rho_S=1$, the model reduces to a nested logit by origin status only. Similarly if $\rho_o=1$, the model reduces to a nested logit by size status only.

Notice that equation (4) is the close form solution to the integral presented in equation (2) and the corresponding substitution patterns derived from this share function are:

[17] Train (2002) explains that for $\rho>1$ the model is still consistent with utility maximizing behavior for some range of the explanatory variables but not for all values.

(5) $$\eta_{jk} = \frac{\partial s_j}{\partial p_k}\frac{p_k}{s_j} = \begin{cases} -\dfrac{\alpha p_j}{s_j(y_i - p_j)}\sum_n s_n s_{j/n}\left[(1-s_j)+\left(\dfrac{1}{\rho_n}-1\right)(1-s_{j/n})\right] & if\ \ j=k \\ \alpha\dfrac{p_k}{(y_i-p_k)}\left[s_k + \dfrac{\sum_n\left(\dfrac{1}{\rho_n}-1\right)s_n s_{j/n}s_{k/n}}{s_j}\right] & if\ \ j\neq k \end{cases}$$

where n denotes either origin or size, s_n stands for the share of nest n and $s_{j/n}$ is the share of car j if nest n is selected. If $j=k$ and a car does not share a nest with any other car (not the case in my dataset) or if (both) parameters ρ equals one then the own elasticity reduces to the multinomial logit result $\alpha p_j(1-s_j)/(y_i- p_j)$ For the cross elasticity, the terms of the summation reduce to zero for any nest which does not include both cars j and k.

Given equation (5) it is straightforward to verify that for any two models j and k sharing nests –for example say we have a domestic (d) medium (m) sized car- then:

$$\eta_{dm,dm} \geq (\eta_{fm,dm}, \eta_{ds,dm,}\eta_{dl,dm}) \geq (\eta_{fs,dm}, \eta_{fl,dm})\ and\ (\eta_{fm,dm}) \overset{<}{\underset{>}{}} (\eta_{ds,dm}, \eta_{dl,dm})$$

where η_{n_1,n_2} is the average cross-price elasticity of a car in nest n_2 with respect to a change in price of a car in nest n_1. That is, the two principles of differentiation (origin and size) are treated in a completely symmetric way.

Finally, the expression for s_{ij} has to be aggregated up to the product market share function. While aggregating I take advantage of income and population data available for Colombia. I define ten equally size deciles and compute the per capita income of consumers within each income class. I then calculate equation (4) for the average consumer in each income class and sum up to generate the aggregate market share. However, for Colombia not all income classes can afford a car. Recall the definition of V_{ij} above and note that $ln(y_{ij}-p_j)$ is only defined for positive numbers. I therefore only take into account values where the $ln(y_{ij}-p_j)$ is defined.

V.ii. The Supply Side

The supply model derived in this section will be used to generate an equilibrium condition which allows me to calculate the (unobserved) marginal costs, markups and price-cost margins for all cars in my sample. Elaborating on the model, I also estimate the effects on prices of an external shock on the marginal cost for each model in my dataset.

Assume that in any given year *t*, there are *F* firms, each of which produce some subset J_f, of the *j=1…J* different makes of cars. The firms profit function is given by

$$\pi_f = \sum_{J_f} (p_j - mc_j) M s_j(p) - C_f$$

where mc_j is the marginal cost, C_j is the fix cost of production and *M* is the total market size.[18]

Under a pure Bertrand-Nash equilibrium, the resulting prices must satisfy the following first order condition,

$$s_j(p) + \sum_{r \in J_f} (p_r - mc_r) \frac{\partial s_r(p)}{\partial p_j} = 0$$

where $\delta s_r(p) / \delta p_j$ comes from the demand model.

The markups can be solved by defining a *JxJ* matrix Ω whose *(j,r)* elements are given by:

$$\Omega = \begin{cases} -\dfrac{\partial s_r}{\partial p_j}, & if\ r\ and\ j\ are\ produced\ by\ the\ same\ firm; \\ 0, & otherwise \end{cases}$$

In vector notation the above first order conditions becomes

(6) $$s(p) - \Omega(p - mc) = 0$$

Noting that *s(.)*, *p* and *mc* are *Jx1* vectors, the markup can be estimated by solving for $p - mc$

(7) $$(p - mc) = \Omega^{-1} s(p)$$

Therefore, solving for *mc* in (7) the estimated marginal cost mc^e, is

(8) $$mc^e = \left[p - \Omega^{-1} S(p) \right]$$

where mc^* is a *Jx1* vector. Now, using equation (8) I can calculate the price-cost margins for each car *j*, $(p_j - mc_j^e)/p_j$.

The model derived allows for different counterfactual experiments. In particular, for reasons discussed later on, I am interested in the effects on prices of changes in the marginal cost. Assume therefore, that each model's marginal cost remains unchanged, except for an external shock, for example a variation in the exchange rate. Once the marginal cost

[18] The market size is assumed to be the number of households that, given their income, could at least buy the cheapest car each year. This is approximately 80% of Colombian total households.

changes, firms will adjust price and will solve equation (6) for a new equilibrium price. Let mc_j^o be the estimated marginal cost defined as:

$$mc_j^d = 0.3mc_j^e + 0.7mc_j^e = 0.3mc_j^e + (1+\tau_j^d)mc_I^d \quad if \ j \in domestic \ firm$$
$$mc_j^f = (1+\tau_j^f)mc_I^f \quad if \ j \in foreign \ firm$$

where I am using the fact that domestic cars import 70% of their components. For domestic cars, τ_j^f stands for c*ompletely build up* (CBU) or imported car tariff, while τ_j^d corresponds to the tariff of the main input used in the assembly process or the *completely knock down* (CKD) unit. The imported components marginal cost, mc_I^o, where *o* stands for origin either domestic (*d*) or foreign (*f*), is measured in domestic currency. Note that for a foreign car, this is just the value of the imported vehicle, while for the domestic auto it's the value of the CKD unit.

I can derive the effects on prices of changes in marginal costs by totally differentiating for any given *j* equation (6) with respect to all prices and the marginal cost. Doing so gives:

$$\Lambda dp^n = \Gamma dmc$$

where dp^n is a *Jx1* vector with each element equal to $dp_k^n, (k=1,\cdots,J)$ and *n* stands for the new equilibrium price. Similarly, *dmc* is a *Jx1* vector with each element equal to $dmc_k, (k=1,\cdots,J)$. Λ is a *JxJ* matrix with each j^{th} row and k^{th} column defined as follows

$$\frac{\delta s_j}{\delta p_k} + \sum_{l \in J_f} \frac{\delta^2 s_l}{\delta p_j \delta p_k}\left(p_l - mc_l\right) + \frac{\delta s_k}{\delta p_j} \quad if \ \ j \ and \ k \ are \ produced \ by \ the \ same \ firm$$
$$0 \qquad otherwise$$

Finally, Γ is a *JxJ* matrix with each j^{th} row and k^{th} column equal to $\frac{\delta s_k}{\delta p_j}$, if *j* and *k* are produced by the same firm, *0* otherwise. Inverting Λ gives:

$$\text{(9)} \qquad \frac{dp^n}{dmc} = \Lambda^{-1}\Gamma$$

Equation (9) says that the change in the price of car *j* due to changes in its marginal cost, depends not only on changes in the marginal cost of other cars produced by the same firm, but also on own and cross price derivatives as well as in changes on the demand curve.

VI. Data Description and Some Initial Results

My dataset contains information of prices and characteristics per model sold in Colombia between 1986 and 1998. Indicator variables for whether the car has air conditioning (AC), power windows, power mirrors, power seats, alloy wheels, power door locks, assisted steering wheel and radio as standard equipment were obtained from *Motor* magazine.[19] Other product characteristics, obtained from each models brochure going back to 1986, include the car dimensions (length, width and height), weight, engine displacement, horsepower and number of doors. Absent from a significant number of models are characteristics such as kilometers per gallon, maximum speed, acceleration and number of valves.

The price variable is the list price as shown in several issues of the Colombian *Motor* auto magazine. All prices are deflated by the consumer price index and are in 1996 Colombian pesos, though most of the results, for ease of comparison, are presented in 1996 United States dollars. The sales variable corresponds to sales in Colombia.

The estimations presented below use only the available data on automobiles, by far, the most common type of vehicle sold in Colombia. Prior to 1992, SUV's and pickups sales represented on average less than 20% of the market. After the reforms were implemented, automobiles sales were never lower than 70% of the total.[20]

As a principle of differentiation, rather than using the cars dimensions (as used for example by Goldberg, 1995), I choose engine displacement as measured by cubic centimeters (CC). My choice is based on the fact that automobiles are legally classified in Colombia according to CC, among other things, for insurance purposes. Additionally, consumers perceive many models differently, despite sharing the same chassis and body, because they are equipped with different engines. Such vehicles have the same dimension, they look alike, but they actually belong to a different segment.

During my sample period, six hundred thousand cars were sold. I was able to match price, quantity and characteristics to most of the cars in my dataset. However, I was unable to identify 24,406 cars because they show up as *others* in the quantity dataset. I treat a model/year as an observation, which gives me a sample size of 936 models. Additionally, I was unable to obtain the price for ten observations, and so my final sample size is composed

[19] Specifically I used the website www.motor.com.co, Internet version of the specialized auto magazine *Motor*.
[20] Though sales information for both SUV's and pickups was available, unfortunately characteristics data was not.

of 926 models. Throughout the paper I assumed that two models are the same in two subsequent years if they have the same name and the dimensions have not changed.

In addition, I had access to tariffs information as well as the value added tax and the real exchange rate.[21] The tariffs variable is disaggregated in two. On one hand I have compiled the tariffs for *completely built up* (CBU) imports, that is, fully assembled, ready-to-sell vehicles. On the other, I also have data on tariffs for the main inputs used in the assemble process, the *completely knock down* or CKD units. Such distinction is important as I observe the origin of each model. Therefore, the relevant tariffs for a domestically produced car is the CKD tariff, while for the imported car, the CBU tariff is the appropriate one.

Tables I, II and III provide some summary statistics. Table I presents information on the main characteristics including price. These include horsepower over weight (HP/W), dimension, AC, power windows, power door locks, radio, engine displacement and alloy wheels. HP/W, measured as horsepower per kilogram, proxies for fuel efficiency as well as for power; it is expected to affect positively the utility of a consumer. Dimension is defined as length times width. The effect is not clear, though one tends to believe that on average individuals prefer bigger cars. Finally, engine displacement is measured in liters and the indicator variables (1 if standard equipment, 0 if not) show how, on average, characteristics have changed over time.

A first overview of the data clearly illustrates the structural changes observed in the market once the reforms took place. Both table and figure 1 show significant changes between the pre-reform (1986-1991) and the post-reform period (1992-1998). On average, 22 models were offered between 1986 and 1991. By 1992, 71 different car models were offered, peaking 142 in 1997. Table II however, shows that the number of domestic models offered did not change much over the sample period.

The data also shows that prices in Colombia, in the 1980's, were abnormally high for international standards. In 1986 the mean price of a car was, in 1996 U.S. dollars, almost $23,000 while the average price for a car in the United States at the time was around $18,000.[22] By 1992, average prices in Colombia were over nineteen thousand dollars, approximately a thousand dollars higher than in the US. By the end of my sample period, on

[21] Tariffs data is provided by the National Planning Department, value added by the Ministry of Finance and the real exchange index by the Colombian Central Bank, *Banco de la República*

[22] The average US price is from the US Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts.

average a car could be bought in the US paying just over nineteen thousand dollars. In Colombia, that year, the average price of a car was under fifteen thousand dollars.[23]

Between 1992 and 1994, immediately after the trade reforms were implemented, car sales radically increased. The annual average growth rate of car sales in that period was over 50%, significantly higher than the 10% average growth rate observed in my sample period. As imports increased, the market share of domestic firms dropped. On average, importers gained in seven years over 40% of the car market in Colombia.

A closer look at the data shows that the number of domestic cars expanded with the reforms, but only for a short period of time (Figure 1). Sales of domestically produced cars increased from an average of less than 30 thousand cars per year prior to the reforms to a peak of forty three thousand in 1994. Sales of domestically assembled cars have steadily gone down since then. For example in 1998 only 28,670 domestically assembled cars were sold, less than in 1986.

To further explore my data, and to check the direct effects of trade liberalization on prices, I ran a simple regression of prices against tariffs and competition controlling for car quality. Results are shown in table IV. The regressors include vehicle attributes, tariffs, a competition proxy and time dummies. All included vehicle characteristics contribute positively to the log of price in a precise way. As expected, large cars tend to be more expensive than smaller cars.

For reasons explained above, tariff in table IV is defined to be the CKD tariff if the car is domestically produced and the CBU tariff if the car is imported. The estimated coefficient is statistically significant and has the correct sign. That is, as tariffs drop, prices fall. In both regressions I used a variable called competition to proxy for the increased number of vehicles sold in the market, and therefore to proxy for the increased competition due to the liberalization process. Competition is defined as the number of models within the same segment that compete with car *j*. The results show that prices drop as more models enter the market.

VII. Estimation of the model

The predicted market share derived in equation (4), analytically obtained by solving the integral in equation (2), is a function of observed and unobserved product characteristics, as

[23] To get some perspective, note that in 1992, the US GDP per capita was 21,800 dollars while Colombia's was 1,300. The numbers for 1999 are 31,500 and 6,600 respectively.

well as prices. A straightforward strategy to estimate the model is to choose parameters that minimize the distance between the predicted and the observed market shares:

(10) $$\underset{\theta}{Min} \| s(x_., p_., \xi_.; \theta) - S_. \|$$

where *s(·)* are the predicted market shares and *S* the observed market shares. However, the expected correlation between prices and the unobserved characteristics as well as other computational issues led Berry (1994) to develop a technique that deals with these complications.[24]

Berry (1994) defines ξ as a structural error term, rather than as the difference between the observed and predicted market shares as is done in equation (10).

As shown in equation (1), the mean utility $\delta_j(\cdot)$, is linear in ξ_j. Consequently, given the predicted and observed market shares I want to solve for δ the following system of *J+1* equations:[25]

(11) $$s(\delta; \theta) = S_.$$

Equation (11) cannot be solved analytically due to the presence of three non-linear parameters, α, ρ_O and ρ_S. Therefore using a non-linear numerical procedure I solve for δ as a function of the observed market share and the non-linear parameters.

Define $Z=[z_1,\ldots,z_M]$ to be a set of instruments such that

(12) $$E\left[Z_m \cdot \omega(\theta^*)\right] = 0, \;\; m = 1\ldots M,$$

where ω, a function of the true parameters θ^*, is an error term defined as,

$$\omega = \delta(.) - X\beta \equiv \xi$$

The moment condition given in equation (12) can be used to define the following generalized method of moment estimator (GMM):

(13) $$\min_{\alpha,\beta,\rho} L = \omega(\theta)' Z A^{-1} Z' \omega(\theta)$$

where *A* is a consistent estimate of E[Z'ωω'Z].

As is, the GMM estimator involves a potentially large set of parameters to estimate. However, noting that the β parameters enter linearly, the minimization in (13) can be performed only with respect to the non-linear parameters α and the ρ*'s*. I therefore estimate the β*'s* as follow:

[24] Particularly when dealing with models where non-linearity's arise.
[25] Recall that we are normalizing the outside good to zero.

(14) $$\beta = \left(X'ZA^{-1}Z'X\right)^{-1} X'ZA^{-1}Z'\delta(s,\alpha,\rho),$$

and then substitute this expression into the objective function (13).

VIII. Instruments

As argued earlier, a higher unobserved product quality, ξ should lead firms to set higher prices. Moreover, due to the firms' first order conditions; ξ will also be correlated with the prices and market shares of the other products.

Therefore, the estimation of equation (13) requires instrumental variables that satisfy equation (12). Ideally I would use (model-level) cost data as instruments. However, beyond the average cost of assembling a car for each of the three domestic firms I had no further access to direct cost data. This would be a valid, though insufficient, instrument if I were to estimate demand exclusively prior to 1992 when only domestic producers sold cars in Colombia.

Fortunately, some cost related data is available. Given that (after 1991) imported cars represent a significant share of total sales and that the main inputs of domestically produced cars are also imported I use both a real exchange rate index and import tariffs as instruments.

The advantage of using exchange rates and tariffs is that they are clearly exogenous to the car industry and that they both exhibit significant variation over time and across car segments. The obvious drawback of using exchange rate and tariffs as instruments is that neither of them is model specific, at most, specific to a certain range of cars. Therefore, they are helpful, but not sufficient for identification. The sales tax, which I also use as an instrument has the same advantages and disadvantages of the aforementioned.

A second set of instruments is based on Bresnahan's (1981,87) assumption that the observed characteristics x_{jt} are exogenous (or predetermined). Berry et al. (1995) built on this idea to generate instruments based on the assumption that $E(\xi/X)=0$. In particular, for each product characteristic *x* (excluding price), they use as instruments the (1) own characteristics and (2) the sum of characteristic *x* of all cars produced by the same firm *f* in the same year, and the sum of characteristic *x* of all cars produced in the same year by other firms. These set of instruments assume that the observed characteristics are uncorrelated with the unobserved characteristics, thus satisfying equation (12). Bresnahan, Stern and Trajtenberg (1997) follow a similar approach, but exploit their assumption about the group structure of product differentiation.

Therefore, based on the idea of the exogeneity of observed product characteristics and of the number of models available in the market per period, I build a second set of instruments. These are the average value of the characteristics by cluster (origin and size) and by shared cluster. I also use the total number of cars sold by cluster. The latter are competition based instruments in that they assume that the number of cars available in the market each year is correlated with prices but not with unobserved characteristics.

In summary, the instruments that I use are, the *cost* based set, the BLP type by cluster and the competition based instruments. Table I of the appendix supports the validity of the instruments used as the first stage F-test of the instruments is 20.66, significant at the 1% level. Further, a Hausman test of overidentifying restrictions returns a value 19.99, not enough to reject the null hypothesis.[26]

IX. Results

The main results from my benchmark specification are summarized in Table V. They differ significantly from the logit and IV logit results presented in Table II of the appendix. In particular, the estimates of the logit models are imprecisely estimated while the results for the IV logit improve significantly. The sign of most characteristics are the expected but for the most part are not statistically significant. However, the coefficient for the marginal utility of income α, increases when moving from the OLS logit to the IV logit specification.

The results of the PD GEV model shown in Table V are promising. The coefficients are precisely estimated and appear to be reasonable from an economic point of view. The results suggest that individuals prefer bigger cars as well as high horse power relative to weight. The coefficient on power windows remains negative, as in the logit and IV logit models, the only counterintuitive result. Finally, the marginal utility of income has the correct sign and it is statistically different from zero and both ρ_o and ρ_S lie in the unit interval as required to be consistent with utility maximization. The estimated coefficients of these parameters suggests that there is indeed a significant degree of market segmentation along both origin and size dimensions.

The positive and statistically significant coefficient for the domestic dummy implies an outward shift of the demand curve if a car is Colombian made. The observed home bias means, given ρ_o less than one, that a car will enjoy certain degree of protection against

[26] The critical value at the five percent significance level and with 16 degrees of freedom is 26.30

foreign competition if it is domestically produced. Similar arguments imply that small cars seem to enjoy stronger preferences relative to medium and large cars.

Once accurate demand estimates are available, I apply equation (5) to calculate own and cross price elasticities. Table VI reports own price elasticities by origin and size. On average demand elasticities are higher for domestic cars, though over time this pattern tends to change. Similarly, medium sized cars tend to have higher elasticities than small and large cars.

Table VII reports cross price elasticities averages by origin and size. The estimate of ρ_o suggests that consumers tend to view products of the same origin –either domestic or foreign- as closer substitutes than products of different origin. Indeed table VII (partially) confirms this. As the price of a domestic automobile goes up, individuals are more likely to substitute towards domestic rather than switching to foreign cars. On the contrary, as change in the price of a foreign vehicle has a stronger effect on domestic than on foreign cars, suggesting once more a strong home bias in Colombia.

Similarly, the estimate of ρ_s implies that consumers tend to substitute towards cars of the same size. Table VII confirms this finding, as substitution towards other size vehicles is very low, mostly concentrated in medium sized vehicles.

Tables VIII, IX and X report a sample of own and cross price elasticities for several cars in three different years, 1987, well before the reforms, 1992, beginning of the reforms and 1996, when such reforms are expected to be consolidated. Several points can be extracted from these tables. First, as expected, luxurious cars have very inelastic demands, while middle priced cars tend to be more price sensitive, possibly induced by a stronger competition in the medium sized segment (see table II, column vii). Second, cross elasticity patterns seem to be consistent with the idea that similar cars tend to be closer substitutes for one another. For example, in 1992 a 1% increase in the price of a small Chevrolet Sprint will have no effect over a Mercedes, but it will have considerable effect over a less expensive Mazda 323 HS or Renault 9 Brio. And third, these tables strongly suggest that the functional form is not driving the results. More precisely, opposite to simple logit or IV logit models, prices do not drive own price elasticities as explained in Nevo (2000).

X. Effects of the Reforms

Once I have accurate measures of elasticities, I make use of equation (7) to calculate the price-cost margin for each vehicle. Theory (and intuition) suggests that as competition increases, margins should fall.

First, lets look at the estimated markups (*p-mc*). Table XI reports the average markups by origin and size. As expected, markups did fall, but only until 1994. Beyond that, markups remained relatively stable. By origin, foreign cars clearly have higher markups, though over time some convergence is observed between imported and domestic cars. By size, results are the expected, that is, large cars have higher markups, while smaller cars have lower markups.[27]

The (sales weighted) average price-cost margins (PCM), defined as *(p-mc)/p*100*, are reported in Table XII. Figure 2 plots these results by origin. The first pattern that emerges from the graph is that PCM are declining even before the reforms took place. Such pattern, prior to 1992, a period where only domestic firms were present in the market may seem surprising. This behavior is explained by the observed fall in prices, which in turn was caused by a combination of events.

The most important episode prior to the reforms was the government decision to deregulate the market. Under this policy, the government sold its share of domestic firms to foreign private investors. Mazda's headquarters in Japan bought CCA (Mazda producers in Colombia) and Renault and Toyota bought Sofasa. Second, led by GM, the operating contract signed between each of the three domestic firms and the government was unified. Price regulation was terminated, and all three firms began to operate in Colombia under the same conditions. Third, Sofasa introduced a new model, the Renault 21, that turn out to have assembling defects. This forced the company, not only to inspect all models sold previously, but also to lower the price of all Renault 21's sold afterwards. It was a combination of these factors that induced a stronger competitive behavior in the automobile market even before the reforms took place. Therefore, as prices declined, with costs relatively unchanged, price-cost margins dropped.

Costs dropped drastically in 1992 due to the trade reforms. CKD tariffs declined by almost 20%, CBU tariffs dropped from 75% to 38%, non-tariff barriers such as import license

[27] Note that for large cars the post-reform markup increased relative to the pre-reform period. The introduction of more luxurious cars (such as BMW's, Mercedes', inexistent prior to 1992) explains this behavior.

requirements were eliminated and further a real appreciation process began to take place. All this combined implied a significant drop in costs and consequently an increase in PCM.

Many of the imported cars in 1992 were large expensive cars, hence autos with high margins. As competition increased, margins began to fall. By 1994 domestic car margins reached a historic low. At that point, PCM for foreign vehicles stabilized, but domestic PCM began to increase. Three reasons explain this behavior. First, though domestic firms did not prepare in anticipation for foreign competition, they did so when competition arrived. Sofasa and GM, for example, installed modern equipment to improve the painting process. These improvements entered the assembly line between 1995 and 1996. Similarly, on these lines, all three firms reorganized the assembly plant and developed new technical training centers. Second, in 1996 the government implemented a differential sales tax. If a car under 1.4 liters was assembled domestically the sales tax was set to 20%, if it was imported the corresponding sales tax was set to be 35%. This 15% difference together with the already existing 30% difference on average between the CKD tariff (recall, 70% of a domestic car) and the CBU tariff gave domestic cars extra advantages. Finally, the real appreciation process ended and devaluation began to increase at the end of my sample period.

Given the behavior of the PCM, it seems interesting to check the sensitivity of domestic firms and foreign importers to external shocks on the marginal cost. Using the supply model developed earlier I calculate the effect on prices of an external shock on the marginal cost of each vehicle, such as a change in the exchange rate. Figure 3 shows the pass through effect to be stronger on foreign cars relative to domestic cars. It is also evident from the graph that the effect is much more volatile on importer than on domestic firms.

Such pattern is due in part to the fact that domestic cars have *only* 70% of its components imported. Moreover, domestic firms import relatively larger amounts of CKD units as different models use the same unit in the assembly process. Importantly, evidence collected while visiting Colombian firms suggest that domestic firms' imports are less dependent on external shocks as they are much more linked to their headquarters.[28] Foreign car importers, on the contrary, rarely have any direct link with the headquarters world guidelines, and in occasions have had trouble importing the amount required of cars because Colombia is not a priority market for these firms. Thus, they are much more exposed to possible external shocks fluctuation.

[28] Of course, these external shocks must remain at certain levels. Colombia nominal devaluation in the 1990's never was larger than the 25% reached in 1998.

With prices falling, particularly in the second half of the nineties, given the observed behavior of PCM, then in must be that costs dropped even more. Table XIII presents evidence of that. No direct cost data was available beyond the average cost of domestic parts bought in Colombia for use in the assembly process. Column 1 of table XIII shows that on average these costs were almost half in the nineties than in the eighties. Specifically, these costs were on average 4.4 thousand dollars before 1992. By 1998 this number was less than 2.5 thousand dollars.[29]

The remaining columns of table XIII show the marginal cost calculated from the model estimated above. Between 1986 and 1991 marginal costs remained relatively stable around 16 thousand dollars on average. During the nineties these marginal costs dropped steadily reaching around 9.5 thousand dollars in 1998. By origin, despite the observed convergence in costs, domestic cars still present lower costs than foreign cars.

It is worth noting that comparatively, Colombian average price-cost margins are similar to those reported by Goldberg and Verboven (2001) for European cars and Berry et al (1999) for US autos. Goldberg and Verboven report price-cost margins of around 20% with peaks in Italy of about 40%. Berry et al. margins vary from about 20% for cheap cars to around 40% for expensive luxurious vehicles. Brambilla's (2003) PCM for Brazil and Argentina are higher than those I find. She only reports the average result over time and over models. For Argentina, her estimates for own elasticities are similar to mine, but her PCM are around 50%, much higher than those I find. In Brazil, with very inelastic own elasticities, the PCM is around 60%.[30]

Finally, as prices decline, consumer welfare as measured by consumer surplus is expected to increase. The results, presented in Table XIV, show that consumer welfare behaved as expected. Consumer surplus increased, particularly in 1993 and 1994 immediately after the reforms took place. The average change in consumer welfare, when comparing the average consumer surplus of the pre-reform period with the post-reform period was of about three million pesos, around 3,271 1996 dollars. This is the observed increase in welfare due to the trade reforms.

To grasp a complete view of the effects of the reforms, I ask what the consumers' welfare would have been in the absence of imported vehicles. In order to implement this

[29] In 1996 dollars.
[30] The mean own price elasticity for all models in Brazil is –1.7.

counterfactual scenario I remove all foreign cars from the available choice set, re-compute the market shares of domestic cars only and then re-estimate consumer surplus.

Given the unavailability of foreign vehicles before the reforms the counterfactual exercise is only relevant for 1992 onwards. Moreover, as ρ_O is set to one in equation (3), the demand model discussed earlier reduces to a one level nested logit, where consumers can only choose according to the vehicles size. Initially lets assume that prices and characteristics remain unchanged when the choice set is reduced to domestic cars only. Under this scenario, the first column of Table XV presents the difference between the observed consumer welfare and the (new) estimated welfare under the counterfactual assumptions. In the first year of the reforms, the gains in consumer welfare are small as few foreign models were available and because expensive luxurious cars accounted for a large part of the imported vehicles. The gains per purchaser quickly peaked in 1993 when they reached $4,298 dollars and on average, the gains per consumer due to the availability of imported cars in the Colombian market were of $3,000.[31]

Lets now relax the assumption that prices of domestic cars remained unchanged in the absence of imported vehicles[32]. To do so, I need to re-compute the new equilibrium price using equation (7) assuming that only domestic cars were available in the Colombian market. The estimated (average) increase in the price of domestic vehicles is estimated to be just below 4%. The second column of Table XV reports welfare gains per purchaser using this new set of prices. As prices are higher, the estimated consumers surplus per purchaser decreases, and therefore the welfare gains of introducing imported vehicles in the market are slightly greater than those estimated with fix price. The average (estimated) increase in consumer welfare per purchaser is $3,276. When comparing this figure with the $3,000 found when assuming fix prices, one concludes that most of the welfare gains for consumers came from variety, not from price changes.

XI. Specifications Checks

Table XVI checks how robust the model is to the characteristics chosen for the main specification, model 1. Model 2 runs the regression without the Air Conditioning dummy giving

[31] To avoid confusion recall that earlier I found the increase in consumer welfare to be $3,271 per purchaser, when comparing the pre and post reform period. The $3,000 figure should be taken as the increase in consumers' welfare due to a variety increase (from foreign vehicles) in the Colombia market.

[32] I will however keep the assumption that characteristics of domestic cars are the same independent of the availability of foreign cars. Given the trend of characteristics observed in table I it doesn't seem such a strong assumption.

its non-significance in Model 1. Results are maintained both in terms of point estimates and statistically significance.

Model 3 runs the same regression as model 1, but excluding dimension. As one of my principles of differentiation I chose engine displacement as a measure of size. In principle, it may be of concern to include dimension, as measured by length times width, with size dummies. The results from excluding dimension in model 3 suggest that my results in model 1 are valid since my estimates do not change significantly.

XII. Conclusion

In this paper I have examined the changes in price-cost margins before and after major trade reforms took place in the Colombian auto industry. I made use of a discrete choice random utility model to determine the factors that influence demand for cars as economic reforms took place. The demand estimates allows me to calculate own and cross price elasticities, which I plug into a supply model to estimate price-cost margins without observing marginal costs. Finally, I calculate consumer surplus as a measure of consumer welfare.

The results suggest that trade liberalization had important effects over the car industry. As tariffs dropped, previously unavailable foreign cars were introduced into the market, domestic firms improved the quality of their product and were forced to reduce price due to competition. A combination of these factors implied that consumer welfare increased by almost three thousand dollars on average per consumer. Moreover, the results suggest that most of the welfare gains were due to increased variety, rather than to decrease in prices.

I find that before the reforms were implemented price-cost margins were falling. As the industry restructured in the second half of the eighties, the three domestic firms newly intensified competition drove prices down. Given relatively unchanged costs, price cost margins began to fall. Despite the ongoing liberalization process that was taking place in other countries during the 1980s, anecdotal evidence suggests that Colombian firms did not prepare in advance for the expected lower tariffs. It was only after the reforms were implemented that domestic firms began to worry about improving their production process.

The results indicate that price-cost margins behavior differed when considering domestic and foreign firms. Initially, regardless of origin, price-cost margins dropped for all cars as a consequence of the liberalization process. However, by 1995, margins of imported vehicles stabilized at around 35%. Domestic vehicles' price-cost margins, on the contrary, began to increase, reaching, by the end of the sample period, about the same level to that observed in the first year, around 34%.

The main explanation for such performance is that costs kept on falling despite the fact that tariffs did not. Indeed, some indirect effects of the trade liberalization process made domestic firms to actually increase price-cost margins. The increased competition forced domestic firms to improve efficiency in their plants. However, even after the liberalization measures were implemented, tariffs remained relatively high for imported cars, while the relevant tariff for domestic cars was much lower. Also, in the mid nineties, the government implanted a differential sales tax between domestic and imported cars, which served as another form of protection. Moreover, importers of foreign cars are for the most part small domestic firms importing cars with no strong link with the multinational headquarters, while domestic firms depend directly on the headquarters. This structure makes imported cars much more dependent on external shocks.

Overall, the liberalization reforms had the expected effect, but they seem to be still half way through. As of today, it is scheduled that in 2007 tariffs be reduced to 0% for imported cars from Mexico and Venezuela. Currently Colombia is negotiating the Free Trade Area of the Americas and simultaneously seeking to reach a bilateral agreement with the U.S. The effects of such future reforms remain to be explored but are without doubt of interest, not only for Colombia, but also for other developing countries that face similar situations.

This suggests future extensions based on the model and the results found of the paper. As part of a policy debate, it is important to disentangle the effects of trade reforms on specific markets. As globalization increases, small-scale markets, such as the Colombian one, will be much more exposed to decision made abroad as well as to how foreign firms behave.

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Table I Summary Statistics Means (Sales Weighted) (Standard Deviation in Parenthesis)										
	No. of Models	Price[1]	HP/W[2]	Engine Displacement[3]	Dimension[4]	AC[5]	Power Windows[5]	Power Door Locks[5]	Radio[5]	Alloy Wheels[5]
1986	18	22,988	0.078	1.516	6.836	0.091	0.152	0.093	0.107	0.034
		(6,571)	(0.013)	(0.337)	(0.874)	(0.296)	(0.369)	(0.299)	(0.318)	(0.185)
1987	23	25,082	0.079	1.508	6.831	0.177	0.243	0.267	0.268	0.132
		(7',967)	(0.011)	(0.377)	(0.910)	(0.389)	(0.438)	(0.452)	(0.452)	(0.345)
1988	19	23,522	0.078	1.459	6.652	0.275	0.416	0.242	0.224	0.137
		(8,073)	(0.013)	(0.382)	(0.989)	(0.458)	(0.506)	(0.440)	(0.428)	(0.353)
1989	21	21,111	0.078	1.462	6.675	0.281	0.406	0.205	0.326	0.122
		(6,801)	(0.013)	(0.365)	(0.976)	(0.460)	(0.503)	(0.413)	(0.480)	(0.334)
1990	27	20,815	0.079	1.473	6.718	0.212	0.390	0.319	0.354	0.150
		(6,756)	(0.012)	(0.358)	(0.911)	(0.416)	(0.496)	(0.474)	(0.487)	(0.363)
1991	26	18,434	0.080	1.464	6.663	0.195	0.298	0.272	0.329	0.134
		(6,349)	(0.009)	(0.333)	(0.880)	(0.404)	(0.466)	(0.453)	(0.479)	(0.347)
1992	71	19,415	0.082	1.508	6.889	0.289	0.325	0.238	0.360	0.363
		(10,185)	(0.013)	(0.345)	(0.722)	(0.456)	(0.471)	(0.429)	(0.483)	(0.484)
1993	82	19,922	0.083	1.509	6.941	0.294	0.406	0.282	0.433	0.333
		(9,778)	(0.014)	(0.353)	(0.723)	(0.458)	(0.494)	(0.453)	(0.498)	(0.474)
1994	122	18,679	0.082	1.447	6.823	0.308	0.367	0.282	0.447	0.401
		(7,876)	(0.0129)	(0.317)	(0.719)	(0.463)	(0.483)	(0.452)	(0.499)	(0.492)
1995	127	17,986	0.081	1.425	6.736	0.276	0.348	0.287	0.401	0.492
		(7,730)	(0.013)	(0.295)	(0.671)	(0.449)	(0.478)	(0.454)	(0.492)	(0.501)
1996	133	16,533	0.081	1.386	6.601	0.299	0.265	0.230	0.403	0.466
		(7,083)	(0.0123)	(0.262)	(0.664)	(0.460)	(0.442)	(0.422)	(0.492)	(0.500)
1997	142	15,897	0.083	1.386	6.591	0.188	0.240	0.237	0.472	0.427
		(6,379)	(0.012)	(0.239)	(0.674)	(0.392)	(0.428)	(0.426)	(0.501)	(0.496)
1998	115	14,444	0.086	1.418	6.653	0.328	0.274	0.227	0.547	0.463
		(6,341)	(0.012)	(0.246)	(0.709)	(0.471)	(0.448)	(0.421)	(0.500)	(0.501)
1986-98	926	18,862	0.082	1.448	6.735	0.259	0.318	0.249	0.390	0.335
		(8131)	(0.013)	(0.314)	(0.771)	(0.438)	(0.465)	(0.433)	(0.488)	(0.472)
1986-91	22	22,300	0.079	1.480	6.729	0.205	0.317	0.233	0.268	0.118
1992-98	113	17,437	0.083	1.440	6.748	0.283	0.318	0.255	0.437	0.421

[1] Price in 1996 dollars
[2] HP/W: measured in Horse Power (HP) per Weight (in kilograms)
[3] Engine Displacement measured in Cubic Liters
[4] Dimension is width*length. Square meters
[5] Indicator Variables, 1 if it has the characteristic as standard equipment, 0 otherwise
Source: See text.

Table II
Summary Statistics
(sales weighted)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)					(viii)				(ix)		
	Price[1]	CKD (Input) Tariffs[2]	CBU (imported car) Tariffs[3]	Tariffs[4]	Sales Tax	Real Exchange Rate Index	Number of Models Offered					Market Share[5]				Number of Cars Sold		
							Domestic	Foreign	Small	Medium	Large	Domestic	Small	Medium	Large	Total	Domestic	Foreign
1986	22,988	19.94	200.00	19.94	26.55	113.96	18	-	5	8	5	100.00	31.28	46.47	22.25	29,150	29,150	-
1987	25,082	20.66	200.00	20.66	26.86	114.77	23	-	6	10	7	100.00	43.62	30.11	26.27	34,277	34,277	-
1988	23,522	19.52	200.00	19.52	25.95	113.78	19	-	6	6	7	100.00	47.54	27.04	25.42	36,775	36,775	-
1989	21,111	20.24	218.00	20.24	26.88	120.60	21	-	6	8	7	100.00	47.68	30.07	22.25	30,471	30,471	-
1990	20,815	20.53	116.00	20.53	27.35	130.99	27	-	7	11	9	100.00	48.47	28.79	22.74	25,786	25,786	-
1991	18,434	19.45	75.00	19.45	26.45	114.75	26	-	7	11	8	100.00	45.14	34.04	20.82	22,206	22,206	-
1992	19,415	3.00	38.83	13.20	28.50	108.71	27	44	13	28	30	71.53	44.36	36.09	19.55	34,230	24,485	9,745
1993	19,922	3.00	38.12	18.38	28.80	110.29	23	59	14	36	32	56.22	42.60	39.89	17.51	62,324	35,037	27,287
1994	18,679	3.00	35.00	15.92	27.16	102.87	25	97	21	63	38	59.62	52.66	35.10	12.24	72,452	43,199	29,253
1995	17,986	3.00	35.00	14.96	26.48	104.46	28	99	26	67	34	62.64	56.67	35.00	8.33	66,191	41,462	24,729
1996	16,533	3.00	35.00	14.21	26.28	100.00	36	97	30	71	32	64.97	64.98	30.82	4.21	61,442	39,921	21,521
1997	15,897	3.00	34.64	18.12	27.12	92.77	32	110	37	81	24	52.01	53.62	44.04	2.34	74,687	38,999	35,688
1998	14,444	3.00	34.83	19.53	27.81	100.99	25	90	29	74	12	48.07	39.01	57.27	3.73	59,643	28,670	30,973
1986-91	22,300	20.06	168.17	20.06	26.67	118.14	22	-	6	9	7	100.00	43.96	32.75	23.29	29,778	29,778	-
1992-98	17,437	3.00	35.92	16.33	27.45	102.87	28	85	24	60	29	59.29	50.56	39.74	9.70	61,567	35,968	25,599
1986-98	24.74	10.87	96.96	18.05	27.09	109.92	25	85	16	36	19	78.08	47.51	36.52	15.97	46,895	33,111	25,599

[1] Price in 1996 US dollar

[2] Tariffs for the CKD units used by domestic producers (%)

[3] Tariff for imported cars (%)

[4] Tariffs used in regression. It uses CKD tariffs for domestically produced cars and assembled car tariffs for foreign cars (%)

[5] As defined by total sales

Source: See text.

Table III
Summary Statistics

Variable	Mean	Std Dev	Min	Max
Sales Tax	32.41	7.33	20	45
Real Exchange Rate Index	109.21	23.78	8.75	187.89
Tariffs[1]	26.82	13.48	3	40
CKD Tariffs[2]	11.05	10.86	3	30
Assembled Car Tariffs[3]	58.69	54.27	31.5	218

[1] If Domestic Car, CKD tariffs. If Imported Car CBU Tariffs
[2] Tariffs for main components of domestically assembled cars (the CKD unit)
[3] Tariffs for imported cars (CBU)
Source: See Text.

Table IV[x]
Dependant Variable Log(price)

Log(Dimension)	1.431	0.777
	(0.103)***	(0.105)***
Log(HP/weight)	0.599	0.325
	(0.061)***	(0.065)***
AC	0.109	0.116
	(0.019)***	(0.018)***
Power Windows	0.088	0.073
	(0.023)***	(0.023)***
Log(Engine Displacement)		0.939
		(0.090)***
Small	-0.296	
	(0.040)***	
Medium	-0.149	
	(0.0338)***	
Competition	-0.152	-0.113
	(0.0538)***	(0.091)***
Tariffs	0.017	0.012
	(0.006)***	(0.012)***
Constant	2.471	2.438
	(0.273)***	(0.024)***
Time Dummies (p-value)	0.000	0.000
Observations	926	926
R^2	0.78	0.81

*** Significant at 1% level; ** 5%; * 10%
Robust standard errors in parenthesis
[x] See text for variable definitions
Source: My calculations.

Table V Demand Estimates		
	PD GEV	
	Estimate	**(S.E.)**
α	4.529	(1.931)***
ρ_o	0.636	(0.220)***
ρ_s	0.444	(0.255)*
Domestic	0.682	(0.193)***
Small	0.727	(0.202)***
Medium	0.206	(0.104)**
Dimension	1.298	(0.582)**
HP/W	3.829	(2.334)*
AC	0.016	(0.071)
Power Windows	-0.149	(0.079)**
Constant	-19.735	(6.759)***
GMM	21.72	

*** Significant at 1% level; ** 5%; * 10%
Robust standard errors in parenthesis
Source: My calculations.

Table VI Average Own Elasticities (Sales Weighted)						
	Total	**Domestic Cars**	**Foreign Cars**	**Small Cars**	**Medium Cars**	**Large Cars**
1986	-3.82	-3.82	-	-3.19	-4.17	-3.98
1987	-3.78	-3.78	-	-3.25	-4.99	-3.27
1988	-4.10	-4.10	-	-3.98	-5.15	-3.19
1989	-4.63	-4.63	-	-4.59	-4.28	-5.19
1990	-4.22	-4.22	-	-4.34	-4.17	-4.01
1991	-5.36	-5.36	-	-4.55	-6.49	-5.28
1992	-4.15	-4.37	-3.60	-4.28	-4.09	-3.98
1993	-4.42	-4.56	-4.24	-4.93	-4.19	-3.69
1994	-4.76	-5.13	-4.20	-5.21	-4.21	-4.37
1995	-4.44	-4.58	-4.20	-4.53	-4.17	-4.92
1996	-3.95	-3.88	-4.08	-3.52	-4.95	-3.16
1997	-3.52	-3.50	-3.54	-3.10	-3.95	-4.83
1998	-3.27	-3.08	-3.44	-3.35	-3.53	-3.22
1986-91	-4.32	-4.32	-	-3.99	-4.88	-4.15
1992-98	-4.07	-4.16	-3.90	-4.13	-4.16	-4.02
1986-98	-4.19	-4.23	-3.90	-4.06	-4.49	-4.08

Source: My calculations.

Table VII
Average Cross Price Elasticities

	Total	Domestic vs. Domestic	Foreign vs. Foreign	Domestic vs. Foreign*	Foreign vs. Domestic*	Small vs. Small	Medium vs. Medium	Large vs. Large	Small vs. Other*	Medium vs. Other*	Large vs. Other*
1986	0.0306	0.0306	-	-	-	0.0615	0.0842	0.1335	0.0031	0.0048	0.0026
1987	0.0235	0.0235	-	-	-	0.0699	0.0547	0.0901	0.0016	0.0051	0.0025
1988	0.0311	0.0311	-	-	-	0.0701	0.1244	0.0962	0.0020	0.0053	0.0022
1989	0.0323	0.0323	-	-	-	0.1007	0.0987	0.0991	0.0015	0.0047	0.0022
1990	0.0291	0.0291	-	-	-	0.1181	0.0717	0.0883	0.0012	0.0044	0.0018
1991	0.0352	0.0352	-	-	-	0.1023	0.0919	0.1315	0.0012	0.0047	0.0015
1992	0.0053	0.0197	0.0027	0.0025	0.0038	0.0538	0.0069	0.0097	0.0015	0.0019	0.0009
1993	0.0049	0.0187	0.0031	0.0027	0.0064	0.0501	0.0046	0.0115	0.0014	0.0020	0.0009
1994	0.0041	0.0166	0.0035	0.0025	0.0051	0.0311	0.0051	0.0107	0.0012	0.0021	0.0006
1995	0.0039	0.0152	0.0028	0.0016	0.0070	0.0249	0.0049	0.0098	0.0008	0.0022	0.0008
1996	0.0035	0.0118	0.0027	0.0019	0.0042	0.0189	0.0055	0.0041	0.0004	0.0022	0.0007
1997	0.0030	0.0121	0.0023	0.0014	0.0042	0.0121	0.0041	0.0044	0.0007	0.0021	0.0007
1998	0.0036	0.0125	0.0031	0.0020	0.0050	0.0137	0.0043	0.0224	0.0012	0.0022	0.0005
1986-91	0.0303	0.0303	-	-	-	0.0871	0.0876	0.1064	0.0018	0.0048	0.0021
1992-98	0.0040	0.0152	0.0029	0.0021	0.0051	0.0292	0.0051	0.0104	0.0010	0.0021	0.0007
1986-98	0.0162	0.0222	0.0029	0.0021	0.0051	0.0559	0.0431	0.0547	0.0014	0.0034	0.0014

* The percentage change in the market share of <top group> given a 1% change in the price of <bottom group>
Source: My calculations.

Table VIII
A Sample from 1987 of Estimated Own and Cross Price Elasticities

	Renault 21 RX	Mazda 626 L	Chevrolet Monza SLE	Renault 9 GTS	Mazda 323 NX	Mazda 323 HS	Chevrolet Chevette	Chevrolet Sprint	Renault 4	PCM
Renault 21 RX	**-1.690**	0.148	0.002	0.002	0.002	0.002	0.000	0.004	0.002	0.62
Mazda 626 L	0.075	**-1.944**	0.002	0.002	0.002	0.002	0.000	0.004	0.002	0.55
Chevrolet Monza SLE	0.003	0.002	**-2.020**	0.106	0.122	0.004	0.042	0.010	0.006	0.53
Renault 9 GTS	0.003	0.002	0.046	**-5.141**	0.217	0.004	0.325	0.015	0.011	0.21
Mazda 323 NX	0.003	0.002	0.046	0.155	**-4.377**	0.004	0.338	0.014	0.010	0.24
Mazda 323 HS	0.004	0.003	0.003	0.005	0.005	**-2.229**	0.002	0.111	0.081	0.47
Chevrolet Chevette	0.004	0.002	0.043	0.152	0.222	0.004	**-2.090**	0.013	0.008	0.53
Chevrolet Sprint	0.004	0.002	0.002	0.004	0.004	0.024	0.002	**-2.753**	0.280	0.37
Renault 4	0.004	0.003	0.003	0.004	0.004	0.023	0.002	0.223	**-1.701**	0.63

Row *i*, column *j* gives the percentage change in the market share of car *j* given a 1% change in the price of car *i*.
Cars are sorted by price, the top car is the most expensive.
Source: My calculations.

Table IX
A Sample from 1992 of Estimated Own and Cross Price Elasticities

	Mercedes E320	Honda Integra LS Mec	Subaru Legacy	Mazda 626L	Chevrolet Swift 1.6	Mazda 323 HS	Renault 9 Brio	Chevrolet Sprint	**PCM**
Mercedes E320	**-1.1650**	0.0011	0.0009	0.0013	0.0003	0.0004	0.0005	0.0008	0.86
Honda Integra LS Mec	0.0000	**-3.5959**	0.0013	0.0008	0.0036	0.0004	0.0005	0.0008	0.29
Subaru Legacy	0.0000	0.0014	**-2.9107**	0.1230	0.0003	0.0004	0.0005	0.0008	0.35
Mazda 626L	0.0000	0.0003	0.0065	**-2.6574**	0.0009	0.0016	0.0021	0.0033	0.40
Chevrolet Swift 1.6	0.0000	0.0016	0.0002	0.0022	**-3.9645**	0.0109	0.0188	0.0343	0.26
Mazda 323 HS	0.0000	0.0003	0.0002	0.0023	0.0028	**-2.0048**	0.0564	0.1167	0.52
Renault 9 Brio	0.0000	0.0003	0.0002	0.0023	0.0026	0.0308	**-4.2808**	0.4213	0.24
Chevrolet Sprint	0.0000	0.0003	0.0002	0.0021	0.0024	0.0319	0.1409	**-3.1550**	0.33

Row *i*, column *j* gives the percentage change in the market share of car *j* given a 1% change in the price of car *i*.
Cars are sorted by price, the top car is the most expensive.
Source: My calculations.

Table X
A Sample from 1996 of Estimated Own and Cross Price Elasticities

	Mercedes C230	Citroen ZX	Mazda 626 L	VW Golf GL	Mitsubishi Lancer	Chevrolet Corsa L 5d	Daewoo Racer GTI	Hyundai Accent LS	Skoda Felicia GLX	Ford Festiva Hatch	Renault 9 Brio	Mazda 323 Coupe	Chevrolet Sprint	PCM
Mercedes C230	**-1.1626**	0.0001	0.0266	0.0004	0.0006	0.0004	0.0002	0.0002	0.0008	0.0006	0.0002	0.0004	0.0005	0.8885
Citroen ZX	0.0001	**-3.5386**	0.0001	0.0055	0.0049	0.0004	0.0077	0.0034	0.0127	0.0086	0.0002	0.0004	0.0005	0.2827
Mazda 626 L	0.0015	0.0000	**-2.2248**	0.0001	0.0001	0.0011	0.0000	0.0000	0.0002	0.0001	0.0007	0.0015	0.0018	0.4716
VW Golf GL	0.0001	0.0007	0.0001	**-2.4602**	0.0037	0.0004	0.0111	0.0025	0.0094	0.0064	0.0002	0.0004	0.0005	0.4074
Mitsubishi Lancer	0.0001	0.0003	0.0001	0.0019	**-4.6281**	0.0091	0.0043	0.0094	0.0451	0.0267	0.0107	0.0246	0.0338	0.2162
Chevrolet Corsa L 5d	0.0000	0.0000	0.0004	0.0001	0.0024	**-3.4345**	0.0000	0.0026	0.0182	0.0096	0.0341	0.0728	0.0978	0.2978
Daewoo Racer GTI	0.0001	0.0007	0.0001	0.0073	0.0038	0.0004	**-3.0199**	0.0039	0.0169	0.0105	0.0002	0.0004	0.0005	0.3323
Hyundai Accent LS	0.0001	0.0003	0.0001	0.0019	0.0075	0.0102	0.0040	**-2.3948**	0.0452	0.0265	0.0139	0.0321	0.0445	0.4181
Skoda Felicia GLX	0.0001	0.0003	0.0001	0.0017	0.0072	0.0136	0.0034	0.0087	**-2.0773**	0.0260	0.0190	0.0439	0.0610	0.4831
Ford Festiva Hatch	0.0001	0.0003	0.0001	0.0018	0.0073	0.0124	0.0036	0.0089	0.0452	**-2.2976**	0.0171	0.0395	0.0548	0.4361
Renault 9 Brio	0.0000	0.0000	0.0004	0.0001	0.0025	0.0261	0.0000	0.0030	0.0208	0.0108	**-2.1786**	0.0760	0.1027	0.4645
Mazda 323 Coupe	0.0000	0.0000	0.0004	0.0001	0.0027	0.0268	0.0000	0.0033	0.0230	0.0119	0.0363	**-2.1514**	0.1070	0.4696
Chevrolet Sprint	0.0000	0.0000	0.0004	0.0001	0.0028	0.0270	0.0000	0.0034	0.0239	0.0124	0.0367	0.0801	**-2.0584**	0.4948

Row *i*, column *j* gives the percentage change in the market share of car *j* given a 1% change in the price of car *i*.

Cars are sorted by price, the top car is the most expensive.

Source: My Calculations.

Table XI
Markup (P-MC)
(1996 Dollars)
(Sales Weighted)

	Total	Domestic	Foreign	Small	Medium	Large
1986	8.484	8.484	-	6.924	7.989	11.713
1987	10.601	10.601	-	7.499	9.526	16.984
1988	9.587	9.587	-	6.564	6.794	18.210
1989	7.136	7.136	-	4.952	8.608	9.825
1990	8.306	8.306	-	5.565	8.555	13.835
1991	6.445	6.445	-	5.973	5.343	9.268
1992	8.070	5.741	13.923	4.751	7.756	16.178
1993	7.276	5.935	8.997	4.229	6.645	16.126
1994	5.451	4.385	7.025	3.412	6.264	11.892
1995	5.462	4.259	7.480	3.617	6.075	15.445
1996	4.974	4.569	5.724	4.312	4.753	16.801
1997	4.987	4.694	5.307	4.741	4.748	15.086
1998	5.277	5.173	5.373	4.835	5.045	13.481
1986-91	8.426	8.426	-	6.246	7.803	13.306
1992-98	5.928	4.965	7.690	4.271	5.898	15.001
1986-98	7.081	6.563	7.690	5.183	6.777	14.219

Table XII
Average Price Cost Margins
(P-MC)/P*100
(Sales Weighted)

	Total	Domestic	Foreign	Small	Medium	Large
1986	32.79	32.79	-	33.48	31.41	34.33
1987	31.96	31.96	-	33.03	30.52	33.09
1988	29.44	29.44	-	30.06	20.58	36.51
1989	24.42	24.42	-	22.43	25.66	24.72
1990	25.40	25.40	-	22.00	24.57	29.05
1991	24.76	24.76	-	29.51	21.60	24.95
1992	35.78	27.55	40.82	26.94	30.33	44.69
1993	33.01	25.70	35.86	24.93	28.74	41.37
1994	30.59	23.44	32.44	21.89	29.61	37.03
1995	32.72	24.39	35.08	25.49	28.89	45.79
1996	31.35	26.74	33.06	32.86	25.44	43.05
1997	33.65	29.83	34.76	38.35	28.83	42.66
1998	34.09	34.77	33.90	40.20	30.81	43.60
1986-91	28.13	28.13	-	28.42	25.72	30.44
1992-98	33.03	27.49	35.13	30.09	28.95	42.60
1986-98	30.77	27.78	35.13	29.32	27.46	36.99

Source: My calculations.

Table XIII
COST DATA
(1996 Dollars)

	Avg. Cost of Domestic Parts Bought by Domestic Firms	Estimated Marginal Costs Total	Domestic	Foreign
1986	4,319	16,245	16,245	-
1987	4,205	16,993	16,993	-
1988	5,096	16,336	16,336	-
1989	4,529	16,018	16,018	-
1990	4,356	15,144	15,144	-
1991	3,995	14,405	14,405	-
1992	3,761	13,382	12,472	15,668
1993	3,089	14,301	13,285	15,604
1994	3,107	13,879	13,580	14,322
1995	2,897	12,957	12,575	13,599
1996	2,711	11,741	11,201	12,742
1997	2,562	10,925	10,320	11,586
1998	2,496	9,577	9,036	10,079
1986-91	4,416	15,857	15,857	-
1992-98	2,946	12,395	11,781	13,372
1986-98	3,624	13,993	13,662	13,372

Source: My calculations.

Table XIV
Welfare
(1996 Dollars)

1986	4,142
1987	4,069
1988	3,763
1989	2,817
1990	2,124
1991	1,746
1992	2,987
1993	7,913
1994	6,901
1995	6,331
1996	7,456
1997	7,551
1998	5,528
1986-91	3,110
1992-98	6,381
1986-98	4,871

Source: My calculations

Table XV
Welfare improvements due to the existence of foreign cars in the market
(Observed Welfare minus Counterfactual Welfare)
(1996 Dollars)

	Counterfactual with Fix Price	Counterfactual with New Equilibrium Price
1992	1,270	1,365
1993	4,298	4,329
1994	2,287	3,172
1995	2,453	2,843
1996	3,354	3,506
1997	3,966	4,242
1998	3,371	3,477
1992-98	3,000	3,276

Source: My Calculations.

Table XVI
Demand Estimates
Specification Checks

	PD GEV Model 1	**PD GEV** Model 2	**PD GEV** Model 3
α	4.529	5.909	4.466
	(1.931)***	(1.683)***	(1.586)***
ρ_o	0.636	0.667	0.713
	(0.220)***	(204)***	(0.173)***
ρ_s	0.444	0.427	0.425
	(0.255)*	(0.234)*	(0.299)
Domestic	0.682	0.725	0.740
	(0.193)***	(0.200)***	(0.206)***
Small	0.727	0.732	0.651
	(0.202)***	(0.183)***	(0.206)***
Medium	0.206	0.160	0.166
	(0.104)**	(0.094)*	(0.117)
Dimension	1.298	1.906	
	(0.582)**	(0.619)***	
HP/W	3.829	5.294	3.679
	(2.334)*	(2.738)**	(2.844)
AC	0.016		0.02
	(0.071)		(0.080)
Pwr Windows	-0.149	-0.123	-0.129
	(0.079)**	(0.076)	(0.094)
Constant	-19.735	-24.724	-18.273
	(6.759)***	(5.896)***	(5.081)***
GMM	21.72	22.14	27.42

*** Significant at 1% level; ** 5%; * 10%
Robust standard errors in parenthesis
Source: My calculations.

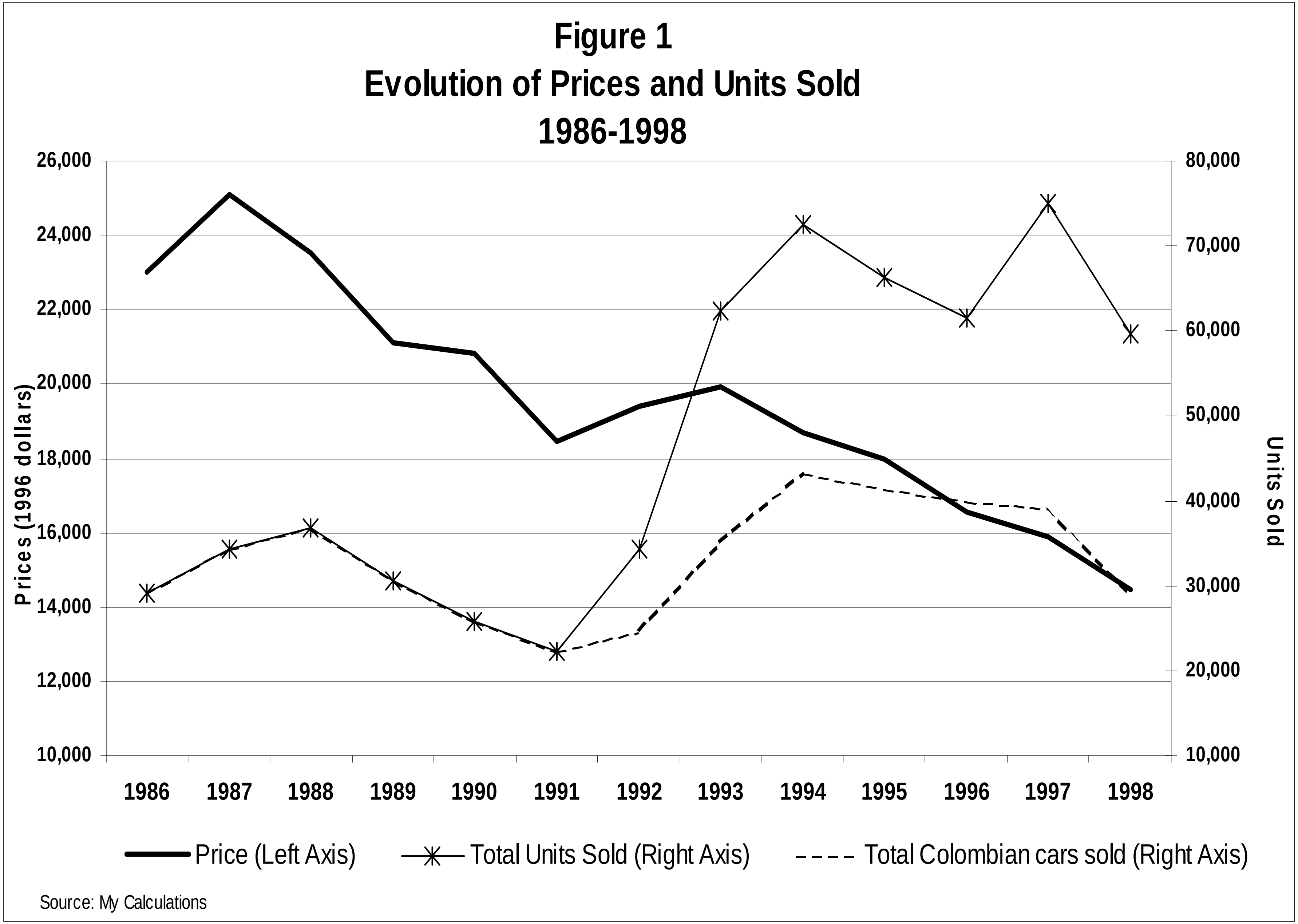
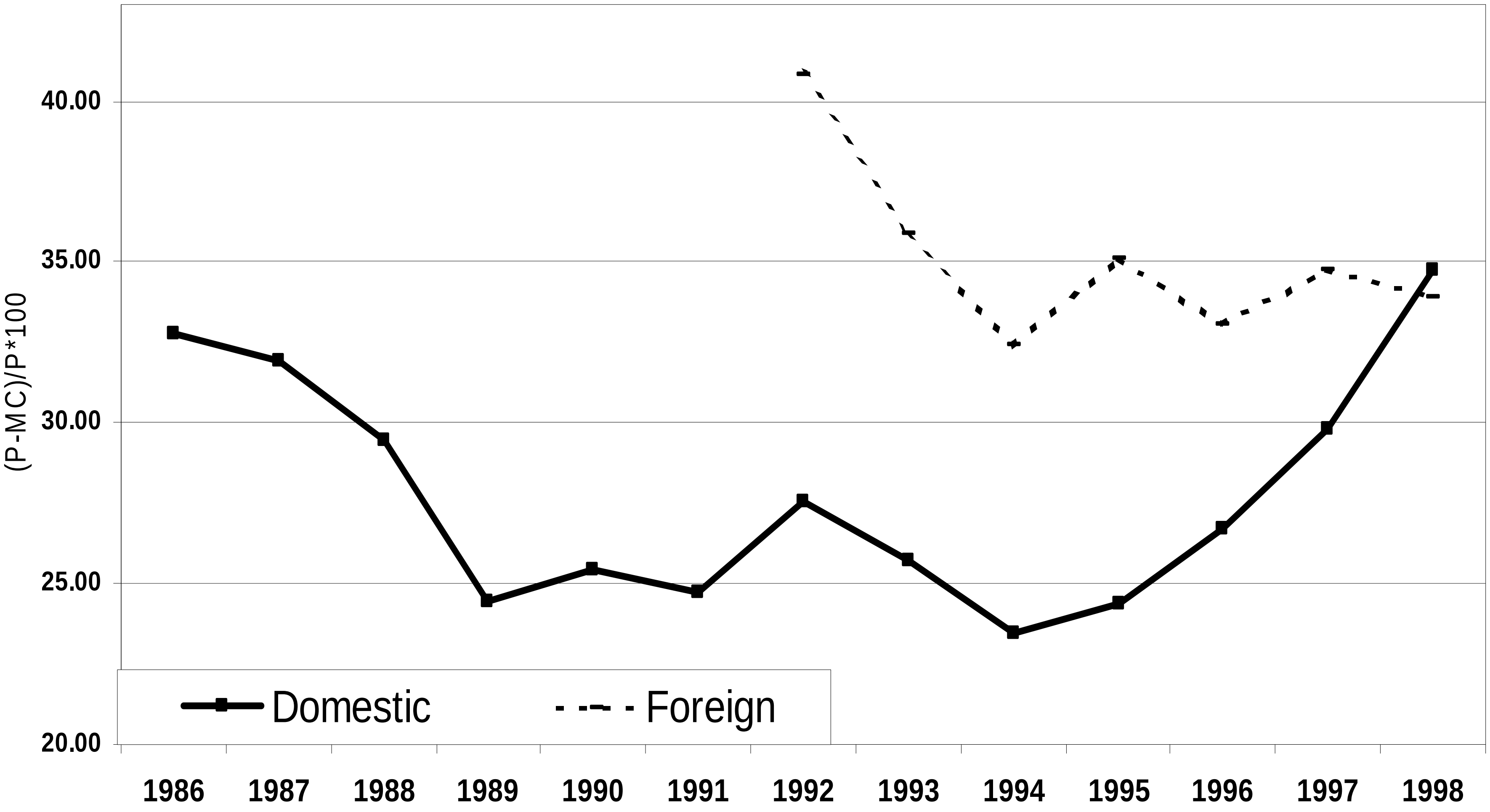


Figure 1
Evolution of Prices and Units Sold
1986-1998
26,000
24,000
22,000
20,000
18,000
16,000
14,000
12,000
10,000
Prices (1996 dollars)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
Units Sold
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
Price (Left Axis)
Total Units Sold (Right Axis)
Total Colombian cars sold (Right Axis)
Source: My Calculations

Figure 2
Price-Cost Margins Evolution
1986-1998



Source: My Calculations

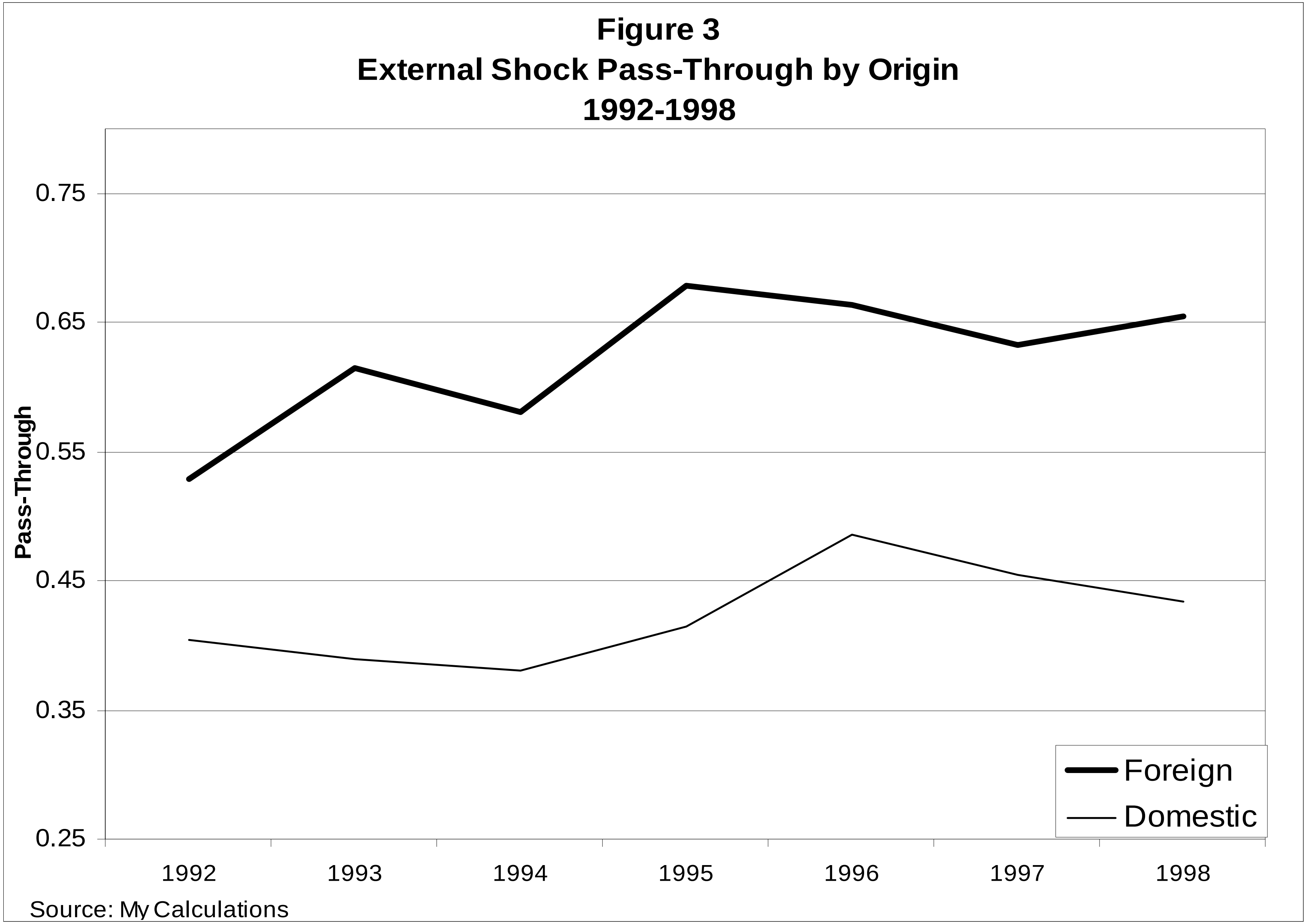


Figure 3
External Shock Pass-Through by Origin
1992-1998
Pass-Through
0.75
0.65
0.55
0.45
0.35
0.25
1992
1993
1994
1995
1996
1997
1998
Foreign
Domestic
Source: My Calculations

Table A.1 First Stage Results for Demand		
	Coefficient	**S.E.**
Dimension	-0.553	(0.039)***
HP/W	-1.762	(0.178)***
AC	-0.039	(0.006)***
Pwr Windows	-0.021	(0.008)***
Domestic	0.051	(0.085)
Small	-0.163	(0.058)**
Medium	-0.143	(0.038)***
IV 1	-0.573	(0.253)**
IV 2	-0.430	(0.812)
IV 3	0.003	(0.001)**
IV 4	-2.616	(1.572)*
IV 5	-0.978	(3.862)
IV 6	0.692	(0.204)***
IV 7	-0.138	(0.055)**
IV 8	0.011	(0.105)
IV 9	-0.006	(0.002)***
IV 10	0.111	(0.058)*
IV 11	0.015	(0.161)
IV 12	0.002	(0.002)
IV 13	0.002	(0.000)***
IV 14	0.001	(0.001)
IV 15	-0.001	(0.000)***
IV 16	0.002	(0.000)***
IV 17	-0.004	(0.000)***
F Test of excluded instruments	20.66	
(p-value)	0.00	
Exogeneity Test	19.996	
(p-value)	0.22	

IV 1 = The average dimension for cars sharing the size cluster
IV 2 = The average dimension for cars sharing the origin cluster.
IV 3 = Te average dimension for cars sharing both size and origin cluster.
IV 4 = The average HP/W for cars sharing the size cluster.
IV 5 = The average HP/W for cars sharing the origin cluster.
IV 6 = The average HP/W for cars sharing both size and origin cluster.
ÌV 7 = The average AC for cars sharing the size cluster.
IV 8 = The average AC for cars sharing the origin cluster.
IV 9 = The average AC sharing both size and origin cluster.
IV 10 = The average of power windows sharing the size cluster.
IV 11 = The average of power windows sharing the origin cluster.
IV 12 = The average of power windows sharing both size and origin cluster.
IV 13 = Total Number of models offered within the size cluster.
IV 14 = Total number of models offered within the origin cluster.
IV 15 = Real exchange rate index
IV 16 = Tariffs. For domestic cars it's the CKD tariff, for imported cars it is the import tariff
IV 17 = Sales tax,

*** Significant at 1% level; ** 5%; * 10%
Time dummy variables are also included.
The F test is the F test of the excluded instruments

Table A.2
Dependant Variable:lnSjt-lnSot

	Logit	IV logit
α	1.799	3.024
	(0.605)***	(1.274)***
Domestic	1.322	1.308
	(0.111)***	(0.111)***
Small	1.048	0.896
	(0.202)***	(0.221)***
Medium	0.356	0.228
	(0.136)***	(0.156)
Dimension	0.239	1.702
	(0.810)	(1.206)
HP/W	-1.536	2.867
	(3.457)	(4.376)
AC	-0.038	0.032
	(0.127)	(0.133)
Pwr Windows	-0.208	-0.132
	(0.136)	(0.1433)
Constant	-10.956	-13.315
	(0.914)***	(1.708)***

*** Significant at 1% level; ** 5%; * 10%

Source: My Calculations