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AUTOMOBILE DEMAND AND SUPPLY IN BRAZIL: EFFECTS OF TAX REBATES AND TRADE LIBERALIZATION ON PRICE-MARGINAL COST MARKUPS IN THE 1990s*

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TEXTO PARA DISCUSSÃO

Uma publicação que tem o objetivo de divulgar resultados de estudos desenvolvidos, direta ou indiretamente, pelo IPEA e trabalhos que, por sua relevância, levam informações para profissionais especializados e estabelecem um espaço para sugestões.

SUMMARY

SINOPSE

Este trabalho é um esforço pioneiro para a estimação da oferta e da demanda de automóveis no Brasil com um modelo de Escolha Discreta em um mercado oligopolístico com produtos diferenciados. Nós aplicamos uma modelagem econométrica de logit hierárquico (*Nested Logit*) para o lado da demanda, e adotamos a hipótese de firmas fixadoras de preços com múltiplos produtos diferenciados no lado da oferta, para avaliar as profundas transformações ocorridas na indústria automotiva brasileira nos anos 1990, especialmente a adoção de políticas como os incentivos fiscais para os chamados carros populares (introduzidos em 1993) e a liberalização comercial (iniciada em 1991 e revertida parcialmente sob o chamado regime automotivo). Nós constatamos que, embora os carros nacionais ainda auferissem taxas consideravelmente altas de *markup* em relação aos seus similares importados (líquidas de impostos sobre valor agregado e tarifas) em todos os segmentos de mercado no final da nossa amostra (1997), essas taxas tiveram uma queda drástica e permanente durante o *boom* de importações de 1995, não apenas por causa dessas importações, mas também em virtude da competição doméstica mais acirrada. Uma constatação, talvez surpreendente, é que, ao contrário do verificado em estudos em outros países, os carros populares e compactos têm as maiores taxas de *markup*, na medida em que são muito menos ameaçados pela competição estrangeira do que os carros grandes e de luxo. Essas taxas não se traduzem em margens preço-custo mais altas também em unidades monetárias, mas, devido ao grande volume de vendas, esses modelos correspondem a grandes percentagens dos lucros das firmas.

ABSTRACT

This work is a pioneer effort to estimate supply and demand of automobiles in Brazil with a Discrete Choice model in a differentiated product oligopolistic market. We apply a Nested Logit model to the demand side and assume differentiated product price-setting firms on the supply side to evaluate the severe transformations undergone by the Brazilian automobile industry in the 1990s, especially policy events such as the tax rebates created for the so-called popular models (introduced in 1993) and the trade liberalization (initiated in 1991 and partially reversed in 1995 under the so-called Automotive Regime). We find that, although domestic cars still enjoyed considerably higher price-marginal cost markup rates than their imported counterparts (net of VATs and duties) in all market segments at the end of our sample (1997), these rates had dropped drastically and permanently during the 1995 import boom, not only because of import, but also from fiercer domestic competition. A perhaps striking finding is that, as opposed to what was verified in studies for other countries, popular and compacts enjoy the highest price-marginal cost markup rates, as they are significantly less threatened by imported competitors than the larger and luxurious models. These rates do not translate into higher price-cost margins in money units, but due to their high sales volumes these models account for great shares of the firms' profits.

1 INTRODUCTION

With total net revenues of US$ 17,990 millions in 1998, topping 9.99% of Brazilian industrial GDP,[1] a positive trade balance for most of its lifetime, and both backward and forward linkages to most other industries, the automobile industry has played a powerful role in the Brazilian economy since its infancy, thanks to a variety of government incentives and commercial protection along its several stages of development. Radical policy turns during the 1990s changed dramatically the industry's face, especially the trade balance and the supply structure. Yet their effects on the internal degree of competitiveness have been hardly evaluated so far. The problems are not only the oligopolistic supply structure, the unit demand with high differentiation, and the consequent non-linear correlation between (endogenous) prices and unobserved product characteristics; the complexity and inequality of the Brazilian tax and import tariff schedule system in most periods also calls for a more sophisticated modeling.

This work intends to set a reference point for that evaluation. It is a pioneer effort to estimate simultaneously supply and demand of automobiles in Brazil.[2] We build on recent advances in differentiated market modelling to adopt a hedonic Discrete Choice specification for demand and model the market as a differentiated product oligopoly. For that purpose, a fully disaggregate dataset had to be constructed by us, with detailed information on each and every passenger car model sold in Brazil during the 1990s (but excluding pickups, vans and minivans, SUVs and jeeps).

The adopted framework, along with a correspondingly rich dataset and a detailed survey of the evolution of the intricated tax/tariff system, enables us to assess the differentiated impacts of major policy events, such as the revolutionary popular car program launched in 1993 and the ups and downs of the trade liberalization process, which provide a fascinating natural experiment for study. Indeed we do find some interesting results for the Brazilian case: although domestic cars still enjoyed considerably higher price-marginal cost markups than their imported counterparts in all market segments at the end of our sample (1997), these price-marginal cost markups rates had dropped drastically and permanently during the 1995 boom, not only because of import, but also from fiercer domestic competition. Perhaps more striking is the finding that popular cars, despite targeting lower income consumers (otherwise excluded from the new car market), have enjoyed higher price-marginal cost markups rates than large and luxury models, even though the latters' price-marginal cost markups in money units were quite higher, due to their corresponding higher prices.

1. Source: Anfavea (Brazilian Motor Vehicle Manufacturers Association).

2. Past estimations of Brazilian demand for automobiles failed to take account of the oligopolistic supply structure of the industry and of the correlation of prices with the ommited hedonic variables, as the authors preferred dynamic stock adjustment models to describe the consumers' behavior. [See Baumgarten (1972), Milone (1973), Coates (1985) and Vianna (1988)]. DeNegri (1998) estimated price elasticities around 0.6, not far from the previous authors. Even though he did use technical characteristics as explaining variables, he did not instrument them. We will review the bias that can arise when instruments are not utilized.

The present article is divided into six sections. The next section summarizes the main historical events in the recent past of the Brazilian automobile industry and introduces the most important institutional features of the market, such as supply structure, tax and tariff policy and other particular arrangements. The third section reviews the recent literature on automobile demand estimation. The fourth section describes in detail the model we estimated: each step and the corresponding assumption underlying to it are explained, and their potential influence on the results is discussed. The fifth section lists the data we collected and their most interesting stylized facts, reports our estimates and discusses them. Our conclusions point out to policy implications and possible future extensions.

2 THE AUTOMOBILE INDUSTRY IN BRAZIL: THE 1990s

Since 1956, when multinational auto makers were attracted by Brazilian federal government with tax rebates and market protection to invest in local plants,[3] until 1990, automobile imports were either suspended or levied a prohibitive tariff in Brazil. In addition, high local content requirements favored domestic part suppliers, even when tax and tariff rates for both machinery and part imports were reduced. These requirements were placed, in particular, during the installation of the industry in the late 1950s and when a new program (Befiex) was created in the 1970s, whereby investors were granted tax and tariff exemptions or rebates, in exchange for export goal commitments [Guimarães (1989)].

After a wave of mergers and acquisitions in the late 1960s and a reorganization of the market segments following entrance of the American Big Three (also in the 1960s) and Fiat (1976), the incumbents succeeded in capturing the government industrial development council so as to extinguish incentives to new entrants, what virtually barred new entrances until the 1990s [Guimarães (1980*a*)]. Thus, the passenger car industry entered 1990 featuring only three makers: Autolatina (a Volkswagen-Ford joint venture, effective from 1986 to 1994, when they became independent companies again[4]), Fiat and General Motors.

Import liberalization in the automobile market came up then as part of a more comprehensive process of unilateral trade liberalization launched in March 1990, when President Fernando Collor de Mello took office. Underlying to this liberalization was a widespread belief within the liberal forces in support of President Collor that import competition was the best way to undermine market power in concentrated industries. According to this view, protection induced x-inefficiency and magnified passthrough of cost increases, thus fueling inflation in a vicious circle. Cars were one of Collor's main targets, so much so that he labeled Brazilian vehicles as "horse carts" (meaning that protection had slowed down innovation and quality upgrading). At that time, non-tariff effective protection was converted into tariff rates and a timetable for their reduction was set (see Table 1). Some tariff reduction

3. Before that, car makers imported already assembled or CKD vehicles (Ford set up an assembly line in 1919 and GM in 1924). For more on Brazilian automobile industry's infancy [see Guimarães (1980b) and Shapiro (1994)].

4. Although VW and Ford shared assembly lines and engines during the joint venture lifetime, and even though in some cases they marketed the same model under both brands (with different names), their distribution channels were never shared; that is why we treat them as different makers throughout the joint venture lifetime.

deadlines were eventually anticipated. The most important one occurred in September 1994 and originated an import boom, which coincided with the Mexican crisis.

TABLE 1
PROPOSED TARIFF REDUCTION TIMETABLE

	1990	1991	1992	1993	1994
Automobile	85	60	50	40	35
Parts and Components	40	30	25	20	20

Source: Fonseca (1996).

In the meantime, in order to prepare economic agents for the transition from price freezes and other types of price control to import competition, while pursuing solutions for the sales stagnation, "Sector Summits" were setup, involving federal government, manufacturers and workers. This type of roundtable (except for the participation of workers) had already taken place in the late 1980s during President José Sarney's term and aimed at finding means to increase output and keep employment levels. At that time, however, they were actually utilized to run price controls (they were consulted regularly to approve price raises), so they functioned in fact as price-coordinating cartels led by government bodies.[5]

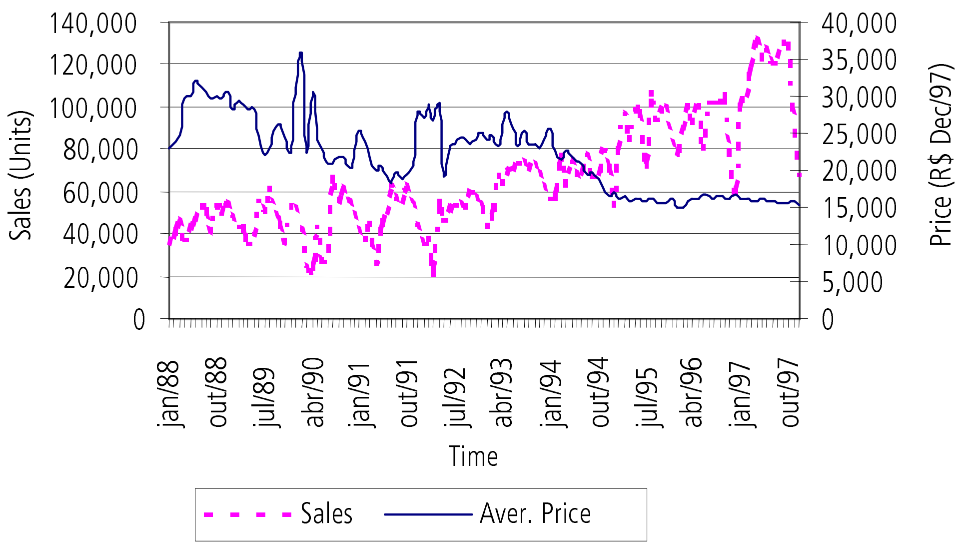
In a first stage the Sector Summit was one of the so-called "Executive Groups of Sector Policy" inspired by the late Automobile Industry Executive Group (GEIA), which steered the early stages of the industry in the 1950s. However, lack of mutual confidence among the parties in discussion, skepticism regarding irreversibility of trade liberalization and an excessive concern on the short-run — obviously due to the high rates of inflation in course — jeopardized negotiations until 1991; the committee's role as price coordinator prevailed. In a second stage, after the economic policymakers were replaced, the talks started converging to a common discourse. The first Sector Summit in this new stage took place in February 1992 and yielded as immediate effects a cutback of the IPI (federal value-added tax on industrial products) rate charged on vehicles and of the nominal markup rates and a relaxation of the workers' wage claims.

A new round of negotiations took place in February 1993, and achieved a new cutback on IPI rates. At that time sales stagnation, the need of export promotion and the technological gap of the Brazilian vehicles (the "horse carts") dominated the talks. However, they did not evolve to any impact measure and thus far had failed to raise the domestic sales level; the parties longed for some "new event". The new event did come: right after that negotiation round President Itamar Franco (who replaced President Collor upon his impeachment) came to scene and manifested his discontent with the absence of "popular cars" in the Brazilian industry, such as the long-ago phased out Volkswagen Beetle. Volkswagen accepted bringing back the outdated model *provided* it was granted an IPI tax exemption. In reply, the other

5. For a more accurate description and appraisal of the industrial policy related to the Sector Summits, see Salgado (1993) — where we draw most of the following historical report on that issue from — and Anderson (1999).

manufacturers offered models for the same "popular price" (US$ 6,850) or less[6] if they enjoyed the same exemption. The proposal was led by Fiat, which at that time already had a "popular model", the Uno Mille. The parties agreed then on reducing the IPI tax rate for the 1,000 cc tax bracket to a symbolical 0.1%. The so-called *Automotive Agreement* was enacted in April 1993, only two months after the 2nd Sector Summit, and gave domestic sales a significant momentum, as Figure 1 shows. Nevertheless the average market price remained above the 1990-91 level — a period when the economic activity had been severely depressed.

FIGURE 1
Domestic Sales vs Average Price



Source: IPEA Automobile databank.

The market boom proceeded along the implementation of the Real Plan (the successful stabilization plan that extinguished Brazil's chronical hyperinflation) in mid-1994, when consumption of durable goods gained additional momentum, as the amount of credit available for car purchases increased.[7] At that time, as opposed to the mid-eighties, car prices were not controlled by the Government, but the Automotive Agreement ruled that if prices for popular cars exceeded the agreed amount, the tax rebate would be cancelled. Now, the popular cars were the ones whose demand increased most, as the credit expansion benefited mainly lower-income potential consumers. This market failure fueled the existing black market for those models, where new or even low-mileage used cars were traded at a premium over list prices, in a similar fashion to what had happened in the mid-eighties, when all prices had been controlled.

As the Government's orientation was committing not to intervene through price controls, the Ministry of Finance in September 1994 resorted to an anticipation of Mercosur's Common External Tariff rate applied to automobiles,

6. The expression "popular car" was actually very inappropriate at that time (and still is), as the great majority of Brazilian population remained unable to afford a car at such price.

7. DeNegri (1998) reckons that credit for durable good consumption expanded approx. 60% at that time.

which was due to come into effect in January 1995, unless automobiles were included in Mercosur's List of Exceptions. This anticipation was meant to introduce competition in the low-price car segments, so as to prevent premia and consequent deterioration of inflationary expectations.

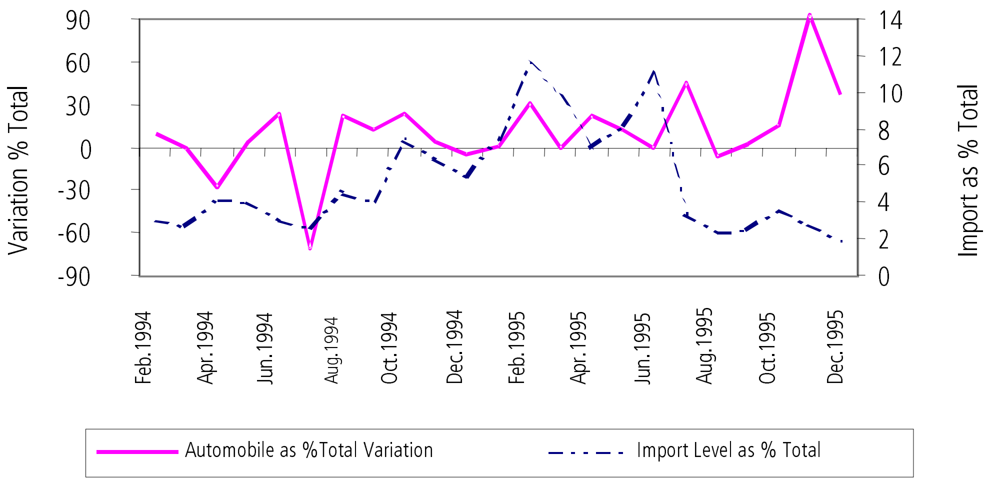
Meanwhile, due to a surge of confidence of foreign investors upon stabilization, capital inflows had boomed and the new Brazilian currency, the Real, had quickly overvalued. Imported automobile prices became therefore extremely competitive, and the numbers of available makes, models and retailers were multiplied overnight. The effect on the trade balance was disastrous: not only did automobile imports soar, but also the impact on *total* imports was visible.

Figures 2 and 3 illustrate the dramatic pressure that automobiles placed upon Brazil's trade balance. Figure 2 plots both the share of automobile imports on total imports and the share of the monthly *variation* of import value on the *variation* of total imports. It reads that automobiles contributed a great deal to Brazil's trade balance deterioration. The peak was in February 1995, when motor vehicles' share on imports reached 11.57% and responded for 30% of the total import increase. In addition, Figure 3 shows that the motor vehicles' trade deficit amounted to 47% of total trade deficit in 1995, whereas in the preceding years (1990-1993) trade surpluses averaging 9.6% of total surplus were recorded, and 1994 was the turning point, when the surplus was reversed to a deficit.

The Mexican crisis added to the balance of payments' chaos, as capital flows reverted all of a sudden. The Government relucted to take measures towards an exchange devaluation, and tried to circumvent the problem by tightening further the restraints placed in August 1994 on the credit market — the number of installments was limited, not only for loans, but also for purchase clubs ("consórcios", a very popular arrangement in Brazil). Nonetheless automobile imports remained high and this led the Government to revert the tariff reduction process: in February 1995 the tariff rate went back to the previous level (32%) and in March 1995 it was unexpectedly raised further to 70%, a level to be compared to those effective in the early 1990s. As import levels still did not founder at once (orders embarked before the tariff increase had been exempted, making up a record high 500 million dollar import level in June, when they were finally recorded), quotas were also imposed, what raised opposition among exporting countries and local importers.

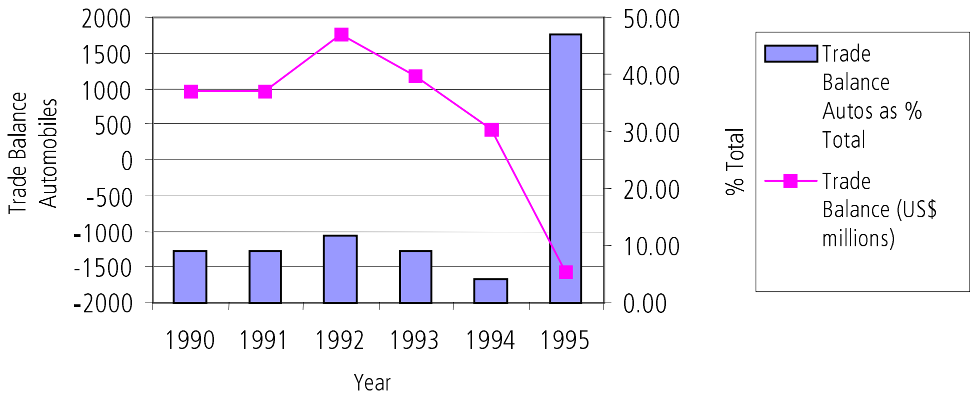
If the combination of quotas and a high rate finally succeeded in dampening the import flow, on the other hand it was politically impracticable to bar imports from Mercosur, and Argentina had been attracting large amounts of investment in automobile plants since the first treaty that created Mercosur. Brazilian auto makers signaled that they would invest more and more in Argentina in detriment of Brazilian plants, to assemble cars and export them back (as a great share of the parts were manufactured in Brazil).

FIGURE 2
Automobile Import Level and Variation Ratios



Source: SECEX (Brazilian Foreign Trade Secretariat).

FIGURE 3
Impact of Automobiles on Trade Deficit



Source: SECEX (Brazilian Foreign Trade Secretariat).

The Brazilian Government's reaction to both of these manifested intentions was creating a mechanism which would induce importing firms to build plants in Brazil in exchange for greater ease to import, thus consolidating Brazil (the largest market in South America by far) as an export platform for Latin America. That was formally established in the so-called *Automotive Regime*, which was initially enacted as a December 1995). This regime granted initially a 50% rebate off the legal import tariff, among other tax benefits, in exchange for a commitment to export US$ 1 for each US$ 1 imported.

The Automotive Regime's protectionist bias and its enactment *after* the deadline agreed at the World Trade Organization for Trade Related Incentive Measures (Trims) raised all the more protests from independent importers and from the countries that exported motor vehicles to Brazil, who threatened to set up a panel at the WTO. In response to these pressures, the Brazilian Government created in August 1996 a new regime especially for contenting the unsatisfied parties: the *Quota Regime* benefited Japan, South Korea and European Union by allowing them to export 50,000 vehicles paying the same 35% *tariff* enjoyed by incumbents and "newcomers" (name given to firms that joined the Automotive Regime and had no passenger car plant in Brazil yet). At the time the quotas were renewed (one year later), the same *rebate* (50% of due rate) was extended to the quotas (at that time the full legal rate had already gone down to 63%).

TABLE 2
Dates that Each Incumbent/Newcomer Joined the Automotive Regime

FIRM	Habilitation date[b]	Publication date[c]
Ford (incumbent), Mercedes-Benz[a]	05/Feb/96	06/Mar/96
General Motors (inc.)	07/Feb/96	06/Mar/96
Volkswagen (inc.)	13/Feb/96	06/Mar/96
Fiat (inc.)	13/Feb/96	06/Mar/96
Volvo[a]	26/Feb/96	06/Mar/96
Renault	02/May/96	03/May/96
Asia Motors	18/Apr/96	17/Jun/96
Chrysler	05/Aug/96	21/Aug/96
Honda	07/Aug/96	04/Dec/96
Land Rover	05/Dec/97	05/Dec/97
North/Northeast Special Regime		
Asia Motors	30/May/97	30/May/97
Hyundai	30/May/97	30/May/97

Source: Ministry of Industry and Trade – Brazil.

[a] Mercedes-Benz and Volvo already had plants in Brazil, but as of that time exclusively for buses and trucks.

[b] Date when the firm was issued a certificate entitling it to enjoy the benefits of the Regime.

[c] Date of publication by the Official Press (*Diário Oficial da União*).

This complicated evolution of different tariff rates in various brackets can be better followed on Table 3. There the evolution of the tariff rates due by each group (incumbents/newcomers and independent importers) is displayed. Note that in January 1999 both of them started paying the same duty, although the rebate to the latter was still subject to quotas. It is also worth reminding that both newcomers and incumbents only enjoyed the rebated tariff rate as from the date they joined the Automotive Regime. Finally, after two extensions, the Quota Regime expired in January 2000, when independent importers started again paying higher tariffs than incumbents and newcomers.

Besides local importers and exporting countries, another pressure group came to scene: politicians from Northeastern states (the poorest region of Brazil), concerned with the concentration of investments in new plants by both incumbents and newcomers in Southern and Southeastern states, which were closer to the greatest consumer markets and part suppliers in Brazil and Argentina,[8] claimed for additional tax subsidies in their region to attract some share of the new investment flow. Such benefits, extended to North and Center-West Regions, were approved by the National Congress and enacted in March 1997 (Act 9440, 14/Mar/1997), the most important one being a 75% IPI rebate for vehicles manufactured there.

8. Thus far only São Paulo and Minas Gerais had auto plants. The Automotive Regime brought new plants to both states, but also to Paraná, Rio Grande do Sul and Rio de Janeiro.

TABLE 3

Evolution of Legal Tariff Rates for Each Group of Firms and Vehicle Category

Date	Industrial and trade policy events[a]	Mercosur	Incumbents and newcomers			Independent importers		
			Import tax rate for cars	Import tax rate for light commercials (LCs)	I.T. rate for mass transportation vehicles (incl. buses)	Import tax rate for cars	Import tax rate for light commercials (LCs)	I.T. rate for mass transportation vehicles (incl. buses)
Jan/91		0.00	85.0	85.0	85.0	85.0	85.0	85.0
Feb/91	Economic Ministry Order (*Portaria* 58/91) sets Import Tax Rate Reduction Timetable (ITRRT).	0.00	60.0	60.0	60.0	60.0	60.0	60.0
Jan/92	ITTRT is anticipated by Decree 135/92	0.00	50.0	50.0	50.0	50.0	50.0	50.0
Oct/92	Decree 135/92	0.00	40.0	40.0	40.0	40.0	40.0	40.0
Jun/93	Decree 135/92	0.00	35.0	35.0	35.0	35.0	35.0	35.0
Sep/94	MF Order (Port. 506/94)	0.00	20.0	20.0	20.0	20.0	20.0	20.0
Feb/95	Decree 1391/95	0.00	32.0	32.0	32.0	32.0	32.0	32.0
Apr/95		0.00	70.0	32.0	32.0	70.0	32.0	32.0
May/95	Decree 1427/95	0.00	70.0	70.0	32.0	70.0	70.0	32.0
Mar/96	Automotive Regime (Dec/95) – First Firms join (see Table 2)	0.00	35.0	32.5	32.5	70.0	65.0	65.0
Sep/96	First Year Quota Regime (Decree 1987- Aug 20, 1996) from Aug 21, 1996 to Aug 20, 1997)	0.00	35.0	32.5	32.5	35.0	35.0	35.0
Jan/97	Full Rates go down to 63% (cars) and 55% (LC)	0.00	31.5	27.5	27.5	35.0	35.0	35.0
Sep/97	Quota Regime is renewed for one more year (Aug 21, 1997 to Sep 02, 1998).50% rebate off I.T. rate is extended to quotas (Decree 2307/97). Quota Regime is renewed again in Sep/98 for one more year (Decree 2770/98) and in Sep/99 it is extended for three months so that firms still enjoyed quotas not used thus far (Decree 3164/99) – total period: Sep 03, 1998 to Dec 31, 1999.	0.00	31.5	27.5	27.5	31.5	27.5	27.5
Jan/98	Full Rates go down to 49% (cars) and 45% (LC).[a]	0.00	24.5	23.0	23.0	24.5	23.0	23.0
Jan/99	Full Rates go down to 35%.	0.00	23.0	23.0	23.0	23.0	23.0	23.0
Jan/00	Quota Regime is not renewed; all independents are included in TEC´s List of Exceptions.	0.00	23.0	23.0	23.0	35.0	35.0	35.0
Jan/01	TEC is lowered; independents are kept in List of Exceptions	0.00	22.5	22.5	22.5	35.0	35.0	35.0

Sources: Abeiva, DeNegri (1998), *Quatro Rodas* (may/1995).

[a] Tariff may not be less than Mercosur's Common External Tariff (TEC).

The 1997 Asian Crisis brought forth a need to raise tax revenues, and the tax rates on cars were raised in November 1997. Sales went down and new temporary (emergency) automotive agreements followed from 1998 to 1999, when unions, industry and government finally agreed on a more simplified tax structure, with only three rates for passenger vehicles. The evolution of tax rates is summarized on Table 4.

We shall be concerned now with the theoretical framework necessary to evaluate such a myriad of tax and tariff modifications and their impact on price-marginal cost markup rates. We need a model for estimating both demand and supply in the automobile market for this purpose.

TABLE 4
Evolution of Legal Tax Rates for Each Vehicle Category

Date	Industrial Policy Events[a]	IPI Rate[b]				
		Up to 1.000 cc	Up to 100 HP gasoline	Up to 100 HP ethanol	More than 100 HP gasoline	More than 100 HP ethanol
Jan/91		20.0	37.0	32.0	42.0	37.0
Feb/92	Sector Summit	14.0	31.0	26.0	36.0	31.0
Feb-Mar/93	Sector Summit (Decree 755/93)	8.0	25.0	20.0	30.0	25.0
Ápr/93	Automotive Agreement (Decree 799/93) – Popular Car Program	0.1	25.0	20.0	30.0	25.0
Feb/95	Sector Summit – Decree 1391/95	8.0	25.0	20.0	30.0	25.0
Nov/97	Asian Crisis – Decree 2375/97	13.0	30.0	25.0	35.0	30.0
Aug/98	Emergency Automotive Agreement (effective until Dec/99) – Decree 2706/98	8.0	25.0	20.0	30.0	25.0
Jan/99	Popular Car Rates are raised back – Decree 2706/98	10.0	30.0	25.0	35.0	30.0
Mar/99	Emergency Automotive Agreement (effective for 60 days)[c] – Decree 2980/99	5.0	17.0	12.0	35.0	30.0
May/99	Automotive Agreement is renewed for 90 more days[d] – Decree 3069/99	7.0	20.0	15.0	35.0	30.0
Aug/99	Automotive Agreement is renewed until Sep.30[d] – Decree 3158/99	7.0	20.0	15.0	35.0	30.0
Oct/99	Decree 3186/99	10.0	25.0	20.0	25.0	20.0

Sources:
[a] *Quatro Rodas* (May/1995); *Carta da Anfavea* (various issues); DeNegri (1999).
[b] Anfavea, *Statistical Yearbook – Brazilian Automotive Industry* (various issues).
Notes:
[c] Besides lower *ad valorem* rates, a R$ 350.00 bonus was granted for populars and gas/ethanol/diesel-4X4 LCs, and R$ 250.00 for non-popular vehicles with engine less than 127HP and diesel LCs.
[d] Besides lower *ad valorem* rates, a R$ 375.00 bonus was granted for populars.

3 REVIEW OF THE LITERATURE

Studies on demand for automobiles may be classified into two major categories. The first one is a subset of a broader literature on consumption models, namely the models on consumption of *durable goods*. In these models automobiles are grouped as one homogeneous good, and this good is accounted as an asset the agent chooses to invest in. The main purpose of this kind of model is to analyze the dynamic properties of the demand for automobiles, especially the response of intertemporal choice to macroeconomic variables, such as interest rate or money holdings (indicating ease of obtaining credit), average price of autos, or average operation costs, average household income, etc. Vehicle characteristics do not play any role in these models, as they are not concerned at all with the decision of the consumer regarding which brand to buy, but only if he/she buys a new car or a used car or spends or invests his/her money otherwise. This kind of approach, therefore, is not useful for analyzing impacts of differentiated tax or tariff schedules on the composition of sales.

The literature on differentiated goods, on the other hand, focuses on how the consumer chooses his/her car from a range of different cars available in the market.

Since Chamberlin's classical work (1933), economists have been aware that diversity of tastes across individuals and idiosyncratic preferences over brands or varieties are potential sources of market power. But as Anderson, De Palma and Thysse (1992) remark, the market is unlikely to support a large number of products because of increasing returns to scale in R&D, production, marketing and distribution.

There is a wide array of models in that literature, allowing for several different market structures: monopoly with differentiated goods — also known as multiproduct monopoly; differentiated oligopoly where each firm serves a niche of the market with one good only; and differentiated multiproduct oligopoly. Heterogeneity, on its turn, can arise from different sources. We identify three major traditions in analyzing these sources.

The first one makes use of a representative consumer to construct a "pseudo-demand". This approach can also be regarded as a representation of the aggregate preferences of consumers for the variants of a differentiated product. Examples are the CES preference models of Spence (1976), Dixit and Stiglitz (1977), and Bajic (1993).

The second one supposes that consumers have the same ordinal preferences among the good but differ in their cardinal preferences. Thus, even though they judge a good for their quality only and they agree in their ordering of quality contents, they differ in their willingness to pay for quality, such that different variants of the good are able to be present in the market. This approach is named *vertical differentiation*. Examples are Bresnahan (1981) and Shaked & Sutton (1982).

Third, consumers are not identical because they are distributed along some characteristics space[9] according to some density; the firms or goods are defined as bundles of these characteristics, so they are also points in the same characteristics space. The consumers make different choices according to the distance that separates them or their tastes from the closest available good in that space. This approach, named *spatial*, *address, location* or *characteristics*, was inaugurated by Hotelling's (1929) classical setup of a "linear city", and has been enriched to allow for multidimensional attributes by Lancaster (1966). If one assumes in addition that the consumer's utility has an i.i.d. unbounded random component, it follows that any good is a potential substitute for all the others, whereas, in the other extreme, in a linear or circular city each single good has a non-zero cross-price elasticity with, at most, two "neighbors". Feenstra & Levinsohn (1995), Goldberg (1995) and Berry, Levinsohn and Pakes (1993, 1995) also utilize multidimensional attributes for cars.

A major contribution of the spatial approach is that it reduces dramatically the dimension of the patterns of substitution, whereas specifying demand as a function of the price of each and every substitute increases the number of parameters exponentially with the number of variants of the good available in the market. For example, if the market for automobiles comprises 100 "different" models, but the relevant characteristics they display are in number of five, one has to estimate at most

9. Hotelling (1929) used a "linear city" and Salop (1979), a circular city.

ten parameters — mean and standard deviation of each characteristic — instead of 10,000 cross-price elasticities.[10]

An attempt was made by Berkovec (1985) to reconcile a discrete choice model with models of new automobile production and used vehicle scrappage. This allows for both dynamic effects and product differentiation to be accounted. Unfortunately for our purposes such a model requires information on the actual household-level consumption.

3.1 EMPIRICAL STUDIES[11]

The first attempts to apply the characteristics approach and test it empirically were the hedonic regressions. The initial concern of the hedonic pricing methodology, however, was the estimation of reduced form parameters only. "Hedonic prices are defined as the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them" [Rosen (1974, p. 34)]. Econometrically, implicit prices are estimated by regressing the product price on characteristics. By comparing them across different periods, one is able to construct quality indexes.

Unfortunately it is not straightforward to recover from those estimations the underlying supply and demand functions (as the regression only tracks the intersection of those curves) especially if the supply curve arises from some imperfectly competitive pricing behavior; in that case, price lies above marginal cost, so there is an omitted variable (price-marginal cost markup) bias. Moreover, this methodology is not able to detect quality changes that are introduced simultaneously in all goods.

Attempts to use hedonic pricing as a starting point for complete characterization of the market equilibrium [e.g. Rosen (1974) Epple (1987)] raised the necessity to carefully specify sources of error and orthogonality conditions. Requisite orthogonality conditions found by Epple are quite strong: if important characteristics are unmeasured and they are correlated with measured characteristics, a bias will arise. To deal with that problem, the author proposed a specification with random coefficients and used instrumental variables to estimate the parameters, since ordinary least squares would provide inconsistent estimates.

A better way to recover the underlying utility and cost functions has been developed by using microeconometric tools.[12] In particular, advances in the econometric theory of Discrete Choice and computational improvements have given rise to an increasing number of empirical tests, using different assumptions to model consumer behavior. Discrete Choice models were developed so that one could deal with discontinuous demands due to corner solutions, as opposed to interior solutions

10. Levinsohn (1988) prefers placing zero restrictions into the matrix of cross-price derivatives after a first-round estimation.

11. A very comprehensive survey of the household-level studies on automobile demand in the USA is found in Train (1993), ch. 7.

12. Microeconometrics' unit of analysis is the individual decision maker; "(...) being individuals ourselves, we find it easier to produce insights into the behaviour of these units than we do into the behaviour of economy-wide aggregates" [Pudney (1989, p.2)].

that stem from neoclassical convex preferences. Therefore, they are the most appropriate econometric models that render empirically operational both the vertical differentiation and location theoretical models. Indeed, Hotelling himself showed that aggregating over a population of heterogeneous demands may yield continuous market demands, if one assumes a continuum of consumers uniformly distributed over a bounded interval. Only unfortunately his proof is not robust to different demand specifications.

An alternative way of generating continuous demands is to recognize that some (idiosyncratic) characteristics of the consumers are not observable by the firms. By assuming a distribution from which these taste parameters are drawn, a Discrete Choice model can be estimated. "Discrete Choice models start from the assumption that each consumer chooses the single option (here a variant of a differentiated product) that yields the greatest utility, while from the viewpoint of the outside observer (here firms), utility is described as a random variable reflecting unobservable taste differences".[13] Again: utility is called random, not because the consumer behavior is necessarily stochastic, but because some factors may not be observed, which may be varying across and affecting the consumer's choices. This preserves, for instance, the transitivity property of the preference operator.

Most of the random utility models in the Discrete Choice literature assume additively separable utility functions. One of the most popular distributions in this class is the multinomial logit. Unfortunately this distribution has an undesirable feature: the ratio of two choice probabilities is independent of whatever other choices are available – a property known as "Independence of Irrelevant Alternatives".[14] To overcome partially this problem it was suggested that choices are modeled in a sequential fashion: the consumer chooses first from a range of classes of goods, then chooses from that class another subset of the goods, and so forth, up to the endnode.[15]

These models are called Nested Multinomial Logit. A shortcoming of this sort of modeling is that patterns of substitution are restricted *a priori* by the assumptions the author makes about the decision tree, such as the order of choices (does the consumer decide first the class of car he/she buys, or the make, or the nationality, or the color, or the range of prices he is willing to pay?), the partition of the consumption set (number and breadth of the available subsets), and so on.

Despite the variety of available modelings, the literature has focused successfully on a particular order of choices, namely: 1) class (compact, midsize, etc.); 2) nationality or origin (domestic or imported); 3) model. Goldberg (1995) estimated a five stage NL model — where each stage refers to a step in a sequential decision

13. Cf. Anderson *et al.* (1992), pp.3-4. This approach contrasts with the psychologists' assumption that human individual behavior is inherently stochastic because individuals fluctuate in their comparisons and evaluations of alternatives.

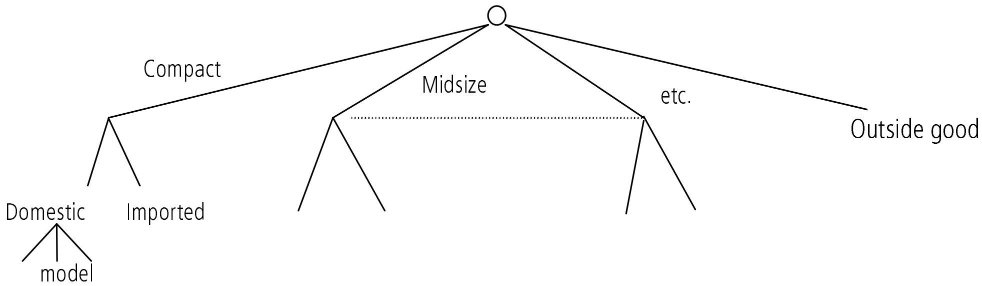
14. An odd implication of this property is that if a new alternative is introduced, all the selection probabilities are reduced in the same proportion, notwithstanding the proximity of the new alternative to a particular subset of the preexisting alternatives. For instance, the introduction of a "red bus" as an alternative to the automobile and the blue bus will affect both in the same degree, what obviously lacks sense.

15. "The nested logit structure assumes (...) that choices within each stage are similar in unobserved factors, so that IIA holds for any pair of alternatives within each stage, but not for the entire choice set." [Goldberg (1995, p. 898)].

process[16] — but, by interacting household and vehicle characteristics as explaining variables, she claims that the IIA property does not hold in her findings. She used that estimation to study the exchange rate passthrough and the effects of VERs in the U.S. industry.

Verboven (1996) estimated a NL model with an outside alternative, as depicted on Figure 4, to study price discrimination by manufacturers for a cross-section of selected European countries. Goldberg and Verboven (1998) extend that model with slight changes for a panel of the same countries, so as to study the impact of exchange rate fluctuations. Fershtman, Gandal and Markovich (1999) also employ a NL to simulate the impact of tax rate variations on the automobile market in Israel — they drop the second stage, as all cars traded in Israel are imported. These three papers borrow from a more general framework set up by Berry (1994) and described below. For our present purposes, Nested Logit provides sensible estimates — in spite of unsatisfying substitution patterns pointed out by Berry, Levinsohn and Pakes (1993 and 1995) and that we shall refer to in our conclusions — and so we follow the references above for formulating our own model.

FIGURE 4



4 THE MODEL

4.1 A BROADER FRAMEWORK

Berry (1994) provides a very broad framework for estimating Discrete Choice models of differentiated products in oligopolistic markets, which embraces nested logit, vertical differentiation and the random coefficient model [named BLP after the paper by Berry, Levinsohn and Pakes (1993 and 1995)] as special cases. All of these models utilize market level data, which is more appropriate for our purposes, as Brazil lacks data on household consumption of automobiles.

Berry was inspired in Bresnahan (1981) to assume that characteristics are exogenous, that there exists an outside alternative (outside good) and that firms are multiproduct and compete in prices, thus obtaining a Bertrand-Nash equilibrium. In both papers assuming exogeneity does not bring any major problem, as Berry sets up his model for a cross-section estimation, and Bresnahan uses a two-year panel only.

16. Unlike the other authors, which assumed an outside alternative as the 0^{th} group including the used car, Goldberg places two additional stages: the first one is to decide whether buying at least a car or not and the second is whether buying a new car or a used car.

Such a short time is not expected to be long enough for a firm to develop a new car in response to the market environment (see comment below).

Total demand (i.e., excluding the outside good) is modeled as a fraction of the potential market, which is assumed to be the total number of households. The discrete choice assumption means that each household is assumed to buy either zero or one car (unit demand) — this is a shortcoming of the model, as it rules out multiple purchases. The car purchased is the one that gives the household the highest utility. The difference between the sum of the shares of all cars marketed and the total number of households in the economy equals the share of the outside good, which can be a used car, a motorcycle, a public means of transportation, etc.[17]

A household utility is function of the automobile's characteristics (both unobserved and observed, including price), the characteristics of the outside alternative and the own households' characteristics (including income). Unobserved characteristics may be design, inherent comfort, and any variable that the econometrician cannot measure, proxy or simply collect, but that are observed and taken account of by both the consumers and the producers. The set of observed characteristics ordinarily includes engine power, size, fuel efficiency, equipment, etc., which are readily available in specialized magazines and can be collected by the econometrician. Formally:

$$q_j = M \cdot s_j(p_j, x_j, \xi_j, \theta), \quad j = 0,1, ...J \quad \text{(total quantity demanded of good } j) \qquad (4.1)$$

where

- $s_j(p_j, x_j, \xi_j, \theta) = \int_{A_j} f(\eta, x, \sigma_\eta) d\eta$, (market share of good j); (4.2)

- $A_j = \{(\eta, z) \mid U(p_j, x_j, \xi_j, \eta, z, \theta_d) > U(p_k, x_k, \xi_k, \eta, z, \theta_d), \forall k \neq j\}$ (4.3)

(that is, the set of households who prefer good j);

- M is the total size of the potential market;
- p_j = price of good j;
- x_j = K X 1 vector of observed characteristics of good j;
- ξ_j = mean of unobserved characteristics of good j;
- θ = vector of parameters (θ_d is (K+1) X 1 subvector with demand parameters);
- $\eta_i = (\varepsilon_{ij}, \nu_i')$;
- z_i = vector of observed characteristics of household i;
- ν_i = vector of unobserved characteristics of household i;
- $f(\cdot)$ = the probability density function of ν;

17. Absent an outside alternative in the specification, the consumer would be forced to choose from the inside alternatives only, so demand would depend exclusively on price differences. Consequently, a general increase in prices would not decrease aggregate demand, and vice-versa.

- ε_{ij} = unobserved (idiosyncratic) random error (i.i.d. across both household and car model level);
- σ = parameter (or vector of parameters) of the distribution of ν;
- i = household or individual (i = 1, ...M).

This is the usual way of deriving market shares in Discrete Choice models, except for the introduction of the outside alternative.

Utility function specifications adopted in Discrete Choice models use to be special cases of the following more general model [see Davis (2000)]:

$$u_{ij}\ (p_j,\ x_j,\ \xi_j,\ z_i,\ \nu_i,\theta) = \varphi(p_j,\ x_j,\ z_i)'\,\gamma_i(z_i,\ \nu_i,\ \theta) + \xi_j + \varepsilon_{ij}, \qquad (4.4)$$

where:

$\varphi\,(\cdot)$ is a known function;

$\gamma\,(\cdot)$ is a function known up to θ.

Therefore we can classify Discrete Choice models within this broader framework according to:

I) Sources of individual (household) heterogeneity:

a) Whether individual household data are available or not;

b) Wherever (a) is negative, whether household unobserved characteristics can be simulated through some bootstrap method or, alternatively, drawn from a parametric distribution generated with estimated parameters;

II) Functional forms of $\varphi\,(\cdot)$ and $\gamma\,(\cdot)$;

III) Distribution assumed for the random error.

Henceforth we assume that observed product characteristics are available. As regards (II), adopted functional forms are usually linear and additively separable. However, if only market level data are available and differences in the distribution of the ε_{ij} across j are assumed independent of the observed product characteristics, this introduces a problem pointed out by Berry (1994) and Berry, Levinsohn and Pakes (1993, 1995): one can write the utility function as

$$u_{ij}\ (p_j, x_j, \xi_j, z_i, \nu_i, \theta) = \delta_j\ (p_j, x_j, \xi_j, \theta) + \varepsilon_{ij} \qquad (4.5)$$

where δ_j is the mean utility of good j across consumers; so (4.2) can be written as:

$$s_j = \int_{\varepsilon} \prod_{q\neq j} F(\delta_j - \delta_q + \varepsilon)dF(\varepsilon) \qquad (4.6)$$

and estimation requires, at most, computation of a unidimensional integral. Assuming in (III) that ε_{ij} follows an extreme value distribution:

$$f(\varepsilon) = \exp(-\exp\ (\varepsilon)\ ) \qquad (4.7)$$

a closed form is available. The problem with this type of specification is that it generates substitution effects that depend on the vector of δ_j indices only. "Since under mild regularity conditions [see Berry (1994)], there is a unique vector of market shares associated with each vector of δ-indices, an implication of (4.6) is that the cross-price elasticities between any two products, or, for that matter, the similarity in their price and demand responses to the introduction of a new third product, depends only on their market shares. That is, conditional on market shares, substitution patterns do not depend on the observable characteristics of the product." [Berry, Levinsohn and Pakes (1993, p.10)]. But "it is important to note that this property is a function of the identically and independently distributed additive error and not on any specific distributional assumption (such as logit) on the errors." [Berry (1994, p.246)]. In other words, the IIA property is a special (stronger) case of this problem.

Since available Brazilian household surveys do not carry information on purchases of particular models, we will have to rely on market level data only. Therefore, the main (most utilized) models available, based on the logit assumption, are the following:

1) Multinomial Logit – in this case no household characteristic z_i is observed, and no ν_i is assumed. Therefore the share function specification is:

$$s_j(p_j, x_j, \xi_j, \theta) = \frac{\exp\{\varphi(p_j, x_j)'\gamma(\theta) + \xi_j\}}{1 + \sum_{k=1}^{J} \exp\{\varphi(p_k, x_k)'\gamma(\theta) + \xi_k\}} \qquad (4.8)$$

As mentioned before, this model has the undesirable IIA property. If some z_i is observed, the individual demand function will still satisfy the IIA property, but the market demand will not necessarily do so. "However, unless very rich data on consumer characteristics are available, the model may still be insufficiently flexible to replicate any true substitution pattern." [Davis (2000, p.996)].

2) Multinomial Nested Logit [McFadden (1978)] – still assuming unavailable both z_i and ν_i, we now group the products into G+1 exhaustive and mutually exclusive sets, g = 0,1,...G (g = 0 denotes the outside good). Within the groups another nesting can be arranged for subgroups, h = 1,...H_g, where H_g is the number of subgroups in group g. Now assume that the random error can be decomposed in the following manner:

$$\varepsilon_{ij} = \zeta_{ig} + (1 - \sigma_2)\cdot \zeta_{ihg} + (1 - \sigma_1)\cdot \zeta_{ij} \qquad (4.9)$$

where h and g index subgroups and groups respectively, and that

$$\zeta_{ig},\ (1 - \sigma_2)\cdot \zeta_{ihg} + (1 - \sigma_1)\cdot \zeta_{ij} \text{ and } \zeta_{ig} + (1 - \sigma_2)\cdot \zeta_{ihg} + (1 - \sigma_1)\cdot \zeta_{ij} \qquad (4.10)$$

have the extreme value distribution. By assuming some utility specification of type (4.5), the share function turns into:

$$s_j = s_{j/hg}\ s_{hg/g}\ s_g = \frac{e^{\delta_j/(1-\sigma_1)}}{D_{hg}} \frac{D_{hg}^{(1-\sigma_1)/(1-\sigma_2)}}{\sum_{h\in\Im_g} D_{hg}^{(1-\sigma_1)/(1-\sigma_2)}} \frac{[\sum_{h\in\Im_g} D_{hg}^{(1-\sigma_1)/(1-\sigma_2)}]^{(1-\sigma_2)}}{\sum_{g\in\Im_G}[\sum_{h\in\Im_g} D_{hg}^{(1-\sigma_1)/(1-\sigma_2)}]^{(1-\sigma_2)}} \quad (4.11)$$

where:

$$D_{hg} = \sum_{j\in\Im_{hg}} e^{\delta_j/(1-\sigma_1)};$$

$\Im_{hg}$ is the set of goods sold in subgroup *h* of group *g*;

$\Im_g$ is the set of all subgroups in group *g*;

$\Im_G$ is the set of all groups;

$s_{j/hg} = q_j / \sum_{j\in\Im_{hg}} q_i$ is the share of good j in subgroup h of group g;

$s_{hg/g} = \sum_{i\in\Im_{hg}} q_i / \sum_{i\in\Im_g} q_i$ is the share of subgroup h in group g.

As compared to the simple logit model, the nested logit model preserves the assumption that consumer tastes have an extreme value distribution, but allows consumer tastes to be correlated (in a restricted fashion) across products. McFadden (1978) shows that the NL model is consistent with random utility maximization when $0 \leq \sigma_2 \leq \sigma_1 \leq 1$. If both σ_1 and σ_2 are zero, the simple logit model arises (preferences are uncorrelated across all goods). If only σ_1 is positive and σ_2 is zero, individual preferences are only correlated across goods within the same subgroup (localized competition). If σ_1 and σ_2 are both positive, preferences are also correlated within the whole group. If the sigmas approach each other, then the correlation within the subgroup is equal to the correlation within the group.

3) Mixed Multinomial Logit: Boyd and Mellman (1980) and Cardell and Dunbar (1980) pioneered the use of random coefficients in Discrete Choice models applied to cross-sections. In recognizing that consumers would have different preferences for automobiles, they postulated a simple additively separable utility function with an extreme-value error with the innovation that the consumers might have a unique set of parameters. Formally:

$$u_{ij}\ (p_j, x_j, \nu_i, \theta) = (p_j, x_j')\cdot(\alpha_i, \beta_i')' + \varepsilon_{ij} \quad (4.12)$$

so that the market share is given by:

$s_j(p_j, x_j, \theta) =$

$$\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}\cdots\int_{-\infty}^{+\infty} \frac{\exp\{(\mathrm{p_j}, \mathrm{x_j}')\cdot(\alpha_i, \beta_i')'\}}{1+\sum_{k=1}^{J}\exp\{(\mathrm{p_k}, \mathrm{x_k}')\cdot(\alpha_i, \beta_i')'\}} f(\beta)\cdot d\alpha\cdot d\beta_1\cdot d\beta_1 ... d\beta_K \qquad (4.13)$$

This specification is able to generate consumer heterogeneity and does not feature neither the IIA property nor the price elasticities depending only on market shares. McFadden and Train (2000) show that under mild regularity conditions any Discrete Choice model derived from random utility maximization has choice probabilities that can be approximated arbitrarily closely by the Mixed Multinomial Logit (MMNL) choice model. However, Davis (2000) notes that this result depends on the assumption that the variance of the additive logit error can be made arbitrarily small.

The authors postulate a lognormal specification for the parameter distributions:

$(\alpha_i, \beta_i) = \exp(\mu + \Sigma\cdot\nu_i);$

where

$\nu_i \sim N(0,I);$

so that

$\theta = (\mu,\Sigma).$

For simplicity Σ is assumed diagonal. The odd note is that these specifications restrict the utility coefficients (α_i, β_i') to be nonnegative.

4) Mixed Multinomial Logit with Unobserved Product Characteristic [Berry, Levinsohn and Pakes (1993 and 1995)], also called BLP.

As compared to the original MMNL model, BLP adds the unobserved product characteristics and postulate a different (normal) specification for the characteristics' coefficients:

$$u_{ij}\ (p_j,\ x_j,\ \xi_j,\ \nu_i,\ \theta) = g_i(p_j) + x_j\beta_i + \xi_j + \varepsilon_{ij}, \qquad (4.14)$$

where

$(\alpha_i, \beta_i) = \mu + \Sigma\cdot\nu_i,$

and g_i is a function of some unobserved individual characteristic that may be input from external data sources. In their case, they simulate a lognormal income distribution using moments estimated externally, such that $g_i(p_j) = -\alpha\cdot\ln(y_i - p_j)$ and the income elasticity decreases with income (see footnotes 18 and 19).

The BLP model carries the MMNL advantage in allowing for richer patterns of substitution than the multinomial and nested multinomial models. And by postulating the utility to be additively separable in the random coefficients, the authors are able to build in a very neat two-step simulation routine into the inversion procedure proposed by Berry (1994). Note that the market share formula can be written out as:

$$s_j(p_j, x_j, \theta) = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}\ldots\int_{-\infty}^{+\infty} \frac{e^{\delta_j(x_j, p_j, \xi_j, \theta_1)+\mu(x_j, p_j, v_i, \theta_2)}}{1+\sum_{k=1}^{J} e^{\delta_k(x_k, p_k, \xi_k, \theta_1)+\mu(x_k, p_k, v_i, \theta_2)}} f(\nu)d\nu \qquad (4.15)$$

and the moment conditions used for GMM estimation are linear in part of the parameters (θ_1). Since the obtained distribution above has not a closed form, the authors use a fixed point argument to calculate it numerically.

Note that if we did have household level data, we would be able to pursue yet other approaches, combining those microdata with one of the models above. There exist three main references on such combinations. Goldberg (1995) combined Nested Logit with U.S. Consumer Expenditure Survey (CES) microdata. Berry, Levinsohn and Pakes (1997) combined BLP model with GM's marketing survey CAMIP. Petrin (2001) combined BLP with CES data. Both surveys (Camip and CES) convey information on characteristics of households (age, income, family size, etc.) that actually purchased vehicles, and in addition CAMIP features information on second choice vehicles. However, as CAMIP's sample was choice-based (thus including only households that had effectively purchased vehicles, while CES is sampled from the whole population), Berry, Levinsohn and Pakes complemented it with information from the U.S. Current Population Survey.

4.2 OUR MODEL

BLP did find plausible and significant supply and demand parameter estimates for a sample of U.S. automobile annual sales data from 1971 to 1990. It is worth mentioning that Wojcik (2000) compares NL with BLP using the same U.S. databank. She finds that, despite greater richness of substitution patterns, the BLP model comes out with less precise estimates of parameters and has a very poor forecasting power as compared to the Nested Logit approach. However, in response to her, Berry and Pakes (2001) point out three flaws in her argument:

a) first of all, to say that *Nested Logit* performs better than the random coefficients logit is odd to begin with, because the former is a special case of the latter;

b) most important, Wojcik uses different independent variables in her BLP based predictions as compared to her nested logit predictions. In particular, for the nested logit predictions she includes on the right-hand side an endogenous variable — a function of the left-hand side market shares being predicted. This endogenous variable would be unknown in a true out-of-sample prediction and "could easily account for the apparent superiority of the nested logit, as no similar endogenous variable is included in the BLP-style specification." (p.43); and

c) finally, the BLP model was concerned on obtaining reasonable own and cross price and characteristics elasticities that could be used in various policy analysis, whereas Wojcik focuses on out of sample prediction of market shares. To adress this question one must decide what one wants to condition on for the prediction exercise. Berry and Pakes add a remark that BLP price elasticity estimates, considered "too high" by Wojcik, called the attention of General Motors, who had had similar findings with market surveys. On the other hand, the elasticities obtained by Wojcik would end up generating negative price-marginal cost markups.

BLP's computational burden and the excess of structural breaks in the recent Brazilian history, described on Section 2, have discouraged, however, its application to Brazilian data so far. The NL assumption of localized competition in categories (compact, midsize, and so forth), on the other side, seems appropriate for the automobile market in general, as marketing strategies and press coverage point out.

It is true, as mentioned above, that NL still carries the unfortunate properties that: *a)* the only similarity taken into account between a pair of cars is their placement in the same group; *b)* substitution patterns are independent of similarity between models within a group; and *c)* substitution patterns rely only on their market shares only. But the results obtained so far are already powerful and set up a valuable starting point and a reference for future estimations of disaggregate demand for automobiles in Brazil.

We start then by assuming the following utility specification:

$$u_{ij}\ (p_j,\ x_j,\ \xi_j,\ \theta) = -\alpha \cdot p_j + x_j\beta + \xi_j + \varepsilon_{ij}, \qquad (4.16)$$

which was used by Fershtman, Gandal and Markovich (1999). Note that this is a special case of (4.5), where $\delta_j = -\alpha \cdot p_j + x_j\beta + \xi_j$.

Goldberg and Verboven (1998) add information on annual income, thus substituting a term $\alpha \cdot \ln(y_i - p_j)$ for $-\alpha \cdot p_j$ on the equation above. This would have three advantages: *a)* Price elasticity would be decreasing in income;[18] *b)* Income elasticity would be decreasing in income,[19] and *c)* Market share would be homogeneous of degree zero in (y_i, p_j). Since we do not have data on household purchases at model level to match income, income "observations" should be drawn from a simulated lognormal distribution with parameters estimated from household

18. Differentiating equation (4.5) with respect to $\ln(p_j)$, we get the formula for price elasticity:

$$\frac{\partial \ln(s_j)}{\partial \ln(p_j)} = \frac{\partial \ln(s_j)}{\partial \ln(y_i - p_j)} \cdot \frac{\partial \ln(y_i - p_j)}{\partial \ln(p_j)} = \alpha \cdot \frac{\partial \ln(y_i - p_j)}{\partial p_j} \cdot \frac{\partial p_j}{\partial \ln(p_j)} = \frac{-\alpha}{y_i - p_j} \cdot p_j$$

Differentiating the price elasticity w.r.t. y_i, we get:

$$\frac{\partial^2 \ln(s_j)}{\partial y_i \partial \ln(p_j)} = \frac{-\alpha \cdot (y_i - p_j) - \alpha \cdot p_j}{(y_i - p_j)^2} = \frac{-\alpha \cdot y_i}{(y_i - p_j)^2}$$. So, the price elasticity is decreasing in income.

19. Analogously to the previous note, by differentiating (4.15) with respect to $\ln(y_i)$, we get the formula for income elasticity:

$$\frac{\partial \ln(s_j)}{\partial \ln(y_i)} = \frac{\partial \ln(s_j)}{\partial \ln(y_i - p_j)} \cdot \frac{\partial \ln(y_i - p_j)}{\partial \ln(y_i)} = \alpha \cdot \frac{\partial \ln(y_i - p_j)}{\partial y_i} \cdot \frac{\partial y_i}{\partial \ln(y_i)} = \frac{\alpha}{y_i - p_j} \cdot y_i$$

Differentiating the income elasticity w.r.t. y_i, we get:

$$\frac{\partial^2 \ln(s_j)}{\partial y_i \partial \ln(y_i)} = \frac{\alpha \cdot (y_i - p_j) - \alpha \cdot y_i}{(y_i - p_j)^2} = \frac{-\alpha \cdot p_j}{(y_i - p_j)^2}$$. So, the income elasticity is decreasing in income.

data, as Berry, Levinsohn and Pakes (1993) do,[20] or from deciles of the observed distribution, as Verboven (1996) does.

Two problems arise when we try this approach. One is that, in contrast to the U.S., the great majority of the Brazilian population earn in a whole year much less than the price of the cheapest model available in the market (see Table 5). Indeed, according to the latest household expenditure survey available, only 35.5% of the metropolitan households have an automobile (POF/IBGE 1995/1996), and the rate is certainly lower in other areas. In that case, either our code should truncate the utility of "sampled" (simulated) households when the lowest vehicle price is greater than the household's income, or the distribution itself should be truncated. The first alternative was pursued but it was not successful, because the number of households with truncated utility was always too high as a share of the total. The second approach has not been implemented yet, and is a future extension – a theoretical problem for this approach is that the potential market M turns to be endogenous, as the truncation point would depend on prices, so we would need another equation to define it.

TABLE 5

Percentage of Households that can afford a New Vehicle

	μ_y [a]	σ_y [a]	Cheapest car's price[b]	% Households that can afford it
1989	6.07991	1.14574	16219.48	16.22
1990	6.13679	1.14484	13012.23	22.84
1991[c]	6.09226	1.12427	11023.66	25.79
1992	6.04481	1.08497	11103.32	23.46
1993	6.02156	1.06145	10625.30	23.57
1994[c]	6.05611	1.06469	9353.012	28.58
1995	6.20543	1.05596	8503.266	36.73
1996	6.29618	1.05787	9721.957	35.23
1997	6.29098	1.06529	10658.78	32.00

Sources:

[a] PNAD (Annual Household Survey).

[b] IPEA automobile database (Oct-Set average), and

[c] Interpolated using PME (Monthly Employment Survey), as PNAD was not run in those years.

Note: μ_y and σ_y are parameters of lognormal distribution estimated from household survey microdata. Last column is an estimate of 1 – c.d.f. of this lognormal evaluated at the cheapest car's price. The parameters were interpolated from pairs of PNADs

We could also try to plug the value of the installment as the price, instead of the full amount; this would introduce information from the financial market, such as interest rates and constraints on number of installments. Unfortunately, however, we could not find a reliable series of interest rates or of average number of installments, or even of the effective amount of loans for vehicles (the Central Bank has a separate series as from 1999 only). Modelling the functioning of consórcios and relating them to a financial market equilibrium would also be a challenging task, all the more that this market has been intervened so often by oscilating regulation. We gave up that approach for these reasons.

Absence of income effects should therefore be taken into account when interpreting our estimates.

20. Berry, Levinsohn and Pakes (1999) perform a first order approximation: they use $-\alpha \cdot p_j / y_i$.

Note, however, that if we assume that the income effect is log-linear: $\alpha \cdot [\ln(y) - \ln(p_j)]$, then income would be integrated out in the share formula, as long as one makes the very reasonable assumption that the distribution of household income is independent from the distribution of prices [Nevo (2000)]. Thus, excluding income from our utility function can be understood as posing an additively separable income effect. It is worth reminding that Verboven (1996) made a Box-Cox transformation on the price variable ($-\alpha \cdot \frac{(p_j)^{\mu} - 1}{\mu}$) and estimated a significantly negative Box-Cox parameter. Our log-price specification is an *a priori* restriction of μ to equal zero.

Now, we can normalize the mean utility of the outside alternative to zero: $\delta_0 = 0$. Also notice that the outside alternative is a singleton. This implies $D_0 = D_{00} = 0$, so that

$$s_0 = s_{0/00}\ s_{00/0}\ s_g\Big|_{g=0} = \frac{1}{1}\ \frac{1}{1} \cdot \frac{1}{\sum_{g=0}^{G} [\sum_{h \in \Im_g} D_{hg}^{(1-\sigma_1)/(1-\sigma_2)}]^{(1-\sigma_2)}} =$$

$$= \frac{1}{\left\{ 1 + \sum_{g=1}^{G} [\sum_{h \in \Im_g} D_{hg}^{(1-\sigma_1)/(1-\sigma_2)}]^{(1-\sigma_2)} \right\}} \tag{4.17}$$

We show in Appendix I that by taking the logs of the NL cdf's and after tedious algebra one obtains the following linear equation:

$$\ln(s_j) - \ln(s_0) = -\alpha_i \cdot ln(p_j) + x_j\ \beta + \xi_j + \sigma_1 \cdot \ln(s_{j/hg}) + \sigma_2 \cdot \ln(s_{hg/g}) \tag{4.18}$$

The supply-side: For the cost function, a log-linear specification[21] was chosen: logarithm of marginal cost is regressed on logs of the good's characteristics and other cost shifters. Formally:

$$\ln(mc_j) = \mathbf{w}_j \cdot \gamma + \omega_j, \tag{4.19}$$

where w and ω are observed and unobserved cost shifters, respectively. The vector **w** can have elements in common with **x**. Quantity can easily be added to this specification to allow for testing different hypotheses of returns to scale. Note that instruments are needed in the estimation to correct for simultaneity bias if we include endogenous variables such as sales or some other proxy for quantity.

It so happens that we do not observe the actual marginal cost for each model. To estimate an industry's marginal cost function, we rely then on a market behavior assumption to obtain marginal costs indirectly. Note that if one assumes a price-setting Nash equilibrium, prices equal marginal cost plus a price-marginal cost

21. The log-linear specification was adopted by Berry, Levinsohn and Pakes (1993, 1995 and 1999). Fershtman *et al.* (1999) adopted a linear specification.

markup. First define $\Im_f$ as the set of all products produced by the multiproduct firm *f.* Thus, the profit is given by:

$$\Pi = \sum_{j \in \Im_f} (p_j \cdot (1-\tau_j) - mc_j) \cdot M \cdot s_j(p, x, \xi; \theta) \text{ - } F, \tag{4.20}$$

where:

mc_j is the marginal cost of good *j*;

F is the fixed cost; and

τ_j is total tax and duty burden levied upon good *j*.

The marginal cost can be constant or easily generalized to depend on q_j. If we do assume a constant marginal cost, economies of scale will arise because of the common fixed cost. Now, by maximizing the profit with respect to the price of each product produced by *f*, one obtains the first-order conditions:

$$\sum_{r \in \Im_f} (p_r \bullet (1-\tau_r) - mc_r) \cdot M \cdot \frac{\partial s_r(p, x, \xi; \theta)}{\partial p_j} + M \cdot s_j(p, x, \xi; \theta) = 0 \text{ , } j \in \Im_f \tag{4.21}$$

The FOC above define pricing equations, or price-cost price-marginal cost markups ($p_j - mc_j$) for each good. Now, we can stack the FOCs of all firms and use a vector notation:

$$s(p, x, \xi, \theta) - \Delta(p, x, \xi, \theta) \cdot [p \bullet (1-\tau) - mc] = 0, \tag{4.22}$$

where

$$\Delta_{jr} = \begin{cases} -\partial s_r / \partial p_j \text{, if r and j are produced by the same firm } f \\ 0 \text{ otherwise} \end{cases}$$

is the matrix of cross-price derivatives;

b (·) is the price-marginal cost markup vector;

s(.) is the share vector;

p is the price vector;

x is the observed product characteristic vector;

mc is the marginal cost vector;

• is an element-by-element vector multiplication operator; and

τ is the vector of total tax and duty burdens levied upon each car model.

Note that the whole matrix Δ is block-diagonal, as we assume that firms take into account the models produced by themselves alone. We call this assumption a *Multiproduct Cournot-Nash Markup Solution* (MPCN) in prices. Alternatively, we can take into account only own-price elasticities, so that Δ is diagonal. We call that a *Single Product Cournot-Nash Markup Solution* (SPCN) in prices. If firms take into account cross-price effects of models produced by all firms, the solution is a

Multiproduct Cartel (MPC) and Δ is a full matrix in a given year [see Nevo (2001) and Hausman, Leonard and Zona (1994)].

Solving for the price-cost markup:

$$p \bullet (1 - \tau) - mc = \Delta(p, x, \xi, \theta)^{-1} \cdot s(p, x, \xi, \theta) \qquad (4.23)$$

and defining:

$$b(p, x, \xi, \theta) = \Delta(p, x, \xi, \theta)^{-1} \cdot s(p, x, \xi, \theta) \qquad (4.24)$$

we see that the price-marginals cost markups depend only on the parameters of the demand system and the equilibrium price vector. However, since p is function of ω, $b(p, x, \xi, \theta)$ is a function of ω as well, and "cannot be assumed to be uncorrelated with it" [Berry, Levinsohn and Pakes (1995, p. 854)].

We can substitute the price-marginal cost markup vector into the cost function and the supply equation:

$$[p - b(p, x, \xi, \theta)] \bullet (1 - \tau) = \mathbf{w} \cdot \gamma + \omega, \qquad (4.25)$$

is linearly estimated.

4.3 ESTIMATION

It is easy to understand that if both the firms and the consumers observe ξ_j, which is unobserved by the econometrician only, prices will be correlated to this error. Therefore, ignoring this correlation will bias the estimation. This problem is analogous to the classic simultaneity problem in the analysis of demand and supply in homogeneous product markets. "The simultaneity problem is complicated by the discreteness in the choice set of individuals which generates individual demand functions that are nonlinear functions of the attributes (in particular of the unobserved attributes) of the product" [Berry, Levinsohn and Pakes (1993, p.16)]. That is why we have to instrument for prices on the demand side.

Besides the simultaneity bias, we noted above that there does exist contemporaneous correlation between demand and supply errors. Errors should also be correlated in a dynamic setting, where firms would adjust their technology or their product specifications to changes in demand behavior.[22] Following Goldberg and Verboven (1998), however, we chose to estimate demand and supply recursively. The reason is that misspecification or excess omitted variables in the supply-side equation can do more harm to the demand-side estimation than the inclusion of correlation between demand and supply can help efficiency. As the demand-side equation is fully linearized, we estimate it simply by Instrumental Variables (Two Stage Least Squares). Thus, we do account for endogeneity of prices, but we end up assuming orthogonality of ε and ω.

Adopted instruments for prices and for the logs of the partial shares $s_{j/hg}$ and $s_{hg/g}$ (which are admittedly endogenous) are summations of the respective characteristics

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22. A both formal and empirically tractable treatment of an estimable infinite horizon supergame — where firms first decide on the development of new models or changes in design or technical specifications on the existing ones and then compete in prices — is still missing in the literature. Filling this gap and rendering the model a dynamic one is the most notable extension to be done from the present framework.

across all the goods produced by the same firm (within the same group[23]), and of the goods produced by all firms (also within the same group). The econometric intuition is that characteristics of competing goods should be correlated with the demand for good *j*, but will be uncorrected with the firm's cost function for good *j*. These instruments have been suggested and proven to be optimal by Berry, Levinsohn and Pakes (1993 and 1995). As one of the characteristics is a vector of constants, a pair of instruments turns out to be the numbers of models sold by the firm and sold by the rivals. In addition, we include the number of firms competing in the particular group, as a proxy for degree of competition.

Once we run the demand side and estimate α, σ_1 and σ_2, we are able to calculate Δ, and consequently the price-marginal cost markup vector $b(\cdot)$. Subtracting $b(\cdot)$ from p, we get an estimated marginal cost and run (4.25). Estimation is therefore completely recursive. Sums of characteristics are used to instrument the cost-side equation likewise, so as to overcome the simultaneity bias.

5 DATA AND ESTIMATION RESULTS

5.1 DATA

For the present estimation, we focused on the market for passenger cars, thus excluding pickups, trucks, vans and minivans, SUVs (Sport Utility Vehicles), jeeps and buses. Extreme luxury and sport cars (all Mercedes, most of Audis, BMWs and Volvos and top models of other brands) were later also excluded, because we understood that their market is not supposed to behave in the same fashion as the others do. But we do hope to be able to include pickups, jeeps and SUVs in a near future, as these information is readily accessible from the same sources we used so far, and their market share has increased steadily since trade liberalization, especially among the independent importers.

Sales data were collected from a variety of sources: the domestic manufacturers report their domestic sales of both domestic and Mercosur imported vehicles to Sindipeças, the Brazilian association of manufacturers of parts and components, on a very detailed level. Imported car sales of the domestic brands from countries outside Mercosur were provided by Anfavea, the national association of motor vehicle manufacturers. Sales of the independent importers were provided by Abeiva, the association that represents their interests, and complemented by information graciously provided by some individual importers, namely those of Honda, Mitsubishi, Daewoo/Daihatsu, Chrysler, Nissan, Renault and Citroen brands. All sources' figures were compared and criticized for the sake of consistency.

Prices and information on standard equipment were collected from the Brazilian monthly magazines *Quatro Rodas* and *AutoEsporte*. Characteristics were found on *Jornal do Carro*, a weekly supplement of the São Paulo-based daily newspaper *Jornal da Tarde*, and complemented by importers' information and by *Quatro Rodas* and

23. One could ask why not use the summations within the *subgroup* instead of *group*. The reason is that a non-negligible number of independent firms compete in a group with a single model, and that would give rise to severe multicollinearity of the instruments with the own characteristics, eventually forcing us to exclude half of the instruments to allow estimation.

other specialized magazines.[24] Fuel consumption information per model was provided by Cetesb, the São Paulo State environmental agency that runs the national program of emission control (Proconve), and complemented by Jornal do Carro, whose figures were found consistent with Cetesb's tests.

We also collected data on hourly wages in the transport equipment industry in the countries of origin for each model traded in Brazil. They have been converted to Brazilian currency and deflated by the same index as the other variables, the General Price Index (IGP-OG). The countries of origin were found on Jornal do Carro and on some of Anfavea's and importers' tables. Data on wages come from *the International Yearbook of Labour Statistics* (ILO), *International Yearbook of Industrial Statistics* (Unido), Brazilian Ministry of Labor[25] and statistical bureaus from Italy and Uruguay.

Last but not least, we collected data on total output of passenger cars for each manufacturer in the country of origin. Sources were Frank Bessem's web page (Global Car Production Statistics Pages[26]), which compiles a great number of sources; Anfavea; *World Motor Vehicle Data* (a publication of the American Automobile Manufacturers Association); and *Automobile in Cifre* (a publication of the Italian manufacturers' association Anfia), various issues.

Monthly data were eventually aggregated into annual values. For this aggregation, we selected the best-selling version of each model and took its characteristics and origin, the simple averages of its price and tax/tariff rate, and the sum of its sales. Following Berry *et al* (1993 and 1995) we also aggregated trim levels, as not only we had an unreasonably high list of models but also price differences among these trim levels were not found to rely on any of the observed characteristics. Following Fershtman, Gandal and Markovich (1999), however, we keep models with same chassis and different engine sizes separated, except for very few imported models (most of them with very low sales) for which such disaggregate information was missing.

Our sample comprises the model years from 1989 to 1997. The beginning of each model year was placed in October of the previous year, when the domestic manufacturers ordinarily start selling their new models.

Though somewhat subjective, the classification of models into compacts, midsize, large and luxury followed criteria of similarity in size and price range. Populars were defined according to the legislation that created this tax bracket. As regards nationality, we followed Berry, Levinsohn and Pakes (1993a, 1995) in classifying incumbent branded models as domestic, except when they were brought from outside Mercosur *and* we perceived that the marketing strategy highlighted the origin (that was the case of VW Golf and Passat) or the design was considered too

24. Namely *AutoEsporte* and *VI* (special editions), besides the U.S. based Internet URL "www.cars.com".

25. RAIS (Annual Report on Social Information) is filled out by firms and provides wage information at a municipal level, what enables us to differentiate some domestic manufacturers according to plant location. As most of them have plants in more than one location, we took a simple arithmetical average over all locations we knew of for each make, as no clear-cut division of assembly lines by model was perceived; in particular, engines were produced in a plant and assembled into the vehicles in another plant in another city.

26. The URL is: http://www.geocities.com/MotorCity/Speedway/4939/carprod.html

fancy for a domestic car at that time and so the consumers would in fact perceive them as imported (that was the case of Fiat Coupe and Ford Mondeo and Taurus). Newcomers were considered imported even if they came from Mercosur. In other words, nationality was taken into account in a different way on the demand side (where origin is what the consumer believes) as compared to the supply side (where cost and tariff rate depend on both the make and the actual country of origin, as described below).

Last but not least, the choice of the potential market was based on the latest available Family Budget Survey (POF/IBGE – Pesquisa de Orçamentos Familiares), performed in 1995/96. We truncated the number of households in the following way:

Let $y_{min} = \min\{y_h | X_h > 0, h = 1, \ldots H\}$,

where:

X_h is gross expenditure of household h on passenger vehicles (either used or new);

H = number of households.

Then M was defined as $\#\{h \mid y_h \geq y_{min}\}$, i.e., the number of households with total income greater than or equal to y_{min}. The estimated number is 12,480,883. However, as Fershtman, Gandal and Markovich (1999) point out, M will only affect the constant, all the more that we chose a recursive estimation.

5.2 ASSIGNING TAX AND TARIFF RATES TO VEHICLE MODELS

It is important to stress that we assigned the **total** tax and tariff burden for each car in each period, i.e., not only the effect of IPI (whose rates were reported on Table 3), but also of ICMS (a state VAT) and other minor cascading revenue taxes; the total tax burden was extracted from Anfavea's Statistical Yearbook and the tariff rate from Table 3. We were extremely careful in observing not only the dates when each tax or tariff rate was altered but also (and most importantly) to which model it applied — the reader should remember that taxes varied across horsepower and/or engine size and fuel, and tariffs varied across firms (under the Automotive Regime and the popular car regime) and origin (Mercosur vehicles paid no duty). We highlight four important issues we had to observe:

1) The 1993 Automotive Agreement rebated the tax rate not only of 1000cc engine-powered models but also of their closest counterparts from firms that did not have 1000cc engines available at that time, while they set up specific assembly lines for that purpose; this was a transition device to preserve some equality of benefits to all firms. Moreover, until 1996 only *domestically* produced cars with 1000cc engines were eligible to the popular tax rate classification.

2) In 1991, because of tighter environmental rules, firms applied for a raise of the horsepower threshold between the other tax brackets; they claimed that the introduction of fuel injection (required to comply with the declining targets) raised the power of many cars and some of them surpassed the legal threshold, so they would be punished if no waiver were provided. The waiver was granted for the 1992

models and from then on, and GM was its main beneficiary (not surprisingly they had been the main claimer).

3) As Table 2 shows, firms joined the Automotive Regime on different dates, so the date the tariff rate started being rebated varied for each individual firm.

4) When the quotas were distributed to the firms, they were country-specific; therefore vehicles imported, for instance, by Toyota from its UK plant or by Honda from its U.S. plant were levied the maximal tariff rate, because they could not be listed within the quotas (only the *Japanese* Toyotas and Hondas could).

Another very important observation regards the enforcement of quotas. We tried several approaches to find out whether the quotas ended up being binding or not. We report the two most convincing of them below.

TABLE 6a

Imported Vehicle Realized Sales vs. Quotas

Brand	Quota 1996/97 (A)	Total Sales[a] Sep-96/ Aug-97 (B1)	Total Sales Oct-96/ Sep-97 (B2)	Sales not subject to Quotas[a] Sep-96/ Aug-97 (C1)	Sales not subject to Quotas[b] Oct-96/ Sep-97 (C2)	"Net Sales" Sep-96/ Aug-97 (D1) = (B1) - (C1)	"Net Sales" Oct-96/ Sep-97 (D2) = (B2) - (C2)	Binding Quota: (D1)>(A)?	Binding Quota: (D2)>(A)?
Audi	1,478	3250	3,450	0	0	3,250	3,450	Y	Y
BMW	2,555	3240	3,266	221	221	3,019	3,045	Y	Y
Citroen	2,202	2263	2,266	401	407	1,862	1,859	N	N
Daewoo	3,209	1874	1,866	0	0	1,874	1,866	N	N
Daihatsu	1,042	669	653	0	0	669	653	N	N
Honda	1,730	2,327	2,318	2,132	2,192	195	126	N	N
Hyundai	3,949	3,604	3,615	0	0	3,604	3,615	N	N
Kia Motors	8,564	11,334	11,602	0	0	11,334	11,602	Y	Y
Land Rover	123	848	870	0	0	848	870	Y	Y
Mazda	2,184	988	1,145	0	0	988	1,145	N	N
Mitsubishi	5,579	7,007	6,978	332	263	6,675	6,715	Y	Y
Nissan	1,168	904	905	0	0	904	905	N	N
Peugeot	2,762	6,596	6,525	5,229	5,017	1,367	1,508	N	N
Subaru	1,526	776	837	0	0	776	837	N	N
Suzuki	3,328	3,002	3,390	0	0	3,002	3,390	N	Y
Toyota	6,005	8,999	9,790	2,677	3,353	6,322	6,437	Y	Y

Source: Abeiva.
Notes:
[a] Includes Light Commercials, vans and trucks, all of them benefited by the Quota Regime.
[b] Sales from Mercosur (zero tariff) and from countries other than the headquarters of the firms (full tariff).

In the first approach, Table 6a displays the assignment of quotas to each of the brands of the (so far) independent importers included in our sample and compares the quota (effective from Aug 21, 1996 to Aug 20, 1997) with the unit sales reported during the same period. By assigning the origin of the model — as reported by *Jornal do Carro* — to the corresponding unit sales — as reported by the sources mentioned above — we subtract from total sales the units that came from countries other than the headquarters (these were assigned full tariffs by our algorithm anyway and did not count for the quotas). If the "net sales" obtained are above the quota, we conclude the marginal models of that brand paid ful-tariff, therefore the quota is binding. According to this approach, only Audi, BMW, Kia, Land Rover, Mitsubishi, Suzuki and Toyota filled up their quotas — note that we display the calculation using two different lags between importation and sale: a 10-day lag (sales from September 1996 to August 1997) and a 40-day lag (sales from September 1996 to August 1997).[27]

There are two important caveats here: *a)* sales (even at wholesale level) do not necessarily respond to import entrance immediately, and we are not able to observe stock adjustment, so it is theoretically possible that some brand sold more than the quota by reducing previous stocks (still the quota could be exactly binding, and the previous stock had paid full tariff anyway); *b)* the assignment of origin to each model may have some measurement errors, either because we could not keep track of the origin for the whole period and had to impute them on a biannual basis (in the meantime an importer might have shifted imports to come from another country) or simply because of misreports by *Jornal do Carro* and missing information by Anfavea and independent importers in 1996.

In the second approach (see Table 6b), we gathered individual import data from Siscomex, the database of the Federal Revenue System, and grouped them by brand and import regime. As we are not able to observe the identity of the importer due to fiscal secrecy requirements, we adopted — for the purpose of the following analysis — the simplifying assumption that the imports for each brand have been undertaken by their respective authorized representative. We were concerned only with imports from the headquarter countries, as they were the only ones that benefited from the Regime of Quotas. The limitation of this approach is data availability: Siscomex initiated in 1997, and from the previous system (Alice) it is not possible to retrieve the identity of the importer or exporter. Therefore, accounting only for imports in 1997 until Aug 20, total imports may be below the quota and yet the importer may have reached the quota in the full period because of the imports recorded in 1996.

In fact, if we compare the quotas assigned to each brand/country with the corresponding total quantities effectively imported, we already find a great number of brands subject to binding quotas: Audi, Hyundai, Land Rover and Mitsubishi (see fourth column). Still, this comparison would not explain why BMW, Citroen, Kia Motors and Suzuki did import a great number of units paying full tariff many months before the end of the quota year (Aug 20, 1997). Assuming a not so bounded rationality on the side of the importers (i.e., that they were fully aware of how many units they were able to import under the Regime of Quotas) and that no other non-tariff barrier took place, it would be reasonable to conclude that these importers brought vehicles paying full tariff because they had used their quotas entirely. According to our investigations at the Federal Revenue Secretariat, however, these full-tariff entries may also be results of errors of the importer while filling up their import forms. When the importer claims the tariff rebate at the port even though some field has been incorrectly filled up, the customs agent corrects the printed form but he/she almost never sends a message to the database manager to enter the correction into Siscomex, so the imports paying full tariff may be overestimated.

27. Suzuki's quotas were binding if we use a 40-day import-sales lag, but not if we use a 10-day lag. As slackness was not significant (less than one percent difference), we assumed they were indeed binding.

TABLE 6b
Quotas vs. Observed Vehicle Imports Under Different Regimes

Brand	Quota 1996/97 (A)	Total Observed Imports from Headquarter 1997 (until Aug 20) (B)	Total Imports greater than Quota ((B)>(A))?	Observed Imports under Regime of Quotas 1997 (until Aug 20) (C)	Imports paying full tariff (D)	Observed Imports under Automotive Regime (E)	Seemingly Binding Quota (non-negligible (D)>0?)	Earliest Date of Full-tariff Import
Audi	1478	2578	Y	1017	1402	159	Y	Feb/1997
BMW	2555	2323	N	2122	201	0	Y	Feb/1997
Citroen	2202	1365	N	1048	317	0	Y	Feb/1997
Daewoo	3209	1131	N	1131	0	0	N	
Daihatsu	1042	574	N	574	0	0	N	
Honda	1730	92	N	0	5	87	N	
Hyundai	3949	3406	N	3026	380	0	Y	Apr/1997
Kia Motors	8564	8284	N	6679	1605	0	Y	Feb/1997
Land Rover	123	609	Y	108	501	0	Y	Feb/1997
Mazda	2184	1908	N	1908	0	0	N	
Mitsubishi	5579	6044	Y	5100	944	0	Y	Jan/1997
Nissan	1168	1022	N	1021	1	0	N	
Peugeot	2762	2538	N	0	0	2538	N	
Subaru	1526	1146	N	1146	0	0	N	
Suzuki	3328	3659	Y	3298	331	0	Y	Feb/1997
Toyota	6005	5171	N	5170	1	0	N	

Sources: Abeiva and Federal Revenue Secretariat.
Note: (B) equals the sum of (C), (D), and (E), and it does not include imports for diplomats nor imports in transit.

We ended up opting for a conservative solution, namely for assigning marginal full tariff to the common set (intersection) of the two approaches, i.e., to the brands that faced binding quotas according to both approaches: Audi, BMW, Kia, Land Rover,[28] Mitsubishi and Suzuki. The estimation of the model is conditioned, therefore, on this assumption, even though previous estimations produced results quite robust to different combinations of binding/slack quotas.

All these details were important for computing as accurately as possible the average tax and tariff burden over all months when the vehicle model prices were quoted. In view of the huge variance of rates both across models and along time, we had to be very careful at this stage of the research.

5.3 DESCRIPTIVE STATISTICS

Some descriptive statistics are worth looking at. Table 7 displays the evolution of imported car sales per make, and shows their increasing share in the total market, with a peak in 1995, as both manufacturers and importers were able to ship a huge amount of vehicles before the import tariff was raised, enjoying thus the previous (lower) rate — this explains the peak in imports in June 1995, as shown on Figure 5. It is also worth noting that the greater pressure on trade balance was placed by the local manufacturers, who imported three quarters of the total.

28. Actually all Land Rover's models were SUVs, so they ended up not being included in our sample.

Correlations between variables are summarized on Tables A.1 (Demand) and A.2 (Supply), in the Appendix.

Figures 6 through 9 depict the evolution of car sales in the local market. Imported cars[29] and non-popular domestic cars are on average quite similar as regards size, but the former have higher HP and weight, and are correspondingly less fuel-efficient. Notice that the average size and weight of imported cars decreased temporarily in 1995, when the range of imported models was extended to more compact versions. The reversion of trade liberalization brought the imported cars back to an upper-income-oriented large car niche.

TABLE 7

Imported Passenger Cars — Annual Sales

	1991	1992	1993	1994	1995	1996	1997	Total
Incumbents	**4,307**	**13,208**	**31,015**	**102,942**	**226,953**	**119,598**	**162,332**	**660,355**
Fiat [a]	865	4,766	19,239	80,686	89,872	8,832	17,080	221,340
Volkswagen [b]	0	3,784	10,252	18,812	63,984	56,562	66,030	219,424
Ford	3,005	4,256	302	1,054	38,532	50,548	75,280	172,977
General Motors	79	41	152	474	31,257	71	1	32,075
Mercedes Benz	327	251	865	1,365	2,000	3,026	3,198	11,032
Volvo	31	110	205	551	1,308	559	743	3,507
Newcomers	**0**	**1,604**	**8,281**	**23,624**	**38,908**	**27,313**	**32,236**	**131,966**
Renault	0	270	2,128	10,042	19,877	8,789	8,541	49,647
Asia Motors [c]	0	0	162	1,659	5,698	7,787	7,486	22,792
Honda	0	741	4,157	6,822	4,851	2,076	2,048	20,695
Hyundai [c]	0	593	1,676	2,141	3,305	2,650	1,952	12,317
Audi	0	0	0	1,474	3,072	2,441	3,756	10,743
Chrysler	0	0	0	132	105	1,495	6,455	8,187
Kia Motors [c]	0	0	158	1,354	2,000	2,075	1,998	7,585
Independent Importers	**10,516**	**4,995**	**13,613**	**28,390**	**39,513**	**20,456**	**21,494**	**138,977**
Peugeot	0	56	599	5,296	8,915	5,955	4,810	25,631
Lada	10,423	2,881	3,359	1,898	849	0	3	19,413
Citroen	64	276	1,093	4,220	5,813	2,542	2,261	16,269
Toyota	0	315	2,226	2,572	5,078	1,902	3,628	15,721
BMW	0	364	1,931	3,503	2,915	3,412	3,256	15,381
Daewoo	0	0	0	2,260	5,178	2,613	1,650	11,701
Mitsubishi	22	336	580	1,612	2,696	2,078	1,932	9,256
Mazda	0	119	912	2,409	2,412	594	1,410	7,856
Subaru	0	263	1,267	1,992	1,653	375	837	6,387
Suzuki	7	385	1,540	1,676	1,645	61	751	6,065
Daihatsu	0	0	0	670	1,687	737	640	3,734
Nissan	0	0	106	282	672	187	316	1,563
Total Imported Sales	**14,823**	**19,807**	**52,909**	**154,956**	**305,374**	**167,367**	**216,062**	**931,298**
Total Domestic Sales	**573,864**	**573,126**	**782,308**	**824,794**	**980,736**	**1,093,037**	**1,360,281**	**6,188,146**
Imported/ Total Sales	**3%**	**3%**	**6%**	**16%**	**24%**	**13%**	**14%**	**13%**
Incumbent Imports/ Total Imports	**29%**	**67%**	**59%**	**66%**	**74%**	**71%**	**75%**	**71%**

Sources: Abeiva, Anfavea and individual firms.

[a] Including Alfa Romeo.

[b] Including Seat.

[c] Despite being enrolled in the Automotive Regime and enjoying its benefits at that time, these makers suspended indefinitely their investments in Brazil after the Asian crisis in 1997.

Domestic popular and non-popular, as well as Mercosur cars, have slowly but continuously gained engine power and weight during the 1990s, whereas no clear trend is detected with respect to size or fuel efficiency.

Figures 10 and 11 display the price evolution for each vehicle segment, the former covering domestic models and the latter the imported models. Note that the

29. In these graphs "imported cars" is the denomination for cars imported by both incumbents and entrants from countries outside Mercosur.

domestic prices start converging to a narrower price range along 1995 during the import boom, when imported model prices decreased in a fast pace. This suggests fiercer competition in the upper income class segments. The process of convergence of domestic prices was partially reversed in 1996 when the Automotive Regime (and later the Quota Regime) was introduced, while the imported model prices stabilized (suggesting a decreasing market power on their side). Figures 12 and 13 display the evolution of pre-tax prices and also point out to a greater descent of larger and more luxurious models until 1995, when they finally stabilized. Therefore the decline of imported model prices is not solely due to the decline of tariffs, as one may hastily conclude. This pattern is less accentuated in the cases of compacts, midsized and popular models.

FIGURE 5
Vehicle Imports

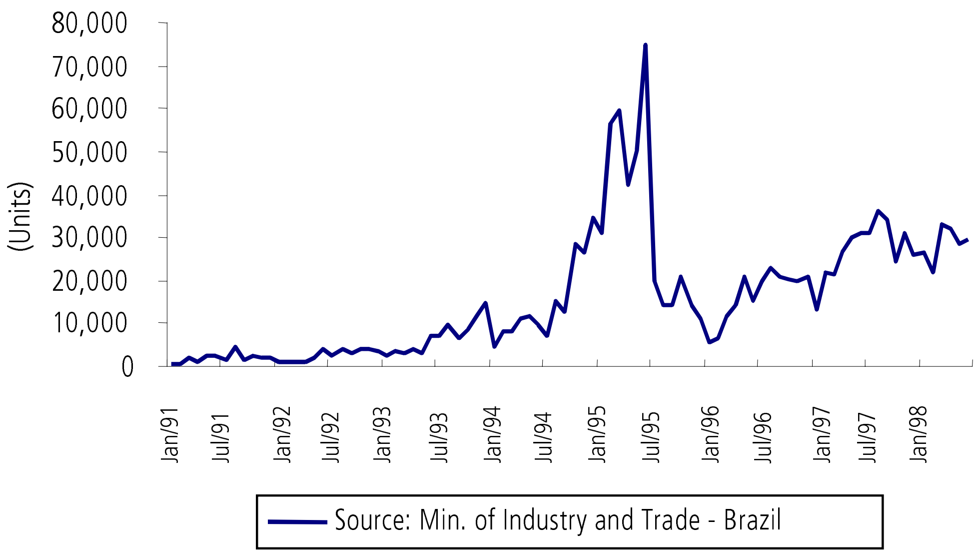


FIGURE 6
LENGTH
Sample Weighted Average

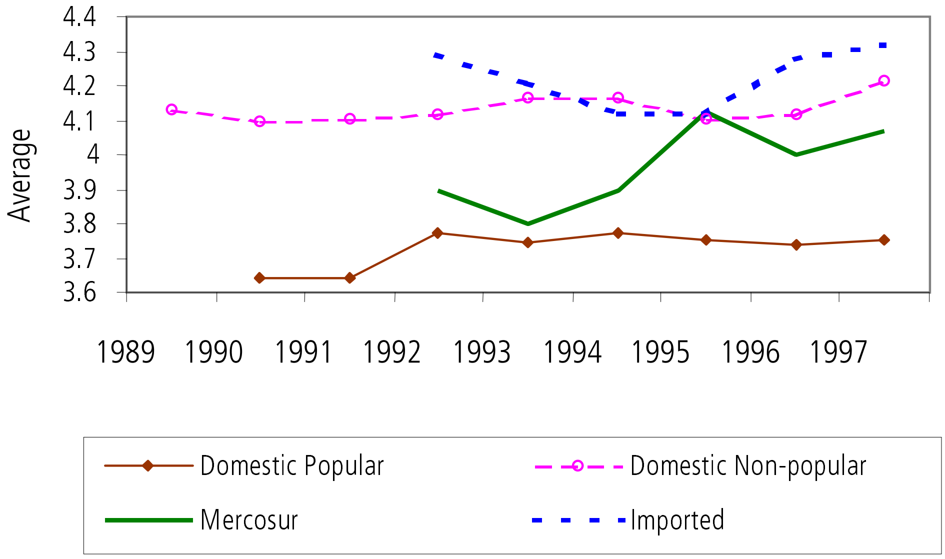


FIGURE 7
WEIGHT
Sample Weighted Average

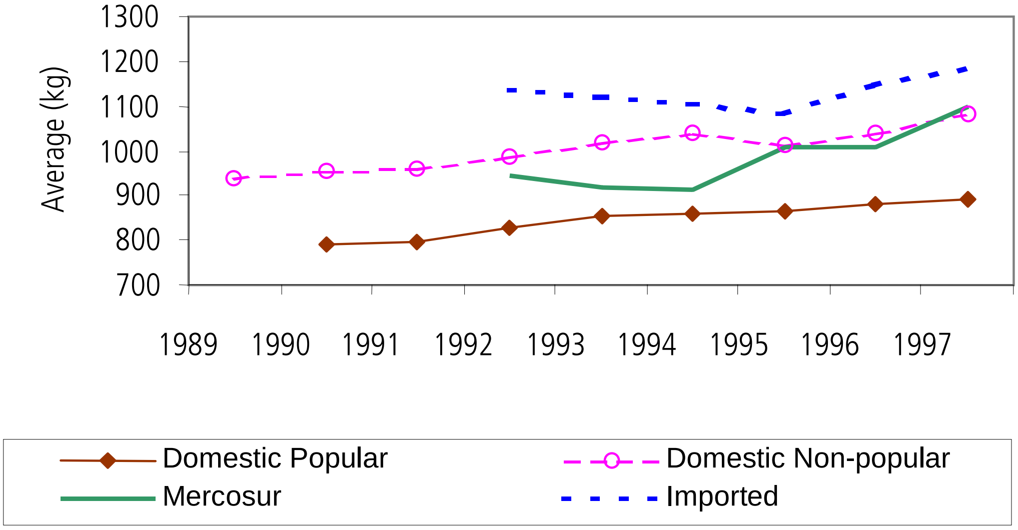


FIGURE 8
FUEL EFFICIENCY
Sample weighted average

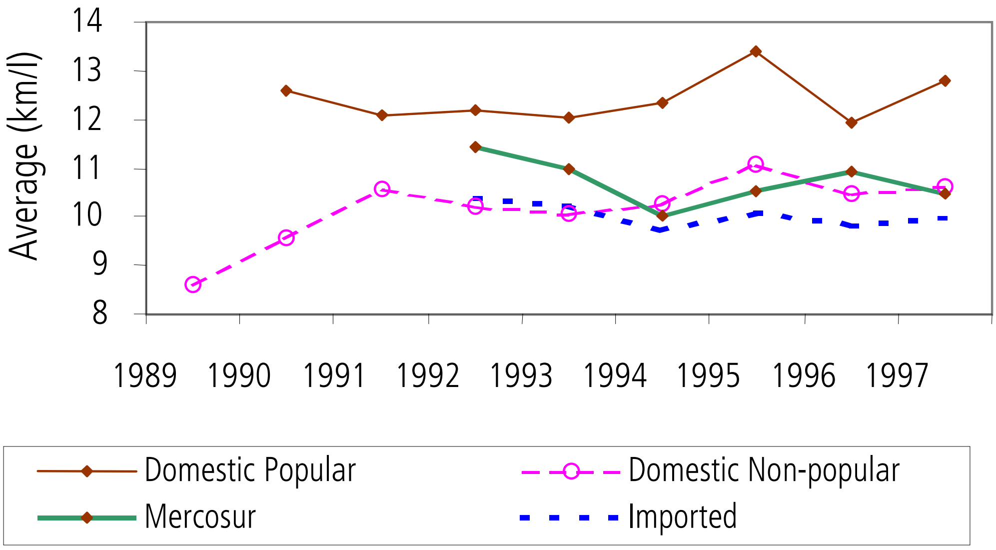


FIGURE 9
HORSEPOWER
Sample weighted average

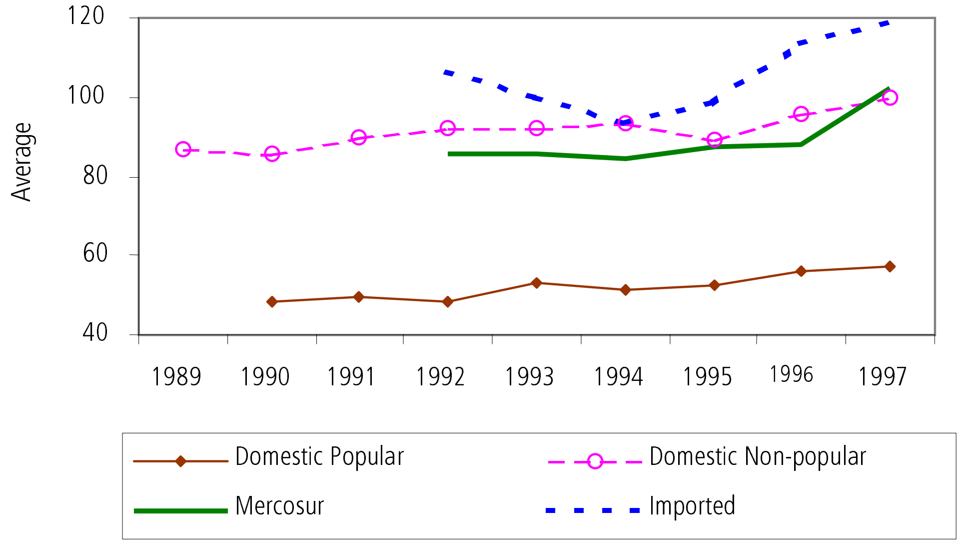


FIGURE 10
Domestic Vehicle Prices

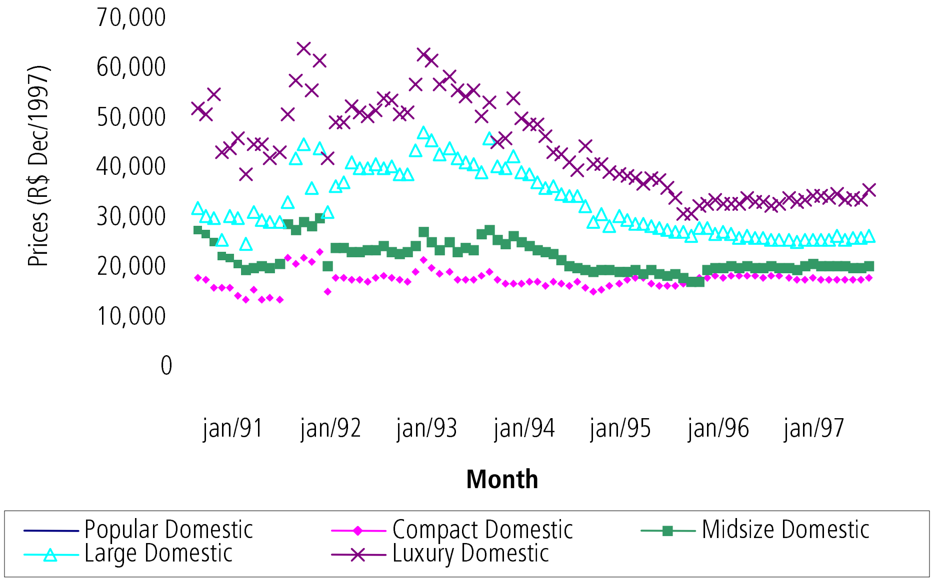


FIGURE 11
Imported Vehicle Prices

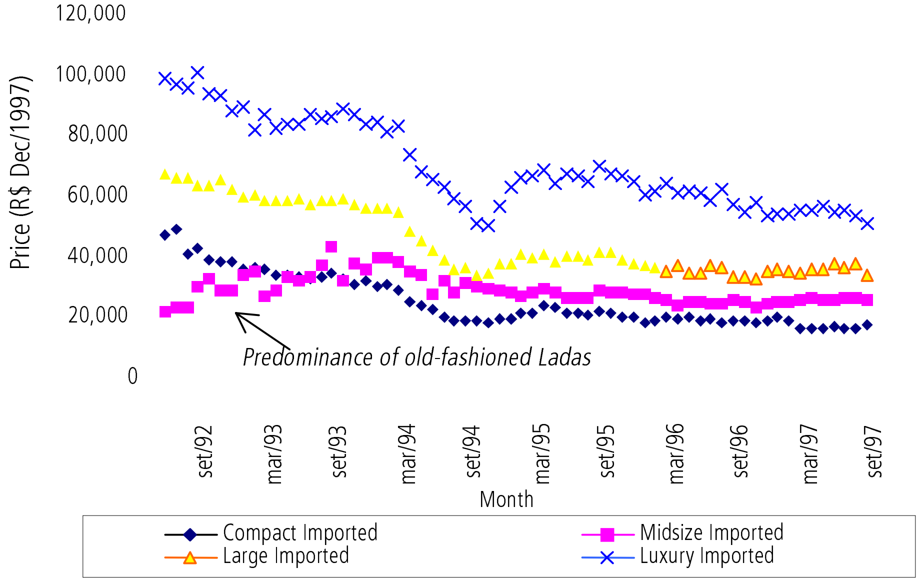


FIGURE 12
Domestic Pre-Tax Prices

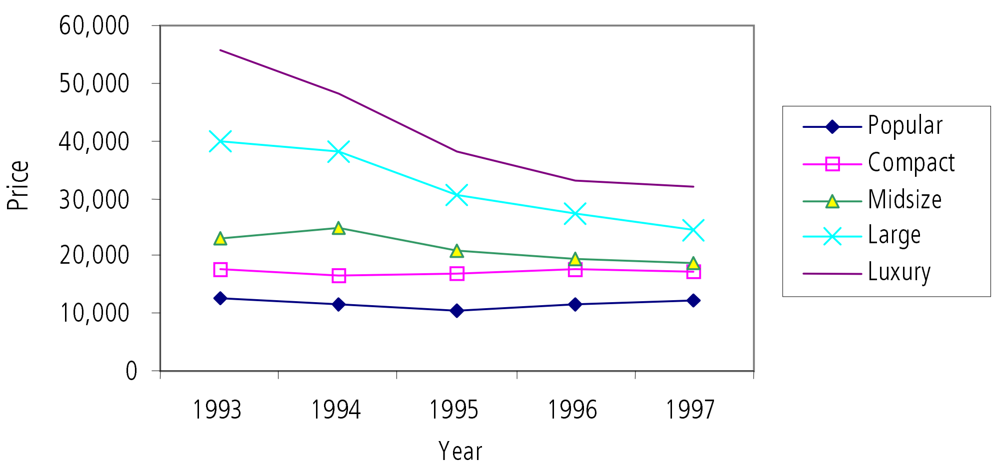


FIGURE 13
Imported Pre-Tax Prices

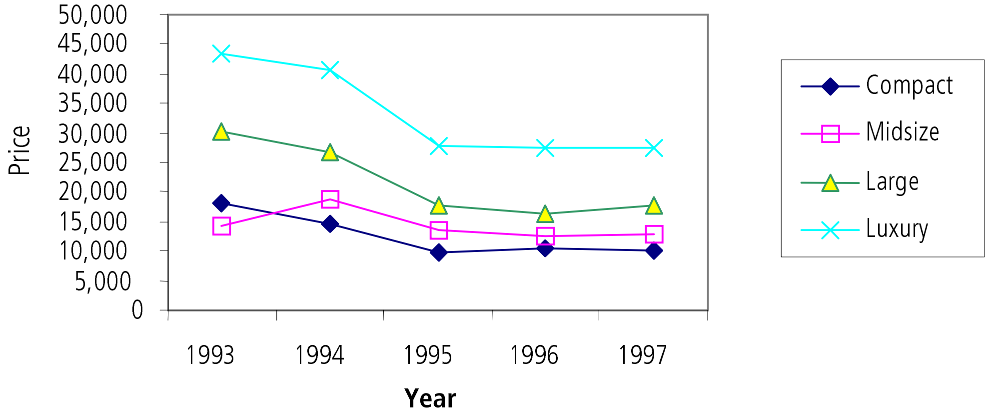
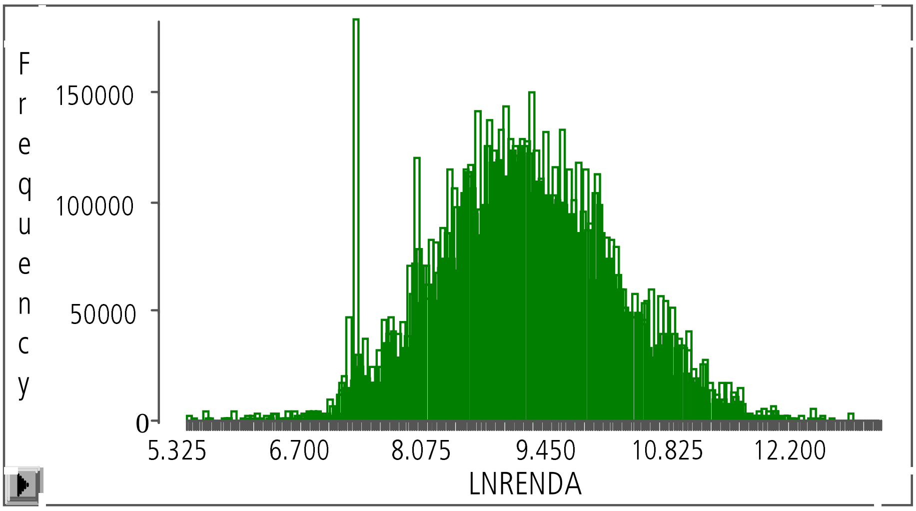


Figure 14 depicts the income distribution of included households. Note how it truly resembles a lognormal distribution (the plotted histogram refers to the pdf of ln(household income).

FIGURE 14
Distribution of ln (yh) of Households s.t. yh ≥ y min



5.4 ESTIMATES

We pooled annual data from 1993 to 1997, and display our results on Table 8. Year 1993 was chosen as our first year because the introduction of popular cars by the Automotive Agreement at that year impacted the market dramatically – even though the tax rate for 1000 cc cars had been lower than for other cars since 1990. We also realized that the tariff reduction process for parts and components stabilized in 1993, so our sample truncation also prevented us from omitting an important variable in the supply-side equation.

TABLE 8

Dependent Variable: LN(NETSHARE)
Method: Instrumental Variables (2SLS).
Included observations: 720

Variable	Coefficient	*t*-Statistic	Coefficient	*t*-Statistic
CONSTANT	1.401754	1.4827	-0.814377	-1.24237
LN(PRICE)	-0.712178	-6.4134***	-0.467184	-5.86624***
HP_WT	5.407943	5.4310***	2.995532	4.43230***
PWR_ST	0.140248	4.9787***	0.114634	4.76011***
WID	0.425639	3.9354***	0.357556	3.80739***
POPULAR	0.551252	8.4221***	0.614464	1.02413
MIDSIZE	1.008203	22.5328***	0.915383	7.72316***
LARGE	-0.090243	-1.5064	-0.240744	-6.07944***
LUXURY	-0.640729	-7.1713***	-0.842244	-13.29702***
REAL	0.283407	5.6947***	0.312971	7.23162***
REAL*POPULAR	0.345138	3.9344***	0.351714	4.55474***
REAL*MIDSIZE	-0.269598	-5.4546***	-0.286916	-6.62149***
REAL*LARGE	0.145686	2.7908**	0.151646	3.30097***
REAL*LUXURY	-0.599693	-10.1548***	-0.587151	-11.31038***
REGIME	0.181921	4.3389***	0.194097	5.27338***
REGIME*POPULAR	0.163305	1.8600*	0.119251	1.55631
REGIME*MIDSIZE	-0.573555	-11.7250***	-0.551344	-12.89387***
REGIME*LARGE	-0.296807	-5.9456***	-0.272332	-6.24830***
REGIME*LUXURY	-0.211184	-3.6183***	-0.177226	-3.48994***
LN($s_{j/hg}$)	0.992881	48.9651***		
LN($s_{hg/g}$)	0.931903	51.2089***		
LN($s_{j/hg}$)+ LN($s_{hg/g}$)			0.952902	62.41589***

R-squared	0.99295	0.99453
Adjusted R-squared	0.99275	0.99437
S.E. of regression	0.15417	0.13573
F-statistic	1412.36	1916.955
Mean dependent variable	-8.91200	-8.911998
S.D. dependent variable	1.81010	1.81010
Sum squared residuals	16.6134	12.89634
Prob(F-statistic)	0.00000	0.000000

Notes: * Significant at 10% level; ** Significant at 5% level; ***Significant at 1% level.
Instrument list: CONST PWR_ST PWR_STIN PWR_STOU HP_WTIN HP_WTOUT NCARSIN NCARSOUT NFIRMGR WID WIDIN WIDOUT HP_WT LARGE MIDSIZE LUXURY POPULAR REAL REAL*PWR_ST REAL*PWR_STIN REAL*PWR_STOU REAL*WID REAL*WIDIN REAL*WIDOUT REAL*HP_WT REAL*HP_WTIN REAL*HP_WTOUT REAL*POPULAR REAL*NCARSIN REAL*NCARSOUT REAL*NFIRMGR REAL*LARGE REAL*MIDSIZE REAL*LUXURY REGIME REGIME*POPULAR REGIME*NCARSIN REGIME*NCARSOUT REGIME*NFIRMGR REGIME*LARGE REGIME*MIDSIZE REGIME*LUXURY REGIME*PWR_ST REGIME*PWR_STIN REGIME*PWR_STOU REGIME*WID REGIME*WIDIN REGIME*WIDOUT REGIME*HP_WT REGIME*HP_WTIN REGIME*HP_WTOUT

The explained (LHS) demand-side variable is called Netshare (s_j/s_0), which enters in log. Explaining variables (RHS) are log of price in Reais of December 1997; horsepower divided by weight (HP_WT) as a proxy for performance; width (WID) as a proxy for inner space;[30] and dummies for power steering (PWR_ST) as standard

30. We understand that a better measure for inner space would be wheelbase X width (for example, cars made by Fiat are relatively short, but feature more spacious interiors due to presence of transverse engine), but wheelbase data were not available for most of the models. We could use length instead of wheelbase, as Berry *et al* (1993 and 1995) did, but as opposed to the USA — where big cars are valued by consumers and parking space is widely available —, in Brasil, just like in Europe and Israel, long cars are hard to park, and so consumer actually value short cars (indeed most of our estimations that included length displayed a negative sign for this variable). Therefore width alone is a better proxy for inner space.

equipment[31] and for each category except compacts (POPULAR, MIDSIZE, LARGE and LUXURY), besides the sigma estimates (ln($s_{j/hg}$) and ln($s_{hg/g}$)). Structural breaks in 1995 (REAL Plan and duty rate drop) and 1996 (Automotive REGIME) were accounted for by introducing intercept dummies and also multiplying them by the category dummies.

Instruments used are the inside-firm and outside-firm summations of the automobile characteristics, both by themselves and multiplied by the structural break dummies (HP_WTN and HP_WTOUT, WIDIN and WIDOUT, PWR_STIN and PWR_STOUT), and the numbers of cars (NCARSIN and NCARSOUT), besides the number of firms competing within the group (NFIRMGR). Berry *et al* (1993*a* and 1995) prove optimality for this sort of instruments, and the intuition is simple: competitors' characteristics are strongly correlated to the demand for own model, but supposed to be uncorrelated to its costs.

The very low standard errors indicate very precise estimates. The estimated parameters for the continuous features (HP_WT and WID) have the expected positive sign, as well as the PWR_ST dummy. Although we could reject the null hypothesis of equality of σ_1 and σ_2 at 1% (t-statistic = 2.57), we could not reject the hypothesis that σ_2=1, and this crashes our price-marginal cost markup estimation. Note that this points out to a very strong correlation within subgroups and groups — much stronger in Brazil than in Europe or Israel (see Verboven (1996) and Fershtman, Gandal and Markovich (1999)] —, suggesting a quite localized competition pattern. To avoid instability throughout the rest of the code because of the high σ_2, we chose the single-nested specification — thus restricting correlation across models of different subgroups (domestic vs. imported) to be the same within the same group as within the same subgroup, i.e., not distinguishing domestic from imported models within the same group — and proceed our analysis based on this restriction.

After calculating price-marginal cost markups implied by the demand-side equation and subtracting them from the prices to obtain marginal costs,[32] we estimated supply-side equations with different specifications. In all of them we used as explaining variables weight (WGT), horsepower (HP) and TRUNK capacity in logs, plus dummies for standard AIR conditioner, power steering (PWR_ST) and power windows (PWR_WD). Wages were also input in logs. Time dummies for 1994, 1995 (REAL), 1996 and 1997 (REGIME) and for the categories (except COMPACT) were also added.

We also experimented a specification including log of sales per model in Brazil (SALES) to test for Increasing Returns of Scale (IRS), even though an industry featuring constant marginal costs and fixed costs already have IRS. We find that

31. As opposed to other countries studied, air conditioner is rarely a standard item in Brazilian automobile models, despite the local climate. It is true that makers and dealers push consumers a lot to purchase "optional" equipments, but unfortunately we have no data on sales for each "package".

32. Please note that for estimating the block-diagonal Δ matrix we took into account the following joint ownwerships of distribution channels: Daewoo/Daihatsu; VW/Seat; Fiat/Alfa-Romeo. Even though Audi is controlled by VW in Germany and shares a plant with VW to produce jointly Golfs and Audis A3, it was considered a separate firm, because the pioneer importer (Senna) was able to keep its exclusivity from the beginning to present.

ln(SALES) has a negative and highly significant coefficient. Due to endogeneity, ln(SALES) was not used as instrument.[33]

Another (and theoretically better) proxy for scale is the output (in units) of the brand (or respective joint venture) in the country of origin. Assuming it to be endogenous, it does not appear significantly different from zero. On the other hand, if we assume exogeneity, scale does appear significant, but with the "wrong" (positive) sign, thus pointing out to Decreasing Returns to Scale. Estimates are displayed on Table 9. The other estimated coefficients are significant and present the expected sign, even though some of their magnitudes vary quite widely across different specifications. Taking Specification 2 as the most appropriate one, the estimates point out that increasing scale in 1% in the automobile industry brings a decrease of 0.096% in marginal costs.

TABLE 9

Dependent Variable: LN (MC)

Method: Instrumental Variables (2SLS)

Included observations: 720

Variable	(1)		(2)		(3)		(4)	
	Coefficient	*t*-Statistic	Coefficient	*t*-Statistic	Coefficient	*t*-Statistic	Coefficient	t-Statistic
C	3.152462	5.04154***	3.281864	4.32868***	1.607472	1.33116***	2.626424	4.06196***
AIR	0.103896	4.74849***	0.028198	0.87066	0.084573	3.29068**	0.097317	4.44942***
PWR_ST	0.055598	2.67361***	0.050191	1.98960**	0.050962	2.38315***	0.054020	2.61124***
PWR_WD	0.090876	4.12577**	0.050282	1.76498*	0.094540	4.19312***	0.092123	4.20480***
LN(WGT)	0.376739	3.45998**	0.543278	3.93353***	0.440122	3.71303***	0.398320	3.67017***
LN(WAGES)	0.073675	5.52165*	0.067404	4.15113***	0.073978	5.44768***	0.073778	5.55997***
LN(HP)	0.504062	9.82802**	0.402293	6.00612***	0.492414	9.33258***	0.500096	9.80133***
LN(TRUNK)	0.245803	8.21728***	0.239845	6.61333***	0.266287	7.98627***	0.252778	8.47087***
POPULAR	-0.039965	-1.02875	0.135328	2.12069**	-0.033698	-0.84772	-0.037831	-0.97905
MEDIUM	-0.073974	-2.46818**	-0.102742	-2.77755***	-0.079628	-2.59124***	-0.075899	-2.54584***
LARGE	-0.022969	-0.57182	-0.054220	-1.10063	-0.028726	-0.69971	-0.024929	-0.62397
LUXURY	0.188756	4.07691***	0.133230	2.30801**	0.162444	3.23252***	0.179797	3.89655***
D94	-0.006053	-0.27556	-0.011557	-0.43376	-0.015005	-0.64876	-0.009101	-0.41618
D97	-0.006244	-0.28398	0.019054	0.69664	-0.000467	-0.02056	-0.004277	-0.19551
REAL	-0.288531	-13.80571***	-0.289196	-11.42229***	-0.296370	-13.53535***	-0.291200	-13.99750***
REGIME	-0.079546	-3.87997***	-0.085412	-3.43322***	-0.081887	-3.91411***	-0.080343	-3.94021***
LN(SALES)			-0.096009	-4.06742***				
LN(OUTPUT)					0.082091	1.50537	0.027950	2.96967***

Notes: *Significant at 10% level; **Significant at 5% level; ***Significant at 1% level.

Instrument list: C PWR_ST PWR_STIN PWR_STOUT PWR_WD PWR_WDIN PWR_WDOUT AIR AIRIN AIROUT LN(WAGES) LN(WGT) LN(WGTIN) LN(WGTOUT) LN(HP) LNHPIN LNHPOUT LN(TRUNK) LNTRKIN LNTRKOUT POPULAR LUXURY REAL REGIME D94 D97

5.5 IMPLICATIONS FOR PRICE-MARGINAL COST MARKUPS

We summarize our findings with respect to price-marginal cost markup levels by market segment on Tables 10a, 10b and 10c. Our most striking finding is that, in contrast to previous studies reviewed [Berry, Levinsohn and Pakes (1993 and 1995); Verboven (1998); and Fershtman, Gandal and Markovich (1999)], the price-marginal cost markup/final-price ratio in Brazil (see Table 10a) appear greater for smaller, simpler models, and lower for large and luxury cars.

33. Note that in the first specification, without an endogenous explaining variable, the 2SLS estimates is the same as the OLS, because then each explaining variable is projected on itself. I am grateful to Eduardo Pontual Ribeiro for reminding me of that.

TABLE 10a

Evolution of Price-Marginal Cost Markup/Total Price By Category

Groups and Subgroups		1993	1994	1995	1996	1997
Domestic	Popular	13.37	12.74	11.08	10.44	10.78
	Compact	16.67	21.05	13.37	13.71	11.90
	Midsize	9.63	8.67	7.79	8.21	8.70
	Large	8.53	8.80	8.15	8.54	9.94
	Luxury	8.94	9.73	9.47	9.67	9.41
Imported	Compact	4.91	5.24	5.23	5.68	6.33
	Midsize	4.83	5.42	5.23	5.27	5.71
	Large	5.37	5.36	4.89	4.71	5.38
	Luxury	5.01	5.36	5.11	4.62	5.41

TABLE 10b

Evolution of Price-Marginal Cost Markup/Pre-Tax Price By Category

Groups and Subgroups		1993	1994	1995	1996	1997
Domestic	Popular	17.34	15.70	14.24	14.71	14.00
	Compact	25.61	31.76	20.74	21.85	17.77
	Midsize	14.86	13.54	12.97	13.35	12.98
	Large	13.06	13.20	12.99	14.01	14.83
	Luxury	13.46	14.47	14.13	15.16	13.80
Imported	Compact	10.12	10.14	10.25	10.28	10.35
	Midsize	10.10	10.16	10.66	10.86	10.58
	Large	10.43	10.32	10.31	10.29	10.46
	Luxury	10.22	10.35	10.66	10.50	10.56

TABLE 10c

Evolution of Price-Marginal Cost Markups in R$ by Category

Groups and Subgroups		1993	1994	1995	1996	1997
Domestic	Popular	1,727	1,478	1,177	1,306	1,307
	Compact	2,958	3,500	2,239	2,570	2,053
	Midsize	2,200	2,139	1,624	1,700	1,625
	Large	3,411	3,355	2,466	2,483	2,427
	Luxury	4,966	4,687	3,592	3,388	3,023
Imported	Compact	1,815	1,473	1,014	1,075	1,044
	Midsize	1,445	1,909	1,436	1,346	1,351
	Large	3,143	2,775	1,809	1,693	1,833
	Luxury	4,451	4,212	2,976	2,888	2,912

Note: Price-marginal cost markups in R$ of December 1997.

If we correct these ratios to take into account that the tax burden rates vary widely across categories (see Table 10b), we still find that popular and compact models enjoy greater price-marginal cost markup rates. However, one should bear in mind that these estimates have error margins. We report on Table 16 standard deviations (in percentual points) of selected vehicles' price-marginal cost markup rates for the MPCN solution, calculated by the delta method; that is, from equation (4.24) the markup rate's variance is:

$$\mathrm{Var}(b(p, x, \xi, \theta)) = [\partial b(\theta)/\partial \theta] \cdot \mathrm{Var}(\theta) \cdot [\partial b(\theta)/\partial \theta]' \qquad (4.26)$$

Standard deviations reported are the square roots of the obtained matrix's diagonal after correcting for VATs and duties. Thus, some differences of price-marginal cost markup rates are not significant.

But even where we do not reject the difference, this does not mean that firms enjoy greater profits with the popular and compact models — Table 10c shows that the price-marginal cost markups in absolute values are greater for larger vehicles, as the price difference more than compensate the difference of ratios — but rather that those simpler models are more profitable per unit of money spent in their production than the more sophisticated ones, and that their prices contain a greater price-marginal cost markup share. Of course fixed transaction costs per unit (incurred in the distribution and sales process) may reverse these results.

Higher price-marginal cost markups/final-price ratios for populars and compacts may be due to the greater number of different models and firms who compete in the upper segments (that is where most of the imported cars are located) which translates into lower margins on higher prices, while small cars are chosen from a very small set of models (see Table 11) predominantly from domestic makers with great market shares, and make up significant profits based on bulk sales, although the high price-marginal cost markup rates apply to lowprices. This reason is magnified by the substitution pattern implied by NL models. As we commented above, substitution patterns do not depend on cars' similarities. As Verboven's formulas (reproduced on the Appendix) show, the cars' shares within group, subgroup or total, along with the price coefficient and the sigmas, are the only factors that determine own- and cross-price elasticities.

TABLE 11
Number of Models/Versions per Category

Groups and Subgroups		1993	1994	1995	1996	1997
Domestic	Popular	6	8	6	8	7
	Compact	10	10	10	12	11
	Midsize	45	48	45	35	26
	Large	23	25	27	24	13
	Luxury	11	11	10	6	4
Imported	Compact	4	7	12	9	9
	Midsize	11	18	22	18	17
	Large	9	14	21	22	26
	Luxury	7	11	15	14	13

Moreover, income effects are absent, as commented on Subsection 4.2, so we should expect that popular cars face more elastic demands than what we found when we take account of income. Therefore, more reasonable substitution patterns should be obtained in a random-coefficient estimation like Berry, Levinsohn and Pakes's (1993 and 1995) and/or by introducing some input on income.

Another possible explanation for this pattern on price-marginal cost markup rates is that most standard automobile models are sold through *consórcios*, or purchase clubs, so there is a significant inertia in sales volume when prices increase. We do not have data on distribution of sales across different channels, but it is straightforward to assume that at least the imported cars were not sold significantly through *consórcios* at the time of our sample.

It is apparent from Tables 12a and 12b that price-marginal cost markups as a whole increased during 1994 because of the great demand acceleration and decreased during the 1995 import boom (see also Table 13a), and the manufacturers most affected by price-marginal cost markup erosion were the domestic ones, especially Volkswagen and Fiat — and this is very easy to understand: the duty rate drop at that time leveraged imports mostly in the compact car segment, where VW and Fiat's sales are concentrated; moreover, GM launched Corsa, the first completely new popular car (thus far popular cars were simply long-existing models converted to 1000 cc engines), capturing a market share not to be despised, even though the market *size* increased, as well as each model's sales. In 1996 price-marginal cost markup variation of the groups diverged, most probably as an effect of the introduction of the Automotive Regime: incumbents were able to raise their price-marginal cost markup rates, while independent importers had theirs decreased. In 1997, due to the introduction of the Quota Regime, the movement was reversed: incumbents lost margins whereas entrants were able to raise them. Effects of the two regimes on newcomers are mixed and difficult to disentangle: firms joined the Regime on different dates and the analysis would have to be made on a case-by-case basis.

From Table 10b, however, we can see that the imported models' net average profitability have been remarkably stable.

An interesting exercise we made was to calculate the share of the final price variation (by class) due to price-marginal cost markup variation (see Table 13b). We find that both variables moved at the same direction in average for all segments in all years, the most notable exceptions being domestic compacts in 1993-1994 and 1994-1995: in 1993-1994 compact cars had their final prices reduced while price-marginal cost markups increased, and the opposite occurred in 1994-1995; note that tax rates did not change for them, but the rates for populars did, so the movement may be reflecting market share reaccomodations. Also note that in 1995 most of the average final prices decreased along with price-marginal cost markups, whereas in 1997 most imported cars had their prices reduced even though their price-marginal cost markups were raised, certainly reflecting some change of behavior under the Automotive and Quota Regimes or the demand peak.

On Table 16 we report selected models' price-marginal cost markup rates (net of value-added taxes and duties) for the three oligopolistic solutions (SPCN, MPCN and MPC), total profits (gross of fixed costs) for the MPCN and own-price elasticities. As Tables 10's averages already show, small cars display higher price-marginal cost markups and corresponding lower own-price elasticities, and vice-versa for large and luxury cars. Vehicles with high own-price elasticities but relatively high price-marginal cost markups are either leaders in the large car segment or belong to firms with greater market share. In fact, the price-marginal cost markup rates for the MPC solution would be unreasonably large for the models of the four incumbents (Fiat, Ford, GM and Volkswagen), which offer the largest variety of models identified in our sample. On the other hand, the price-marginal cost markup rates barely differ between SPCN and MPCN when the brand has very few models; this is the case of most of the independent importers and newcomers.

TABLE 12a

Evolution of Price-Marginal Cost Markup/Total-Price by Make

	1993	1994	1995	1996	1997
			Total Average		
	11.65	11.75	9.83	10.91	10.25
			Average per Make and Firm Status		
Incumbents	**11.78**	**11.95**	**10.06**	**11.06**	**10.37**
Volkswagen	13.35	14.31	11.47	12.47	11.05
Seat	.	.	4.40	5.02	5.42
Fiat	12.28	12.17	10.28	11.71	11.00
Alfa Romeo	.	5.46	5.22	4.90	5.37
Ford	8.17	8.35	7.64	7.72	8.39
GM	10.68	9.39	8.81	9.31	9.71
Newcomers and Mercosur-Based	**5.30**	**5.62**	**5.48**	**5.70**	**5.97**
Audi	.	5.21	4.60	4.86	5.52
Chrysler	.	.	5.75	5.21	5.45
Citroen	5.13	5.25	5.43	5.96	6.31
Honda	4.88	5.25	4.90	4.08	4.95
Hyundai	5.40	5.64	5.74	6.05	6.37
Peugeot	6.72	6.48	6.01	6.44	6.71
Renault	4.89	5.14	4.73	4.16	5.16
Volvo	4.90	5.17	4.92	4.74	5.30
Non-Mercosur	**4.86**	**5.08**	**4.82**	**4.07**	**4.31**
BMW	.	5.14	4.80	4.65	5.14
Daewoo	.	5.15	4.90	5.08	5.74
Daihatsu	4.81	5.07	4.49	4.41	4.98
Kia Motors	.	5.05	4.66	4.57	5.25
Lada	4.83	5.08	4.45	.	4.16
Mazda.	4.87	5.15	4.73	4.26	5.10
Mitsubishi [a]	4.88	5.12	4.74	4.26	4.41
Nissan	.	5.16	4.76	4.79	5.33
Subaru	4.83	5.07	4.78	4.31	5.06
Suzuki	4.82	5.13	4.97	4.57	4.96
Toyota [b]	4.86	5.08	4.82	4.07	4.31

[a] Averages are calculated over sampled passenger cars only.

[b] Even though these makers did setup plants in Brazil, they did not enroll in the Automotive Regime, so they did not enjoy the same tariff rebates as the so-called *newcomers*.

TABLE 12b

Evolution of Price-Marginal cost Markup/Pre-Tax-Price by Make

	1993	1994	1995	1996	1997
	Total Average				
	17.39	17.54	14.66	16.27	15.29
	Average per Make and Firm Status				
Incumbents	**17.58**	**17.83**	**15.01**	**16.51**	**15.48**
Volkswagen	19.93	21.36	17.12	18.61	16.49
Seat	.	.	6.57	7.50	8.09
Fiat	18.33	18.16	15.34	17.48	16.41
Alfa romeo	.	8.15	7.79	6.53	7.96
Ford	12.19	12.47	11.40	11.53	12.52
GM	15.94	14.01	13.16	13.90	14.49
Newcomers and Mercosur-Based	**7.88**	**8.37**	**8.22**	**7.93**	**8.70**
Audi	.	7.78	6.87	6.32	6.63
Chrysler	.	.	8.58	6.62	8.13
Citroen	7.65	7.84	8.10	8.69	9.37
Honda	7.28	7.83	7.32	6.09	7.39
Hyundai	7.18	7.56	6.70	6.03	6.40
Peugeot	8.06	8.42	8.57	8.92	9.49
Renault	10.03	9.68	8.97	8.89	10.02
Volvo	7.31	7.71	7.34	7.07	7.90
Non-Mercosur	**7.23**	**7.63**	**7.12**	**6.15**	**6.98**
BMW	7.26	7.58	7.20	6.07	6.43
Daewoo	.	7.67	7.16	6.16	7.55
Daihatsu	.	7.69	7.31	6.75	8.43
Kia Motors	.	7.54	6.95	5.97	6.29
Lada	7.21	7.58	6.64	.	6.20
Mazda.	7.26	7.69	7.06	6.05	7.52
Mitsubishi [a]	7.28	7.64	7.08	5.99	6.20
Nissan	.	7.69	7.11	6.34	7.80
Subaru	7.21	7.56	7.14	6.15	7.50
Suzuki	7.20	7.66	7.42	6.82	6.51
Toyota [b]	7.30	7.67	7.05	6.12	7.33

[a] Averages are calculated over sampled passenger cars only.

[b] Even though these makers did setup plants in Brazil, they did not enroll in the Automotive Regime, so they did not enjoy the same tariff rebates as the so-called *newcomers*.

TABLE 13a

Percentage Variation of Absolute (R$) Price-Marginal Cost Markup

Groups and Subgroups		1993-1994	1994-1995	1995-1996	1996-1997
Domestic	Popular	-14.42	-20.34	10.99	0.07
	Compact	18.33	-36.04	14.80	-20.12
	Midsize	-2.75	-24.10	4.69	-4.41
	Large	-1.64	-26.50	0.67	-2.23
	Luxury	-5.61	-23.36	-5.69	-10.76
Imported	Compact	-18.86	-31.15	5.99	-2.81
	Midsize	32.14	-24.75	-6.26	0.34
	Large	-11.71	-34.80	-6.43	8.31
	Luxury	-5.37	-29.35	-2.94	0.82

Source: Table 10c.

TABLE 13b

Share of Price-Marginal Cost Markup Variation in Total Price Variation

Groups and Subgroups		1993-1994	1994-1995	1995-1996	1996-1997
Domestic	Popular	18.39(-)	34.67(-)	11.03(+)	0.20(+)
	Compact	-48.54(-)	-948.42(+)	41.15(+)	163.13(-)
	Midsize	-3.31(+)	13.92(-)	-4.44(-)	12.96(-)
	Large	3.00(-)	11.55(-)	-0.51(-)	2.05(-)
	Luxury	3.78(-)	10.7(-)	4.12(-)	44.61(-)
Imported	Compact	3.85(-)	5.48(-)	-7.29(-)	1.29(-)
	Midsize	8.77(+)	6.52(-)	3.33(-)	-0.33(-)
	Large	5.44(-)	6.83(-)	9.56(-)	-6.45(-)
	Luxury	2.32(-)	6.33(-)	-2.41(+)	-0.30(-)

Note: Sign in parenthesis refers to price variation.

TABLE 14

Evolution of Own-Price Elasticities by Category

Groups and Subgroups		1993	1994	1995	1996	1997
Domestic	Popular	6.11	6.88	7.32	7.59	7.90
	Compact	8.39	7.91	7.55	7.16	7.30
	Midsize	9.45	9.42	8.93	9.29	8.87
	Large	8.92	8.99	8.98	8.78	7.64
	Luxury	8.40	7.56	7.40	6.83	7.59
Imported	Compact	9.88	9.86	9.82	9.87	9.81
	Midsize	9.87	9.88	9.61	9.50	9.69
	Large	9.83	9.76	9.76	9.82	9.74
	Luxury	9.80	9.69	9.45	9.66	9.70

TABLE 15

Evolution of Sales by Category

GROUPS AND SUBGROUPS		1993	1994	1995	1996	1997
Domestic	Popular	195,351	396,225	581,317	659,173	862,004
	Compact	144,109	118,351	183,254	243,788	232,608
	Midsize	316,849	342,617	308,761	208,650	247,306
	Large	86,791	80,569	132,793	129,661	134,801
	Luxury	35,054	41,999	21,741	22,443	40,380
Imported	Compact	1,377	3,780	12,428	6,912	8,442
	Midsize	6,469	16,118	67,106	45,308	34,985
	Large	5,336	10,213	29,853	17,275	29,348
	Luxury	1,578	5,565	13,811	6,130	7,866

TABLE 16

Selected Vehicle Models in 1997

Make	Model	Category	Price	Qty	q*(p-mc) (in R$ 1,000)	Own-Price Elasticity	Price-Marginal Cost Markup Rates				Tax Burden (%)
							SPCN	MPCN	Std.Dev. MPCN	MPC	
Volks	Gol 1.6	Comp.Dom.	16,976	110,262	269,805	-5.60	11.96	14.41	3.14	87.99	33
Volks	Gol 1.8	Comp.Dom.	18,170	20,978	54,586	-9.10	7.36	14.32	3.12	85.18	33
Fiat	Uno Mille 1.0	Pop.	10,690	103,799	135,466	-8.79	8.76	12.21	2.76	135.82	23
Fiat	Palio 1.0	Pop.	12,363	228,491	339,246	-7.42	10.37	12.01	2.71	127.51	23
GM	Vectra 2.0	Lg.Dom.	24,333	66,268	185,692	-6.11	10.97	11.52	2.58	34.22	33
Volks	Gol 1.0	Pop.	12,691	250,920	343,374	-7.18	10.73	10.78	2.46	125.37	23
GM	Vectra CD 2.0	Lx.Dom.	36,808	15,495	57,753	-6.88	10.11	10.13	2.31	44.87	30
GM	Omega 2.2	Lg.Dom.	35,985	3,349	12,155	-9.73	6.89	10.09	2.28	29.80	33
GM	Corsa Wind 1.0	Pop.	12,103	161,317	184,626	-8.16	9.44	9.46	2.18	130.50	23
Fiat	Palio 1.5	Comp.Dom.	16,627	47,300	73,129	-8.07	8.31	9.30	2.13	86.68	33
Volks	Parati 1.6	Md.Dom.	18,961	30,016	52,695	-8.92	7.51	9.26	2.12	39.25	33
Volks	Pointer 1.8	Md.Dom.	21,237	1,856	3,601	-9.86	6.80	9.14	2.10	36.39	33
Volks	Santana GLS 2.0	Lx.Dom.	28,590	9,366	24,456	-8.08	8.29	9.13	2.10	46.98	33
Volks	Polo Classic 1.8	Md.Dom.	21,661	14,653	28,962	-9.43	7.11	9.12	2.09	35.96	33
Volks	Logus 1.8	Md.Dom.	21,373	2,412	4,640	-9.84	6.81	9.00	2.07	35.69	33
Fiat	Palio 1.6	Comp.Dom.	20,146	22,268	40,339	-9.05	7.41	8.99	2.06	82.02	33
Volks	Quantum GLS 2.0	Lx.Dom.	31,819	3,778	10,773	-9.18	7.30	8.96	2.06	43.25	33
Ford	Ka 1.0	Pop.	11,310	36,342	36,627	-9.52	8.09	8.91	2.07	131.11	23
GM	Corsa Sedan 1.6	Md.Dom.	17,339	23,633	36,503	-9.13	7.34	8.91	2.05	40.45	33
Ford	Fiesta 1.0	Pop.	11,927	79,843	84,655	-9.05	8.51	8.89	2.06	130.80	23
GM	Kadett 2.0	Md.Dom.	17,793	27,601	43,495	-9.00	7.45	8.86	2.03	40.02	33
GM	Corsa SW 1.6	Md.Dom.	18,152	10,801	17,341	-9.56	7.01	8.84	2.03	39.79	33
Fiat	Tempra Ouro 2.0	Lx.Dom.	28,913	11,741	29,927	-7.62	8.79	8.82	2.03	46.76	33

(continua)

(continuação)

Make	Model	Category	Price	Qty	q*(p-mc) (in R$ 1,000)	Own-Price Elasticity	Price-Marginal Cost Markup				Tax Burden (%)
							SPCN	MPCN	Std.Dev. MPCN	MPC	
GM	Ipanema 2.0	Md.Dom.	19,288	3,237	5,485	-9.81	6.83	8.78	2.02	39.07	33
Volks	Santana 2.0	Lg.Dom.	23,255	15,617	31,485	-9.02	7.43	8.67	2.00	35.35	33
Volks	Quantum 2.0	Lg.Dom.	24,790	3,890	8,259	-9.70	6.91	8.56	1.98	33.64	33
Ford	Escort 1.8	Md.Dom.	17,912	58,105	87,799	-7.98	8.40	8.44	1.94	39.95	33
Fiat	Palio Wkd 1.6	Md.Dom.	18,390	35,339	51,466	-8.74	7.67	7.92	1.84	39.44	33
Fiat	Tipo 1.6	Md.Dom.	18,733	4,335	6,429	-9.77	6.85	7.92	1.84	39.12	33
Fiat	Siena1.6	Md.Dom.	19,902	2,607	4,106	-9.83	6.81	7.91	1.84	38.13	33
Fiat	Tempra 2.0	Lg.Dom.	24,381	20,738	39,123	-8.73	7.68	7.74	1.80	34.68	33
Ford	Ka 1.3	Comp.Dom.	14,384	5,492	5,775	-9.70	6.90	7.31	1.70	86.98	33
Ford	Fiesta 1.3	Comp.Dom.	15,194	7,196	7,983	-9.64	6.95	7.30	1.70	86.88	33
GM	Corsa 1.6	Comp.Dom.	15,823	11,288	12,651	-9.48	7.07	7.08	1.65	87.24	33
Renault	Clio	Comp.Imp.	15,470	4,606	4,911	-9.74	6.88	6.89	1.61	7.53	33
Renault	19 1.6	Md.Imp.	21,218	2,133	3,094	-9.85	6.80	6.84	1.60	8.25	33
Peugeot	306	Md.Imp.	23,312	1,810	2,868	-9.86	6.80	6.80	1.59	8.22	33
Citroen	ZX 1.8	Md.Imp.	27,113	1,453	2,674	-9.87	6.79	6.79	1.59	8.18	33
Fiat	Tempra SW 2.0	Lg.Dom.	25,099	810	1,181	-9.87	5.09	5.81	1.35	25.73	50
Peugeot	106	Comp.Imp.	13,885	909	720	-9.88	5.69	5.71	1.33	6.33	44
Audi	A3	Lx.Imp.	44,396	1,496	3,708	-9.63	5.29	5.58	1.30	6.67	49
Seat	Cordoba	Md.Imp.	22,806	1,902	2,403	-9.86	5.15	5.54	1.29	6.21	49
Volks	Golf 1.8	Md.Imp.	22,618	13,073	16,350	-9.48	5.34	5.53	1.29	6.13	49
Alfa Romeo	155	Lx.Imp.	43,744	268	642	-9.87	5.33	5.47	1.28	6.77	47
Ford	Taurus 3.0	Lx.Imp.	50,588	1,154	3,190	-9.69	5.46	5.47	1.28	6.87	47
Ford	Mondeo 1.8	Lg.Imp.	31,533	7,556	13,021	-9.48	5.34	5.46	1.27	6.68	49
Chrysler	Neon	Lg.Imp.	30,577	2,473	4,128	-9.78	5.37	5.46	1.27	6.89	47
Audi	A4	Lx.Imp.	64,541	1,789	6,302	-9.57	5.29	5.46	1.27	6.46	49
Chrysler	Stratus	Lg.Imp.	38,928	2,076	4,394	-9.80	5.36	5.44	1.27	6.86	47
Alfa Romeo	164	Lx.Imp.	52,962	1,025	2,903	-9.72	5.30	5.35	1.25	6.62	48
KIA	Clarus	Lg.Imp.	32,836	1,482	2,601	-9.83	5.34	5.34	1.25	6.87	47
Nissan	Primera	Lg.Imp.	44,494	145	345	-9.91	5.34	5.34	1.25	6.86	47
Citroen	Xantia	Lg.Imp.	41,091	701	1,533	-9.88	5.32	5.32	1.24	6.77	47
Volvo	850	Lx.Imp.	71,792	113	430	-9.90	5.30	5.30	1.24	6.57	48
BMW	Series 3	Lx.Imp.	67,094	520	1,504	-9.82	4.31	4.31	1.01	5.34	58
Daewoo	Espero	Lg.Imp.	28,803	1,463	2,167	-9.84	5.14	5.14	1.20	6.66	49
Toyota	Corolla	Lg.Imp.	32,656	2,608	4,367	-9.77	5.09	5.13	1.20	6.52	50
Hyundai	Accent	Md.Imp.	21,444	1,280	1,405	-9.88	5.12	5.12	1.20	6.21	49
KIA	Sephia	Md.Imp.	18,120	1,090	1,011	-9.88	5.12	5.12	1.20	6.25	49
Suzuki	Baleno	Md.Imp.	26,195	370	495	-9.91	5.11	5.11	1.19	6.19	49
Mazda	626	Lg.Imp.	36,915	356	670	-9.90	5.10	5.10	1.19	6.58	50
Volks	Passat 2.0	Lg.Imp.	35,440	875	1,578	-9.87	5.06	5.09	1.19	6.33	50
Mitsubishi	Lancer	Md.Imp.	31,081	759	976	-9.89	4.14	4.14	0.97	5.00	59
Subaru	Legacy	Lg.Imp.	36,981	512	952	-9.89	5.03	5.03	1.18	6.48	50
Honda	Civic 4D	Lg.Imp.	43,877	1,308	2,789	-9.84	4.86	4.86	1.14	6.14	52
Lada	Laika	Md.Imp.	12,147	904	456	-9.89	4.16	4.16	0.97	5.04	59

Notes: SPCN = Single Product Cournot-Nash; MPCN = Multiproduct Cournot-Nash; MPC = Multiproduct Cartel.
Codes: Comp. = Compact; Md. = Midsize; Lg. = Large; Lx. = Luxury; Pop. = Popular; Imp. = Imported; Dom. = Domestic.
Net of all VATs, revenue taxes and duties.

Back to the question whether higher price-marginal cost markup rates signify higher profits, Tables 17 and 18 shed some light on what really brings cash to the firms. Table 17 displays the 40 greatest price-marginal cost markups in Reais at the end of our sample. The top of the list is Renault 19, followed by Nissan Maxima. The latter featured a modest 5 percent price-marginal cost markup rate, which happened to be applied on a very high unit price. Gol 1.6, which had the highest price-marginal cost markup, ranked 6^{th} in the same list. On the other hand, on Table 18 we see the models that account for the greatest shares of the firms' profits. Domestic compact and popular cars lead the list, showing that their low prices are compensated by their high price-marginal cost markup rates and high sales volumes.

Therefore, even though the press continually reports that firms would rather produce more expensive cars, they (the firms) cannot forfeit the popular models, which account for the bulk of their sales and carry enviable profit margins as a percentage of their unit prices.

TABLE 17
Vehicle Models Ranked by Absolute Price-Marginal Cost Markups in 1997

Rank	Make	Model	Price-Marginal Cost Markup Rate	Price-Marginal cost Markup (R$)	Rank	Make	Model	Price-Marginal Cost Markup Rate	Price-Marginal Cost Markup (R$)
1	Renault	19 1.6	10.07	4,128.42	21	Volks	Logus 1.8	8.82	2,548.95
2	Nissan	Maxima	5.30	3,801.87	22	Suzuki	Swift	5.58	2,478.94
3	Alfa Romeo	164	10.13	3,727.22	23	Volks	Gol 1.0	14.41	2,446.94
4	Volks	Logus 1.6	10.09	3,629.32	24	Mitsubishi	Colt	5.11	2,429.82
5	Honda	Civic Hatch	5.46	3,522.46	25	Volks	Quantum GLS 2.0	13.86	2,412.93
6	Volks	Gol 1.6	14.05	3,301.94	26	Ford	Verona 2.0	5.47	2,394.53
7	Peugeot	106	5.24	3,274.83	27	Daewoo	Lanos	5.34	2,376.08
8	Volvo	850	5.31	3,163.53	28	BMW	Series 3	5.62	2,268.24
9	GM	Kadett 1.8 (alc)	4.31	2,892.14	29	Volks	Golf 1.8	13.86	2,254.34
10	Fiat	Tempra Ouro 2.0	5.37	2,857.84	30	Peugeot	405 1.8	5.21	2,194.89
11	Volks	Santana GLS 2.0	8.96	2,851.56	31	KIA	Sephia	5.32	2,186.96
12	Volks	Passat Variant 2.8	5.35	2,832.34	32	Fiat	Uno Mille 1.0	8.69	2,182.03
13	Ford	Mondeo 2.0	11.52	2,802.13	33	Volks	Passat Variant 2.0	5.01	2,153.35
14	Alfa Romeo	Coupe 2.0	5.47	2,764.68	34	Ford	Versailles 2.0	4.86	2,132.51
15	Volks	Polo Classic 1.8	5.26	2,710.81	35	Volks	Passat 2.0	5.63	2,123.82
16	GM	Corsa SW 1.6	9.13	2,611.10	36	Volks	Parati 1.6	8.56	2,123.06
17	Ford	Royal 1.8	5.10	2,603.42	37	Peugeot	405 1.6	5.44	2,116.61
18	Volks	Santana 1.8	14.32	2,602.07	38	GM	Ipanema 2.0	5.33	2,109.64
19	Fiat	Palio 1.5	9.00	2,578.80	39	Toyota	Camry	5.37	2,057.27
20	Volks	Gol 1.8	9.02	2,555.92	40	Volks	Parati 2.0	8.43	2,032.19

TABLE 18
Vehicle Models Ranked by Profits[a] in 1997

Rank	Make	Model	Qty	q*(p-mc) (in R$ 1,000)	Rank	Make	Model	Qty	q*(p-mc) (in R$ 1,000)
1	Volks	Gol 1.0	250,920	343,374	21	Fiat	Tempra Ouro 2.0	11,741	29,927
2	Fiat	Palio 1.0	228,491	339,246	22	Volks	Polo Classic 1.8	14,653	28,962
3	Volks	Gol 1.6	110,262	269,805	23	Volks	Santana 1.8	15,266	28,802
4	GM	Vectra 2.0	66,268	185,692	24	Volks	Santana GLS 2.0	9,366	24,456
5	GM	Corsa Wind 1.0	161,317	184,626	25	GM	Corsa SW 1.6	10,801	17,341
6	Fiat	Uno Mille 1.0	103,799	135,466	26	Volks	Golf 1.8	13,073	16,350
7	Ford	Escort 1.8	58,105	87,799	27	Ford	Mondeo 1.8	7,556	13,021
8	Ford	Fiesta 1.0	79,843	84,655	28	GM	Corsa 1.6	11,288	12,651
9	Fiat	Palio 1.5	47,300	73,129	29	GM	Omega 2.2	3,349	12,155
10	GM	Vectra CD 2.0	15,495	57,753	30	Volks	Quantum GLS 2.0	3,778	10,773
11	Volks	Gol 1.8	20,978	54,586	31	Volks	Golf 2.0	7,052	9,865
12	Volks	Parati 1.6	30,016	52,695	32	GM	Omega CD 2.0	2,302	9,504
13	Fiat	Palio Wkd 1.6	35,339	51,466	33	Ford	Fiesta 1.4	6,405	9,168
14	GM	Kadett 2.0	27,601	43,495	34	Volks	Quantum 2.0	3,890	8,259
15	Volks	Parati 1.8	23,323	43,249	35	Ford	Fiesta 1.3	7,196	7,983
16	Fiat	Palio 1.6	22,268	40,339	36	Volks	Quantum 1.8	3,908	7,861
17	Fiat	Tempra 2.0	20,738	39,123	37	Fiat	Tipo 1.6	4,335	6,429
18	Ford	Ka 1.0	36,342	36,627	38	Audi	A4	1,789	6,302
19	GM	Corsa Sedan 1.6	23,633	36,503	39	GM	Kadett 1.8	3,800	6,031
20	Volks	Santana 2.0	15,617	31,485	40	Ford	Ka 1.3	5,492	5,775

[a] Net of VATs, duties and revenue taxes, but not of fixed costs.

TABLE 19
Cross-Price Elasticities For Selected Models

	Gol 1.6 Gas	Gol 1.0 Gas	Santana 2.0 Gas	Palio 1.0 Gas	Uno 1.0 Gas	Tempra 2.0 Gas	Corsa Wind 1.0G	Vectra CD 2.0G	Ka 1.0 Gas	Fiesta 1.0 Gas	Clio 1.O Gas	Civic 4D Gas	Corolla Gas	Audi A3 Gas
Gol 1.6 Gas	-5.59991	0.00413	0.00413	0.00413	0.00413	0.00413	0.00413	0.00413	0.00413	0.00413	0.00413	0.00413	0.00413	0.00413
Gol 1.0 Gas	0.00939	-7.17743	0.00939	2.76086	2.76086	0.00939	2.76086	0.00939	2.76086	2.76086	0.00939	0.00939	0.00939	0.00939
Santana 2.0 Gas	0.00059	0.00059	-9.02080	0.00059	0.00059	0.89987	0.00059	0.00059	0.00059	0.00059	0.00059	0.00059	0.00059	0.00059
Palio 1.0 Gas	0.00855	2.51407	0.00855	-7.42253	2.51407	0.00855	2.51407	0.00855	2.51407	2.51407	0.00855	0.00855	0.00855	0.00855
Uno 1.0 Gas	0.00389	1.14210	0.00389	1.14210	-8.78518	0.00389	1.14210	0.00389	1.14210	1.14210	0.00389	0.00389	0.00389	0.00389
Tempra 2.0 Gas	0.00078	0.00078	1.19495	0.00078	0.00078	-8.72611	0.00078	0.00078	0.00078	0.00078	0.00078	0.00078	0.00078	0.00078
Corsa Wind 1.0 G	0.00604	1.77496	0.00604	1.77496	1.77496	0.00604	-8.15662	0.00604	1.77496	1.77496	0.00604	0.00604	0.00604	0.00604
Vectra CD 2.0 G	0.00058	0.00058	0.00058	0.00058	0.00058	0.00058	0.00058	-6.88431	0.00058	0.00058	0.00058	0.00058	0.00058	0.00058
Ka 1.0 Gas	0.00136	0.39987	0.00136	0.39987	0.39987	0.00136	0.39987	0.00136	-9.52235	0.39987	0.00136	0.00136	0.00136	0.00136
Fiesta 1.0 Gas	0.00299	0.87851	0.00299	0.87851	0.87851	0.00299	0.87851	0.00299	0.87851	-9.04697	0.00299	0.00299	0.00299	0.00299
Clio 1.O Gas	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	-9.73906	0.00017	0.00017	0.00017
Civic 4D Gas	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	-9.84423	0.07537	0.00005
Corolla Gas	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.15028	-9.76942	0.00010
Audi A3 Gas	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	-9.62646

Note: cross-price elasticities should be read down along the column, i.e. the column displays the percentage variation of sales for the model that labels the column, in response to a 1% variation in the price of the car listed on each row.

Cross-price elasticities are displayed on Table 19. They are quite reasonable except for the equality of various values in a same column or row due to NL restraints already mentioned. Note the remarkably higher cross-price elasticities for popular cars, indicating a high degree of substitutability (as perceived by consumers) across popular models.

6 CONCLUSIONS

By applying an Instrumental Variable version of Nested Logit to automobile demand in Brazil we were able to obtain very precise and meaningful estimates of both demand and supply equations. With these estimates we are able to evaluate how domestic vehicle manufacturers were affected by trade liberalization after more than 30 years of market foreclosure, and how price-marginal cost markups evolved following the introduction of the popular car models.

We found out that the incumbent manufacturers have been able to maintain their market leadership and consequently to enjoy greater price-marginal cost markups as compared to their imported counterparts in all vehicle categories imported cars in Brazil.. This result was expected; it had also been found by Verboven (1996) in Europe. The figures also support the anedoctal evidence that domestic markup rates dropped drastically and permanently during the 1995 boom, not only because of import, but also from fiercer domestic competition.

A striking result we provide here is that, as opposed to European countries and the USA, for example, domestic compact models sell at higher markup rates than larger and more sophisticated domestic cars, in spite of the evidence that the former price-marginal cost markups declined most. The differences are lower and less significant when we calculate price-marginal cost markups as share of pre-tax prices. The explanation presented above for the general price-marginal cost markup rate drop is particularly important in the segment of compacts and populars. This markup rate ranking points out that the domestic manufacturers are the most benefited by Brazilian tax policy which favors popular cars and overburdens larger, fancier cars, because in the former segment the presence of independent importers is null (lower tax rates for 1000cc engines are a singular feature of Brazilian market, so the other exporting countries had not enough scale to produce and export this kind of car to Brazil). Still, because of a great abyss in absolute prices, this does not mean that the firms extract more profit from each unit sold; on the contrary, the popular car that ranked highest in the list of absolute price-marginal cost markups in 1997 (Gol 1.0) was the 23rd, and among the compacts (Gol 1.6) the highest price-marginal cost markup rate translated to the 6th position in absolute values. This finding reinforces the speeches of executives from the domestic firms that complain about the popular car regime because these cars allegedly earn a very low margin on bulk sales. But these bulk sales **do** compensate for the lower markup values: the popular cars end up accounting for the greatest shares of total revenues of the incumbent firms.

On the other hand, in spite of a greater price reduction (net of taxes), large and luxury cars' price-marginal cost markup rates seem to have been less affected by escalation of domestic and import competition. In the final year of our sample (1997), under the Automotive Regime, these models actually seemed to have their price-marginal cost markup rates higher than before import opening (even though the difference is again not significant). The introduction of the Quota Regime is probably another reason for dampening competition in the luxury segment, as it softened competition from independent importers, which, in addition, revised their import mix towards new market niches, especially SUVs and fancy pickups, which were insufficiently served by local manufacturers. Still this result paradoxically contrasts with the observed decline of the pre-tax prices in these market segments. A possible explanation for this paradox is that 1997 was the peak of vehicle sales and production in Brazil, and the average own-price elasticity as estimated by the Nested Logit formulae ended up being quite low in that segment as compared to 1993 — see Table 13. From the Appendix it is apparent that elasticities predicted by Nested Logit respond negatively to increases of their sales[34] even if the model's share in the segment decreases. This "artificially" lower own-price elasticity may have dominated similar effects on cross-price elasticities and thus driven price-marginal cost markups up.

A natural extension of this work is to provide an evaluation of welfare impacts of Brazilian tariff and tax policies with counterfactual exercises and to simulate alternative tax policies, such as the ones discussed more recently among government, manufacturers and labor unions. In view of Nested Logit's limitations to provide reasonable substitution patterns, it might also be worth pursuing some version of a random coefficient model as the one estimated by Berry, Levinsohn and Pakes (1993 and 1995).

34. The term $-q_j/M$ in the elasticity formula accounts for the share of sales in "total" market, i.e., in the number of households — all of them potential automobile consumers. This effect may have been of second order in 1995 as compared to the effect of fiercer competition, translated into lower shares of individual domestic models within their respective groups. Table 14 (reporting sales per category) reinforces this interpretation: according to it, sales of large and luxury domestic models decrease in absolute and/or relative terms when compared to their domestic counterparts in 1995, while the opposite occurs in 1997.

APPENDIX

Dividing (4.11) by (4.17), we get:

$$\ln(s_j)-\ln(s_0)=\frac{\delta_j}{1-\sigma_1}-\ln(D_{hg})+\frac{1-\sigma_1}{1-\sigma_2}\cdot\ln(D_{hg})- \\ -\ln(K)+(1-\sigma_2)\cdot\ln(K) \tag{A.1}$$

where:

$$K=\sum_{h\in\Im_g} D_{hg}^{(1-\sigma_1)/(1-\sigma_2)}$$

Simplifying:

$$\ln(s_j)-\ln(s_0)=\frac{\delta_j}{1-\sigma_1}+\frac{\sigma_2-\sigma_1}{1-\sigma_2}\cdot\ln(D_{hg})-\sigma_2\cdot\ln(K) \tag{A.2}$$

Now notice that:

$$s_g=\frac{K^{1-\sigma_2}}{\left\{1+\sum_{g=1}^{G}[\sum_{h\in\Im_g} D_{hg}^{(1-\sigma_1)/(1-\sigma_2)}]^{(1-\sigma_2)}\right\}} \tag{A.3}$$

and

$$s_{hg/g}=\frac{(D_{hg})^{\frac{1-\sigma_1}{1-\sigma_2}}}{K} \tag{A.4}$$

Substituting (4.17) into (A.3), taking logs and solving for ln(K), we get:

$$\ln(K)=\frac{\ln(s_g)-\ln(s_0)}{1-\sigma_2} \tag{A.5}$$

Taking logs of (A.4), substituting ln(K) into it and solving for ln(D_{hg}):

$$\ln(D_{hg})=\frac{(1-\sigma_2)\cdot\ln(s_{hg/g})+\ln(s_g)-\ln(s_0)}{1-\sigma_1} \tag{A.6}$$

Substituting (A.5) and (A.6) into (A.2) we get:

$$\ln(s_j)-\ln(s_0)=\frac{\delta_j}{1-\sigma_1}+\frac{\sigma_2-\sigma_1}{1-\sigma_1}\cdot\ln(s_{hg/g})+ \\ +\left[\ln(s_g)-\ln(s_0)\right]\cdot\left[\frac{\sigma_2-\sigma_1}{(1-\sigma_1)\cdot(1-\sigma_2)}-\frac{\sigma_2}{1-\sigma_2}\right] \tag{A.7}$$

Simplifying:

$$\ln(s_j) - \ln(s_0) = \frac{\delta_j}{1-\sigma_1} + \frac{\sigma_2 - \sigma_1}{1-\sigma_1} \cdot \ln(s_{hg/g}) - [\ln(s_g) - \ln(s_0)] \cdot \left[\frac{\sigma_1}{1-\sigma_1}\right] \quad \text{(A.8)}$$

Now, from (4.11) we know that

$\ln(s_g) = \ln(s_j) - \ln(s_{j/hg})$- $\ln(s_{hg/g})$.

Substituting it into (A.8), we obtain:

$$[\ln(s_j) - \ln(s_0)] \cdot \left[1 + \frac{\sigma_1}{1-\sigma_1}\right] = \frac{\delta_j}{1-\sigma_1} + \frac{\sigma_2}{1-\sigma_1} \cdot \ln(s_{hg/g}) + \frac{\sigma_1}{1-\sigma_1} \cdot \ln(s_{j/hg}) \quad \text{(A.9)}$$

Simplifying, dividing by ($1-\sigma_1$) and substituting δ_j, we obtain (4.18)

According to Verboven (1996), the elasticities for a two-stage nested logit are:

$$e_{jj} \equiv -\frac{\partial q_j}{\partial p_j}\frac{p_j}{q_j} = \alpha p_j \left[\frac{1}{1-\sigma_1} - \left(\frac{1}{1-\sigma_1} - \frac{1}{1-\sigma_2}\right)\frac{q_j}{Q_{hg}} - \frac{\sigma_2}{1-\sigma_2}\frac{q_j}{Q_g} - \frac{q_j}{M}\right]$$

$$e_{jk} \equiv \frac{\partial q_k}{\partial p_j}\frac{p_j}{q_k} = \alpha p_j \left[\left(\frac{1}{1-\sigma_1} - \frac{1}{1-\sigma_2}\right)\frac{q_j}{Q_{hg}} + \frac{\sigma_2}{1-\sigma_2}\frac{q_j}{Q_g} + \frac{q_j}{M}\right]$$

$$e_{jk`} \equiv \frac{\partial q_{k`}}{\partial p_j}\frac{p_j}{q_{k`}} = \alpha p_j \left[\frac{\sigma_2}{1-\sigma_2}\frac{q_j}{Q_g} + \frac{q_j}{M}\right]$$

$$e_{jk``} \equiv \frac{\partial q_{k``}}{\partial p_j}\frac{p_j}{q_{k``}} = \alpha p_j \frac{q_j}{M}$$

where k, k'and k" are vehicles that respectively belong to the same subgroup, to a different subgroup within the same group and to a different group. Derivatives used in equation (4.22) are obtained by inverting the formulas above.

Posing a single nest translates to assuming $\sigma_i = \sigma_2 = \sigma$. Thus, the formulas above simplify to three cases only:

$$e_{jj} \equiv -\frac{\partial q_j}{\partial p_j}\frac{p_j}{q_j} = \alpha p_j \left[\frac{1}{1-\sigma} - \frac{\sigma}{1-\sigma}\frac{q_j}{Q_g} - \frac{q_j}{M}\right]$$

$$e_{jk`} \equiv \frac{\partial q_{k`}}{\partial p_j}\frac{p_j}{q_{k`}} = \alpha p_j \left[\frac{\sigma}{1-\sigma}\frac{q_j}{Q_g} + \frac{q_j}{M}\right]$$

$$e_{jk``} \equiv \frac{\partial q_{k``}}{\partial p_j}\frac{p_j}{q_{k``}} = \alpha p_j \frac{q_j}{M}$$

TABLE A.1

Correlation Matrix For Demand-Side Variables

	LN (NETSHARE)	LN (PRECO)	HP_WT	PWR_ST	WID	POPULAR	MEDIUM	LARGE	LUXURY	D94	REAL	D97	REGIME	LN($s_{j/hg}$)	LN($s_{hg/g}$)	LN($s_{j/hg}$) + LN($s_{hg/g}$)
LN(NETSHARE)	1.000	-0.473	-0.315	-0.342	-0.123	0.303	0.102	-0.158	-0.200	-0.146	-0.124	-0.079	-0.022	0.634	0.451	0.880
LN(PRECO)	-0.473	1.000	0.579	0.635	0.469	-0.386	-0.286	0.269	0.558	0.035	-0.068	-0.081	-0.064	0.067	-0.375	-0.185
HP_WT	-0.315	0.579	1.000	0.380	0.311	-0.387	-0.034	0.069	0.272	0.063	0.071	0.062	0.055	-0.084	-0.176	-0.193
PWR_ST	-0.342	0.635	0.380	1.000	0.322	-0.161	-0.305	0.283	0.356	0.278	0.268	0.183	0.150	0.121	-0.413	-0.160
WID	-0.123	0.469	0.311	0.322	1.000	-0.191	-0.091	0.296	0.243	0.153	0.125	0.094	0.073	0.028	-0.029	0.007
POPULAR	0.303	-0.386	-0.387	-0.161	-0.191	1.000	-0.168	-0.126	-0.075	0.068	0.045	0.054	0.035	0.132	0.122	0.201
MEDIUM	0.102	-0.286	-0.034	-0.305	-0.091	-0.168	1.000	-0.540	-0.321	-0.082	-0.090	-0.085	-0.060	-0.313	0.101	-0.222
LARGE	-0.158	0.269	0.069	0.283	0.296	-0.126	-0.540	1.000	-0.239	0.007	0.027	0.031	0.019	0.006	0.002	0.007
LUXURY	-0.200	0.558	0.272	0.356	0.243	-0.075	-0.321	-0.239	1.000	0.059	0.041	0.019	0.012	0.212	-0.085	0.139
D94	-0.146	0.035	0.063	0.278	0.153	0.068	-0.082	0.007	0.059	1.000	0.744	0.517	0.321	-0.082	-0.265	-0.250
REAL	-0.124	-0.068	0.071	0.268	0.125	0.045	-0.090	0.027	0.041	0.744	1.000	0.695	0.431	-0.092	-0.204	-0.218
REGIME	-0.079	-0.081	0.062	0.183	0.094	0.054	-0.085	0.031	0.019	0.517	0.695	1.000	0.620	-0.017	-0.182	-0.135
D97	-0.022	-0.064	0.055	0.150	0.073	0.035	-0.060	0.019	0.012	0.321	0.431	0.620	1.000	0.015	-0.140	-0.078
LN($s_{j/hg}$)	0.634	0.067	-0.084	0.121	0.028	0.132	-0.313	0.006	0.212	-0.082	-0.092	-0.017	0.015	1.000	-0.230	0.769
LN($s_{hg/g}$)	0.451	-0.375	-0.176	-0.413	-0.029	0.122	0.101	0.002	-0.085	-0.265	-0.204	-0.182	-0.140	-0.230	1.000	0.445
LN($s_{j/hg}$) + LN($s_{hg/g}$)	0.880	-0.185	-0.193	-0.160	0.007	0.201	-0.222	0.007	0.139	-0.250	-0.218	-0.135	-0.078	0.769	0.445	1.000

TABLE A.2

Correlation Matrix For Supply-Side Variables

	LN(MC)	AIR	PWR_ST	PWR_WD	LN(WGT)	LN(WAGES)	LN(HP)	LN(TRUNK)	POPULAR	MEDIUM	LARGE	LUXURY	D94	REAL	REGIME	D97	LN(SALES)	LN(OUTPUT)
LN(MC)	1.000	0.503	0.537	0.552	0.732	0.140	0.751	0.491	-0.405	-0.239	0.282	0.538	-0.141	-0.257	-0.213	-0.089	-0.384	0.057
AIR	0.503	1.000	0.665	0.702	0.459	0.217	0.492	0.014	-0.176	-0.265	0.218	0.301	0.124	0.145	0.100	0.072	-0.389	0.172
PWR_ST	0.537	0.665	1.000	0.664	0.556	0.150	0.566	0.165	-0.224	-0.255	0.334	0.267	0.090	0.140	0.083	0.093	-0.333	0.103
PWR_WD	0.552	0.702	0.664	1.000	0.510	0.159	0.557	0.099	-0.203	-0.328	0.222	0.396	0.105	0.140	0.146	0.137	-0.373	0.112
LN(WGT)	0.732	0.459	0.556	0.510	1.000	0.093	0.837	0.548	-0.312	-0.236	0.420	0.487	0.086	0.092	0.067	0.049	-0.302	-0.006
LN(WAGES)	0.140	0.217	0.150	0.159	0.093	1.000	0.197	0.043	0.000	-0.203	0.086	0.139	0.104	0.308	0.241	0.115	-0.112	0.063
LN(HP)	0.751	0.492	0.566	0.557	0.837	0.197	1.000	0.423	-0.461	-0.138	0.313	0.433	0.088	0.096	0.073	0.057	-0.391	0.043
LN(TRUNK)	0.491	0.014	0.165	0.099	0.548	0.043	0.423	1.000	-0.343	0.052	0.376	0.202	-0.009	-0.001	-0.014	-0.030	-0.153	-0.123
Popular	-0.405	-0.176	-0.224	-0.203	-0.312	0.000	-0.461	-0.343	1.000	-0.183	-0.142	-0.092	0.002	-0.006	0.022	0.015	0.353	-0.014
Medium	-0.239	-0.265	-0.255	-0.328	-0.236	-0.203	-0.138	0.052	-0.183	1.000	-0.509	-0.329	-0.046	-0.070	-0.073	-0.051	0.046	-0.045
Large	0.282	0.218	0.334	0.222	0.420	0.086	0.313	0.376	-0.142	-0.509	1.000	-0.255	0.030	0.049	0.047	0.027	-0.115	-0.068
Luxury	0.538	0.301	0.267	0.396	0.487	0.139	0.433	0.202	-0.092	-0.329	-0.255	1.000	-0.002	-0.005	-0.015	-0.009	-0.203	0.093
D94	-0.141	0.124	0.090	0.105	0.086	0.104	0.088	-0.009	0.002	-0.046	0.030	-0.002	1.000	0.581	0.361	0.212	-0.049	0.102
Real	-0.257	0.145	0.140	0.140	0.092	0.308	0.096	-0.001	-0.006	-0.070	0.049	-0.005	0.581	1.000	0.622	0.365	-0.056	0.106
Regime	-0.213	0.100	0.083	0.146	0.067	0.241	0.073	-0.014	0.022	-0.073	0.047	-0.015	0.361	0.622	1.000	0.588	-0.027	0.061
D97	-0.089	0.072	0.093	0.137	0.049	0.115	0.057	-0.030	0.015	-0.051	0.027	-0.009	0.212	0.365	0.588	1.000	0.012	0.016
LN(SALES)	-0.384	-0.389	-0.333	-0.373	-0.302	-0.112	-0.391	-0.153	0.353	0.046	-0.115	-0.203	-0.049	-0.056	-0.027	0.012	1.000	-0.099
LN(OUTPUT)	0.057	0.172	0.103	0.112	-0.006	0.063	0.043	-0.123	-0.014	-0.045	-0.068	0.093	0.102	0.106	0.061	0.016	-0.099	1.000

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