A Customs Union with Multinational Firms: The Automobile Market in Argentina and Brazil

Irene Brambilla †
Yale University

March 2004

Abstract

In this paper, I estimate the economic effects of adopting a customs union in the context of an oligopolistic market with multinational firms, tariffs and non-tariff barriers. Specifically, I estimate a model of demand and supply for cars in Argentina and Brazil and I look at the consequences of adopting MERCOSUR, a regional trade agreement to be fully implemented in 2006. I use the random-coefficient approach to estimate the demand for differentiated products. On the supply side, I develop a model of the strategic behavior of multinational firms in the presence of active trade intervention in the form of tariffs and non-tariff barriers (NTBs). I propose a minimum-distance estimator that allows for the joint estimation of production costs and shadow costs of the NTBs without making functional form assumptions.

To explore the effects of the trade policy, I derive equilibrium conditions for firms under the changed policy parameters and I use the estimates of demand and costs to predict the outcome in these counterfactual equilibria. I decompose the effects on prices, volumes of trade, profits and consumer welfare into the separate impacts of two simultaneous changes in policy: the removal of NTBs and the adoption of a common external tariff.

† I am grateful to Gene Grossman, Bo Honoré, and Elie Tamer for their guidance and suggestions, and to Guido Porto for helpful comments on several drafts. I also wish to thank Steve Berry, Penny Goldberg, Han Hong, Giovanni Maggi, and seminar participants at Chicago GSB, Columbia, Georgetown, NYU, NYU Stern, Princeton, Santa Cruz, Texas-Austin, Toronto, The Worldbank, and Yale for helpful discussion. All errors are mine. email: irene.brambilla@yale.edu

1 Introduction

In this paper I estimate the economic effects of adopting a customs union in the context of an oligopolistic market with multinational firms and trade balance constraints. I focus on the impact of trade reforms on trade volumes, prices, and economic welfare. To do this, I study the automobile markets in Argentina and Brazil in the context of MERCOSUR, a regional trade agreement between Argentina, Brazil, Uruguay and Paraguay.

The policy experiment that I examine has some unique features. While Argentina and Brazil agreed to form a customs union in the car market by 2006, the transition involves changes in tariffs and elimination of non-tariff barriers (NTBs) including trade balance constraints and bilateral quotas. In particular, the trade reform that is now taking place involves two main and distinctive instruments. First, the member countries agreed to set a common external tariff on imports of cars from the rest of the world that is higher than the pre-agreement tariff rate. Since Brazil was levying a much higher tariff on cars than Argentina prior to the reform, this leveling of tariffs implies a slight increase in Brazilian taxes and a sharp increase in Argentine taxes. This is a movement away from free trade that should be more relevant in Argentina than in Brazil. Second, both countries have agreed to fully eliminate the NTBs. This is a clear movement towards free trade in both countries.

The automobile market in MERCOSUR is dominated by multinational firms that simultaneously produce in both countries, are involved in bilateral trade, and import from the rest of the world. The strategic interaction between the subsidiaries of the same corporations in Argentina and Brazil and the complexity of the trade policy provide a rich environment for economic analysis and broaden the scope for econometric measurement.

The empirical strategy I use comprises the estimation of demand and supply for cars to recover the structural parameters of both the Argentine and Brazilian markets. I use these parameters to simulate an equilibrium under a customs union an assess its impact on quantities, prices, profits, trade volume and welfare.

On the demand side, I adopt the random-coefficient model of Berry (1994) and Berry, Levinsohn and Pakes (1995). Most relevant for my purposes, this model allows for the estimation of a structural demand function. I am also able to recover own price and cross-price elasticities for different cars.

On the supply side, I characterize the behavior of multinational firms in oligopolistic competition. I derive the first order conditions for profit maximization taking into account the strategic interdependence caused by the interaction of firms, not only with competitors but also with subsidiaries in other countries. With these FOCs and the parameters of demand estimated with the Berry, Levinsohn and Pakes (1995) procedure, I can recover the marginal costs of production for different car models and for different firms and the shadow costs imposed by the non-tariff barriers (NTBs).

The model is general enough that I can use it to characterize the optimal behavior of firms, conditional on demand, for different policy scenarios. I proceed to derive a set of FOCs for all firms in three different equilibria, each capturing different elements of the trade reform. I begin by describing the equilibrium during the *convergence period*, the initial situation. Then, I characterize the *no-NTBs* equilibrium, in which the bilateral quotas and the trade balance constraints are removed but the tariffs rates remain at the pre-customs union level. And finally, I define the *customs-union* equilibrium, which adds the adoption of a common external tariff to the elimination of non-tariff barriers. By comparing these equilibria, I am able to identify the main economic effects of the trade policies being adopted by these countries in this particular market.

I find that under a customs union, prices of vehicles are on average 659 dollars lower in Argentina and consumers are better off by 393 dollars per vehicle than during the convergence period. The opposite happens in Brazil where cars are 100 dollars more expensive and consumers suffer a loss in welfare of 204 dollars per vehicle. Tariff revenue increases in both countries, and in Brazil it more than offsets the loss in consumer welfare.

Using a decomposition of the policy changes, I find that the elimination of non-tariff barriers dominates the leveling of tariffs for all the effects that I measure. It is easy to see why this is true in Brazil, since the common external tariff does not increase much. But the result is true even in Argentina where the adjustment in tariffs is substantial. In particular, imports from the rest of the world increase under the new regime even though tariffs against these goods become more discriminatory.

Another finding is that, in the customs union, imports from Brazil decrease in Argentina. The strategic interaction between subsidiaries in the two countries explains this seemingly counterintuitive result. The existing trade balance constraints distort the price decisions of the firms and trade between partners in the initial equilibrium. When NTBs are eliminated, the directions of change in bilateral flows are a priori unpredictable.

Previous evaluations of trade policy in automobile markets have looked at the voluntary export restraint (VER) of Japanese vehicles in U.S. that was set up in 1981. Dixit (1988) calibrates a model with two differentiated products, American and Japanese. He computes the optimal tariff on cars and finds that restricting Japanese imports, by means of a higher tariff, would have been welfare enhacing for the U.S. Feenstra (1984) and (1988) estimates the increase in prices of Japanese cars that was due to the VER. He shows that part of the increase in prices is explained by an upgrade in quality. Goldberg (1995) and later Berry, Levinsohn and Pakes (1999) estimate more complete models of supply and demand in the U.S. market and simulate the counterfactual equilibrium without the VER. These papers have very different predictions: while Goldberg finds that the VER was binding in the first years after it was imposed, Berry, Levinsohn and Pakes suggest the opposite.

There are several elements that clearly differentiate my analysis from this literature. First, the policy experiment is more complex and it involves the individual identification of the effects of two simultaneous changes in policy, the elimination of NTBs and the leveling of tariffs. Second, I model the behavior of multinational automobile producers in two separate markets, Argentina and Brazil. This requires modeling the strategic interaction among firms and among the subsidiaries within a firm. Finally, I am able to estimate production cost and the shadow cost of NTBs (represented by Lagrange multipliers) with fewer assumptions on functional forms. Both Goldberg and Berry, Levinsohn and Pakes need to assume a specific form for the production cost to disentangle its effect on prices from the effect of NTBs. They estimate a single Lagrange multiplier (shadow cost of NTBs) for all firms. In contrast, I introduce a minimum distance procedure that allows for the estimation of marginal costs and different Lagrange multipliers for each producer without any assumption on the determinants of production costs.

This same empirical strategy can be applied to different industries and to different free trade areas. For example, it can be used to simulate the effects that the incorporation of a new country to the European Union would have on the other member countries, in a particular industry.

The paper is organized as follows. The next section provides a brief description of the automobile trade policy in Argentina and Brazil pre and post-MERCOSUR. Section 3 lays out a model of demand and supply. Section 4 discusses the estimation while section 5 reports the results. Section 6 describes the counterfactual equilibria, the estimation strategy and results of the trade reforms. Section 7 concludes. Technical details are gathered in the Appendix.

2 The automobile market in Argentina and Brazil

Automobiles are produced in Argentina and Brazil by subsidiaries of multinational corporations. [1] These firms manufacture in each country and import from the other and from the rest of the world. Cars are also imported into these markets by firms that do not have production facilities in the region.[2] Throughout this paper, I focus on demand and supply for cars produced domestically in Argentina or Brazil or imported by local producers. These firms capture more than 90% of the combined market. Moreover, other imports are subject to a different trade regime.

Historically, the industry has been heavily protected in Argentina and Brazil. In 1990 the two countries agreed to eliminate tariffs for bilateral imports and to set "quotas" on *net* imported units in both countries.[3] Each country kept its own tariff rate on imports from the rest of the world and later imposed a *global trade balance constraint* (GTB) that restricted the total value of imports to be less or equal to the total value of exports. Trade of vehicles grew rapidly and it accounted for a large part of total bilateral trade.[4]

[1] These firms are: Ford, General Motors, Chrysler, Fiat, Volkswagen, Mercedes Benz, Peugeot-Citroën, Renault, Toyota and Honda. Chrysler and Mercedes Benz merged in 2000 and formed Daimler-Chrysler.

[2] Among the most important are Rover, Isuzu and Daewoo.

[3] That is, the number of imported units may not exceed the number of exported units by more than a negotiated limit.

[4] For example, in 1997, imports of cars accounted for more than 17% of Brazilian imports from Argentina,

In 1995, Brazil, Argentina, Uruguay and Paraguay formed a customs union called MERCOSUR. The automobile sector received different treatment from other goods. The sector was initially left out of the agreement and its incorporation was scheduled for 2000. I refer to this transition from 1996 to 1999 as the *convergence period*. The change in the trade barriers from the convergence period to the customs union is the focus of my research.

Before the formal adoption of MERCOSUR, at the beginning of 1995, the tariff for outside vehicles was 2% in Argentina and 32% in Brazil. These countries agreed to adopt a common external tariff of 35% by the end of 1999. Convergence to the common rate was gradual in Argentina, with steady trimestral increases. In Brazil, it was more erratic, although never higher than 35% (it reached 35% in 1996 and in 1999).

The implementation of non-tariff barriers was more complicated as it involved two different policy interventions. From 1996 to 1999, imports were subject to an intertemporal global trade balance constraint (GTB) in each country, which stipulated that for each firm the value of imports could not exceed the value of exports (plus other export credits) during the entire convergence period. To compute trade balance, both imports from the partner and the rest of the world were included in these constraints. Exports were multiplied by a factor of 1.2. In addition, firms were granted export credits that could be included in the value of exports in the trade balance constraints. Investment in capital goods and net exports of spare-parts were considered export credits (which were not multiplied by 1.2). Firms could also buy export credits from independent spare-part producers.

The countries also implemented quantitative restrictions. According to the 1990 agreement, trade between partners was subject to annual quotas on *net* imports, with the purpose of balancing trade in units.[5] These quotas were negotiated by the two countries and then arbitrarily assigned to firms, presumably based on past participation on the market.

In 2000 the two non-tariff barriers (NTBs) were eliminated. However, they were replaced by a bilateral trade balance constraint that established that the annual value of exports to the partner should be equal to the value of imports.[6] As a consequence, a *managed customs*

and 10% of Argentine imports from Brazil.

[5] For example, in the case of Argentina, the total number of cars that this country imports from Brazil minus the total number of cars that it exports to Brazil may not exceed a given limit (quota).

[6] To be more precise, in each country, the value of imports is restricted to be less or equal to the value of

union was arranged: tariffs were zero for internal trade and uniform for external trade, but trade between partners was not free of NTBs. Implementation of the full customs union was deferred until 2006. The following table summarizes the different regimes

Convergence Period (1996-1999)	Managed Customs Union (2000-2005)	Customs Union (2006)
Internal tariff: 0% Different external tariff (≤35%) Global Trade Balance (GTB) Quota for net Imports	Internal tariff: 0% Common external tariff (35%) Bilateral Trade Balance	Internal tariff: 0% Common external tariff (35%)

In the next sections, I develop and estimate a model of industry demand and supply, including trade policy restrictions, for the period 1996-1999. With these results I simulate what the equilibrium would have been in 1996-1999, had the trade policy been that of a full customs union. I identify separately the impact on prices, quantities and welfare of the removal of NTBs and the convergence of external tariffs.

3 The model

3.1 Demand

I model demand using a random-coefficient logit approach. Consumers in Argentina and Brazil are assumed to choose only one car or none among all available models by maximizing a utility function defined over the characteristics of the different products and allowed to vary across individuals. Aggregate demand is obtained by the aggregation of individual choices. This same approach has been used in the estimation of demand for cars by Berry (1994), Berry, Levinsohn and Pakes (1995), Berry, Levinsohn and Pakes (1999) and Petrin (2002).[7]

exports multiplied by a "deviation coefficient" that is subject to annual adjustments to gradually loosen the constraint.

[7] A more straightforward way of modeling aggregate demand for differentiated products is to write a full system with a demand function for each product that depends on all prices and other control variables,

In my model, there are two countries and different time periods. Demand parameters differ across countries but not across time. For simplicity of notation, I describe the utility and demand functions for one country and year. At the end of the section I explain how the model is expanded to accommodate two countries and many time periods.

Utility of consumer i from purchasing product j, U_{ij}, is given by

$$U_{ij} = \alpha_i \left(y_i - p_j \right) + x_j' \beta_i + \xi_j + \varepsilon_{ij}$$

where y denotes income and p price.[8] I distinguish between two types of product characteristics: those that are observed by the econometrician like size and horsepower (denoted by x) and other unobserved characteristics, such as shape, popularity of the model and consumers' subjective perceptions of quality of the vehicle and reputation of the manufacturer.[9] ξ is a linear combination of the latter. This simplified form is adopted because without further information I am only able to recover this composite *unobservable*.[10]

The marginal utilities of after-purchase income (α_i) and of product characteristics (β_i) are specific to an individual. ε is a zero-mean random idiosyncratic term. It is independent and identically distributed across individuals and products, following a type I extreme-value distribution. Under this assumption, the difference between two random terms ($\varepsilon_j - \varepsilon_h$) follows a logistic distribution, which facilitates the computation of the probabilities of choosing each good.

The marginal utilities are parameterized as a linear combination of characteristics of the consumers, summarized by a vector ν

$$\alpha_i = \alpha_o + \sum_r \alpha_r \nu_{ir}; \qquad \beta_{ki} = \beta_{ko} + \sum_r \beta_{kr} \nu_{ir} \qquad k = 1,...K\,; r = 1,...R$$

like the linear expenditure demand system (LES) and the almost ideal demand system (AIDS) (see Deaton and Muellbauer (1980)). A limitation in the application of this approach is that the number of demand parameters increases exponentially with the number of available choices. In the present context, there are many car models available and the demand parameters easily outnumber the price-quantity observations of prices and quantities.

[8] The subindex j indicates both domestic and imported vehicles. I will distinguish vehicles according to country of origin in the supply section.

[9] Firms are assumed to observe these characteristics when setting prices.

[10] The unobservable ξ could in principle differ by individual. However, I estimate the model with market-level data, which does not allow for the estimation of different ξ's.

where K and R are the number of characteristics of the vehicles and individuals, respectively.

Consumers' characteristics are those individual variables relevant to the vehicle choice problem such as income, family size, number of children and age. As a result, marginal utility of income varies with income level and different individuals have different tastes for each car characteristic.[11] For simplicity of notation, I write each random coefficient as a function of all individual characteristics. If a more restrictive form is desired, the appropriate weight can be set to zero.

Individuals can choose not to purchase a new vehicle. This choice is usually referred to as the *outside alternative.* In this case, utility (U_{io}) depends on income and the utility of the alternative to a new car or reservation utility u_i.

$$U_{io} = \alpha_i y_i + u_i + \varepsilon_{io}$$

The reservation utility, which can be interpreted as the utility derived from either having a used car or using a different means of transportation, is assumed to be individual specific and is modeled as a linear combination of individual characteristics.

$$u_i = u_o + \sum_r u_r \nu_{ir}$$

For each consumer, the utility from purchasing each product can be normalized with respect to the expected utility when no car is purchased, by subtracting the latter. Thus

$$\widetilde{U}_{ij} = -u_i - \alpha_i p_j + x_j' \beta_i + \xi_j + \varepsilon_{ij} \tag{1}$$

where $\widetilde{U}_{ij}$ is the excess utility of car j relative to the outside alternative.

[11]Both the additive random term and the variable marginal utilities are introduced to allow for heterogeneity across individuals. Without heterogeneity all individuals would choose the same vehicle. With the sole addition of the additive random term, individuals choose different cars but they all have the same expected utility from each model, and in particular the same expected first choice. Moreover, deviations from the expected first choice are not explained by characteristics of the cars or of the individuals. This implies that substitution across products is only determined by market shares and does not depend on product characteristics. Hence, two very different models might end up being closer substitutes than two similar models. The logistic distribution assumption on the error term adds the independence of irrelevant alternatives property, which has been extensively documented in the multinomial logit literature. The use of variable coefficients eliminates these awkward substitution patterns.

Each individual chooses the product with the highest normalized utility, which in turn is a function of product and individual characteristics and of the utility parameters.[12] I summarize these parameters with the vector $\boldsymbol{\theta} = (\alpha_o, ...\alpha_R\ ; \beta_{1o}, ...\beta_{KR}\ ; u_o, ...u_R)$. Let $\mathbf{P}$, $\mathbf{x}$ and $\boldsymbol{\xi}$ denote the vectors of prices, observable characteristics of the cars and unobservables, respectively. Given the type I extreme-value distribution of the additive random terms, the probability $\sigma_j(\boldsymbol{\theta}, \nu_i)$ that car j is individual $i's$ preferred alternative has the following closed-form solution

$$\sigma_j(\boldsymbol{\theta}, \nu_i) = P\left(\widetilde{U}_{ij} \geq \widetilde{U}_{ih}, \forall h | \boldsymbol{\theta}; \nu_i; \mathbf{P}, \mathbf{x}, \boldsymbol{\xi}\right) = \frac{e^{-u_i - \alpha_i p_j + x_j\acute{}\beta_i + \xi_j}}{1 + \sum_{h=1}^{J} e^{-u_i - \alpha_i p_h + x_h\acute{}\beta_i + \xi_h}} \tag{2}$$

Note that these probabilities are conditional on ν_i, the vector of individual characteristics. The marginal probability of a random consumer choosing car j is obtained by integrating over the population distribution of ν and it is equal to the market share of product j. Aggregate demand is the market share multiplied by the number of individuals in the market, N. Let G be the cumulative distribution function of ν over the population of individuals. Then, aggregate demand for model j is

$$q_j = N \int \sigma_j(\boldsymbol{\theta}; \nu_i; \mathbf{P}, \mathbf{x}, \boldsymbol{\xi})\, dG(\nu_i) \tag{3}$$

Besides the level of demand, I am also interested in the price derivatives, as they are needed in the characterization and later estimation of the first order conditions. Because individuals have heterogenous tastes they react differently to a price change. Let $\eta_{jk}(\boldsymbol{\theta}, \nu_i)$ denote the change in the probability of individual i choosing product j when there is a change in the price of product k, that is $\eta_{jk}(\boldsymbol{\theta}, \nu_i) = \frac{\partial \sigma_j(\boldsymbol{\theta}, \nu_i)}{\partial p_k}$. The aggregate response to a change in price, $h_{jk} = \frac{\partial q_j}{\partial p_k}$, is once again obtained by integrating the individual responses over the distribution of idiosyncratic characteristics ν_i, which gives

$$h_{jk} = N \int \eta_{jk}(\boldsymbol{\theta}; \nu_i; \mathbf{P}, \mathbf{x}, \boldsymbol{\xi})\, dG(\nu_i) \tag{4}$$

with

[12] A limitation of this approach is that it ignores the dynamic aspects of the decision. Individuals only take present prices into account.

$$\eta_{jk}\left(\boldsymbol{\theta},\nu_{i}\right)=\begin{cases}-\alpha_i\sigma_j\left(\boldsymbol{\theta},\nu_{i}\right)\left(1-\sigma_j\left(\boldsymbol{\theta},\nu_{i}\right)\right) & \text{for } k=j\\ \alpha_i\sigma_j\left(\boldsymbol{\theta},\nu_{i}\right)\sigma_k\left(\boldsymbol{\theta},\nu_{i}\right) & \text{for } k\neq j\end{cases}$$

In my study, there are two countries (a and b) and different years (t). There is one vector of demand parameters for each country, $\boldsymbol{\theta}^a$ and $\boldsymbol{\theta}^b$, which is constant across time. Observed characteristics of the cars (x) are the same in the two countries since characteristics are used to define a same product (if x_j^a is different from $x_{j'}^b$, j and j' are considered to be different models), but they may change over the years. The distribution of characteristics of the consumers (G), the prices $(\mathbf{P})$ and the unobservables $(\boldsymbol{\xi})$ may vary by country and year.[13] Let t and h denote time and country, respectively. Aggregate demand in country h in period t is

$$q_{jt}^h=N_t^h\int\sigma_j\left(\boldsymbol{\theta}^h;\nu_{it}^h;\mathbf{P}_t^h,\mathbf{x}_t^h,\boldsymbol{\xi}_t^h\right)dG_t^h\left(\nu_{it}^h\right) \tag{5}$$

Notice that demand is written as a function of the *vector* of characteristics $\mathbf{x}_t^h$, which is indexed by h even though observable characteristics of cars are the same in both countries. This allows for the possibility of having different car models available in the two countries. In such a case (as it indeed happens in my data), the *vector* of characteristics is not the same.

In the next section, I use (5) to characterize the firms' problem and market equilibrium.

3.2 Supply

I model the supply side of the car market as a differentiated-product oligopoly with price competition. There are F multinational corporations with subsidiaries in Argentina and Brazil. Each firm produces some car models in Argentina, some models in Brazil and some models in the rest of the world. There are no restrictions regarding the possibility of a same good being produced in more than one country.

Producers face constant marginal costs. The cost of a particular car model depends on the country where it is produced (for example, due to different input costs) and on its

[13] Unobservables differ across markets because they include subjective perceptions.

characteristics.

In both countries, firms sell cars produced domestically, cars imported from the internal (MERCOSUR) partner and cars imported from the outside. Imports from the internal partner are free of taxes, whereas outside imports face a tariff τ^a in Argentina and τ^b in Brazil. These tariffs are different in the two countries, they start at an initial value and converge at the end of the period to the agreed level of τ. Imports are valued for tariff purposes at marginal costs.

Let q denote quantity, p price and c marginal cost. The superscript $h = a$ (Argentina) and b (Brazil) indicates the country in which a model is sold. Therefore p_j^a is the price of model j in Argentina. A_{ft}, B_{ft} and W_{ft} are the sets of cars produced by firm f in period t in Argentina, Brazil and the rest of the world, respectively, and sold in Argentina. While A'_{ft}, B'_{ft} and W'_{ft} denote the sets of cars sold in Brazil.

Profits in country h of multiproduct firm f are given by the sum of profits for each good produced by f in Argentina, Brazil and the rest of the world and sold in country h. Demand is a function of all prices in country h, summarized in the price vector $\mathbf{P}^h$ that includes the prices of cars sold by firm f and also the prices of the cars offered by competitors. Profits in period t in Argentina and Brazil are, respectively

$$\begin{aligned} \pi_{ft}^a &= \sum_{j \in A_{ft}} \left(p_{jt}^a - c_{jt}\right) q_j^a \left(\mathbf{P}_t^a\right) + \sum_{j \in B_{ft}} \left(p_{jt}^a - c_{jt}\right) q_j^a \left(\mathbf{P}_t^a\right) + \\ &+ \sum_{j \in W_{ft}} \left(p_{jt}^a - c_{jt}\left(1 + \tau_t^a\right)\right) q_j^a \left(\mathbf{P}_t^a\right) \end{aligned} \tag{6}$$

$$\begin{aligned} \pi_{ft}^b &= \sum_{j \in A'_{ft}} \left(p_{jt}^b - c_{jt}\right) q_j^b \left(\mathbf{P}_t^b\right) + \sum_{j \in B'_{ft}} \left(p_{jt}^b - c_{jt}\right) q_j^b \left(\mathbf{P}_t^b\right) + \\ &+ \sum_{j \in W'_{ft}} \left(p_{jt}^b - c_{jt}\left(1 + \tau_t^b\right)\right) q_j^b \left(\mathbf{P}_t^b\right) \end{aligned} \tag{7}$$

The firm chooses retail prices in Argentina and Brazil for all of its products to maximize its profits. The demand function and the competitors´ prices are taken as given.[14] Furthermore, characteristics of the products and entry-exit decisions are assumed to be exogenous to the pricing decision.

Imports by each firm, in each country, are subject to an intertemporal *global trade balance constraint* (GTB), by means of which the cumulative value of imports cannot exceed the cumulative value of exports. In addition, there is an annual quota for net imports from the trade partner (measured in units).

The Argentine and Brazilian GTBs for firm f can be written respectively as

$$\sum_{t\in T^0}\left(\sum_{j\in B_{ft}} c_{jt}q_j^a\left(\mathbf{P}_t^a\right)+\sum_{j\in W_{ft}} c_{jt}\left(1+\tau_t^a\right)q_j^a\left(\mathbf{P}_t^a\right)\right) \leq 1.2\sum_{t\in T^0}\sum_{j\in A'_{ft}} c_{jt}q_i^b\left(\mathbf{P}_t^b\right)+X_f^a \quad (8)$$

$$\sum_{t\in T^0}\left(\sum_{j\in A'_{ft}} c_{jt}q_j^b\left(\mathbf{P}_t^b\right)+\sum_{j\in W'_{ft}} c_{jt}\left(1+\tau_t^b\right)q_j^b\left(\mathbf{P}_t^b\right)\right) \leq 1.2\sum_{t\in T^0}\sum_{j\in B_{ft}} c_{jt}q_j^a\left(\mathbf{P}_t^a\right)+X_f^b$$

where T^0 denotes the period in which the GTB was in place, which coincides with the *convergence period*. The left-hand side corresponds to firm f 's imports, and the right-hand side to its exports. Exports of finished vehicles are multiplied by 1.2. Exports to the rest of the world, export credits from the acquisition or export of capital goods and net exports of spare-parts are included in the exogenous terms X_f^a and X_f^b.

The bilateral quantitative constraints dictate that in aggregate, net imports cannot exceed a negotiated annual limit (quota) in each country. I model each firm's constraint as a lower and an upper bound on net imports of the Brazilian subsidiary, $\underline{Q}_{ft}$ and $\overline{Q}_{ft}$, exogenously assigned.[15] The lower bound is the (negative of the) quota in Argentina, and the upper bound the quota in Brazil. Thus,

$$\underline{Q}_{ft} \leq \left(\sum_{j\in A'_{ft}} q_i^b\left(\mathbf{P}_t^b\right)-\sum_{j\in B_{ft}} q_j^a\left(\mathbf{P}_t^a\right)\right) \leq \overline{Q}_{ft} \quad (9)$$

[14] Demand is fully observed by firms, including the term ξ, which is unobservable to the econometrician.

[15] Anecdotal evidence suggests that they were assigned according to previous shares in imports and production.

Each firm maximizes total cumulative profits subject to the global and bilateral constraints. Given the particular ownership structure of the firms, in which the same corporations are located in Argentina and Brazil, the constraints link the equilibria in the two countries. When firms set prices, they add to the usual determinants of equilibrium (competition among firms and among products within the same firm) considerations of trade balance in both countries. They manipulate imports and exports in both locations to satisfy the constraints. Hence, prices in Brazil affect prices in Argentina, and vice versa.

Let λ_f^a and λ_f^b be the Lagrange multipliers associated with the GTBs of Argentina and Brazil respectively; and μ_{ft}^a and μ_{ft}^b denote the multipliers associated with the bilateral quantitative constraint (μ_{ft}^a is associated with the lower bound, the quota in Argentina, and μ_{ft}^b with the upper bound, the quota in Brazil). The first two are constant because there is a single cumulative constraint, the latter two, on the other hand, vary from year to year.

Let $\mathbf{q}_{ft}^h$ and $\mathbf{p}_{ft}^h$ be the vectors of quantities and prices of firm f in country h, and $\boldsymbol{\Delta}_{ft}^h$ its matrix of partial derivatives of demand with respect to price, with $\boldsymbol{\Delta}_{ft(ij)}^h = \partial q_{it}^h / \partial p_{jt}^h$. The first order conditions for firm f in period t and in countries a and b are

$$q_{ft}^a\left(\mathbf{P}_t^a\right) + \Delta_{ft}^a\left(\mathbf{P}_t^a\right)\left(\mathbf{p}_{ft}^a - \mathbf{c}_{ft}^{*a}\right) = 0 \tag{10}$$

$$q_{ft}^b\left(\mathbf{P}_t^b\right) + \Delta_{ft}^b\left(\mathbf{P}_t^b\right)\left(\mathbf{p}_{ft}^b - \mathbf{c}_{ft}^{*b}\right) = 0$$

where $\mathbf{c}_{ft}^{*h}$ is the vector of *adjusted marginal costs*, defined as the production marginal costs augmented by the implicit costs imposed by the trade taxes and restrictions[16]

$$c_{jt}^{*a} = \begin{cases} c_{jt} & \text{for } j \in A_{ft} \\ c_{jt}\left(1 + \lambda_f^a - 1.2\lambda_f^b\right) + \left(\mu_{ft}^a - \mu_{ft}^b\right) & \text{for } j \in B_{ft} \\ c_{jt}\left(1 + \tau_t^a\right)\left(1 + \lambda_f^a\right) & \text{for } j \in W_{ft} \end{cases} \tag{11}$$

$$c_{jt}^{*b} = \begin{cases} c_{jt}\left(1 + \lambda_f^b - 1.2\lambda_f^a\right) - \left(\mu_{ft}^a - \mu_{ft}^b\right) & \text{for } j \in A'_{ft} \\ c_{jt} & \text{for } j \in B'_{ft} \\ c_{jt}\left(1 + \tau_t^b\right)\left(1 + \lambda_f^b\right) & \text{for } j \in W'_{ft} \end{cases}$$

[16] The definition of adjusted marginal costs follows from the first order conditions.

Notice that, as opposed to production costs, adjusted costs of a given model may differ in the two countries due to different trade policy parameters or to different impacts of the restrictions; therefore c_{jt}^{*a} is not necessarily equal to c_{jt}^{*b}.

In Argentina, the cost of imports from Brazil is increased by $(100 \times \lambda^a)$ percent because each unit imported tightens the Argentine GTB. At the same time, each such export from Brazil helps relax the Brazilian GTB. This reduces the cost by $\left(100 \times 1.2\lambda^b\right)$ percent, and vice versa for Brazil. Imports from the rest of the world only tighten the GTB because there is no associated export credit. The cost of external imports is also increased by the tariff rate.

A priori, it is not possible to predict the effect of the NTBs on internal trade flows, as the net effect of the GTB on costs can be either positive or negative. Empirical results in section 6 show that imports from Brazil to Argentina are actually larger under the NTBs than when they are removed.

Stacking the first order conditions for the two countries, all time periods and all firms, the system can be written simply as

$$q(\mathbf{P}) + \Delta(\mathbf{P})(\mathbf{P} - \mathbf{c}^*) = 0 \tag{12}$$

$\mathbf{q}$, $\mathbf{P}$ and $\mathbf{c}^*$ are the stacked quantity, price and cost vectors across firms, years and countries, and $\boldsymbol{\Delta}$ is block diagonal, with $\boldsymbol{\Delta}_{ij} = 0$ when products i and j are produced by different firms, sold in different countries or belong to different periods.

The equilibrium prices and quantities satisfy the system of first order conditions given the random-coefficient demand function.

4 Estimation

4.1 Demand

The demand parameters to be estimated are the marginal utilities of income and product characteristics and the mean alternative utilities. I summarize these parameters with the vector $\boldsymbol{\theta} = (\alpha_o, \ldots \alpha_R; \beta_{1o}, \ldots \beta_{KR}; u_o, \ldots u_R)$, where R is the number of individual characteristics and K the number of car characteristics. I separately estimate different parameters for Argentina and Brazil. For simplicity of notation, I do not include the country superscript h in this section. I use the method developed by Berry (1994) and Berry, Levinsohn and Pakes (1995), which I lay out below.

I do not observe individual choices, only aggregate sales of each vehicle in different markets (time periods and regions), their prices and characteristics, and a sample from the distribution of individual characteristics in the population of each market. Identification of coefficients that vary by individual with only aggregate data is possible because the differences in aggregate choices in different markets are tied to differences in the distribution of demographics.[17]

One important issue is that $\boldsymbol{\xi}$ is not observed by the econometrician, but it is observed by the individuals and firms. Firms set prices given the demand function, which includes $\boldsymbol{\xi}$. In addition, some elements of $\boldsymbol{\xi}$ (for example, the shape of the car) affect production costs. Thus, price is correlated with $\boldsymbol{\xi}$ both via demand and cost. As price is an explanatory variable in the demand equation and the unobservables are the error term, instruments are needed to obtain consistent estimates. The difficulty is that, in contrast to the usual instrumental variables setting, ξ_{jt} is not an additive random term but enters the demand equation non-linearly, and I need to invert the system of demand equations to solve for $\boldsymbol{\xi}$.

Cost shifters (such as input prices) that vary across products could in principle be used as instruments but I do not have this kind of information. To solve this problem, the standard practice in the literature is to use demand-side instruments. Equilibrium prices depend on a product´s own characteristics and also on the characteristics of other alternatives. Intuitively, the price of a car depends on how close in the space of characteristics it is to others, and whether these substitutes are produced by the same firm or by competitors. The instruments that I use are a car's own characteristics, the average characteristics of the cars manufactured by the same firm and the average characteristics of models produced by

[17]For example, if it is observed that in a particular market both the average household size and the share of station wagons are larger than in other markets, it can be concluded that (other things equal) large households derive higher utility from station wagons than smaller households (β_k is higher). The actual procedure is more complex and it involves comparing the entire distributions of individual characteristics, not just the means.

its competitors.[18] The identifying assumption is that unobservable characteristics are mean independent from observable characteristics, $E\left(\xi_{jt}|\mathbf{x}\right) = 0$. Hence, if the instruments $\mathbf{z}$ are linear combinations of $\mathbf{x}$, they satisfy the orthogonality conditions

$$E\left(z_{jt}\xi_{jt}\right) = 0 \tag{13}$$

where j indexes the vehicle and t the time period.

The aggregate demand system from equations (2) and (3) can be written as

$$q_{jt} = N_t \int \frac{e^{-u_{it}-\alpha_{it}p_{jt}+x_{jt}\acute{}\beta_{it}+\xi_{jt}}}{1+\sum_{h=1}^{J} e^{-u_{it}-\alpha_{it}p_{ht}+x_{ht}\acute{}\beta_{it}+\xi_{ht}}} dG\left(\nu_{it}\right) \qquad j = 1,...J\,; t = 1,...T_j \tag{14}$$

Let T be the number of time periods and T_j the number of time periods in which product j is available. There are $\sum_j T_j$ demand equations. There are also T equations that restrict the market shares to add up to one in each market; together with the market size, this implies T demand equations for the outside alternative.

Let $\xi(\boldsymbol{\theta}, G)$ be the vector of unobservables $\boldsymbol{\xi}$ that solves the non-linear system above.[19] I need this vector, given $\boldsymbol{\theta}$ and G, to construct the orthogonality conditions (13). Thus, it is necessary to compute the integral in equation (14), which does not have a closed-form solution. This integral is the expected value of the probability that a random individual chooses model j. I estimate it using a simulation method (Pakes (1986), Lerman and Manski (1981)), which involves estimating an expectation with a sample average. I sample n_s consumers from the distribution G.[20] I compute the individual probabilities for each of the consumers (at a given value of $\boldsymbol{\theta}$) and I average them. More formally, the solution for the unobservables can be defined as follows. Let G_{n_s} be the empirical distribution of the sample of n_s consumers, and i_s the subindex for the sampled consumers. $\xi(\boldsymbol{\theta}, G_{n_s})$ is defined as the

[18] Berry, Levinsohn and Pakes (1995) use the *sum* of characteristics of same-firm and rival models, instead of the average, and they show that these instruments are optimal based on Chamberlain (1986) and Pakes (1994). In practice, however, the matrix of instruments constructed in this way is nearly collinear. The use of averages avoids the problem.

[19] Berry (1994) establishes its existence and uniqueness, provided all shares are strictly positive and some mild regularity conditions are satisfied.

[20] G may be a known parametric distribution or an empirical distribution (i.e. a household survey). In my case, I take draws of income and family size from household surveys, and draws from a standard normal to simulate the random alternative utilities.

vector of unobservables that solves the system[21,22]

$$q_{jt} = \frac{N_t}{n_s} \sum_{i_s} \frac{e^{-u_{i_s t} - \alpha_{i_s t} p_{jt} + x_{jt}' \beta_{i_s t} + \xi_{jt}}}{1 + \sum_{h=1}^{J} e^{-u_{i_s t} - \alpha_{i_s t} p_{ht} + x_{ht}' \beta_{i_s t} + \xi_{ht}}} \qquad j = 1,...J\,; t = 1,...T_j \tag{15}$$

This form of simulation-based estimator is used later in this section to estimate the price derivatives and in section 6 to predict quantities and estimate the compensating variation of counterfactual changes in policy.

The vector of unobservables is used to construct the sample analogue of the orthogonality conditions.

$$g(\boldsymbol{\theta}, G_{n_s}) = \frac{1}{J} \sum_j \frac{1}{T_j} \sum_t z_{jt} \xi_{jt}(\boldsymbol{\theta}, G_{n_s, t})$$

The estimator is the vector of parameters $\hat{\boldsymbol{\theta}}$ that minimizes an appropriate norm of the sample moment conditions

$$\hat{\boldsymbol{\theta}} = \arg\min_{\boldsymbol{\theta}} g(\boldsymbol{\theta}, G_{n_s})^T \widehat{W}_1 g(\boldsymbol{\theta}, G_{n_s}) \tag{16}$$

$\widehat{W}_1$ is an $L \times L$ weighting matrix (where L is the number of instruments) that is arbitrarily chosen. For efficiency, $\widehat{W}_1$ is the inverse of a consistent estimator of the variance of the orthogonality conditions (it gives more weight to the moments with lower variance). Hence, in practice the estimation is carried out in two steps.

To estimate the price derivatives, I use a simulation-based estimator of the integral in equation (4). I take a sample of n_s consumers and compute the individual derivatives at the estimated value of the demand parameter $\hat{\boldsymbol{\theta}}$. I average them and multiply by the market size to obtain the expected value of the derivative and the aggregate response, respectively.

$$h(\widehat{\boldsymbol{\theta}}, G_{n_s, t}) = \frac{N_t}{n_s} \sum_{i_s} \eta\left(\widehat{\boldsymbol{\theta}}, \nu_{i_s, t}\right) \tag{17}$$

The estimator h is written as a function of $\hat{\boldsymbol{\theta}}$ and G_{n_s} to emphasize the fact that it

[21] $\xi(\boldsymbol{\theta}, G_{n_s})$ is an approximation of $\xi(\boldsymbol{\theta}, G)$.

[22] Berry, Levinsohn and Pakes (1995) provide a contraction mapping algorithm to solve for $\xi(\boldsymbol{\theta}, G_{n_s})$ recursively.

depends on the estimated value of the demand parameters and the sample of n_s individuals.

4.2 Supply

In this section I describe how to estimate the marginal costs of production using observed prices and quantities, the estimates of the price derivatives, and the first order conditions (FOCs) derived from the firms' price-setting behavior in the *convergence period* equilibrium. The Lagrange multipliers in (11) are estimated jointly with the marginal costs. My goal is to recover structural parameters of the production technology that I use later to predict consistently the firms' behavior in the hypothetical situation of a customs union (such as is scheduled for 2006).

Consider first the simple case of a country that produces J goods with no trade barriers. The system of FOCs is the same as equation (12). If prices and quantities are observed and with an estimator of the matrix of partial derivatives $\Delta\left(\hat{\boldsymbol{\theta}}, G_{n_s}\right)$, the FOCs can be inverted to yield the following estimator of the marginal costs[23]

$$\widehat{\mathbf{c}} = \mathbf{p} + \Delta\left(\hat{\boldsymbol{\theta}}, G_{n_s}\right)^{-1}\mathbf{q}$$

Inverting the system of FOCs to get just-identified estimates of the marginal costs is the common practice in the literature. Goldberg (1995) and Berry, Levinsohn and Pakes (1999) use a variant of this method to evaluate the impact of the Japanese VER; Petrin (2002) to quantify the effect of the introduction of the minivan; Nevo (2000) and (2001) to investigate market power and mergers in the cereal industry.

In my model with two countries and trade restrictions, the FOCs are overidentified and cannot be inverted. This is because most goods are manufactured in one country and sold in two countries (with the few exceptions of those products manufactured in two countries and those sold in only one country). Hence, for most products there is one marginal cost and two pricing equations in each time period, which means that there are twice as many equations as unknowns.

Notice that there are two Lagrange multipliers per firm per year for the bilateral

[23] $\Delta\left(\hat{\boldsymbol{\theta}}, G_{ns}\right)$ is obtained by arranging the estimator of the price derivatives $h\left(\hat{\boldsymbol{\theta}}, G_{ns}\right)$ in matrix form.

quantitative restrictions (μ^a and μ^b) and two Lagrange multipliers per firm for the multiperiod global trade balance constraints (λ^a and λ^b). Although this increases the number of unknowns, the system remains overidentified since in my model many goods are produced by a few firms (this means that there are many pricing equations with few unknown Lagrange multipliers).[24]

Instead of the "perfect-fit" method employed by previous authors for the one-country case, in which the costs are just-identified, I propose a minimum-distance procedure. The estimator of $(\mathbf{c}, \boldsymbol{\lambda}, \boldsymbol{\mu})$ makes the system of first order conditions as close to zero as possible given the estimator of the price derivatives, as dictated by the following criterion function

$$\begin{aligned}\left(\widehat{\mathbf{c}}, \widehat{\boldsymbol{\lambda}}, \widehat{\boldsymbol{\mu}}\right) &= \arg \min_{(\mathbf{c},\boldsymbol{\lambda},\boldsymbol{\mu})} \left(\mathbf{q} + \Delta(\mathbf{P}, \hat{\boldsymbol{\theta}}, G_{n_s}) \left(\mathbf{P} - c^*(\mathbf{c}, \boldsymbol{\lambda}, \boldsymbol{\mu})\right)\right)^T \times \\ & \qquad \widehat{W}_2 \left(\mathbf{q} + \Delta(\mathbf{P}, \hat{\boldsymbol{\theta}}, G_{n_s}) \left(\mathbf{P} - c^*(\mathbf{c}, \boldsymbol{\lambda}, \boldsymbol{\mu})\right)\right)\end{aligned} \tag{18}$$

where $\mathbf{c}^*$ is defined as in (11). $\widehat{W}_2$ is a square weighting matrix, with its dimension equal to the number of price equations. For efficiency, $\widehat{W}_2$ can be the inverse of an estimator of the variance of the price equations. However, as I explain below, for computational simplicity I use the identity matrix.

This procedure has considerable advantages over the perfect-fit method. First, it provides a test of the model in the sense that one can test whether the first order conditions are close enough to zero. Notice, on the one hand, that although in the perfect-fit method the FOCs are exactly zero, the marginal costs are estimated with error because the matrix of partial derivatives is an estimator of the true matrix. The FOCs are satisfied mechanically (it is as if running a k-parameter linear regression with k observations). On the other hand, the fact that the minimum-distance estimator of the two-country case does not satisfy the FOCs does not mean that firms are not maximizing profits. The FOCs are satisfied when evaluated at the unobserved true value of the demand derivatives, costs and Lagrange multipliers.

Second, and more important, there are enough degrees of freedom to estimate the Lagrange multipliers together with the marginal costs. Goldberg (1995) and Berry, Levinsohn and Pakes (1999), estimate the impact of Japanese VERs on automobiles using a similar Lagrange

[24]In addition, I observe prices and quantities by semester, hence there are four pricing equations per year.

multiplier approach to estimate the quantitative constraints. However, they model only U.S. demand and the adjusted marginal costs are exactly identified. To separate the effects of production cost and the shadow cost of the VERs (Lagrange multipliers) they assume a logarithmic cost function, in which a model's production cost depends on its characteristics. They later estimate production costs and an average Lagrange multiplier by regressing adjusted marginal costs on product characteristics and a dummy variable for imported vehicles. This has the potential problem of spreading misspecifications of the cost function to the estimation of the costs and Lagrange multipliers. When using my minimum distance estimator, it is not necessary to specify a regression function for the marginal cost. Production cost and Lagrange multipliers can be estimated without further functional form assumptions.

The actual computation of the estimates is not as cumbersome as it may be suggested by their dimension if the identity matrix is used (or more generally, any block-diagonal matrix with zeros for different firms and years). The estimator of the marginal costs has an analytical solution given a value of the Lagrange multipliers. Hence, the numerical search can be limited to the latter ($\boldsymbol{\lambda}$ and $\boldsymbol{\mu}$). The distance function unfolds into the sum of one "distance" per firm. For each firm, there is a two-dimensional search over λ_f^a and λ_f^b, with T nested one-dimensional searches over $\left(\mu_{ft}^a - \mu_{ft}^b\right)$. μ_{ft}^a and μ_{ft}^b are indeed separately identified since the two constraints to which they associate cannot be binding at the same time. If $\mu_{ft}^a - \mu_{ft}^b$ is positive, then μ_{ft}^a is positive and μ_{ft}^b zero, and vice versa. If $\mu_{ft}^1 - \mu_{ft}^b$ is zero, then both multipliers are zero and none of the bilateral constraints are binding.

4.3 Computing Standard Errors

The estimators of the utility function parameters, the price derivatives, and the marginal costs and Lagrange multipliers are consistent and asymptotically normal. In this section I discuss some practical aspects of how to estimate their standard errors. A more thorough discussion about the asymptotic distributions can be found in the appendix.

Consider the estimator of the parameters of the utility function, $\hat{\boldsymbol{\theta}}$. Its variance is dictated by the variance of the orthogonality conditions. In the usual GMM case, that is the variance in the process generating the data, associated to the model's error term (the unobservables

$\boldsymbol{\xi}$ in this model). In the model described in this paper, there is an additional source of variance: the error in the estimation of the integral in equation (14), which translates into writing the orthogonality conditions in terms of $\xi(\boldsymbol{\theta}, G_{n_s})$ instead of $\xi(\boldsymbol{\theta}, G)$.[25,26] Let S_1 and S_2 denote the two sources of variance, respectively. The asymptotic distribution of $\hat{\boldsymbol{\theta}}$ is

$$\sqrt{J}(\hat{\boldsymbol{\theta}} - \boldsymbol{\theta}_o) \rightarrow_d N\left(0, (\Gamma W_1 \Gamma)^{-1} \Gamma W_1 (S_1 + S_2) W_1 \Gamma (\Gamma W_1 \Gamma)^{-1}\right)$$

where Γ is the limit of the matrix of derivatives of the orthogonality conditions with respect to $\boldsymbol{\theta}$, and W_1 is the limit of the weighting matrix. I estimate these two matrices using their sample analogues evaluated at $\hat{\boldsymbol{\theta}}$.

I assume that the unobservables are uncorrelated across products but not necessarily across time and estimate the first variance with[27]

$$\hat{S}_1 = \frac{1}{J} \sum_j \left(\sum_t \frac{z_{jt} \xi_{jt}(\hat{\boldsymbol{\theta}}, G_{n_s})}{T_j} \right) \left(\sum_t \frac{z_{jt} \xi_{jt}(\hat{\boldsymbol{\theta}}, G_{n_s})}{T_j} \right)'$$

To estimate the second source of variance, S_2, I use the same method as Berry, Levinsohn and Pakes (1995), which consists of taking different samples of individuals G_w, computing the unobservables $\xi(\hat{\boldsymbol{\theta}}, G_w)$ and the orthogonality conditions $\left(\frac{1}{J} \sum_j \sum_t \frac{z_{jt} \xi_{jt}(\hat{\boldsymbol{\theta}}, G_w)}{T_j}\right)$ at the estimated value $\hat{\boldsymbol{\theta}}$ for the different samples, and computing their empirical variance.

The estimation of the price derivatives $h\left(\hat{\boldsymbol{\theta}}, G_{n_s'}\right)$ is not as computationally intensive as the search for $\hat{\boldsymbol{\theta}}$ and I use a much larger sample of individuals (n_s'). There are also two error terms in the computation of this estimator: the error due to evaluating the price derivatives at the estimated value of the demand parameters $\hat{\boldsymbol{\theta}}$ instead of the true value $\boldsymbol{\theta}$ and the error in the estimation of integral (4). The second error, however, is of a smaller order of

[25] As the numerical minimization of the GMM distance function involves solving for $\xi(\boldsymbol{\theta}, G_{n_s})$ in each iterative step, there is a limit to the sample size (n_s) imposed by computational tractability (I use 100 individuals per time period and country). This means that the error in approximating $\xi(\boldsymbol{\theta}, G)$ with $\xi(\boldsymbol{\theta}, G_{n_s})$ is significant and its variance must be taken into account.

[26] In cases in which the market shares of the goods are computed by aggregating the choices of a sample of individuals, there is yet a third source of error: the error in the estimation of the "observed " market shares. In this paper I work with the entire population, hence the market shares are truly observed.

[27] Alternatively, an error component model can be specified. The estimator that I use has the advantage of not imposing a parametric assumption on the covariance within products. A bootstrap estimator can also be used, but it involves minimizing the non-linear GMM distance function for each bootstrap sample, which can be computationally burdensome.

magnitude because of the large number of individuals used in the simulation. The asymptotic distribution is dominated by the first error term and the second source of variance can be safely disregarded.

I estimate the first component of the variance of $h\left(\hat{\boldsymbol{\theta}}, G_{n_s\prime}\right)$ by taking draws from the asymptotic distribution of $\hat{\boldsymbol{\theta}}$.$h\left(\hat{\boldsymbol{\theta}}, G_{n_s\prime}\right)$ is evaluated at the different random draws of $\boldsymbol{\theta}$, keeping the distribution $G_{n_s\prime}$ constant and finally, the empirical variance of h is computed.[28]

The lagrange multipliers and the marginal costs are not asymptotically normal. The Lagrange multipliers associated to the trade balance constraints $\left(\hat{\boldsymbol{\lambda}}\right)$ are restricted to be positive and therefore their distribution is truncated at zero. This truncation affects the distribution of the Lagrange multipliers associated to the quotas $(\hat{\boldsymbol{\mu}})$ and the marginal costs, which are not normal. I take draws of $\hat{\boldsymbol{\theta}}$, reestimate $\left(\widehat{\mathbf{c}}, \hat{\boldsymbol{\lambda}}, \hat{\boldsymbol{\mu}}\right)$ for each draw and compute 90% confidence intervals. The variance is a function of the variance of $h\left(\hat{\theta}, G_{n_s}\right)$ and consequently has the same two error terms. By the same reason as before, asymptotics are dominated by the first error term.

5 Data and Results

The total number of vehicles and the share of each corporation during the convergence period (1996-1999) are presented in Tables 1 and 2 for Brazil and Argentina, respectively.[29] The market in Brazil is dominated by Fiat, General Motors and Volkswagen. Together they account for 85% of the approximately 5 million units that were purchased during these four years. Ford follows with an important participation in the number of imports, both from Argentina and extra-zone. Approximately 18% of extra-zone imports belong to Peugeot-Citroën. Given that only about 200,000 units are of extra-zone origin (3.8%), the

[28] The variance of the second term can be computed in the same fashion as the simulation error in the estimation of $\hat{\theta}$. The value of θ is kept fixed at the estimated value $\hat{\theta}$, and different samples of individuals G_w are taken, the price elasticity $h(\hat{\theta}, G_w)$ is evaluated at each distribution of individuals and its empirical variance is the estimator for the second term variance. Notice that if the same individuals are used in the estimation of $\hat{\theta}$ and $h(\hat{\theta}, G_{n_s})$, the two variance terms are correlated. To avoid this problem, different samples of individuals can be used to compute each, although it implies a loss in efficiency.

[29] The data sources for quantities and prices are the *Asociación de Concesionarios de Automóviles de la República Argentina* (Acara) and the *Associação Nacional dos Fabricantes de Veículos Automotores* (Anfavea) for Argentina and Brazil, respectively.

participation of the firm is not very significant in the Brazilian market, however, its presence is relevant in the analysis of the changes in trade flows.

The market is smaller in Argentina, with about a million cars during the entire period. Regarding the origin of the vehicles, 70% is domestic (versus 83% in Brazil), 14.4% are imports from Brazil and 16% are external imports. Participation of firms is more evenly distributed, with Fiat and Renault accounting for 46% of total units, followed by Volkswagen, Ford, Peugeot-Citroën and General Motors. Most imports from Brazil are accounted by Ford (50%) and General Motors (35%). External imports are mainly conducted by Ford, Peugeot-Citroën and Volkswagen.

For the estimation of demand, I use semestral data on sales, average prices and vehicle characteristics from 1996 to 2000. The characteristics that I include in the estimation are length, horsepower and dummy variables for hatchback models, station wagons, sport utility vehicles (SUVs) and minivans.[30] There are 123 different models in Brazil, and 128 in Argentina.

I introduce variable coefficients for the constant, price and length. The variability in the constant is determined by the different alternative utilities of the individuals. I denote the deviation from the mean alternative utility by Z_i and assume that they are independent across individuals and follow a standard normal distribution. The alternative utility can be written as $u_i = u_o + u_1 Z_i$, where u_o is the mean alternative utility and u_1 its standard deviation. The price coefficient depends on income and takes the functional form $\alpha_i = \alpha_o + \alpha_1 / y_i$. The length coefficient varies with family size. In particular length is interacted with a dummy variable B_i with ones for families with more than two children. The random coefficient is $\beta_i = \beta_o + \beta_1 \times B_i$.

I sample income and family size from household surveys and deviations from the mean alternative utility from a standard normal.[31] I take one hundred draws per semester and country.[32] In the Argentine data, household characteristics and sales, but not prices, are

[30] Data on characteristics are from the specialized publications *Megaautos* and *Quatro Rodas*.

[31] I use the *Encuesta Permanente de Hogares* (EPH) for Argentina, and the *Pesquisa Nacional por Amostra de Domicílios* (PNAD) for Brazil.

[32] Households in Brazil are surveyed only annually. However, the semestral disaggregation of sales, prices and product characteristics is still important to estimate of the non-random part of the coefficients.

disaggregated in four geographical regions.[33] To estimate the price derivatives I take a sample of 1300 and 2000 individuals per period and region in Argentina and Brazil, respectively.

Results from the estimation of the demand coefficients are shown in Table 1. The first two rows correspond to the alternative utility. The estimates are $\hat{u}_i^a = 13.5 - 0.9 \times Z_i$ and $\hat{u}_i^b = 7.7 - 0.8 \times Z_i$, which implies that the estimated distributions of the reservation utilities are $u_i^a \tilde{} N(13.5, 0.9)$ and $u_i^b \tilde{} N(7.7, 0.8)$.[34] The main results are the price coefficients, shown in the second two rows. The marginal utilities of income are $\hat{\alpha}_i^a = 0.19 + 0.17/y_i$ and $\hat{\alpha}_i^b = 0.09 - 0.03/y_i$. The coefficients on length and horsepower have the expected signs and the marginal utility of length is larger for families with more than two children. Utility is higher for hatchback models, SUVs and minivans, and lower for station wagons, all relative to sedan models.

The average marginal utility of income over the sample of consumers is 0.25 in Argentina and 0.08 in Brazil. Figure 1 plots the distribution of $\hat{\alpha}_i^a$ and $\hat{\alpha}_i^b$.[35] Using the marginal utilities, I estimate own and cross-price derivatives and elasticities for each car.

Regarding supply, I estimate the marginal cost for each car model, which are time varying. For each firm, I estimate two Lagrange multipliers for the global trade balance constraint (GTB), one for Argentina and one for Brazil, and eight multipliers for the bilateral quotas (four years and two countries).

Table 4 displays the (actual) average price and (estimated) elasticity, production cost and percentage mark-up by country and origin. In Argentina, the mean elasticity is 3.4, and the mean price and production cost are \$16,700 and \$11,300, respectively, with an average

[33] For the purpose of demand estimation, the regions are different markets and their treatment is analogous to that of different time periods. For the estimation of supply parameters, I aggregate regional demands and price derivatives in the same period, as I only observe prices at the national level.

[34] Notice that the signs of the coefficients are inverted with respect to the ones reported on the table. This is because the alternative utility corresponds to the outside alternative, and it is subtracted from the utility of all other products in the normalization in (1). Also note that the coefficients of the deviations enter the equation with negative sign. This is a consequence of using the same distribution (a standard normal) for all markets. When markets are identical, the signs of the coefficients are not identified, in the sense that the vector $-\mathbf{Z}$ generates the same choices as $\mathbf{Z}$. Still the inclusion of this variable is relevant because the variance of the mean utility is recovered.

[35] There are 41600 individuals in Argentina (1300 individuals in 4 regions and 8 semesters and 16000 in Brazil (2000 individuals in 8 semesters).

price-cost margin of 50%.[36,37] Production cost is on average lower for domestic than Brazilian cars ($10,600 and $11,600), while elasticities are similar. However, the price of domestic cars is on average higher ($15,700 compared to $15,100). This finding reflects the GTBs and the inter-country interaction of firms. I argue below that the GTBs are more restrictive in Brazil and that Argentine subsidiaries set lower prices for Brazilian goods to encourage Brazilian exports. The average cost of extra-zone imports is higher than the average cost of MERCOSUR vehicles ($14,700).

In Brazil, demand elasticity is relatively low (1.7), while the average percentage mark-up is 60%, 10% higher than in Argentina. The mean production cost of MERCOSUR cars is about a thousand dollars lower in Brazil than in Argentina. This is the result of different compositions of demand, as the cost of a given product is by assumption the same in both countries. The price of imports from Argentina is higher than the price of domestic cars ($15,900 compared to $14,300), while costs are very similar (9.5 and 9.4) and demand elasticity is higher for Argentine cars. This finding is the opposite of what occurs in Argentina and it is explained by the same argument: Argentine imports are discouraged in Brazil because the GTB is more restrictive. The average price of extra-zone imports is 29,000 dollars, which is high compared to the production cost, the mark-up, and the price in Argentina. It is a consequence of the high external tariff.

The Lagrange multipliers for the GTB are displayed in the first two columns of Table 5. Since the constraint is intertemporal there is only one multiplier per firm and country (λ_f^a and λ_f^b). The Lagrange multipliers represent the increase in profits that would result from an exogenous increase in export credits (acquisition or exports of capital goods and net exports of spare-parts). For example, in the case of General Motors, a 1 dollar increase of export credits in Argentina generates an increase in profits of 40 cents. The same increase in export credits in Brazil, implies that profits go up by 43 cents. In Brazil, these increases range from 14 to 62 cents. Whereas in Argentina, several multipliers are very small and not significantly different from zero, which signals that the price decisions of those firms would

[36] The mark-ups are substantially higher than profit margins since they do not include import and trade taxes.

[37] Berry, Levinsohn and Pakes (1995) estimates of own-price elasticity are relatively higher. The lowest elasticity that they report is 3, for the Lexus in 1983.

be similar without the Argentine GTB. The Lagrange multipliers are significant for Ford, General Motors and Peugeot-Citroën, and they represent hypothetical increases in profits of 50, 40 and 30 cents per 1 dollar increase in export credits. It is also statistically significant for General Motors, although small.

The multipliers can also be interpreted as an adjustment in the marginal cost due to the GTBs, as defined in equation (11). For outside imports, the multipliers are the percentage increase in costs. For example, λ^a is 0.5 in the case of Ford, which means that in Argentina the cost of extra-zone imports is 50% higher than the cost of production. For intra-zone imports there other considerations: internal imports tighten one GTB but loosen the other. The third and fourth columns of Table 5 show the percentage adjustment in intra-zone import costs due to the GTBs. To continue with the example of Ford, the adjusted cost of internal imports in Argentina is 25% lower than the production cost. Thus, prices are lower (than what they would be if there was no GTB) and exports higher. The opposite happens in Brazil, where the cost of Argentine products is 3% higher than the production cost, because imports add the cost of tightening the constraint even more. The decrease in costs of internal imports in Argentina ranges from 11% to 57%. In Brazil, the cost of internal imports increases between 3% and 48%, with the exception of General Motors, whose costs decrease by 5%.[38]

Table 6 reports the estimates of the Lagrange multipliers for the bilateral constraint. I estimate the difference $\mu^0 = \mu^a - \mu^b$. If this difference is positive I assign the values $\hat{\mu}^a = \hat{\mu}^0$ and $\hat{\mu}^b = 0$.[39] A positive value for μ^a and a zero for μ^b, as is the case for the Volkswagen corporation in 1996, means that Argentine net internal imports are as high as allowed by the quota (the lower bound of the constraint is met). In other words, the Argentine subsidiary is importing from Brazil as much as possible without a further increase in its exports. The opposite happens when μ^b is positive, as is the case of Chrysler in 1997. In the majority of the cases, μ^a is positive and μ^b is zero. This is consistent with the results in Table 5 that

[38] This is the addition in costs due to the GTB, the effect of the bilateral quota has to be contemplated, too.

[39] Since the multipliers are non-negative, the standard errors do not define proper confidence intervals in the case in which the coefficients are not significant. The distribution of the estimator has a mass point at zero (the probability of a negative value corresponds to zero).

suggest that the GTB constraint works in the direction of increasing Argentine imports of Brazilian products.[40]

The difference $\mu^a - \mu^b$ is interpreted as the additional cost imposed by the bilateral quota (it is not a percentage increase). In the case of Volkswagen in 1996, Brazilian products sold in Argentina exceed their production cost by 170 dollars, while the cost of Argentine models sold in Brazil is 170 dollar lower.

The fact that the μ_f^h's are different across firms suggests that the quotas were inefficiently distributed among the corporations and that firms could benefit from trading import rights among each other.

6 Customs Union Equilibrium

The model in the previous sections describes the equilibrium under the trade regime during the *convergence period*, characterized by the presence of non-tariff barriers (NTBs) and different tariff schedules in the two countries. In this section I study the effects of forming a customs union on trade flows, prices and welfare. To do that, I compute two additional equilibria: the *no NTBs* equilibrium, in which the GTB constraint and the bilateral quota for net imports are removed but the tariff schedules remain unchanged, and the *customs union* equilibrium in which NTBs are eliminated and a uniform external tariff is adopted. By introducing the *no NTBs* equilibrium, I decompose the transition to a customs union into two sequential changes in policy: the removal of NTBs (given the asymmetric tariff schedule) and the adoption of a common external tariff (given that the NTBs were already removed).

More specifically, let $\left(\mathbf{q}^{CONV}, \mathbf{P}^{CONV}\right)$, $\left(\mathbf{q}^{nNTB}, \mathbf{P}^{nNTB}\right)$ and $\left(\mathbf{q}^{CU}, \mathbf{P}^{CU}\right)$ denote equilibrium quantities and prices in the three cases and τ the common external tariff. The three equilibria can be summarized as follows

[40] Notice that the bilateral constraint, which in most cases restricts Argentine internal imports, is likely to mitigate the effect of the GTB.

Convergence Period	No NTBs	Customs Union
τ^a,τ^b	τ^a,τ^b	$\tau = 35\%$
Global trade balance (GTB)	-	-
Quota for net imports	-	-
$\mathbf{q}^{CONV}, \mathbf{P}^{CONV}$	$\mathbf{q}^{nNTB}, \mathbf{P}^{nNTB}$	$\mathbf{q}^{CU}, \mathbf{P}^{CU}$

Using the estimators of the structural parameters of demand and supply, I simulate the equilibrium prices and quantities under the two counterfactual trade regimes. By comparing the *noNTBs* and the *convergence period* equilibria I assess the impact on trade, prices and welfare of the elimination of the NTBs. Similarly, by comparing the *customs union* and the *noNTBs* equilibria I measure the impact of the adoption of the common external tariff. The sum of the two effects accounts for the total change from the *convergence period* to the *customs union*.

Notice, that this counterfactual exercise provides an estimate of what the effect of a customs union would have been during the period 1996-1999. It is not a prediction of the equilibrium in 2006, when the actual customs union is scheduled to be adopted. The later depends on variables that are exogenous to the model, such as income and characteristics of the cars.

The *noNTBs* and *customs union* equilibria are characterized by the system of first order conditions (12) with a redefinition of the adjusted costs that incorporates the new trade policy in each case. Adjusted costs in the *noNTBs* case are

$$c_{jt}^{*a} = \begin{cases} c_{jt} & \text{for } j \in A_{ft} \text{ and } j \in B_{ft} \\ c_{jt}\left(1+\tau_t^a\right) & \text{for } j \in W_{ft} \end{cases} \tag{19}$$

$$c_{jt}^{*b} = \begin{cases} c_{jt} & \text{for } j \in A'_{ft} \text{ and } j \in B'_{ft} \\ c_{jt}\left(1+\tau_t^b\right) & \text{for } j \in W'_{ft} \end{cases}$$

Adjusted costs in the *customs union* equilibrium are

$$c^{*a}_{jt} = \begin{cases} c_{jt} & \text{for } j \in A_{ft} \text{ and } j \in B_{ft} \\ c_{jt}\,(1+\tau) & \text{for } j \in W_{ft} \end{cases} \tag{20}$$

$$c^{*b}_{jt} = \begin{cases} c_{jt} & \text{for } j \in A'_{ft} \text{ and } j \in B'_{ft} \\ c_{jt}\,(1+\tau) & \text{for } j \in W'_{ft} \end{cases}$$

Since there are no NTBs in the two computed equilibria, the Lagrange multipliers are zero.[41] Trade between partners is free and the relevant costs are the marginal costs of production. The adjustment in costs only includes the tariff on imports from the rest of the world. The elimination of NTBs makes the inter-country strategic component irrelevant, so that firms set prices independently in Argentina and Brazil.

The movement from the *convergence period* to the *noNTBs* equilibrium involves removing trade barriers. Although intuition suggests that it should expand trade, internal imports do not necessarily increase in both countries due to the strategic behavior of multinational firms. In the next section, I show that imports of Brazilian models actually *decrease* in Argentina when the NTBs are removed. Suppose that for a given firm the GTB is less binding in Argentina. The firm then encourages imports of Brazilian models in Argentina (by setting lower prices for said models). Brazilian exports increase, which loosens the GTB in Brazil. In contrast, the removal of the GTBs leads to a decrease in imports from Brazil.

The adoption of a uniform external tariff is a movement away from free trade since both countries raise their tariffs for outside imports that are therefore expected to decrease.[42]

The estimators of the *no NTBs* equilibrium prices and quantities, $\hat{\mathbf{P}}^{nNTB}$ and $\hat{\mathbf{q}}^{nNTB}$, that satisfy the system of first order conditions given the demand functions,

$$q(\hat{\mathbf{P}}^{nNTB}, \hat{\boldsymbol{\theta}}, G_{n_s}) + \Delta(\hat{\mathbf{P}}^{nNTB}, \hat{\boldsymbol{\theta}}, G_{n_s}) \left(\hat{\mathbf{P}}^{nNTB} - c^*(\widehat{\mathbf{c}}, \boldsymbol{\tau}^a, \boldsymbol{\tau}^b)\right) = 0$$

[41] The Lagrange multipliers are reduced form parameters. Their estimators are valid only for the particular trade policy during the *convergence period*. Hence, the only counterfactual equilibria that can be consistently simulated are those that involve removing all NTBs. The value of the Lagrange multipliers is known to be zero in these cases.

[42] In the usual example, the constitution of a customs union involves the elimination of tariffs against the trade partner, hence the change is not entirely against free trade. In the present case, the tariff is already zero among partners.

$$\hat{\mathbf{q}}^{nNTB} = q(\hat{\mathbf{P}}^{nNTB}, \hat{\boldsymbol{\theta}}, G_{n_s})$$

where $q(\hat{\mathbf{P}}^{NTB}, \hat{\boldsymbol{\theta}}, G_{n_s})$ is the simulation-based estimator of quantity defined in (15), $\Delta(\hat{\mathbf{P}}^{NTB}, \hat{\boldsymbol{\theta}}, G_{n_s})$ the simulation-based estimator of price derivatives (17), arranged in matrix form, and $c^*(\widehat{\mathbf{c}}, \boldsymbol{\tau}^a, \boldsymbol{\tau}^b)$ the estimator of the vector of adjusted marginal costs obtained by evaluating (19) at the estimated value of the production costs.

Even though the system is non-linear and does not have a closed-form solution, I find that the operator

$$\hat{\mathbf{P}}^{nNTB}_{(n+1)} = c^*(\widehat{\mathbf{c}}, \boldsymbol{\tau}^a, \boldsymbol{\tau}^b) - \Delta(\hat{\mathbf{P}}^{nNTB}_{(n)}, \hat{\boldsymbol{\theta}}, G_{n_s})^{-1} q(\hat{\mathbf{P}}^{nNTB}_{(n)}, \hat{\boldsymbol{\theta}}, G_{n_s})$$

works in practice like a contraction mapping and reaches a unique fixed-point in a small number of iterations.

Likewise, the estimators of the *customs union* equilibrium, $\hat{\mathbf{P}}^{CU}$ and $\hat{\mathbf{q}}^{CU}$, are

$$q(\hat{\mathbf{P}}^{CU}, \hat{\boldsymbol{\theta}}, G_{n_s}) + \Delta(\hat{\mathbf{P}}^{CU}, \hat{\boldsymbol{\theta}}, G_{n_s}) \left(\hat{\mathbf{P}}^{CU} - c^*(\widehat{\mathbf{c}}, \tau)\right) = 0$$
$$\hat{\mathbf{q}}^{CU} = q(\hat{\mathbf{P}}^{CU}, \hat{\boldsymbol{\theta}}, G_{n_s})$$

where $c^*(\widehat{\mathbf{c}}, \tau)$ is the estimator of the adjusted cost for c^* defined as in (20). I use the same iterative operator to find the solutions.

By comparing quantities and prices in the different equilibria I estimate the changes in trade flows, profits and tariff revenue and I decompose these changes into those caused by the elimination of NTBs and those caused by the adoption of a uniform tariff.

To measure the change in consumers' welfare I use the compensating variation, defined as the negative of the change in income that leaves utility unchanged after a change in prices.[43] In the comparison of the *noNTBs* and the *convergence period* equilibria, the change in income Δy_i^{nNTB} satisfies

[43] This is the definition given in Hicks (1939) and Mas-Colell, Winston and Green (1995). A positive compensating variation implies an increase in welfare.

$$\max_j \left(\alpha_i \left(y_i + \Delta y_i^{nNTB} - p_{jt}^{nNTB}\right) + x_{jt}' \beta_i + \xi_{jt} + \varepsilon_{ijt}\right) =$$
$$\max_j \left(\alpha_i \left(y_i - p_{jt}^{CONV}\right) + x_{jt}' \beta_i + \xi_{jt} + \varepsilon_{ijt}\right)$$

This is the change in individual welfare due to the elimination of NTBs. I am interested in aggregate welfare. Let $\widetilde{G}$ be the joint distribution of ν and ε in the population. The aggregate compensating variation in market t is the expected individual compensating variation multiplied by the market size, N_t.

$$CV_t = -N_t \int \Delta y_i \left(\mathbf{P}_t^{CONV}, \mathbf{P}_t^{nNTB}, \boldsymbol{\theta}, \nu_i, \varepsilon_i\right) d\widetilde{G}(\nu_i, \varepsilon_i) \tag{21}$$

To estimate (21) I compute the compensating variation for n_s consumers and I average them as follows

$$\widehat{CV}_t = -\frac{N_t}{n_s} \sum_{i_s} \Delta y_{i_s} \left(\mathbf{P}_t^{CONV}, \hat{\mathbf{P}}_t^{nNTB}, \hat{\boldsymbol{\theta}}, \nu_{i_s}, \varepsilon_{i_s}\right)$$

To evaluate the compensating variation for a given individual I take a draw of ν_{i_s} from the household survey and of ε_{i_s} from the extreme value distribution. I calculate the utility that the consumer derives from each car, including the outside alternative, at the original prices $\mathbf{P}^{CONV}$ and at the estimated value of the parameters $\hat{\boldsymbol{\theta}}$ and I find the preferred model. I repeat this procedure adding Δy_{i_s} to the consumer's income and changing prices to $\hat{\mathbf{P}}^{nNTB}$. The compensating variation is the negative of change in income that makes the two maximum utilities equal.[44]

The change in consumers' welfare from the adoption of a common external tariff, is the additional change in income Δy_i^{CU} required to achieved the original utility at the prices in the *customs union* equilibrium,[45]

[44]In the simple case in which the marginal utility of income, α_i, is constant, the $\boldsymbol{\varepsilon}$'s can be integrated out of (21) and the expected individual compensating variation has a closed-form solution conditional on ν derived by McFadden (1981).

[45]Δy_i^{CU} is different the change in income Δy_i^* that satisfies

$$\max_j \left(\alpha_i \left(y_i + \Delta y_i^{nNTB} + \Delta y_i^{CU} - p_{jt}^{CU}\right) + x_{jt}\acute{}\beta_i + \xi_{jt} + \varepsilon_{ijt}\right) =$$
$$\max_j \left(\alpha_i \left(y_i - p_{jt}^{CONV}\right) + x_{jt}\acute{}\beta_i + \xi_{jt} + \varepsilon_{ijt}\right)$$

The definition and estimator of the aggregate compensating variation is analogous to the ones above.

I estimate the variance of the estimated quantities and prices, of the change in the trade flows, profits and tariff revenue, and of the compensating variation using the same method described in section 4. I take draws from the distribution of $\hat{\boldsymbol{\theta}}$, reestimate these parameters for the each value of $\hat{\boldsymbol{\theta}}$, and compute the empirical variance.[46]

6.1 Results for Argentina

In this section, I present the estimated changes in Argentine prices, quantities and welfare. First, I describe the effects of the elimination of NTBs (by comparing the *noNTBs* and the *convergence period* equilibria), then the effects of the adoption of a common external tariff (by comparing the *customs union* - counterfactual tariffs - and *noNTBs* - actual tariffs - equilibria), and finally the aggregate effects of forming a customs union. In the next section, I repeat the same analysis for Brazil.

Table 7 reports the effects of the elimination of NTBs in Argentina. The removal of the GTB implies that the cost of external imports is reduced according to the shadow cost of the constraint ($100\times\lambda^a$ percent). Although these multipliers are close to zero for several firms (see Table 5), they are relatively high for Ford and Peugeot-Citroën (50% and 30%, respectively). These two corporations account for 43% of external imports and the

---

$$\max_j \left(\alpha_i \left(y_i + \Delta y_i^{*} - p_{jt}^{CU}\right) + x_{jt}\acute{}\beta_i + \xi_{jt} + \varepsilon_{ijt}\right) =$$
$$\max_j \left(\alpha_i \left(y_i - p_{jt}^{nNTB}\right) + x_{jt}\acute{}\beta_i + \xi_{jt} + \varepsilon_{ijt}\right)$$

Δy_i^* is the negative of the compensating variation for the movement from the *noNTBs* to the *customs union* equilibria. However, it does not serve the purpose of decomposing the transition from the *convergence period* to the *customs union* equilibria because the base utilities are different.

[46] Notice that for each draw it is also necessary to reestimate the marginal costs and Lagrange multipliers.

sales-weighted average decrease in adjusted costs (measured by the multipliers) is 13.5%. This causes the price of external imports to decrease, on average, by 16.2% (approximately 3,600 dollars), and an increase in imported units of 77.9% (approximately 130,000 units).

In contrast with extra-zone imports, intra-zone imports become more costly with the elimination of the GTB. Before the elimination of the NTBs, an additional unit imported from Brazil tightens the GTB in Argentina (by $100\times\lambda^{a}$ percent) but loosens the GTB in Brazil (by $100\times1.2\lambda^{b}$ percent). As I discussed in section 5, the net effect is a reduction in costs of internal imports because the GTB is more binding in Brazil than in Argentina. When the GTB is removed, the cost of MERCOSUR imports increases and so do prices, by 811 dollars (5.4%). The lower prices under the GTB work as an incentive to increase demand for Brazilian models that would help loosen the Brazilian GTB. When this incentive is removed, imports decrease by about 65,000 units (43.3%).[47] Notice, however, that the changes in quantities have wide confidence intervals.

The shadow cost of the bilateral quota acts in the opposite direction: removing the quota should make imports less costly, since the constraint is, in general, binding for Argentine imports. Thus, if there were no quotas, the distortion created by the GTBs would be even larger.

The increased "competition" from extra-zone imports crowds out domestic models, whose purchases fall by 9.1% even though they are in average 1,000 dollars less expensive. This change in the price of domestic models is directly explained by the removal of the GTB: prior to the removal of the GTB, prices of domestic products were higher to make Brazilian imports more competitive. In average, prices decrease by 1,100 dollars per model, and consumers' increase in welfare is 606 dollars per vehicle purchased. Tariff revenue increases by 77.2%, virtually the same increase as the number of imported units, while profits drop by 19.3%. I show in the next section that combined profits in the two countries increase.[48,49]

[47] This means that 43% of MERCOSUR imports in Argentina (6% of the market), prior to the removal of NTBs, are explained by the distorsive effect of the trade balance and quotas.

[48] The fact that a constraint is being removed does not actually imply that profits should increase, given the oligopolistic nature of the market. Quite the opposite, the NTBs increase the relative "cost " of domestic products, acting like a collusive device among firms. When they are removed, domestic prices and profits go down.

[49] There is not an accurate measure of a country's aggregate welfare in this context of multinational firms.

Table 8 displays the estimated effects of convergence to a common tariff level. The adoption of the uniform tariff of 35%, higher than the existing tariff, implies an increase in the cost of extra-zone imports equal to the difference in tariffs before and after the policy. The average increase is 23% in Argentina (the increase is different for each trimester), which passes-through to prices: there is an increase of 2800 dollars (15.4%) in the price of external imports and a smaller increase in the price of domestic models (44 dollars). The price of MERCOSUR imports remains almost unchanged.

Sales of outside imports fall by approximately 120,000 units (40.3%), which are partially replaced by domestic production and internal imports. Moreover, since tariffs are ad-valorem, the composition of external imports moves towards less costly models. The average production cost decreases by 2,000 dollars.

The aggregate average price increase is 489 dollars, which results in a reduction in consumers' welfare of 214 dollars by purchased vehicle. Aggregate profits decrease by 3.1% while tariff revenue increases by 48%.

The aggregate effect of a customs union combines the results in the two previous experiments, the sequential transition from the *convergence period* to the *noNTBS* equilibria, and from the latter to the *customs union* equilibrium. The total response in quantities, prices and welfare is presented in Table 9. The elimination of NTBs and the convergence to the common external tariff work in opposite directions. While after the removal of the GTB, Argentina imports more from outside and less from Brazil and consumers benefit from lower prices, the adoption of a uniform tariff encourages internal imports at the expense of outside models and prices increase yielding a welfare loss for consumers.

Table 9 shows that the effect of the elimination of NTBs predominates for all variables of interest, although the responses are significantly mitigated by the opposing effect of the raise in the external tariff. Prices of external imports decrease by 733 dollars, prices of domestic goods by 940 dollars, while internal imports become 800 dollars more expensive. There is a sharp decrease in imports from the partner: approximately 54,000 units, whereas sales of domestic models and outside imports raise by 5,200 and 10,469 units, respectively. The

In principle profits should not be computed in aggregate welfare as firms are of foreign origin. However, profits are estimated before taxes, and some corporations have a small participation of local capital.

aggregate effect on consumers is positive (due to the reduction in prices) and amounts to 393 dollars per car, however, it is not very precisely estimated.

6.2 Results for Brazil

The adjustment in Brazil's external tariff involved by the custom union is minor. The actual tariff is indeed 35% during 1996 and 1999 and the average tariff level during the convergence period is 33%, which means that the increase in costs due to the adoption of the common tariff is merely 2%. Results are, therefore, dominated by the removal of NTBs, and the effects of the tariff revision is comparatively negligible.

Table 10 displays the effects of the elimination of NTBs. The removal of the GTB induces a reduction in the cost of both external *and* internal imports (in contrast to Argentina) that causes an average decrease in prices of 700 dollars (4.6%) for internal imports and 4000 dollars (13.8%) for outside imports. The number of units imported from Argentina increase by 12.8%, while the increment in external imports is 117%.[50] The large response of outside imports is due to the substantial reduction in costs of 30% in average (given by the Lagrange multipliers λ_f^b, see Table 5). This is not the case for internal imports since the removal of the Argentine GTB (trough λ_f^a) and the bilateral constraints mitigate this effect.

Notice that there is a change in the composition of external imports in favor of models of higher production cost. After the removal of NTBs, the cost of external imports is on average 5,400 dollars higher. This is analogous to Feenstra's (1988) finding for Japanese VERs. He shows that when the VER is imposed, there is an upgrade in the quality of Japanese imports, since the restraint is measured over units, not over values. In contrast, the GTB is computed over values, therefore, when it is removed, more costly models can be imported. Prices of domestic goods increase, on average, 400 dollars.

Overall, there is a 92 dollar increase in prices in Brazil. Consumers are worse off by an amount of 203 dollars for purchased vehicle. Profits increase by 5.7%, a consequence of both higher prices and quantities. Tariff revenue raises by 205%, due to the increase in external imports and to the change in the composition of imports.

[50] Given the small participation of external imports in the market (3.8%), the 117% increase only amounts to approximately 230000 units, 4.4% of the Brazilian market.

The impact of the change in tariffs on prices and quantities in Brazil goes in the same direction as in Argentina (see Table 11), but the magnitudes are much smaller. Overall prices increase by only 8 dollars (less than 0.1%) while consumers are 1 dollar worse off per purchased vehicle.

The net effects are presented in Table 12. As expected, total changes in Brazil are mostly explained by the elimination of NTBs, and the overall policy implies a movement towards free trade, both with respect to the MERCOSUR partner and the rest of the world. The prices of intra and extra-zone imports decline by 730 dollars (4.6%) and 3800 dollars (13.1%), respectively. Domestic prices increase by 413 dollars, with a substitution of domestic production by foreign models. In particular, there is a change in the composition of external cars in favor of more costly models. The increase in domestic prices generates a welfare loss to consumers of 203 dollars per car. The increase in tariff revenue (210%) is more than compensates the negative compensating variation.

7 Conclusions

In this paper I have measured the effects of adopting a customs union in the automobile market in Argentina and Brazil. The trade reform involves the removal of non-tariff barriers and the adoption of a common external tariff. My methodology consists on estimating structural demand and supply parameters that I use to predict outcomes in the customs union equilibrium. I estimate demand by using a random-coefficient approach. I model the behavior of multinational firms in Argentina and Brazil and develop a minimum distance estimator for the production costs and shadow cost of the NTBs.

My main finding is that the relevant effects on prices, trade and welfare are driven by the removal of bilateral quotas and trade balance constraints (the NTBs) rather than by the convergence to a common external tariff. This is as I expected for Brazil since tariffs increase only marginally in this country. It is also true for Argentina even though the increase in tariffs implied by the customs union is substantial.

The elimination of the NTBs comprises a movement towards free trade that leads to an increase in imports from the rest of the world in both countries. The interaction between the

NTBs and the ownership structure of the firms (multinational corporations with subsidiaries in both countries) leads to asymmetric effects on intra-zone trade and welfare for each partner when these restrictions are removed. This asymmetry is also observed in the total effects of the customs union. In particular, internal imports decrease in Argentina and increase in Brazil, with an overall increase in bilateral trade.

Consumers in Argentina are better off after the customs union, while they are worse off in Brazil. The opposite is true for profits of Argentine and Brazilian subsidiaries. Tariff revenue increases in both countries, and in Brazil more than compensates the loss suffered by consumers.

References

Berry, S. (1994): "Estimating discrete choice models of product differentiation," *RAND Journal of Economics*, 25, 242-262.

Berry, S., J. Levinsohn and A. Pakes (1995): "Automobile prices in market equilibrium," *Econometrica*, 63, 841-890.

Berry, S., J. Levinsohn and A. Pakes (1999): "VERs on automobiles: evaluating a trade policy," *American Economic Review,* 89, 400-430.

Berry, S., O. Linton and A. Pakes (2002): "Limit theorems for estimating the parameters of differentiated product demand systems," mimeo, Yale University.

Chamberlain, G. (1986): "Asymptotic Efficiency in Estimation with Conditional Moment Restrictions," *Journal of Econometrics*, 33, 305-334.

Deaton, A. and J. Muellbauer (1980): *Economics and Consumer Behavior*, Cambridge, Cambridge University Press.

Dixit, A. (1988): "Optimal Trade and Industrial Policy for the U.S. automobile industry ", in R. Feenstra, ed., *Empirical Methods for Industrial Trade*, Cambridge, MA, MIT Press.

Feenstra, R. (1984): "Voluntary Export Restraint in U.S. Autos, 1980-81: Quality, Employment and Welfare Effects, " in R.E. Baldwin and A. Krueger, eds., *The Structure and Evolution of Recent U.S. Trade Policy,* Chicago, University of Chicago Press.

Feenstra, R. (1988): "Quality Change under Trade Restraints in Japanese Autos," *Quarterly Journal of Economics*, 103, 131-146.

Goldberg, P. (1995): "Product differentiation and oligopoly in international markets: the case of the U.S. automobile industry," *Econometrica,* 63, 891-951.

Hicks, J.R. (1939): *Value and Capital*, Oxford, Clarendon Press.

Lerman, S. and C. Manski (1981): "On the Use of Simulated Frequencies to Approximate Choice Probabilities," in C. Manski and D. McFadden, eds., *Structural Analysis of Discrete Data with Econometric Applications*, Cambridge, MA, MIT Press.

Mas-Colell, A., M. Whinston and J. Green (1995): *Microeconomic Theory*, New York, Oxford University Press.

McFadden, D. (1981): *Structural Analysis of Discrete Data with Econometric Applications*, Cambridge, MIT Press, Ch. 5.

Nevo, A. (2000): "Mergers with Differentiated Products: the Case of the Ready-to-eat Cereal Industry," *The RAND Journal of Economics*, 31, 395-421.

Nevo, A. (2001): "Measuring Market Power in the Ready-to-eat Cereal Industry," *Econometrica*, 69, 307-342.

Pakes, A. (1986): "Patents as Options: Some Estimates of the Value of Holding European Patent Stocks," *Econometrica*, 54, 755-785.

Pakes, A. (1994): "Dynamic Structural Models, Problems and Prospects: Mixed Continuous Discrete Controls and Market Interactions," in J.J. Laffont and C. Sims, eds., *Advances in Econometrics: The Sixth World Congress of the Econometric Society,* Vol. II, New York, Cambridge University Press.

Petrin, A. (2002): "Quantifying the Benefits of New Products: The Case of the Minivan", *Journal of Political Economy*, 110, 705-729.

A Asymptotic Distribution of $\widehat{\boldsymbol{\theta}}$

This is a sketch of a proof of the asymptotic distribution of the utility function parameters $\hat{\boldsymbol{\theta}}$. For a complete and formal proof of consistency and asymptotic normality see Berry, Linton and Pakes (2002).

The FOCs for the minimization of the GMM distance function in (16) are

$$D_\theta g(\widehat{\boldsymbol{\theta}} G_{n_s})^T \widehat{W}_1 g(\widehat{\boldsymbol{\theta}}, G_{n_s}) = 0$$

where $D_\theta g(\boldsymbol{\theta}, G)$ is the matrix of partial derivatives of $g(\boldsymbol{\theta}, G)$ with respect to $\boldsymbol{\theta}$. By performing a Taylor expansion of $g(\widehat{\boldsymbol{\theta}}, G_{n_s})$ around the true value of the parameters $\boldsymbol{\theta}_o$ the FOCs can be written as

$$D_\theta g(\widehat{\boldsymbol{\theta}}, G_{n_s})^T \widehat{W}_1 \left(g(\boldsymbol{\theta}_o, G_{n_s}) + D_\theta g(\widetilde{\boldsymbol{\theta}}, G_{n_s})(\widehat{\boldsymbol{\theta}} - \boldsymbol{\theta}_o) \right) = 0$$

where $\widetilde{\boldsymbol{\theta}}$ is the mean value of the expansion. Adding and subtracting $g(\boldsymbol{\theta}_o, G_o)$ inside the parenthesis, multiplying some terms by $\sqrt{J}$ and $\sqrt{n_s}$ and solving for $(\widehat{\boldsymbol{\theta}} - \boldsymbol{\theta}_o)$ gives

$$\begin{aligned} \sqrt{J}(\widehat{\boldsymbol{\theta}} - \boldsymbol{\theta}_o) \quad = \quad & -\left(D_\theta g(\widehat{\boldsymbol{\theta}}, G_{n_s})^T \widehat{W}_1 D_\theta g(\widetilde{\boldsymbol{\theta}}, G_{n_s}) \right)^{-1} D_\theta g(\widehat{\boldsymbol{\theta}}, G_{n_s})^T \widehat{W}_1 \times \\ & \left(\sqrt{J} g(\boldsymbol{\theta}_o, G_o) + \frac{\sqrt{J}}{\sqrt{n_s}} \sqrt{n_s} [g(\boldsymbol{\theta}_o, G_{n_s}) - g(\boldsymbol{\theta}_o, G_o)] \right) \end{aligned}$$

Since $g(\boldsymbol{\theta}_o, G_o) = \frac{1}{J} \sum_j \frac{1}{T_j} \sum_t z_{jt} \xi_{jt}(\boldsymbol{\theta}_o, G_o)$ this term explains the error in $(\widehat{\boldsymbol{\theta}} - \boldsymbol{\theta}_o)$ associated to the model's structural error term ξ_{jt} (the unobservable characteristics). The term $g(\boldsymbol{\theta}_o, G_{n_s}) - g(\boldsymbol{\theta}_o, G_o)$ is equal to $\frac{1}{J} \sum_j \frac{1}{T_j} \sum_t z_{jt} \left(\xi_{jt}(\boldsymbol{\theta}_o, G_{n_s}) - \xi_{jt}(\boldsymbol{\theta}_o, G_o) \right)$, which comprises the error in the simulation-based estimator used to compute the unobservables ξ_{jt}.

Define Γ, W_1, S_1 and S_2 as

$$\begin{aligned}
\Gamma &= \lim_{J\to\infty} E\left[D_\theta g(\boldsymbol{\theta}_o, G_o)\right] \\
W_1 &= \lim_{J\to\infty} \widehat{W}_1 \\
S_1 &= \lim_{J\to\infty} E\left(Jg\left(\boldsymbol{\theta}_o, G_o\right) g\left(\boldsymbol{\theta}_o, G_o\right)'\right) \\
S_2 &= \lim_{J\to\infty} \frac{J}{n_s} E\left(n_s\left[g\left(\boldsymbol{\theta}_o, G_{n_s}\right) - g\left(\boldsymbol{\theta}_o, G_o\right)\right]\left[g\left(\boldsymbol{\theta}_o, G_{n_s}\right) - g\left(\boldsymbol{\theta}_o, G_o\right)\right]'\right)
\end{aligned}$$

Berry, Linton and Pakes establish that $\sqrt{\frac{J}{n_s}}\sqrt{n_s}\left(g(\boldsymbol{\theta}_o, G_{n_s}) - g(\boldsymbol{\theta}_o, G_o)\right) \to N\left(0, S_2\right)$ provided $\frac{J^2}{n_s}$ is bounded. They also show that this bound is determined by the substitution pattern across products.

The asymptotic distribution of $\widehat{\boldsymbol{\theta}}$ is

$$\sqrt{J}(\widehat{\boldsymbol{\theta}} - \boldsymbol{\theta}_o) \to_d N\left(0, \left(\Gamma W_1 \Gamma\right)^{-1} \Gamma W_1 \left(S_1 + S_2\right) W_1 \Gamma \left(\Gamma W_1 \Gamma\right)^{-1}\right) = N\left(0, V_\theta\right)$$

S_1 and S_2 are the two *sources of variance* discussed in section 4.3.

B Asymptotic Distribution of $h(\widehat{\boldsymbol{\theta}}, G_{n_s})$

$h(\widehat{\boldsymbol{\theta}}, G_{n_s})$ is the estimator of the price derivatives defined as

$$h(\widehat{\boldsymbol{\theta}}, G_{n_s'}) = N \frac{1}{n_s'} \sum_{i_s} \eta\left(\widehat{\boldsymbol{\theta}}, \nu_{i_s}\right)$$

It depends on the estimator of the utility function parameters $\widehat{\boldsymbol{\theta}}$ and it is estimated with a sample of individuals n_s'.

By performing a Taylor expansion around $\boldsymbol{\theta}_o$ the estimator can be written as

$$h(\widehat{\boldsymbol{\theta}}, G_{n_s'}) = h(\boldsymbol{\theta}_o, G_{n_s'}) + D_\theta h(\widetilde{\boldsymbol{\theta}}, G_{n_s'})(\widehat{\boldsymbol{\theta}} - \boldsymbol{\theta}_o)$$

Subtracting the true price derivatives $h(\boldsymbol{\theta}_o, G_o)$ (evaluated at $\boldsymbol{\theta}_o$ and using the characteristics of the entire population, summarized by the distribution G_o) and multiplying by $\sqrt{J}$ and $\sqrt{n_s'}$ where necessary gives

$$\sqrt{J}\left(h(\widehat{\boldsymbol{\theta}},G_{n'_s}) - h(\boldsymbol{\theta}_o,G_o)\right) = D_\theta h(\widetilde{\boldsymbol{\theta}},G_{n'_s})\sqrt{J}(\widehat{\boldsymbol{\theta}} - \boldsymbol{\theta}_o) + \frac{\sqrt{J}}{\sqrt{n'_s}}\sqrt{n'_s}\left(h(\boldsymbol{\theta}_o,G_{n'_s}) - h(\boldsymbol{\theta}_o,G_o)\right)$$

There are two error terms in the estimation of $h(\widehat{\boldsymbol{\theta}},G_{n_s})$. The first error is due to the use of $\widehat{\boldsymbol{\theta}}$ instead of $\boldsymbol{\theta}_o$. The second error is the simulation error in the computation of the integral in equation (17), which is equal to $h(\boldsymbol{\theta}_o,G_{n'_s}) - h(\boldsymbol{\theta}_o,G_o)$. As I discuss in section 4.3, the first term dominates the asymptotic distribution as the number of sampled individuals n'_s in the estimation of (17) is large enough to make the second error term of a smaller order of magnitude.

Let

$$H = \lim_{J\to\infty} E\left[D_\theta h(\theta_o,G_o)\right]$$

Then,

$$\sqrt{J}\left(h(\widehat{\theta},G_{n'_s}) - h(\theta_o,G_o)\right) \to N\left(0,HV_\theta H'\right)$$

TABLE 1. Market Shares by Firm - BRAZIL
Convergence Period 1996 - 1999

	All Goods	Domestic Products	Imports from Partner	Imports from Outside
Chyrsler	0.5	0	1.4	7.2
Fiat	29.3	32.0	18.2	7.8
Ford	11.1	9.3	21.1	15.9
General Motors	23.2	27.2	4.9	0
Honda	0.7	0.8	0	2.5
Mercedes Benz	0.3	0.2	0.1	2.7
Peugeot-Citroën	1.0	0	2.2	18.5
Renault	1.2	0.4	5.8	2.7
Toyota	0.3	0.2	0.3	3.8
Volkswagen	32.4	29.8	46.0	39.1
Total number of units	**5,176,605**	**4,283,403**	**698,431**	**194,771**
Share by origin	100	82.7	13.5	3.8

TABLE 2. Market Shares by Firm - ARGENTINA
Convergence Period 1996 - 1999

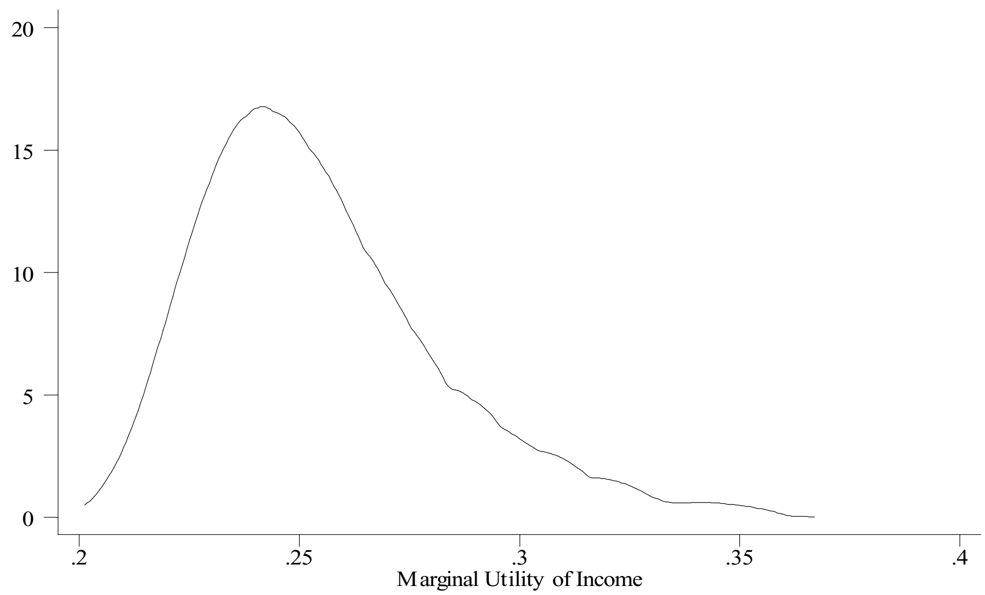
	All Models	Domestic Models	Imports from Partner	Imports from Outside
Chyrsler	1.2	0.6	0	5.0
Fiat	23.3	29.4	10.0	8.7
Ford	15.5	7.2	49.4	20.7
General Motors	8.2	4.0	35.1	1.9
Honda	0.6	0.05	1.4	2.2
Mercedes Benz	0.2	0.02	0.4	1.0
Peugeot-Citroën	12.2	12.4	0	22.5
Renault	22.4	28.9	2.3	12.5
Toyota	0.8	0.1	0.5	3.9
Volkswagen	15.7	17.4	1.0	21.6
Total number of units	**1,047,730**	**730,065**	**150,710**	**166,955**
Share by origin	100	69.7	14.4	15.9

TABLE 3. Utility Function Parameters

	ARGENTINA	BRAZIL
Constant (u_o)	-13.5 (27.4)	-7.7 (33.4)
Constant * N(0,1) (u_1)	0.9 (0.6)	0.8 (0.9)
Price (α_o)	-0.19 (0.05)	-0.09 (0.03)
Price * 1/Income (α_1)	-0.17 (0.08)	0.03 (0.01)
Length (β_o)	4.2 (0.3)	0.4 (0.2)
Length * More than 2 children (β_1)	1.0 (0.5)	0.4 (14.7)
Length Square	-0.5 (1.5)	0.1 (3.0)
Horsepower	3.3 (1.3)	0.4 (0.1)
Hatchback	0.1 (0.5)	0.4 (1.0)
Station Wagon	-0.7 (0.3)	-0.6 (0.2)
SUV or Minivan	0.5 (1.5)	0.5 (0.5)
Category Dummies	Yes	Yes
Test of Overidentifying Restrictions Critical Value: 23.68	20.84	17.45
Mean price coefficient $-\int(\alpha_o + \alpha_1 / y_i) dF(\nu_i)$	-0.25 (0.11)	-0.08 (0.03)

FIGURE 1. Distribution of the Marginal Utility of Income

ARGENTINA



BRAZIL

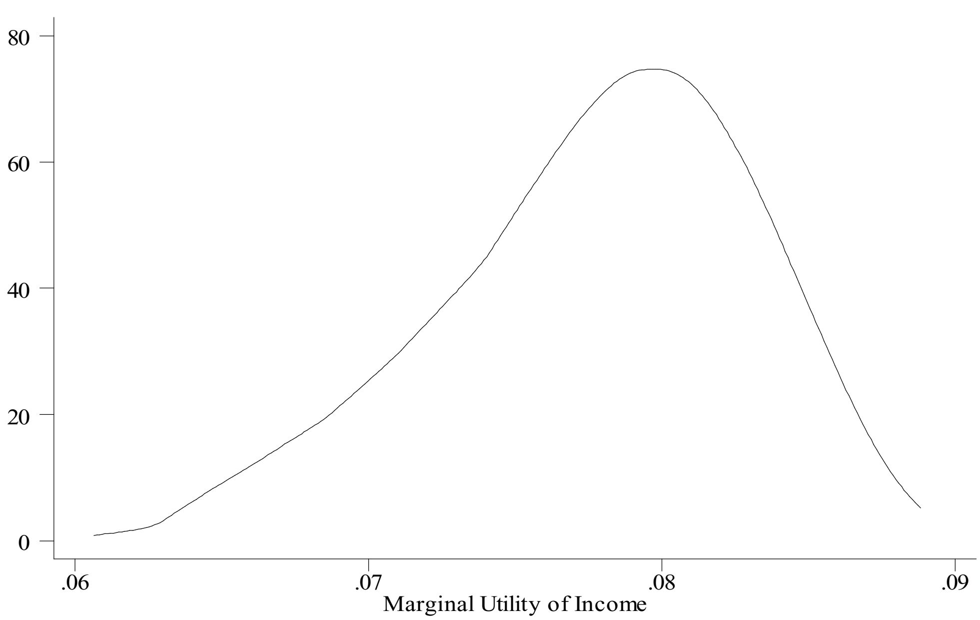


TABLE 4. Price, Elasticity, Production Cost and Mark-up
Convergence Period (1996 - 1999)

	All Models	Domestic Models	Imports from Partner	Imports from Outside
ARGENTINA				
Quantity of Vehicles	1,047,730	730,065	150,710	166,955
Mean Price (thousands of dollars)	16.7	15.7	15.1	22.4
Mean Price Elasticity	-3.4 (0.2)	-3.3 (0.2)	-3.3 (0.2)	-3.7 (0.9)
Mean Production Cost (thousands of dollars)	11.3 [9, 14]	10.5 [9, 13]	11.6 [10, 14]	14.7 [11, 17]
Mean Percentage Mark-up (percentage)	50 [42, 79]	53 [51, 76]	37 [15, 72]	48 [34, 96]
BRAZIL				
Quantity of Vehicles	5,176,605	4,283,403	698,431	194,771
Mean Price (thousands of dollars)	15.1	14.3	15.9	29.0
Mean Price Elasticity	-1.7 (0.3)	-1.5 (0.1)	-1.8 (0.2)	-4.0 (0.5)
Mean Production Cost (thousands of dollars)	9.7 [6, 11]	9.5 [6, 10]	9.4 [6, 10]	15.3 [12, 17]
Mean Percentage Mark-up (percentage)	60 [14, 123]	62 [14, 124]	52 [11, 131]	39 [26, 84]

TABLE 5. Global Trade Balance Constraint (GTB)

	Lagrange Multipliers		Adjustment in Cost of Imports from Partner (percentage)	
	Argentina	Brazil	Argentina	Brazil
	λ^a	λ^b	$\lambda^a - 1.2\lambda^b$	$\lambda^b - 1.2\lambda^a$
Chrysler	0.02	0.29	-33	27
	(0.76)	*(0.80)*	[-436, -2.6]	[2.2, 357]
Fiat	0	0.15	-19	15
	(0.06)	*(0.95)*	[-36, -1.2]	[1.0, 30]
Ford	0.50	0.62	-25	3
	(0.97)	(0.31)*	[-30, 1.2]	[-25, 24]
General Motors	0.40	0.43	-11	-5
	(0.13)*	(0.18)*	[-25, 9]	[-20, 21]
Honda	0	0.37	-45	37
	(0.01)	(0.12)*	[-71, -27]	[22, 59]
Mercedes Benz	0	0.15	-18	15
	(0.24)	*(0.60)*	[-610, 12]	[-15, 508]
Peugeot-Citroën	0.30	0.43	-21	7
	(0.05)*	*(0.84)*	[-200, 3.5]	[-503, 63]
Renault	0	0.48	-57	48
	(0.005)	(0.12)*	[-94, -36]	[30, 78]
Toyota	0	0.27	-33	27
	(0.13)	*(0.93)*	[-100, -11]	[9, 84]
Volkswagen	0	0.14	-16	14
	(0.05)	*(0.88)*	[-44, -0.2]	[0.2, 37]

* Standard errors for estimators that are significantly different from zero at the 5% significan level (two-tail test)

Parentheses and Italics indicate that the estimator is not significantly different from zero at the 5% significance level. Since the multipliers cannot be negative, the distribution of the estimator is truncated at zero. The numbers between parentheses indicate the probability that the estimator is strictly positive

TABLE 6. Lagrange Multipliers for the Bilateral Constraint

	1996		1997		1998		1999		Difference in Cost Adjustments
	Argentina	Brazil	Argentina	Brazil	Argentina	Brazil	Argentina	Brazil	
	μ^a	μ^b	μ^a	μ^b	μ^a	μ^b	μ^a	μ^b	$(1+1.2)(\lambda^b-\lambda^a)$
Chrysler	-	-	0	2.41	0	0.94	0.76	0	59
Fiat	0.16	0	0.19	0	0.18	0	1.82	0	34
Ford	0.04	0	0.15	0	0.25	0	0.76	0	28
General Motors	0	0.29	0.32	0	0.30	0	0.54	0	6
Honda	-	-	0.59	0	4.22	0	5.94	0	82
Mercedes Benz	-	-	-	-	0	0.18	2.05	0	34
Peugeot-Citroën	0	0.75	0	0.33	0.18	0	0.82	0	28
Renault	0	0.40	0.20	0	0.55	0	1.89	0	105
Toyota	-	-	-	-	0	0.38	4.01	0	60
Volkswagen	0.17	0	0.27	0	0.30	0	1.13	0	30

A dash (-) indicates no bilateral trade

TABLE 7. Elimination of NTBs
Argentina, 1996 - 1999

	All Models	Domestic Models	Imports from Partner	External Imports
Mean Change in Price (dollars)	-1,148 [-2828, -1048]	-987 [-3133, -887]	811 [135, 918]	-3,619 [-5612, -1786]
Mean Change in Price (percentage)	-6.9 [-17, -6]	-6.3 [-20, -6]	5.4 [0.9, 6]	-16 [-25, -8]
Change in Units (thousands)	-1.7 [-52, 636]	-66.4 [-584, 93]	-65.4 [-145, 22]	130.0 [51, 1376]
Change in Units (percentage)	-0.2 [-5, 61]	-9.1 [-80, 13]	-43 [-96, 15]	78 [31, 825]
Mean Change in Cost (dollars)	139 [-6101, 2762]	-240 [3038, 831]	0 [-3869, 1312]	204 [-8570, 5545]
Compensating Variation by Unit Sold (dollars)	607 [-66, 1262]	Compensating Variation (millions of dollars)		635 [-69, 1322]
Change in Profits (percentage)	-19 [-30, 18]	Change in Profits (millions of dollars)		-1,165 [-2080, 1110]
Change in Revenue (percentage)	77 [13, 326]	Change in Revenue (millions of dollars)		197 [36, 779]

90% confidence intervals between square brackets
The estimators are not normally distributed

TABLE 8. Adoption of a Common External Tariff
Argentina, 1996 - 1999

	All Models	Domestic Models	Imports from Partner	External Imports
Mean Change in Price (dollars)	489 [417, 810]	44 [7, 620]	-9.1 [-98, 73]	2,886 [2265, 3237]
Mean Change in Price (percentage)	3.2 [0.6, 10.4]	0.3 [0.1, 8]	-0.06 [-12, 1.4]	15 [0.4, 23]
Change in Units (thousands)	-37.2 [-569, -20]	71.7 [45, 422]	10.7 [7, 57]	-119.6 [-1043, -75]
Change in Units (percentage)	-3.6 [-34, -1.6]	11 [6, 289]	13 [6, 986]	-40 [-70, -17]
Mean Change in Cost (dollars)	-639 [-1572, 5137]	39 [-114, 2874]	10 [-20, 3911]	-2,059 [-2951, 5546]
Compensating Variation by Unit Sold (dollars)	-214 [-2079, 206]	Compensating Variation (millions of dollars)		-224 [-2179, 216]
Change in Profits (percentage)	-3.1 [-93, -1.2]	Change in Profits (millions of dollars)		-151 [-100387, -61]
Change in Revenue (percentage)	48 [25, 140]	Change in Revenue (millions of dollars)		217 [120, 1322]

90% confidence intervals between square brackets
The estimators are not normally distributed

TABLE 9. Customs Union
Argentina, 1996 - 1999

	All Models	Domestic Models	Imports from Partner	External Imports
Mean Change in Price (dollars)	-659 [-2372, -551]	-943 [-3110, -847]	802 [46, 881]	-733 [-3322, 1441]
Mean Change in Price (percentage)	-4.0 [-16, -1.3]	-6.0 [-20, -5.4]	5.3 [0.28, 6]	-3.3 [-15, 6]
Change in Units (thousands)	-39.0 [-87, 394]	5.2 [-240, 174]	-54.7 [-96, 40]	10.5 [-32, 420]
Change in Units (percentage)	-3.7 [-8, 37]	0.7 [-33, 24]	-36 [-64, 26]	6.3 [-19, 252]
Mean Change in Cost (dollars)	-500 [-3236, 1810]	-202 [-519, 884]	10 [-1410, 1470]	-1,856 [-6412, 3333]

Compensating Variation by Unit Sold (dollars)	393 [-643, 1731]	Compensating Variation (millions of dollars)	412 [-674, 1814]
Change in Profits (percentage)	-22 [-32, -3.2]	Change in Profits (millions of dollars)	-1,316 [-2229, -207]
Change in Revenue (percentage)	162 [69, 723]	Change in Revenue (millions of dollars)	414 [188, 1719]

90% confidence intervals between square brackets
The estimators are not normally distributed

TABLE 10. Elimination of NTBs
Brazil, 1996 - 1999

	All Models	Domestic Models	Imports from Partner	External Imports
Mean Change in Price (dollars)	92 [-3909, 260]	412 [-3826, 622]	-734 [-4046, -159]	-3,997 [-6961, -1111]
Mean Change in Price (percentage)	0.6 [-26, 1.7]	2.9 [-27, 4.3]	-4.6 [-25, -1]	-14 [-24, -3.8]
Change in Units (thousands)	258.8 [-676, 269]	-58.4 [-1190, -29]	89.2 [-95, 150]	228.0 [134, 777]
Change in Units (percentage)	5.0 [-13, 5]	-1.4 [-27, -0.8]	13 [-13, 21]	117 [69, 399]
Mean Change in Cost (dollars)	707 [489, 3996]	-108 [-162, 2433]	823 [-42, 4813]	5,431 [-1852, 7560]
Compensating Variation by Unit Sold (dollars)	-203 [-541, 655]	Compensating Variation (millions of dollars)		-1,050 [-2799, 3392]
Change in Profits (percentage)	5.7 [-43, 5.8]	Change in Profits (millions of dollars)		1,989 [-24701, 1991]
Change in Revenue (percentage)	205 [128, 396]	Change in Revenue (millions of dollars)		1,857 [1298, 3457]

90% confidence intervals between square brackets
The estimators are not normally distributed

TABLE 11 Adoption of a Common External Tariff
Brazil, 1996 - 1999

	All Models	Domestic Models	Imports from Partner	External Imports
Mean Change in Price (dollars)	8.7 [7.5, 14]	1.0 [1, 5.6]	0.7 [0.7, 3.6]	207.3 [166, 247]
Mean Change in Price (percentage)	0.06 [0.06, 0.1]	0.007 [0.007, 0.048]	0.005 [0.004, 0.031]	0.83 [0.75, 0.89]
Change in Units (thousands)	-2.3 [-3, -0.2]	4.2 [3, 13]	1.0 [0.7, 6]	-7.5 [-20, -4]
Change in Units (percentage)	-0.04 [-0.05, -0.005]	0.10 [0.09, 0.4]	0.13 [0.09, 0.8]	-1.77 [-3.6, -0.87]
Mean Change in Cost (dollars)	-15.9 [-59, -7.8]	0.5 [0.5, 13]	3.3 [2.8, 55]	-20.3 [-234, -7]
Compensating Variation by Unit Sold (dollars)	-1.0 [-3, 6]	Compensating Variation (millions of dollars)		-5.1 [-14, 30]
Change in Profits (percentage)	-0.013 [-0.02, 0.1]	Change in Profits (millions of dollars)		-5.0 [-7.5, 31.2]
Change in Revenue (percentage)	1.4 [1.1, 2.9]	Change in Revenue (millions of dollars)		39.6 [28, 103]

90% confidence intervals between square brackets
The estimators are not normally distributed

TABLE 12. Customs Union
Brazil, 1996 - 1999

	All Models	Domestic Models	Imports from Partner	External Imports
Mean Change in Price (dollars)	100 [-3902, 312]	413 [-3823, 631]	-733 [-4045, -152]	-3,790 [-6753, -858]
Mean Change in Price (percentage)	0.7 [-26, 2]	2.9 [-27, 4]	-4.6 [-25, 0.9]	-13.1 [-23, -3]
Change in Units (thousands)	256.5 [-677, 267]	-54.2 [-1151, -24]	90.3 [-94, 152]	220.5 [130, 769]
Change in Units (percentage)	5.0 [-13, 5]	-1.3 [-27, -0.6]	12.9 [-14, 22]	113.2 [67, 395]
Mean Change in Cost (dollars)	691 [479, 4154]	-107 [-162, 2564]	826 [-30, 5781]	5,410 [-1755, 7548]
Compensating Variation by Unit Sold (dollars)	-204 [-545, 649]	Compensating Variation (millions of dollars)		-1,055 [-2821, 3360]
Change in Profits (percentage)	5.7 [-43, 6]	Change in Profits (millions of dollars)		1,984 [-24691, 2027]
Change in Revenue (percentage)	210 [131, 445]	Change in Revenue (millions of dollars)		1,896 [1329, 3753]

90% confidence intervals between square brackets
The estimators are not normally distributed