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

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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 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 and I show how a particular form of trade balance restriction applied at the firm level can lead to an increase in trade flows in the presence of intra-firm strategic trade. 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 on the cost side.

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.

KEY WORDS: c ustom unions, regional integration, non-tariff barriers

JEL CLASSIFICATIONS: F13, F14, F23

1 Introduction

This paper looks empirically at the behavior of multinational firms in oligopolistic markets with trade balance constraints. I show how a particular form of non-tariff barriers applied at the firm level can lead to an increase in trade flows in the presence of intra-firm strategic trade. In my application, I estimate a model of demand, supply and trade policy in the automobile sector in Argentina and Brazil during 1996-1999. I measure the economic impact of a trade balance constraint that was in effect during that period and I compute predicted economic outcomes for the full adoption of a customs union, as it is scheduled for 2006.

I model the behavior of the firms in the two countries and incorporate the effects of NTBs and tariffs into the price decision making. During this period, there were two non-tariff barriers (NTBs) in place both from the Argentine and from the Brazilian sides: there was a quota on bilateral *net* imports, and there was a trade balance constraint on global trade. Both of these restrictions were applied to each firm and in each of the two countries. I first show that the effect of the trade balance constraint is qualitatively not determined. The combination of trade balance constraints with strategic intra-firm trade can lead to artificially high bilateral trade in one direction. The reason is that a given firm needs to satisfy the constraints in both countries and can use bilateral trade as an instrument to increase exports in the country where they are most needed. When NTBs are eliminated, the directions of change in bilateral flows are a priori unpredictable.

Argentina, Brazil, Uruguay and Paraguay formed a customs union - MERCOSUR - in 1995. The automobile sector was initially excluded from the agreement and it is scheduled to become part of the customs union in 2006. The NTBs will need to be eliminated as part of the negotiations. The evaluation of the effect of trade balance constraint on trade flows shades light both on the behavior of multinational firms under this particular trade policy and on the direction in which trade is going to move after the customs union is fully adopted.

In addition, the MERCOSUR negotiations involve the adoption of a common external tariff which is higher than the average tariffs in Argentina and Brazil during 1996-1999. Thus, the customs union agreement involves two opposing changes in trade policy that have an impact on external imports: the increase in the external tariff - which favors imports from the partners and domestic production in detriment of imports from other countries - and the removal of the trade balance constraint - which leads to an increase in external imports. Whether the trade diverting effect of the increase in the tariff level is more than compensated by the trade creating effect from eliminating the trade balance constraint is again an empirical question.

I estimate the imposed cost of the NTBs and simulate a counterfactual equilibrium in which they are removed and the common external tariff is adopted. By comparing the observed and predicted equilibrium outcomes during 1996-1999, I asses the impact of customs union on prices, trade flows, revenue, profits and welfare. Moreover, by computing an intermediate equilibrium without NTBs but with the different tariff levels that were in effect during 1996-1999, I can decompose the effects two policy changes.

I find that the elimination of non-tariff barriers dominates the leveling of tariffs for all the effects that I measure. 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 the trade balance constrain imposes a higher cost to Brazilian subsidiaries relative to their Argentine counterparts leading to excessive exports from Brazil to Argentina. Hence, under the customs union regime, imports from Brazil are predicted to decrease in Argentina.

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) estimates a structural model of supply and demand in the U.S. market and simulates the counterfactual equilibrium without the VER. Berry, Levinsohn and Pakes (1999) run a similar exercise with a different demand specification.

The empirical strategy that I adopt is very similar in spirit to Goldberg (1995) and

Berry, Levinsohn and Pakes (1999). The estimation method consists on specifying a full structural model of the behavior of the firms - including the choice variables, the nature of the competition and other factors influencing the market - which can be summarized by a system of first order conditions that describes the firms' maximizing behavior. Such system includes quantities, prices, marginal costs, costs imposed by trade policy, and a demand function and price derivatives (or elasticities). If prices, quantities and price derivatives are observed, the cost of each differentiated product can be estimated by finding the values of the cost that satisfy the system of first order conditions. Firms choose prices (or quantities) given a demand function and marginal costs; the researcher works backwards, given the observed prices and the demand function the marginal cost that generated those decisions can be pinned down. In practice, the demand functions are not observed and need to be estimated, either as a first step or jointly with the supply side.

The recovered marginal costs reflect both the cost of production and the costs imposed by trade policy and it is necessary to disentangle the two of them to be able to run a counterfactual exercise that involves a change in trade policy. Both Goldberg and Berry, Levinsohn and Pakes specify a parametric functional form for the cost function in which production cost depends on physical attributes of the automobiles. Instead of estimating the production cost of each car directly, they reduce the number of parameters by estimating the coefficients of a cost function (plus the trade policy parameters). This procedure imposes further functional forms assumptions on a method that is already substantially relying on structure.

In my application, I estimate a model of supply and trade policy in the automobile sector in two countries - Argentina and Brazil. Since automobile firms are subsidiaries of multinational corporations, the same agents are located in the two countries and maximize profits jointly in the two markets. In terms of the estimation method, this translates into observing two sets of quantities, prices and demand derivatives (one in Argentina and one in Brazil) while only one set of marginal costs for each model (since each model is produced in only one country). I develop a minimum distance estimator that takes advantage of the additional information from multiple equilibrium outcomes (in this case two) and allows me to estimate the production cost and the trade policy parameters directly from the behavior of firms, without imposing functional form assumptions on costs of production.

This approach can be applied to any application in which there is market level data on more than one market but only one production cost. It is natural to apply the procedure to trade models, it is also suitable for closed-economy industrial organization applications in which there is demand data on different jurisdictions.

On the demand side, I adopt the random-coefficient model of Berry (1994) and Berry, Levinsohn and Pakes (1995). The procedure to estimate the supply side, however, is independent of the chosen demand model.

In Section 2, I describe the characteristics of the automobile market in Argentina and Brazil and the trade policy; in Section 3, I formalize the description of the industry into a model of oligopoly with differentiated products; the estimation details of the supply side can be found in Section 4. Section 5 describes the data and the results of the estimation both of supply and demand parameters. Section 6 presents the description and results of the counterfactual adoption of a customs union as has been scheduled for 2006.

2 Automobile market and trade policy

Automobiles are produced in Argentina and Brazil by subsidiaries of multinational corporations associated with local investors. The firms located in the area 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). There are no purely domestic firms, and the participation of local capital in the joint ventures with the above mentioned multinationals is minoritarian.

All of these firms have production facilities in both countries. Renault, Toyota and Peugeot-Citroën have regional headquarters in Argentina, while the remaining firms are primarily based in Brazil. Generally, the car models produced in Argentina are different from the models produced in Brazil. In some cases, there are overlaps of the main production lines across the two countries, but final models differ in engine size or design details. For example, between 1996 and 1997, Honda manufactured the Accord in Argentina and the Civic in Brazil (different production lines); while between 1996 and 1999, the Ford Escort was mainly produced in Argentina with the exception of the 2-door version that was produced in Brazil (same production line but different final models).

Firms trade models between Argentina and Brazil and also import and export from and to the rest of the world. The largest fraction of trade is bilateral, other destinations of exports are Latin America and Europe, primarily Italy and France, but this varies substantially by year. Cars produced in Argentina and Brazil are mostly compact, small and medium sized while models imported from third countries include larger vehicles and SUVs. Brazil tends to specialize in the smaller models than Argentina. Trade in finished vehicles is a large fraction of bilateral trade. Just as an example, in 1997, imports of cars accounted for more than 17% of Brazilian imports from Argentina, and 10% of Argentine imports from Brazil.

There are also car manufacturers that do not have production facilities in the area and that only import cars. The most important among these in terms of sales during the second half of the 1990's are Rover, Isuzu and Daewoo. These firms are subject to a different -more restrictive- trade regime in both countries and account for less than 10 percent of domestic sales in each Argentina and Brazil. Throughout this paper, I focus on demand and supply for cars produced domestically in Argentina or Brazil or imported by local producers.

The total number of vehicles sold and the share of each corporation with local production are displayed in Table 1 for the 1996-1999 period. During these four years, approximately 1 million new cars were sold in Argentina and 5 million in Brazil; this 1 to 5 relation is similar to the relation of the population in the two countries. In Argentina, 70 percent of the number of cars is produced domestically, while 14.4 percent are imports from Brazil, the remaining 16 percent are imports from other countries; while in Brazil 83 percent of units are produced domestically and 13.5 percent of cars originated in Argentina, imports from other countries only account for less than 4 percent. The market in Brazil is dominated by Fiat, General Motors and Volkswagen which account for 85 percent of sales (in units); 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.

In Argentina, imports from Brazil receive a different treatment than imports from other countries, and vice versa in Brazil. Trade policy is subject to continuous negotiations both between the two countries and between authorities and firms. There is no arbitrage between bilateral imports and imports from other countries. For example, a car entering Argentina from Brazil is consider a bilateral import if it was actually produced in Brazil. If it was produced elsewhere, it is considered an import from the "rest of the world" and subject to the appropriate trade restrictions. In addition, there are regional content agreements: a car produced in Brazil is subject to the "bilateral imports" trade policy if 60 to 70 percent of its components originated in MERCOSUR countries. The exact percentages vary by year and depend on the year of introduction of the car model - new car models are allowed to have larger fractions of foreign components.

Historically, the industry has been heavily protected in Argentina and Brazil with very few imports during the 1980s. The first liberalization episode took place in 1990 when the two countries agreed to eliminate tariffs for bilateral imports, but kept tariffs for imports from other countries. They also set quotas on *net* imported units in both countries, that were in place until the year 2000. By these quotas, the number of imported units could not exceed the number of exported units by more than a negotiated limit; their purpose was to balance bilateral trade in units. For example, in the case of Argentina, the total number of cars imported from Brazil minus the total number of cars exported to Brazil could not exceed a given limit (quota). These quotas were negotiated by the two countries and then arbitrarily assigned to firms, presumably based on past participation on the market. 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 accounted for a large part of total bilateral trade.

In 1995, Argentina, Brazil, Uruguay and Paraguay formed a customs union (MERCOSUR), which implies free internal trade between partners (no tariffs or non-tariff barriers) and a common external tariff for imports from outside the union. The automobile sector received a different treatment from other goods. The sector was initially left out of the agreement and its incorporation was scheduled for 2000. The years 1996-1999 were established as an initial period to phase-out tariffs and non-tariff barriers and the MERCOSUR trade partners signed bilateral agreements that regulated trade until the customs union was fully achieved. I refer to this transition from the beginning of 1996 the beginning of 2000 as the *convergence period*. The change in trade barriers from the convergence period to the customs union is the focus of this study.

Before the formal adoption of MERCOSUR, at the beginning of 1995, imports from third countries were subject to a tariff of 2 percent in Argentina and 32 percent in Brazil. The MERCOSUR members agreed to adopt a common external tariff of 35 percent 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 percent (it reached 35 percent in 1996 and in 1999). The following table displays the average yearly tariff levels applied to finished vehicles with origin in the "rest of the world" during 1996-1999.[1]

	ARGENTINA	BRAZIL
1996	7%	35%
1997	10%	32%
1998	14%	28%
1999	17%	35%

The tariff for bilateral trade was zero since 1990 and continued to be zero during 1996-1999 and afterwards. 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.[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

[1] Imports from Uruguay receive special treatment as well, but I do not describe that here

[2] This coefficient can in principle be managed by the authorities to introduce slack into the constraint; in practice, it remained constant during the 4 year period 1996-1999.

and net exports of auto-parts were considered export credits (which were not multiplied by 1.2). Firms could also buy export credits from independent spare-part producers.

For a given firm, the constraint in Argentina takes the following form

$$\begin{pmatrix} \text{Imports from Brazil} \\ + \\ \text{Imports from} \\ \text{other countries} \end{pmatrix} \leq 1.2 \begin{pmatrix} \text{Exports to Brazil} \\ + \\ \text{Exports to} \\ \text{other countries} \end{pmatrix} + \begin{pmatrix} \text{Export} \\ \text{credits} \end{pmatrix}.$$

Firms face an analogous constraint in Brazil and have to satisfy both of them intertemporally, during 1996-1999. At the beginning of the period, each firm presented an investment and trade plan for the following four years, which had to be approved by the authorities. In addition to the GTB, there were the quotas on net bilateral imports described above.

In 2000 the two non-tariff barriers (global trade balance and bilateral quotas) were eliminated. However, the objective of free trade between partners agreed upon in 1995 was not achieved. The 1996-1999 non-tariff barriers 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. To be more precise, in each country, the value of imports is restricted to be less or equal to the value of exports multiplied by a "deviation coefficient" that is subject to annual adjustments to gradually loosen the constraint. As a consequence, a *managed customs union* was arranged: tariffs were zero for internal trade and uniform for external trade, but trade between partners was not free of NTBs (there were no NTBs for external imports, though). 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 ($\leq$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 this study, I compare the policy during the convergence period with the policy during the customs union. I estimate demand and production cost using observed data during 1996-1999 and then use the results to predict counterfactual outcomes for the policy that will be implemented in 2006.

The policy described above applies to firms that are actually located in Argentina and Brazil. Cars are also imported into these two countries by firms that do not have production facilities in the region. Among the most important during 1996-1999 are Rover, Isuzu and Daewoo. These firms represent less than 10 percent of the combined market and are subject to a completely different trade regime (they face traditional import quotas and higher tariff levels). Throughout this paper, I focus only on demand and supply for cars produced domestically in Argentina or Brazil or imported by local producers. There are other firms, that have merged or established partnerships with firms that do have local production (for example, Alfa Romeo and Fiat); they are subject to the trade regime described above and I do include them in the analysis by considering that their car models are traded by the local firms.

Expected changes in trade flows

There are two changes in trade policy that I evaluate via the counterfactual analysis: the adoption of a common external tariff and the elimination of the NTBs. The adoption of the common external tariff of 35 percent involves a large increase in the tariff level in Argentina (28 to 18 percentage points depending on the year) which make external imports substantially more costly than compared to the actual trade policy during 1996-1999. The price of car models imported from non-MERCOSUR countries is expected to increase in Argentina after the adoption in the common external tariff and imports are expected to decrease. The expected changes are the same in Brazil but of a smaller magnitude as the actual tariff level during the convergence period is substantially higher in Brazil than in Argentina. In both countries, as external imports become more expensive, external trade is diverted towards bilateral imports and domestic production. The bilateral tariff level was already zero prior to the customs union agreement and therefore there is no trade creation from change in tariffs.

The effects of removing the global trade balance constraint are more complicated. Due to the strategic behavior of the firms across the two countries, removing the NTBs is a movement towards free trade but not necessarily towards more trade. For these corporations, trade is intra-firm and they can manage trade flows to satisfy the trade balance constraint in Argentina and Brazil simultaneously. Suppose that for a given firm the GTB is less binding in Argentina than in Brazil; the firm increases imports of Brazilian models to Argentina which loosens the GTB in Brazil while tightening it in Argentina. By this mechanism, firms can shift export credits across countries according to where they are most needed. They can use the export credits to import from other countries.[3] Under this circumstances, for this particular firm, imports from Brazil to Argentina are artificially high due to the constraint while imports from Argentina to Brazil are artificially low. The removal of the trade balance constrain would imply a decrease of trade in one direction and an increase in the other. The answer needs to be find empirically. In Sections (5) and (6) I find that the GTB is more binding in Brazil and that exports to Brazil to Argentina decrease when the constraint is removed.

The effect of the GTB on external imports is not ambiguous. The price decision for exports to the rest of the world is exogenous to the multinationals' regional headquarters and do not take into account the effects on the trade balance constraint in Argentina and Brazil. Hence, there are no incentives to switch exports credits from the rest of the world. The constraint reduces trade and external imports are expected to increase under the customs

[3] Ideally, firms would like to shift export credits until the constraints were equally binding in both countries, however, the bilateral quotas set a limit to this mechanism.

union. Notice that the total change in external imports due to the adoption of the customs union is driven by two opposite forces: the increase in the external tariff and the removal of the GTB. I find that removing the GTB has a larger impact, meaning that external imports increase in the counterfactual adoption of the customs union.

3 Model of firm behavior

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 the two countries, indexed by f. Each firm produces some car models in Argentina, some models in Brazil and some models in the rest of the world. In each of the two countries, firms sell cars produced domestically, cars imported from the partner (Argentina or Brazil) and cars imported from other countries. 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. In principle, the sets of cars sold in Argentina and Brazil can differ.

The same model is not produced in more than one country, and models are indexed by j. Producers face constant marginal costs for each model, given by c_{jt}. For modeling purposes, it would be possible to specify a more general cost function in which the marginal cost depended on the quantity produced. However, for estimation purposes, it would require data on total quantity produced, which is not available for cars produced in countries other than Argentina and Brazil. The constant marginal cost assumption side-steps this restriction imposed by data availability.

Demands for model j in period t are fully observed by the firms and given by $q^a_{jt}\left(\mathbf{P}^a_t\right)$ and $q^b_{jt}\left(\mathbf{P}^b_t\right)$, in Argentina and Brazil respectively; where $\mathbf{P}^a_t$ is the price vector of all car models sold in Argentina and $\mathbf{P}^b_t$ its counterpart in Brazil. Demand functions vary by country and by time period, and they are independent across countries and time. In particular, it is assumed that demand is static and individuals do not consider future changes in prices in current decisions.

Bilateral imports are free of taxes, whereas outside imports face a tariff τ_t^a in Argentina and τ_t^b in Brazil. These tariffs are different in the two countries and vary by year. Tariffs are applied to the price at which car models are traded internationally, not the price at which they are sold to consumers. Since all trade is intra-firm, firms can in principle choose convenient transfer prices to minimize the effects of tariffs and NTBs and to switch profits across countries depending on corporate tax rates. However, in practice, authorities in the two countries elaborate guidelines of values per model from which the values reported by firms cannot disagree substantially; the testimony of industry experts suggests that these values are reasonably close to the costs of production. Since I do not observe the prices at which firms trade internationally in the data, I assume that firms trade at marginal cost.

Let p_j^a be the retail price of model j in Argentina, and p_j^b the price of the same model in Brazil. Profits in country h (with $h = a,\, b$) 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 $\mathbf{P}_t^h$ 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

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

$$\begin{aligned}\pi_{ft}^b &= \sum_{j\in A'_{ft}} \left(p_{jt}^b - c_{jt}\right) q_{jt}^b\left(\mathbf{P}_t^b\right) + \sum_{j\in B'_{ft}} \left(p_{jt}^b - c_{jt}\right) q_{jt}^b\left(\mathbf{P}_t^b\right) + \\ &\quad + \sum_{j\in W'_{ft}} \left(p_{jt}^b - c_{jt}\left(1+\tau_t^b\right)\right) q_{jt}^b\left(\mathbf{P}_t^b\right)\end{aligned} \tag{2}$$

Firms compete in prices taking the demand functions and the price of the competitors as given. In each time period, they choose two prices for each car model, one for Argentina $\left(p_{jt}^a\right)$ and one for Brazil $\left(p_{jt}^b\right)$. Furthermore, characteristics of the products and entry-exit decisions are assumed to be exogenous to the pricing decision. Since each firm produces more than one car model, when setting the price of a particular model they take into account the effect of a marginal increase in price both on the quantity demanded of that particular model and on the quantities demanded of all other models manufactured by the same firm.

As described so far, the problems in the two countries are independent because of the constant marginal cost assumption, meaning that prices in Brazil (or in any other country) do not affect prices in Argentina and vice versa. For this same reason, the problem of setting prices in third countries is disregarded. However, the price decisions need to contemplate the restrictions imposed by trade policy. The non-tariff barriers link the decisions in the two countries.

Imports by each firm, in each country, are subject to the intertemporal global trade balance constraint (GTB), by means of which the cumulative value of imports during period T^0 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

$$\sum_{t\in T^0}\left(\sum_{j\in B_{ft}} c_{jt} q^a_{jt}\left(\mathbf{P}^a_t\right) + \sum_{j\in W_{ft}} c_{jt}\left(1+\tau^a_t\right) q^a_{jt}\left(\mathbf{P}^a_t\right)\right) \leq$$
$$1.2\sum_{t\in T^0}\sum_{j\in A'_{ft}} c_{jt} q^b_{jt}\left(\mathbf{P}^b_t\right) + X^a_f$$

$$\sum_{t\in T^0}\left(\sum_{j\in A'_{ft}} c_{jt} q^b_{jt}\left(\mathbf{P}^b_t\right) + \sum_{j\in W'_{ft}} c_{jt}\left(1+\tau^b_t\right) q^b_{jt}\left(\mathbf{P}^b_t\right)\right) \leq$$
$$1.2\sum_{t\in T^0}\sum_{j\in B_{ft}} c_{jt} q^a_{jt}\left(\mathbf{P}^a_t\right) + X^b_f$$

where T^0 denotes the period in which the GTB was in place. 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. Export credits from the acquisition or export of capital goods and net exports of components are included in the exogenous terms X^a_f and X^b_f. Exports to other countries are also exogenous to the pricing decision in Argentina and Brazil and are therefore included in X_f^a and X_f^b as well.

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.[4] The lower bound is the (negative of the) quota in Argentina, and the upper bound the quota in Brazil. Thus,

$$\underline{Q}_{ft} \leq \left(\sum_{j \in A'_{ft}} q_{jt}^b \left(\mathbf{P}_t^b \right) - \sum_{j \in B_{ft}} q_{jt}^a \left(\mathbf{P}_t^a \right) \right) \leq \overline{Q}_{ft} \tag{3}$$

Each firm maximizes profits during T^0 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 $\mathbf{\Delta}_{ft}^h$ its matrix of partial derivatives of demand with respect to price, with $\mathbf{\Delta}_{ft(ij)}^h = \partial q_{it}^h / \partial p_{jt}^h$. The first order conditions for firm f in period t and in countries a and b (Argentina and Brazil)

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

can be written in matrix form as

$$\begin{aligned} q^a_{ft}\left(\mathbf{P}^a_t\right) + \Delta^a_{ft}\left(\mathbf{P}^a_t\right)\left(\mathbf{p}^a_{ft} - \mathbf{c}^{*a}_{ft}\right) &= 0 \\ q^b_{ft}\left(\mathbf{P}^b_t\right) + \Delta^b_{ft}\left(\mathbf{P}^b_t\right)\left(\mathbf{p}^b_{ft} - \mathbf{c}^{*b}_{ft}\right) &= 0 \end{aligned} \tag{4}$$

where $\mathbf{c}^{*h}_{ft}$ 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. The definition of adjusted marginal costs follows directly from the first order conditions and is given by

$$\begin{aligned} c^{*a}_{jt} &= \begin{cases} c_{jt} & \text{for } j \in A_{ft} \\ c_{jt}\left(1 + \lambda^a_f - 1.2\lambda^b_f\right) + \left(\mu^a_{ft} - \mu^b_{ft}\right) & \text{for } j \in B_{ft} \\ c_{jt}\left(1 + \tau^a_t\right)\left(1 + \lambda^a_f\right) & \text{for } j \in W_{ft} \end{cases} \\ c^{*b}_{jt} &= \begin{cases} c_{jt}\left(1 + \lambda^b_f - 1.2\lambda^a_f\right) - \left(\mu^a_{ft} - \mu^b_{ft}\right) & \text{for } j \in A'_{ft} \\ c_{jt} & \text{for } j \in B'_{ft} \\ c_{jt}\left(1 + \tau^b_t\right)\left(1 + \lambda^b_f\right) & \text{for } j \in W'_{ft} \end{cases} \end{aligned} \tag{5}$$

For a car produced and sold in Argentina ($j \in A_{ft}$) the cost relevant for the price decision is the marginal cost of production - there is no adjustment. In the case of a car produced in a third country and imported into Argentina ($j \in W_{ft}$), the relevant cost is the production cost augmented by the percentage increase due to the tariff $(1 + \tau^a_t)$ and the shadow increase in cost due to the GTB constraint $(1 + \lambda^a)$. When a car is imported from Brazil to Argentina ($j \in B_{ft}$), the cost does not need to be increased by a tariff since the bilateral tariff is zero, but there are two NTBs that apply, the GTB and the net quota on imports. 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. The net effect of the GTB in Argentina is $\lambda^a - 1.2\lambda^b$, which can be positive or negative. In addition, there is the cost imposed by the net quota, given by $\mu^a - \mu^b$. If the bound in binding in Argentina, μ^a is positive and μ^b is zero. This cost is additive and not multiplicative because the quota applies to units and not values.

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

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

$$q(\mathbf{P}) + \Delta(\mathbf{P})(\mathbf{P} - \mathbf{c}^*(\mathbf{c}, \boldsymbol{\lambda}, \boldsymbol{\mu})) = 0 \tag{6}$$

where $\mathbf{q}$, $\mathbf{P}$ and $\mathbf{c}^*$ are the stacked quantity, price and adjusted cost vectors across firms, years and countries, and $\boldsymbol{\Delta}$ is a block diagonal matrix, with $\boldsymbol{\Delta}_{ij} = 0$ when products i and j are produced by different firms, sold in different countries or in different time periods. The adjusted cost $\mathbf{c}^*(\mathbf{c}, \boldsymbol{\lambda}, \boldsymbol{\mu})$ satisfies the definition in (5). This notation will be useful in the estimation section that follows.

4 Estimation of the supply parameters

In this section I describe how to estimate the marginal cost of production of each car model and the shadow cost of the non-tariff barriers - the Lagrange multipliers - described in Section 3. Since marginal cost may vary over time due to changes in input prices, technical change and other factors, I estimate a different marginal cost per model and per time period.

The estimators are derived from the firms' first order conditions in (6). Intuitively, the estimators are defined as the costs of production and shadow costs of NTBs that satisfy the firm behavior described in the previous section, given prices, quantities and the matrix of price derivatives. Firms observe marginal costs, the trade restrictions and a demand function for each model, and choose the optimal prices (and jointly the equilibrium quantities). If the researcher observes prices, quantities and the matrix of price derivatives, then, the marginal costs that generated the observed equilibrium outcome can be estimated under a particular assumption about how firms behave (i.e. the FOCs).

The data consists of information on prices and quantities sold for each car model, in each country. As a first step, it is necessary to obtain an estimate of the matrix of price derivatives, as this is not directly observed in the data, and that implies estimating demand functions for the two countries, $q^a_{jt}(\mathbf{P}^a_t)$ and $q^b_{jt}(\mathbf{P}^b_t)$. Once there are estimates for the demand functions available, an estimate for the matrix of price derivatives, $\widehat{\boldsymbol{\Delta}}$, can be constructed.

The supply model and the estimation method are general enough that they do not depend on the specification of the demand side. The choice of a demand model depends mainly on available data (individual vs. aggregate data, long or short time-series) and their different implications for welfare evaluation. I model demand using the random coefficients logit model of Berry (1994) and Berry, Levinsohn and Pakes (1995). 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 based on household characteristics and random tastes. Since individual purchases data is not available, the identification of heterogenous preferences is achieved through the variance in demographic composition (individual characteristics) and car model shares (vehicle attributes) across geographic regions and time periods. Aggregate demand is obtained by the aggregation of individual choices. [5,6] More details about the specification of the demand side follow in Section 5.

In what follows, I describe the supply-side estimation for any given estimate of the matrix of derivatives $\widehat{\boldsymbol{\Delta}}$, that is consistent and normally distributed, with variance Σ_{Δ}.

Consider first the hypothetical case of a closed economy with J different car models and one time period. Since there are no trade barriers, the effective marginal cost is simply the cost of production (there are no Lagrange multipliers), so that $\mathbf{c}^* = \mathbf{c}$. The FOCs can be written as $\mathbf{q} + \boldsymbol{\Delta}(\mathbf{P} - \mathbf{c}) = 0$. The supply parameter to be estimated is the $(J \times 1)$ vector of production costs; while the information available is the observed prices and quantities and

[5] This same approach has been used in the estimation of demand for cars by Berry (1994), Berry, Levinsohn and Pakes (1995) and Berry, Levinsohn and Pakes (1999). Goldberg (1995), Petrin (2002) and Berry, Levinsohn and Pakes (2004) use other multinomial logit models to estimate demand for automobiles and include data on individual choices.

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

the estimated matrix of price derivatives. The FOCs are a system of J equations. Given $\mathbf{P}$, $\mathbf{q}$, and $\widehat{\boldsymbol{\Delta}}$, the estimator for the marginal cost of production is the vector $\widehat{\mathbf{c}}$ that solves the system of FOCs

$$\widehat{\mathbf{c}} = \mathbf{P} + \widehat{\boldsymbol{\Delta}}^{-1}\mathbf{q}. \tag{7}$$

The system of FOCs is just identified and there is a unique solution for $\widehat{\mathbf{c}}$, which is the marginal cost that predicts the outcomes $\mathbf{q}$, $\mathbf{p}$ and $\widehat{\boldsymbol{\Delta}}$ given the firm behavior.

This is a perfect fit method where there are no residuals. That does not mean, however, that the vector of marginal costs is estimated without error. There are estimation errors derived from the fact that the matrix of price derivatives is estimated rather than observed. The estimator of the marginal cost is consistent and asymptotically normal (provided $\widehat{\boldsymbol{\Delta}}$ satisfies these characteristics, too) and its variance is a function of the variance of the estimated matrix of price derivatives. The variance of $\widehat{\mathbf{c}}$ can be estimated either via the delta-method or by simulation, by taking different samples of the matrix of price derivatives from a normal distribution with mean $\widehat{\boldsymbol{\Delta}}$ and variance $\widehat{\Sigma}_{\Delta}$ (where $\widehat{\Sigma}_{\Delta}$ is an estimator for Σ_{Δ}) and recomputing $\widehat{\mathbf{c}}$ for each draw.

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 on exports of cars to the U.S.; 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.

This perfect-fit method is problematic when there are other supply parameters to estimate. Suppose that there is still one country, one time period and J car models. Assume that the FOCs take the following form $\mathbf{q} + \boldsymbol{\Delta}\left(\mathbf{P} - \mathbf{c}^*\left(\mathbf{c}, \varphi\right)\right)$. In addition to the vector of production costs given by $\mathbf{c}$, there is an $(R \times 1)$ vector of parameters, φ, that affects price decisions through the adjusted marginal costs $\mathbf{c}^*$ in the same fashion as $\boldsymbol{\lambda}$ and $\boldsymbol{\mu}$ in the model in the previous section. The number of price equations (FOCs) is the same as the number of car models and adjusted marginal costs, J, while the number of parameters to be estimated is $J + R$ ($\mathbf{c}$ and φ). The system of FOCs is underidentified; there are no degrees of freedom to estimate both $\mathbf{c}$ and φ.

Goldberg (1995) and Berry, Levinsohn and Pakes (1999) estimate the impact of Japanese VERs on imports of automobiles to the U.S. using a Lagrange multiplier approach. The parameters of interest in this case are the production cost of each car model, c_{jt}, and one Lagrange multiplier for each year in which the VER was in place, φ_t. The adjusted marginal costs can be written in this case as $c^*_{jt} = c_{jt} + \varphi_t * I_{jt}$, where I is an indicator variable that equals one when a model is imported from Japan. The Lagrange multiplier φ enters additively because the VER applies to units and not values (same as μ in the quota on net bilateral imports between Argentina and Brazil). They observe prices and quantities sold in the U.S., estimate a matrix of price derivatives and derive a set of FOCs. The number of FOCs is the same as the number of marginal costs of production, consequently, there are no degrees of freedom left to recover both $\mathbf{c}$ and φ as in (7).

To reduce the number of parameters to be estimated, both Goldberg (1995) and Berry, Levinsohn and Pakes (1999) add more structure to the supply side. They assume a functional form for the cost function by means of which the marginal cost depends on observable characteristics of the model, such as origin, type of vehicle, size and performance. Let x_{jt} be a vector of observed characteristics of model j in period t, and ω_{jt} a linear combination of unobserved characteristics; they write the marginal cost as $c_{jt} = f\left(x'_{jt}\gamma\right) + \omega_{jt}$. Under this specification, the number of estimating parameters reduces to to the dimension of φ plus the dimension of γ. They first recover $\mathbf{c}^*$ by inverting the FOCs as in (7) and then estimate the parameters of interest from a second step regression of the following form,

$$\widehat{c}^*_{jt} = f\left(x'_{jt}\gamma\right) + \varphi_t * I_{jt} + \omega_{jt} \tag{8}$$

This method has the potential problem of spreading misspecifications of the cost function to the estimation of the supply parameters.

Consider now the two-country model with trade restrictions described in Section 3. The FOCs can be written as $\mathbf{q} + \Delta\left(\mathbf{P} - \mathbf{c}^*\left(\mathbf{c}, \boldsymbol{\lambda}, \boldsymbol{\mu}\right)\right) = 0$, where $\mathbf{c}^*$ is the vector of adjusted marginal costs defined as a function of the vector of production costs and the trade policy parameters according to (5). There is one FOC and one adjusted marginal cost for each price-quantity observation.

The dimension of $\mathbf{c}$ is smaller than the dimension of $\mathbf{c}^*$ and the number of FOCs. To simplify the argument, suppose that exactly the same car models are sold in Argentina and Brazil (that is, the sets A_{ft}, B_{ft} and W_{ft} are equal to the sets A'_{ft}, B'_{ft} and W'_{ft} for all firms f and time periods t). At time t, car model j is produced in only one location - Argentina, Brazil or the rest of the world - and therefore there is only one production cost, c_{jt}; but it is sold in two locations - Argentina *and* Brazil- and therefore there are two prices, p^a_{jt} and p^b_{jt}, and two adjusted marginal costs, c^{*a}_{jt} and c^{*b}_{jt}. In the more general case in which the sets of available vehicles differ in the two countries, there are some cars that are sold only in Argentina, some cars that are sold only in Brazil and some cars that are sold in both countries. Provided there are some cars sold in both countries, the dimension of $\mathbf{c}$ is strictly smaller than the number of FOCs (and the dimension of $\mathbf{p}$ and $\mathbf{c}^*$) and the system of FOCs is overidentified in $\mathbf{c}$. This overidentification allows for the estimation of the trade policy parameters and the costs of production jointly.

Notice that there are two Lagrange multipliers per firm per year for the bilateral quantitative restrictions (μ^a_{ft} and μ^b_{ft}) and two Lagrange multipliers per firm for the multiperiod global trade balance constraints (λ^a_f and λ^b_f). 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).[7]

Instead of the "perfect-fit" method employed by previous authors for the one-country case, in which the costs are just-identified, I use 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

$$\left(\widehat{\mathbf{c}}, \widehat{\boldsymbol{\lambda}}, \widehat{\boldsymbol{\mu}}\right) = \arg\min_{(\mathbf{c},\boldsymbol{\lambda},\boldsymbol{\mu})} \left(\mathbf{q} + \widehat{\Delta}\left(\mathbf{P} - c^*(\mathbf{c}, \boldsymbol{\lambda}, \boldsymbol{\mu})\right)\right)^T \widehat{W_1} \left(\mathbf{q} + \widehat{\Delta}\left(\mathbf{P} - c^*(\mathbf{c}, \boldsymbol{\lambda}, \boldsymbol{\mu})\right)\right) \quad (9)$$

where $\widehat{W_1}$ is a square weighting matrix, with its dimension equal to the number of price

[7] In addition, I observe prices and quantities by semester, hence there are four pricing equations per year. The number of Lagrange multipliers does not increase because of using semestral data.

equations. For efficiency, $\widehat{W_1}$ 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 since it is possible to see if the first order conditions are close enough to zero. 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 without further functional form assumptions about the cost function.

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.

The estimators for the Lagrange multipliers of the GTB $(\boldsymbol{\lambda})$ are constrained to be non-negative during the non-linear search. As a result, there is a truncation at zero in their distribution and asymptotically they are not normally distributed. Since these parameters are estimated jointly with the costs of production and the Lagrange multipliers associated with the net quotas, the distribution of these two sets of coefficients is affected by the truncation and is not normal either. To estimate their variance, I take draws from the estimated distribution of the matrix of price derivatives, $N\left(\widehat{\boldsymbol{\Delta}}, \widehat{\Sigma}_\Delta\right)$ and recompute $\left(\widehat{\mathbf{c}}, \hat{\boldsymbol{\lambda}}, \hat{\boldsymbol{\mu}}\right)$ for each of these draws; I compute 90 percent confidence intervals with the results.

5 Data and first results

The data consist on semestral observations of sales, average prices and vehicle characteristics from 1996 to 2000, for each car model in Argentina and Brazil. There are 123 different models in Brazil, and 128 in Argentina, not all of them available in all time periods.[8]

The estimation of the demand side is based on a multinomial logit model where the utility relative to the outside alternative that individual i derives from car model j in a combination of region-time period t and country h is given by

$$U_{ijt}^{h} = -u_{it}^{h} - \alpha_{it}^{h} p_{jt}^{h} + x_{jt}\acute{} \beta_{it}^{h} + \xi_{jt}^{h} + \varepsilon_{ijt}^{h} \tag{10}$$

where u denotes the alternative utility of not choosing any car model, p is price, x are observed model attributes, ξ are model characteristics that are not observed by the econometrician, and ε is an independent and identically distributed error term that follows a type I extreme-value distribution.

The characteristics that I include in the estimation of demand are length, length squared, horsepower and dummy variables for hatchback models, station wagons, sport utility vehicles (SUVs) and minivans. I introduce coefficients that vary by individual for the constant (alternative utility), 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 $u_{it}^{h} = u_{o}^{h} + u_{1}^{h} Z_{it}^{h}$, where u_{o}^{h} is the mean alternative utility and u_{1}^{h} its standard deviation. The price coefficient depends on income and takes the functional form $\alpha_{it}^{h} = \alpha_{o}^{h} + \alpha_{1}^{h}/y_{it}^{h}$. The length coefficient varies with family size. In particular, I interact length with a dummy variable B with ones for families with more than two children. The variable coefficient is $\beta_{LENGTH,it}^{h} = \beta_{LENGTH,o}^{h} + \beta_{LENGTH,1}^{h} \times B_{it}^{h}$.

[8] The data sources for quantities and prices are associations of car dealers and car manufacturers - 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; - data on characteristics of vehicles are from the specialized publications *Megaautos* and *Quatro Rodas*.

I sample income and family size from household surveys and deviations from the mean alternative utility from a standard normal.[9] I take one hundred draws per semester and country. 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. In the Argentine data, household characteristics and sales, but not prices, are disaggregated into four geographical regions. For the purpose of demand estimation, the regions are different markets and their treatment is analogous to that of different time periods. To estimate the price derivatives I take a sample of 1300 and 2000 individuals per period and region in Argentina and Brazil, respectively. 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.

The term ξ represents a combination of the vehicle characteristics that are observed by customers and firms but not by the econometrician. 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. 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 aggregate of each characteristic of the cars manufactured by the same firm and the aggregate of each characteristic of models produced by its competitors.[10] The identifying assumption is that unobservable characteristics are independent from observable characteristics.

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

[10] Berry, Levinsohn and Pakes (1995) show that these instruments are optimal based on Chamberlain (1986) and Pakes (1994).

Results from the estimation of the demand coefficients are shown in Table 2. 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 $u_i^a \sim N(13.5, 0.9)$ and $u_i^b \sim N(7.7, 0.8)$.[11]

The main results are the price coefficients, shown in the second two rows. The estimates are $\hat{\alpha}_i^a = 0.19 + 0.17/y_i$ and $\hat{\alpha}_i^b = 0.09 - 0.03/y_i$ in Argentina and Brazil, respectively. 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 price coefficient over the sample of consumers is 0.25 in Argentina and 0.08 in Brazil. Using the individual price coefficients and the functional form for the demand functions - which can be derived from (10) - I compute estimated 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 3 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 price-cost margin of 50%.[12,13] 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

[11] 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.

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

[13] 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.

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 4. 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 marginal costs of imports from third countries due to the the trade balance constraint, as defined in Equation (5). For example, in the case of General Motors, the augmented marginal cost of outside imports in Argentina is 40 percent higher than the cost of production of these models. In Brazil, these increases in marginal cost range from 14 to 62 percent. Whereas in Argentina, several multipliers are very small and not significantly different from zero, which signals that the price decisions of those firms would be similar without the Argentine GTB. The Lagrange multipliers are significant for Ford, General Motors and Peugeot-Citroën. It is also statistically significant for General Motors, although small.

There are other considerations when computing the augmented cost of imports from the MERCOSUR partner (see Equation (5)): internal imports tighten one GTB but loosen the other. A vehicle that is exported from Argentina to Brazil, tightens the Brazilian GTB by λ_f^b percent and loosens the Argentina GTB by $1.2\lambda_f^a$ percent. The third and fourth columns of Table 4 show the cost imposed by the GTB on bilateral imports, given by the differences $\lambda_f^b - 1.2\lambda_f^a$ and $\lambda_f^a - 1.2\lambda_f^b$. These differences can be negative. In the case of Ford, for example, the adjusted cost of internal imports in Argentina is 25 percent lower than the production cost. The opposite happens in Brazil, where the cost of Argentine products is 3 percent 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 percent. In Brazil, the cost of internal imports increases between and 48 percent, with the exception of General Motors, whose costs decrease by 5 percent.[14]

The fact that the cost of imports from Brazil is lower in Argentina than the production cost of these vehicles intuitively indicates that prices of these models are lower and exports are higher than what they would be if there was no GTB. Firms face a tighter constraint on outside imports in Brazil (first two columns) and therefore export to Argentina to get export credits in Brazil. This is further explored in Section (6) . The bilateral quota on net imports imposes a limit to the possibilities to arbitrage until the marginal costs in the two countries are equalized.

Table 5 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 $\hat{\mu}^b = 0$.[15] 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 suggest that the GTB constraint works in the direction of increasing Argentine imports of Brazilian products.[16]

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

[15] 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).

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

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 Counterfactual Customs Union Equilibrium

The model in the previous sections describes the equilibrium under the trade regime during 1996-1999, 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. I compute two additional equilibria: one equilibrium without NTBs, in which the GTB constraint and the bilateral quota for net imports are removed but the tariff schedules remain unchanged, and one equilibrium that mimics the customs union to be implemented in 2006 - no NTBs and a common external tariff of 35 percent.

Let $(\mathbf{q}^0, \mathbf{P}^0)$ denote the observed quantities and prices during the convergence period, and $(\mathbf{q}^1, \mathbf{P}^1)$ and $(\mathbf{q}^2, \mathbf{P}^2)$ denote the counterfactual equilibria in the two additional cases. The three equilibria can be summarized as follows

Convergence Period	No NTBs	Customs Union
τ^a, τ^b	τ^a, τ^b	$\tau = 35\%$
Global trade balance (λ)	$\lambda = 0$	$\mu = 0$
Quota for net imports (μ)	$\mu = 0$	$\mu = 0$
$\mathbf{q}^0, \mathbf{P}^0$	$\mathbf{q}^1, \mathbf{P}^1$	$\mathbf{q}^2, \mathbf{P}^2$

By introducing the equilibrium without NTBs, 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).

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 $(\mathbf{q}^1, \mathbf{P}^1)$ and $(\mathbf{q}^0, \mathbf{P}^0)$, I assess the impact of the elimination of the NTBs. Similarly, by comparing $(\mathbf{q}^2, \mathbf{P}^2)$ and $(\mathbf{q}^1, \mathbf{P}^1)$ I measure the impact of the adoption of the common external tariff. The sum of the two effects accounts for the total change due to a transition to a 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.

To compute the two counterfactual equilibria I introduce the counterfactual trade policy parameters into the definition of augmented marginal costs. Adjusted costs when NTBs are removed are given by

$$\begin{aligned} c^{*a}_{jt} &= \begin{cases} c_{jt} & \text{for } j \in A_{ft} \text{ and } j \in B_{ft} \\ c_{jt}\left(1+\tau^a_t\right) & \text{for } j \in W_{ft} \end{cases} \\ c^{*b}_{jt} &= \begin{cases} c_{jt} & \text{for } j \in A'_{ft} \text{ and } j \in B'_{ft} \\ c_{jt}\left(1+\tau^b_t\right) & \text{for } j \in W'_{ft} \end{cases} \end{aligned} \tag{11}$$

Adjusted costs in the customs union equilibrium are

$$\begin{aligned} c^{*a}_{jt} &= \begin{cases} c_{jt} & \text{for } j \in A_{ft} \text{ and } j \in B_{ft} \\ c_{jt}\left(1+\tau\right) & \text{for } j \in W_{ft} \end{cases} \\ c^{*b}_{jt} &= \begin{cases} c_{jt} & \text{for } j \in A'_{ft} \text{ and } j \in B'_{ft} \\ c_{jt}\left(1+\tau\right) & \text{for } j \in W'_{ft} \end{cases} \end{aligned} \tag{12}$$

Since there are no NTBs in neither of the two computed equilibria, the Lagrange multipliers are zero.[17] 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 estimator of $(\mathbf{q}^1, \mathbf{P}^1)$ satisfies the system of first order conditions given the estimated demand function and marginal costs. Let $\mathbf{q} = q(\mathbf{P}, \theta)$ denote the demand function, Δ the matrix of cross price derivatives, $\widehat{\theta}$ the estimator of the demand parameters, and $\widehat{\mathbf{c}}$ the estimator of the marginal costs of production. The estimator $\left(\widehat{\mathbf{q}^1}, \widehat{\mathbf{P}^1}\right)$ solves[18]

$$q(\widehat{\mathbf{P}^1}, \widehat{\theta}) + \Delta(\widehat{\mathbf{P}^1}, \widehat{\theta}) \left(\widehat{\mathbf{P}^1} - c^*(\widehat{\mathbf{c}}, \tau^a, \tau^b, \lambda = 0, \mu = 0)\right) = 0$$

$$\widehat{\mathbf{q}^1} = q(\widehat{\mathbf{P}^1}, \widehat{\theta})$$

Likewise, the estimators of $(\mathbf{q}^2, \mathbf{P}^2)$ are defined by

$$q(\widehat{\mathbf{P}^2}, \widehat{\theta}) + \Delta(\widehat{\mathbf{P}^2}, \widehat{\theta}) \left(\widehat{\mathbf{P}^2} - c^*(\widehat{\mathbf{c}}, \tau = 35\%, \lambda = 0, \mu = 0)\right) = 0$$

$$\widehat{\mathbf{q}^2} = q(\widehat{\mathbf{P}^2}, \widehat{\theta})$$

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. In the comparison of the equilibrium withouth NTBs and the observed convergence period

[17] 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.

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

$$\mathbf{P}^1_{(n+1)} = c^*(.) - \Delta(\mathbf{P}^1_{(n)}, \widehat{\theta})^{-1} q(\mathbf{P}^1_{(n)}, \widehat{\theta})$$

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

equilibrium, the change in income for consumer i at time t and country h $\left(\Delta y_{it}^{1,h}\right)$ satisfies

$$\max_j U_{jt}^h\left(y_{it}^h, p_{jt}^{0,h}, \theta^h\right) = \max_j U_{jt}^h\left(y_{it}^h + \Delta y_{it}^{1,h}, p_{jt}^{1,h}, \theta^h\right). \tag{13}$$

This is the change in individual welfare due to the elimination of NTBs. The change due to the adoption of a common external tariff is given by the additional change in income $\left(\Delta y_{it}^{2,h}\right)$ that solves

$$\max_j U_{jt}^h\left(y_{it}^h, p_{jt}^{0,h}, \theta^h\right) = \max_j U_{jt}^h\left(y_{it}^h + \Delta y_{it}^{1,h} + \Delta y_{it}^{2,h}, p_{jt}^{2,h}, \theta^h\right). \tag{14}$$

To compute the change in aggregate welfare I take a sample of 1,200 and 2,000 individuals for each time period-region combination in Argentina and Brazil, respectively. I compute the $\Delta y_{it}^{1,h}$ and $\Delta y_{it}^{2,h}$ that solve (13) and (14) given the estimator of utility parameters $\widehat{\theta}$ for each of them and calculate the average across individuals.[19] The aggregate change in welfare is the average change multiplied by the market size.

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 by taking draws of $\widehat{\theta}$ and reestimating all estimators for each sampled value of θ. The estimators are not normal because of the non-negativity constraint imposed in the estimation of the Lagrange multipliers in the cost side.[20]

Results

Table 6 shows the changes in prices of imports and trade volumes due to the changes in policy. The first two columns show the changes in external imports; the total effect is decomposed to capture the effect of the elimination of the NTBs and the adoption of the common external tariff. Both changes in policies have the expected results. The elimination of the trade balance constraint results in sales-weighted average decrease in price of external

[19] The change in income for each individual does not have a closed form solution; I take draws of ε for each car model from a type-I extreme-value distribution and numerically search over different changes in income; each step involves finding the preferred car model.

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

imports of 16 percent in Argentina and 14 percent in Brazil; the average increase in imported units is 78 percent and 117 percent in each country. The increase in the tariff level due to the adoption of the common external tariff has the opposite effect. Prices of external imports go up by 15 percent in Argentina and 0.8 percent in Brazil - the increase is small in Brazil because the counterfactual change in the tariff level is not high - and the number of imported units increases. Overall, the effect of the elimination of the NTBs predominates and there is a net increase in trade with the rest of the world although a customs union is formed. The trade creating effect of the elimination of the NTBs more than compensates the trade diverting effect of the higher external tariff.

The last two columns show the changes in bilateral trade flows and prices. As was expected from the estimation of the Lagrange multipliers, imports from Brazil to Argentina are artificially high due to the GTB. The cost imposed by the GTB is larger in Brazil and firms have incentives to switch export credits from Brazil to Argentina; the perceived cost of imports from Brazil to Argentina is lower than the cost of production. Once this distortion is removed by eliminating the GTB, the cost of Brazilian cars becomes higher in Argentina and prices of these vehicles go up (5 percent in average). The opposite happens in Brazil, where the price of Argentine vehicles decrease by 5 percent. Bilateral imports decrease in one direction and increase in the other; the net effect is an increase in bilateral trade.

Bilateral trade increases due to the increase in the external tariff (trade diversion). In Argentina both changes move in opposite directions with the net effect being negative. Imports from Brazil are reduced after the counterfactual customs union is adopted. In Brazil, both changes dictate an increase in bilateral trade.

Table 7 displays the changes in welfare levels after both changes in policy. On average, prices decrease in Argentina and increase in Brazil and as a result consumers are better off in the first country and worse off in the second. Argentine consumers gain 393 dollars per vehicle sold whereas their Brazilian peers lose 204 per vehicle. When aggregating the two countries, consumers are worse off. Revenue increases in both countries since the tariff level is higher and imports are also higher due to the removal of the NTBs. Firm profits decrease in Argentina and increase in Brazil; the net effect is a gain for firms. Total welfare gains are positive even when profits are not included.

7 Conclusions

In this paper I estimate a model of demand and supply of cars in Argentina and Brazil that incorporates two non-tariff barriers: a quota on bilateral net imports and a trade balance constraint. By modeling the behavior of firms in two countries, rather than in one, I am able to capture an additional strategic component of firm behavior - the interaction across markets. In addition, the data on two different markets allows me to estimate the supply parameters (including the shadow cost of the trade policy constraints) by minimum distance instead of by a perfect fit method, and without the need to make functional form assumptions on the cost side as is the usual practice in the literature.

I measure the effects of adopting a customs union in the automobile market in Argentina and Brazil. The trade reform involves the removal of NTBs and the adoption of a common external tariff. My main finding is that the relevant effects on prices, trade and welfare are driven by the removal of 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.

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TABLE 1. Market Share of each Corporation. 1996-1999.

	Argentina				*Brazil*			
	All Models	Domestic Models	Imports from Partner	Imports from Outside	All Models	Domestic Models	Imports from Partner	Imports from Outside
Total number of units	1,047,730	730,065	150,710	166,955	5,176,605	4,283,403	698,431	194,771
Share by origin		69.7	14.4	15.9		82.7	13.5	3.8
Share of each firm								
Chyrsler	1.2	0.6	0	5.0	0.5	0	1.4	7.2
Fiat	23.3	29.4	10.0	8.7	29.3	32.0	18.2	7.8
Ford	15.5	7.2	49.4	20.7	11.1	9.3	21.1	15.9
General Motors	8.2	4.0	35.1	1.9	23.2	27.2	4.9	0
Honda	0.6	0.05	1.4	2.2	0.7	0.8	0	2.5
Mercedes Benz	0.2	0.02	0.4	1.0	0.3	0.2	0.1	2.7
Peugeot-Citroën	12.2	12.4	0	22.5	1.0	0	2.2	18.5
Renault	22.4	28.9	2.3	12.5	1.2	0.4	5.8	2.7
Toyota	0.8	0.1	0.5	3.9	0.3	0.2	0.3	3.8
Volkswagen	15.7	17.4	1.0	21.6	32.4	29.8	46.0	39.1

TABLE 2. 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 $(-\alpha_o)$	-0.19 *(0.05)*	-0.09 *(0.03)*
Price * 1/Income $(-\alpha_1)$	-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 Dummy	0.1 *(0.5)*	0.4 *(1.0)*
Station Wagon Dummy	-0.7 *(0.3)*	-0.6 *(0.2)*
SUV or Minivan Dummy	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	-0.25 *(0.11)*	-0.08 *(0.03)*

Standard errors in parenthesis.

TABLE 3 . Price, Elasticity, Production Cost and Mark-up. 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]

Estimators are not normally distributed. Confidence intervals at the 10% significance level between square brackets

TABLE 4. Global Trade Balance Constraint (GTB)

	Lagrange Multipliers		Adjustment in Cost of Imports from Partner	
	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	-0.33	0.27
	(0.76)	*(0.80)*	[-0.43, -0.02]	[0.02, 0.35]
Fiat	0	0.15	0	0.15
	(0.06)	*(0.95)*	[-36, -1.2]	[0.01, 0.30]
Ford	0.50	0.62	-0.25	0.03
	(0.97)	(0.31)*	[-0.30, 0.01]	[-0.25, 0.24]
General Motors	0.40	0.43	-0.11	-0.05
	(0.13)*	(0.18)*	[-0.25, 0.09]	[-0.20, 0.21]
Honda	0	0.37	-0.45	-0.37
	(0.01)	(0.12)*	[-0.71, -0.27]	[0.22, 0.59]
Mercedes Benz	0	0.15	-0.18	0.15
	(0.24)	*(0.60)*	[-0.61, 0.12]	[-0.15, 0.51]
Peugeot-Citroën	0.30	0.43	-0.21	0.07
	(0.05)*	*(0.84)*	[-0.20, 0.35]	[-0.50, 0.63]
Renault	0	0.48	-0.57	0.48
	(0.005)	(0.12)*	[-0.94, -0.36]	[0.30, 0.78]
Toyota	0	0.27	-0.33	0.27
	(0.13)	*(0.93)*	[-0.10, -0.11]	[0.9, 0.84]
Volkswagen	0	0.14	-0.16	0.14
	(0.05)	*(0.88)*	[-0.44, -0.02]	[0.02, 0.37]

* Standard errors for estimators that are significantly different from zero at the 5% significance 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 5. Lagrange Multipliers for the Bilateral Constraint

	1996		1997		1998		1999	
	μ^a	μ^b	μ^a	μ^b	μ^a	μ^b	μ^a	μ^b
Chrysler	-	-	0	2.41	0	0.94	0.76	0
Fiat	0.16	0	0.19	0	0.18	0	1.82	0
Ford	0.04	0	0.15	0	0.25	0	0.76	0
General Motors	0	0.29	0.32	0	0.30	0	0.54	0
Honda	-	-	0.59	0	4.22	0	5.94	0
Mercedes Benz	-	-	-	-	0	0.18	2.05	0
Peugeot-Citroën	0	0.75	0	0.33	0.18	0	0.82	0
Renault	0	0.40	0.20	0	0.55	0	1.89	0
Toyota	-	-	-	-	0	0.38	4.01	0
Volkswagen	0.17	0	0.27	0	0.30	0	1.13	0

A dash (-) indicates no bilateral trade

TABLE 6. Counterfactual changes in prices of imports and trade flows

	EXTERNAL IMPORTS		BILATERAL IMPORTS	
	Argentina	*Brazil*	*Argentina*	*Brazil*
Elimination of NTBs				
Mean change in price	–16% [-25, -8]	–14% [-24, -3.8]	5% [0.9, 6]	-5% [-25, -1]
Mean change in quantity	78% [31, 825]	117% [69, 399]	-43% [-96, 15]	13% [-13, 21]
Adoption of common external tariff				
Mean change in price	15% [0.4, 13]	0.8% [0.7, 0.9]	-0.06% [-12, 1.4]	0.005% [0.004, 0.03]
Mean change in quantity	–40% [-70, -17]	–1.7% [-4, -0.9]	13% [6, 986]	0.13% [0.1, 0.8]
Overall customs union effect				
Mean change in price	-3% [-15, 6]	-13% [-23, -3]	5% [0.3, 6]	-5% [-25, 0.9]
Mean change in quantity	6% [-19, 252]	113% [67, 395]	-36% [-64, 26]	13% [-14, 22]

Confidence intervals at the 10 percent significance level between square brackets.

TABLE 7. Overall welfare changes when adopting a customs union

	Argentina	*Brazil*
Change in prices (dollars)	-659 [-2372, -551]	100 [-3902, 312]
Compensating variation per vehicle sold (dollars)	393 [-643, 1731]	-204 [-545, 649]
Change in revenue	162% [69, 723]	210% [131, 445]
Change in profits	-22% [-32, -3.2]	5.7% [-43, 6]

Confidence intervals at the 10 percent level of significance between square brackets