A CUSTOMS UNION WITH MULTINATIONAL FIRMS:
THE AUTOMOBILE MARKET IN ARGENTINA AND BRAZIL

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ABSTRACT

This paper looks empirically into the behavior of multinational firms in international oligopolistic markets with trade balance constraints. I show how a particular form of non-tariff barrier 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 has been agreed as part of the Mercosur negotiations, separating the sometimes opposing impacts of the removal of non-tariff barriers and the adoption of a common external tariff. Results show that the elimination of non-tariff barriers dominates the leveling of tariffs. Imports from outside of Mercosur increase under the new regime even though tariffs against these goods become more discriminatory, and exports from Brazil to Argentina decrease once the trade balance constraint is removed.

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1 Introduction

This paper looks empirically into the behavior of multinational firms in international oligopolistic markets with trade balance constraints. I show how a particular form of non-tariff barrier 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 has been agreed as part of the Mercosur negotiations.

Argentina, Brazil, Uruguay and Paraguay formed a customs union - Mercosur - in 1995. The inclusion of the automobile sector was initially negotiated for 2000, with programmed tariff and non-tariff barriers (NTBs) phase-outs during 1996-1999. The complete elimination of the NTBs was later postponed until 2006.

During the period 1996-1999, there were two non-tariff barriers 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 car manufacturer in each of the two countries. The trade balance requirement restricted the value of imports of a particular firm to be less or equal to the value of its exports plus some additional export credits. Both imports and exports from the partner (Argentina and Brazil) and from other countries were included in the trade balance requirement.

I model the behavior of the car manufacturers in Argentina and Brazil and incorporate the effects of tariffs and NTBs into their price decision making. 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. 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. 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 the NTBs 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 the 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 decompose the effects of the two policy changes.

I find that the elimination of non-tariff barriers dominates the levelling of tariffs for all the effects that I measure. In particular, imports from outside of Mercosur increase under the new regime even though tariffs against these goods become more discriminatory. Another finding is that the trade balance constraint 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, exports from Brazil to Argentina are predicted to decrease.

Previous evaluations of trade policy in automobile markets have looked at the voluntary export restraint (VER) of Japanese vehicles exported to the 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 enhancing 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. Verboven (1996) and Goldberg and Verboven (2001) estimate structural models of supply and demand in the European car market and indirectly focus on restrictions to Japanese car model in the context of the study of price discrimination and price dispersion across several European countries.

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. Such system includes 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 recovered. 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. The previous structural studies specify a parametric functional form for the cost function in which the 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 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 is suitable for applications in which there are data of product sales and prices on more than one market but only one production cost. It is natural to apply the procedure to trade models - as in Verboven (1996) and Goldberg and Verboven (2001),- it is also suitable

for closed-economy industrial organization applications with demand and price data on different jurisdictions.

On the demand side, I adopt the random coefficients 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 including 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, most of them 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.[1] There are no purely domestic firms, and the participation of local capital in the joint ventures with multinationals is minoritarian.

All 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 the models maintain some distinctive features such as different engine size or number of doors. 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, Ford produced the Escort in Argentina with the exception of the 1,000cc engine size 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 other countries. The largest fraction of trade is bilateral. Other export destinations are Latin America and Europe, primarily Italy and France, although this varies substantially by year. Cars produced

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[1]Chrysler and Mercedes Benz merged in 2000 and formed Daimler-Chrysler

in Argentina and Brazil are mostly compact, small and medium sized, while models imported from other countries include larger vehicles and SUVs. Brazil tends to specialize in smaller models than Argentina. Trade in finished vehicles is a large fraction of bilateral trade. For 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 whose cars are only available in Argentina and Brazil through imports. The most important among these corporations 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 Argentina and Brazil. Throughout this paper, I focus on demand and supply for cars produced domestically in Argentina or Brazil or imported by firms with local production facilities. Finally, there are firms that, although they do not produce in Argentina or Brazil, have merged or established partnerships with firms that do have local production (for example, Alfa Romeo and Fiat). These firms 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.

The total number of vehicles sold and the share of each corporation in local production are displayed in Table 1 for the period 1996-1999. 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 ratio of populations in the two countries). In Argentina, 70 percent of the number of cars is produced domestically, while 14.4 percent are imports from Brazil and the remaining 16 percent are imports from other countries. 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 the number of vehicles sold. Participation of firms is more evenly distributed in Argentina, with Fiat and Renault accounting for 46 percent of total units, followed by Volkswagen, Ford, Peugeot-Citroën and General Motors.

In Argentina, imports from Brazil receive a different treatment from 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 considered a bilateral import only if it was indeed produced in Brazil. If it was produced elsewhere, it is

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considered a non-Brazilian import 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 on imports from other countries. They also set quotas on bilateral 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. The purpose was to balance bilateral trade in units. These quotas were negotiated by the two countries and then arbitrarily assigned to the individual firms presumably based on past participation in the market. Each country kept its own tariff rate on imports from other countries 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 (further described below). 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). A customs union implies that there is 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 (and later postponed until 2006). 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 in cars until the customs union was fully achieved. I refer to this transition from the beginning of 1996 to the end of 1999 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 external imports of finished cars during 1996-1999.[2]

	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. Trade flows with both the partner and with other countries were included in the computation of the trade balance constraints. Exports were multiplied by a factor of 1.2.[3] In addition, firms were granted export credits that could be included in the value of exports for trade balance purposes. Investment in capital goods 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 component 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 faced an analogous constraint in Brazil and had 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.

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[2]Imports from Uruguay received special treatment as well, but I do not describe that here.

[3]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.

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 new form of NTB. Implementation of the full customs union was deferred until 2006. The following table summarizes the regime during 1996-1999 and the planned customs union

Convergence Period (1996-1999)	*Customs Union*
Internal tariff: 0%	Internal tariff: 0%
Different external tariff ($\leq$35%)	Common external tariff (35%)
Global Trade Balance (GTB)	
Quota on net Imports	

In this study, I compare the policy during the convergence period with the projected policy for the customs union. I estimate demand and production cost using observed data during 1996-1999 and in a second step use the results to predict counterfactual outcomes for the planned customs union.

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 makes external imports substantially more costly relative 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 the 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. Trade is intra-firm and the corporations 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 has an incentive to increase its exports of Brazilian models to Argentina in order to loosen the GTB in Brazil. By this mechanism, firms can shift export credits across countries according to where they are most needed. They can use the export credits to increase imports from other countries.[4] 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 constraint implies a decrease of trade in one direction and an increase in the other. The answer needs to be found empirically. In Sections (5) and (6) I find that the GTB is more binding in Brazil and that Brazilian exports 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 countries outside of Mercosur 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 or to other countries. The constraint reduces trade and external imports are expected to increase under the customs 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 A model of firm behavior under trade restrictions

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 area, indexed by f. Each firm has production facilities both in Argentina and in Brazil. In each of the two countries, firms sell cars produced domestically, cars imported from the trade partner (Argentina or Brazil) and cars imported from other countries. Let A_{ft}, B_{ft} and W_{ft} denote 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} are the sets of cars sold in Brazil. In principle, the sets of cars sold in Argentina and Brazil can differ.

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[4]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 the possibility to arbitrage.

Models are indexed by j. A given model j sold in Argentina or Brazil is not produced in more than one country at the same time. Producers face constant marginal costs for each model, given by c_{jt} (t indexes time). For modelling 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 unavailability.

Demands for model j in period t are fully observed by the firms and given by $q_{jt}^a(\mathbf{P}_t^a)$ and $q_{jt}^b(\mathbf{P}_t^b)$, in Argentina and Brazil respectively; where $\mathbf{P}_t^a$ is the price vector of all car models sold in Argentina and $\mathbf{P}_t^b$ its counterpart in Brazil. Demand functions vary by country and by time period, and they are independent across countries and time. 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, customs authorities 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_{jt}^a be the retail price of model j in Argentina, and p_{jt}^b the price of the same model in Brazil. Firm f's profits in each country are given by the sum of profits over all its models. Separating the car models by origin – Argentina, Brazil, and the rest of the world,– profits in period t in Argentina and Brazil are, respectively

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

$$\pi_{ft}^b = \sum_{j \in A'_{ft}} (p_{jt}^b - c_{jt}) q_{jt}^b(\mathbf{P}_t^b) + \sum_{j \in B'_{ft}} (p_{jt}^b - c_{jt}) q_{jt}^b(\mathbf{P}_t^b) + \tag{2}$$

$$+ \sum_{j \in W'_{ft}} (p_{jt}^b - c_{jt}(1 + \tau_t^b)) q_{jt}^b(\mathbf{P}_t^b).$$

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, p_{jt}^a, and one for Brazil, p_{jt}^b. When setting the price of a particular model, firms take into account the effect on the demand for all models that they manufacture. Furthermore, characteristics of the products and entry-exit decisions are assumed to be exogenous to the pricing decision.

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. 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). The cumulative value of imports during the period in which the GTB was in place cannot exceed the cumulative value of exports. Let T^0 denote this period, which in practice corresponds to the convergence period 1996-1999. 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

$$\sum_{t \in T^0} \left(\sum_{j \in B_{ft}} c_{jt} q_{jt}^a(\mathbf{P}_t^a) + \sum_{j \in W_{ft}} c_{jt}(1 + \tau_t^a) q_{jt}^a(\mathbf{P}_t^a) \right) \leq \tag{3}$$

$$1.2 \sum_{t \in T^0} \sum_{j \in A'_{ft}} c_{jt} q_{jt}^b(\mathbf{P}_t^b) + X_f^a$$

$$\sum_{t \in T^0} \left(\sum_{j \in A'_{ft}} c_{jt} q_{jt}^b(\mathbf{P}_t^b) + \sum_{j \in W'_{ft}} c_{jt}(1 + \tau_t^b) q_{jt}^b(\mathbf{P}_t^b) \right) \leq \tag{4}$$

$$1.2 \sum_{t \in T^0} \sum_{j \in B_{ft}} c_{jt} q_{jt}^a(\mathbf{P}_t^a) + X_f^b.$$

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_f^a and X_f^b. 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 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.[5] The lower bound is the negative of the quota in Argentina, and the upper bound the quota in Brazil. Thus,

$$\underline{Q}_{ft} \leq \left(\sum_{j \in A'_{ft}} q_{jt}^b(\mathbf{P}_t^b) - \sum_{j \in B_{ft}} q_{jt}^a(\mathbf{P}_t^a) \right) \leq \overline{Q}_{ft}. \tag{5}$$

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 - the restrictions imposed by trade policy. They manipulate imports and exports in both locations to satisfy the trade balance constraints and the quotas on net imports. Hence, prices in Brazil affect prices in Argentina, and vice versa.

Notice that the bilateral trade terms, $\sum_{j \in B_{ft}} c_{jt} q_{jt}^a(\mathbf{P}_t^a)$ and $\sum_{j \in A'_{ft}} c_{jt} q_{jt}^b(\mathbf{P}_t^b)$, appear on opposite sides of the Argentine and Brazilian trade balance equations (3) and (4). The first term, for example, are imports from Brazil to Argentina. These imports are counted in both constraints, once as Argentine imports and a second time as Brazilian exports. They tighten the constraint in Argentina while loosening it in Brazil. Firms can manipulate both these terms (via prices) to satisfy the balance constraints simultaneously. In particular they can export from the country where export credits are most needed. This situation can lead to artificially high bilateral trade due to the GTBs. In addition, since exports are multiplied by 1.2, bilateral trade can be artificially high in both directions.

Let λ_f^a and λ_f^b be the Lagrange multipliers associated to the GTBs in Argentina and Brazil respectively; and let μ_{ft}^a and μ_{ft}^b denote the multipliers associated to the bilateral quantitative constraint (μ_{ft}^a is associated to the lower bound, the quota in Argentina, and μ_{ft}^b to the upper bound, the quota in Brazil). The first two are constant across time because there is a single

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

cumulative constraint; the latter two, on the other hand, vary annually.

Let $q_{ft}^h(\mathbf{P}_t^h)$ and $\mathbf{p}_{ft}^h$ be the vectors of demand and prices of firm f in country h (with $h = a, b$, Argentina and Brazil), and $\Delta_{ft}^h(\mathbf{P}_t^h)$ its matrix of partial derivatives of demand with respect to price, with $\Delta_{ft}^h(\mathbf{P}_t^h)_{(ij)} = \partial q_{it}^h/\partial p_{jt}^h(\mathbf{P}_t^h)$. The first order conditions for firm f in period t and in countries a and b can be written in matrix form as

$$
\begin{aligned}
q_{ft}^a(\mathbf{P}_t^a) + \Delta_{ft}^a(\mathbf{P}_t^a)(\mathbf{p}_{ft}^a - \mathbf{c}_{ft}^{*a}) &= 0 \\
q_{ft}^b(\mathbf{P}_t^b) + \Delta_{ft}^b(\mathbf{P}_t^b)(\mathbf{p}_{ft}^b - \mathbf{c}_{ft}^{*b}) &= 0
\end{aligned}
\tag{6}
$$

where $\mathbf{c}_{ft}^{*h}$ is a 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

$$
c_{jt}^{*a} = \begin{cases}
c_{jt} & \text{for } j \in A_{ft} \\
c_{jt}(1 + \lambda_f^a - 1.2\lambda_f^b) + (\mu_{ft}^a - \mu_{ft}^b) & \text{for } j \in B_{ft} \\
c_{jt}(1 + \tau_t^a)(1 + \lambda_f^a) & \text{for } j \in W_{ft}
\end{cases}
\tag{7}
$$

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

For a car produced and sold in Argentina ($j \in A_{ft}$), the relevant cost 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 $(1 + \tau_t^a)$ and the shadow increase in cost due to the GTB constraint $(1 + \lambda_f^a)$. When a car is imported from Brazil to Argentina ($j \in B_{ft}$), the cost does not include 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 $(100 \times \lambda_f^a)$ percent because each unit imported tightens the Argentine GTB. At the same time, each such export from Brazil helps relax the Brazilian GTB, which reduces the cost by $(100 \times 1.2\lambda_f^b)$ percent. The net effect of the GTB in Argentina is $\lambda_f^a - 1.2\lambda_f^b$, which can be positive or negative. If this term is negative, imports are larger than without the GTB. In addition, there is the cost imposed by the net quota, given by $\mu_{ft}^a - \mu_{ft}^b$. If the bound in binding in Argentina, μ_{ft}^a is positive and μ_{ft}^b is zero.

This cost is additive and not multiplicative because the quota applies to units instead of 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

$$q(\mathbf{P}) + \Delta(\mathbf{P})(\mathbf{P} - c^*(\mathbf{c}, \lambda, \mu, \tau^a, \tau^b)) = 0 \tag{8}$$

where $q(\mathbf{P})$, $\mathbf{P}$ and $c^*(\mathbf{c}, \lambda, \mu, \tau^a, \tau^b)$ are the stacked quantity, price and adjusted cost vectors across firms, years and countries, and $\Delta(\mathbf{P})$ is a block diagonal matrix, with $\Delta(\mathbf{P})_{ij} = 0$ when products i and j are produced by different firms, sold in different countries or in different time periods. The adjusted cost $c^*(\mathbf{c}, \lambda, \mu, \tau^a, \tau^b)$ satisfies the definition in (7). This notation will be useful in the estimation section that follows.

4   Estimation of the supply parameters

This section describes the estimation of 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 (8). 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 an estimate of 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, the marginal costs that generated the observed equilibrium outcome can be estimated under an explicit 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, which implies estimating demand functions for the two countries,

$q_{jt}^a \left(\mathbf{P}_t^a\right)$ and $q_{jt}^b \left(\mathbf{P}_t^b\right)$. Once there are available estimates for the demand functions, an estimate for the matrix of price derivatives, $\widehat{\mathbf{\Delta}}$, 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-coefficient 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 aggregating individual choices. [6],[7] More details about the specification of the demand side follow in Section 5. In what follows, I describe the supply-side estimation for any consistent estimate of the matrix of derivatives.

The estimation of the production costs and shadow costs of the NTBs, $(\mathbf{c}, \lambda, \mu)$, consists of a minimum-distance procedure. The estimator is defined as the parameter values that minimize the system of FOCs given the estimates of the price derivatives, as dictated by the following criterion function

$$\left(\widehat{\mathbf{c}}, \widehat{\lambda}, \widehat{\mu}\right) = \arg \min_{(\mathbf{c}, \lambda, \mu)} \left(\mathbf{q} + \widehat{\Delta} \left(\mathbf{P} - c^*(\mathbf{c}, \lambda, \mu, \tau^{\mathbf{a}}, \tau^{\mathbf{b}})\right)\right)^T \widehat{W} \left(\mathbf{q} + \widehat{\Delta} \left(\mathbf{P} - c^*(\mathbf{c}, \lambda, \mu, \tau^{\mathbf{a}}, \tau^{\mathbf{b}})\right)\right). \quad (9)$$

Where the vector $c^*\left(.\right)$ represents the adjusted marginal costs defined as a function of the vector of production costs and the trade policy parameters according to (7), and $\widehat{W}$ is a square weighting matrix, with its dimension equal to the number of price equations. For computational simplicity, I use the identity matrix.

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[6]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.

[7]A more straightforward way of modelling 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.

The estimators for the Lagrange multipliers of the GTB, λ, are constrained to be non-negative. As a result, their distribution is truncated at zero and asymptotically they are not normally distributed. Since these parameters are estimated jointly with the costs of production and the Lagrange multipliers associated to the net quotas, the distribution of these two sets of coefficients is affected by the truncation and is not normal either.[8] To estimate their variance, I take draws from the estimated distribution of the matrix of price derivatives, recompute the estimates of $(\mathbf{c}, \lambda, \mu)$ for each draw, and calculate 90 percent confidence intervals with the results.

The estimators of the shadow cost of the net quotas, μ_{ft}^a and μ_{ft}^b, are separately identified since the two bounds of the quotas 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 is zero, and vice versa.

Previous studies use a perfect fit solution of the first order conditions to estimate the supply side. 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.; Verboven (1996) and Goldberg and Verboven (2001) to study price discrimination and price dispersion in the European car market; 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 these studies, the system of FOCs is inverted to get an exactly identified solution of the marginal costs.[9] In some of these cases, additional costs parameters, such as the shadow cost of trade restrictions, need to be estimated. The common practice is to specify a cost function and to run an additional regression in which each car model's marginal cost (recovered from the inversion of the FOCs) is explained by its physical attributes and the trade restrictions that apply according to the country of origin of the car. This later regression allows to separate the marginal cost recovered from the FOCs into the cost of production and the cost imposed by the trade restrictions.

The minimum distance procedure has considerable advantages over the perfect-fit method. It provides a test of the model since it is in principle possible to check if the first order conditions are close enough to zero. At the same time, 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. Most importantly, there are enough degrees of freedom to estimate

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[8]One consequence is that the distance function is not distributed chi-square and a regular over-identifying restrictions test cannot be performed in this particular case.

[9]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.

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the Lagrange multipliers together with the marginal costs without imposing additional structure on the cost side. Namely, it is not necessary to make functional form assumptions about the cost function, and to spread its potential misspecification errors to the estimation of the cost of production and trade policy parameters. From a data point of view, the approach requires information on sales and prices of the same products in different markets (countries, geographic regions or cities). Intuitively, the system of first order conditions is overidentified due to the fact that more than one price equation is derived for a same marginal cost of production. In the present case, there is one price condition for Argentina and one for Brazil.

5 Data and first results

The vehicle data consist of semestral observations of sales, average prices and vehicle physical characteristics from 1996 to 1999, for each car model sold in Argentina and Brazil. Data on sales by region are available for Argentina but not for Brazil. There are 123 different models in Brazil, and 128 in Argentina, not all of them available in all time periods.[10]

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

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

where u denotes the alternative utility when the consumer chooses not to buy a car, 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 vector x are length, length squared, horsepower and dummy variables for hatchback models, station wagons, sport utility vehicles (SUVs) and minivans.

Consumers are allowed to have different tastes over the alternative utility, prices, and some of the observed characteristics. These variable coefficients are parameterized as a function of

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[10]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*.

individual characteristics and random tastes. I denote the individual deviation from the mean alternative utility by Z 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 $\alpha_{it}^h = \alpha_o^h + \alpha_1^h / y_{it}^h$, where y denotes income. The length coefficient varies with family size. In particular, I interact length with a dummy variable B which is equal to one for families with more than two children. The variable coefficient is $\beta_{Length,it}^h = \beta_{Length,o}^h + \beta_{Length,1}^h \times B_{it}^h$. The coefficients on all other car attributes are constant across individuals.

Since data for individual purchases of cars is not available, I use the distribution of demographic variables across populations in different markets (time and geographic regions) to identify the variable part of the coefficients, as proposed by Berry (1994) and Berry, Levinsohn and Pakes (1995). I sample income and family size from household surveys and deviations from the mean alternative utility from a standard normal.[11] 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.

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 ξ. In addition, some elements of ξ - for example, the shape of the car - affect production costs. Thus, price is correlated with ξ 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 information available. 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 other models, and whether these substitutes are produced by the same firm or by competitors. The instruments that I use are a car's own characteristics, an aggregate of the characteristics of the models manufactured by the

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

same firm, and an aggregate of the characteristics of all models in the market.[12] The identifying assumption is that unobservable characteristics are independent from observable characteristics.

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 $\hat{u}_{it}^a = 13.5 - 0.9 \times Z_{it}^a$ and $\hat{u}_{it}^b = 7.7 - 0.8 \times Z_{it}^b$, which implies that the estimated distributions of the reservation utilities are $u_i^a \sim N(13.5, 0.9)$ and $u_i^b \sim N(7.7, 0.8)$.[13] The main results are the price coefficients, shown in the second two rows. The estimates are $\hat{\alpha}_{it}^a = 0.19 + 0.17/y_{it}^a$ and $\hat{\alpha}_{it}^b = 0.09 - 0.03/y_{it}^b$ 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) obtaining the usual multinomial logit form for market shares, I compute estimated own and cross-price derivatives and elasticities for each car and each time period. I take a sample of 1300 and 2000 individuals per period and region in Argentina and Brazil, respectively, combine their demographic information with the estimates of the demand function parameters, compute the individual derivatives and elasticities, and aggregate them at the national level. The estimates of the price derivatives are used in the estimation of the supply parameters.

On the supply side, I estimate the marginal cost for each car model in each period of time in which the model is available. 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 average price and the 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 dollars, respectively, with an average price-cost margin of 50 percent.[14] Production cost is on average lower for domestic than Brazilian cars (10,600 and 11,600 dollars), while elasticities are similar. However, the price of domestic cars is on average

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[12]Berry, Levinsohn and Pakes (1995) show that these instruments are optimal.

[13]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.

[14]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.

higher (15,700 dollars 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 dollars).

In Brazil, demand elasticity is relatively low (1.7), while the average percentage mark-up is 60 percent, 10 percent 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 dollars compared to 14,300 dollars), while costs are very similar (9,500 and 9,400 dollars) 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.

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 trade balance constraint, as defined in Equation (7). 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 zero, which signals that the price decisions of those firms would be similar without the Argentine GTB. The Lagrange multipliers are non-zero for Ford, General Motors, Peugeot-Citroën and Chrysler.

There are additional considerations when computing the augmented cost of imports from the Mercosur partner (see Equation (7)): 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 Argentine 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. The decrease in

costs of internal imports in Argentina ranges from 11 to 57 percent. In Brazil, the cost of internal imports increases between 3 and 48 percent, with the exception of General Motors, whose costs decrease by 5 percent.

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 quotas. 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 $\hat{\mu}^b = 0$, and vice versa when the difference is negative. 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.[15]

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 dollars lower.

The fact that the μ'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 and estimates from the previous sections describe the equilibrium under the trade regime during 1996-1999, the convergence period, characterized by the presence of non-tariff barriers

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

(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 full customs union – no NTBs and a common external tariff of 35 percent.

Let $\left(\mathbf{q}^0, \mathbf{P}^0\right)$ denote the observed vectors of quantities and prices during the convergence period, and $\left(\mathbf{q}^1, \mathbf{P}^1\right)$ and $\left(\mathbf{q}^2, \mathbf{P}^2\right)$ 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)	$\lambda = 0$	$\lambda = 0$
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 $\left(\mathbf{q}^1, \mathbf{P}^1\right)$ and $\left(\mathbf{q}^0, \mathbf{P}^0\right)$, I assess the impact of the elimination of the NTBs. Similarly, by comparing $\left(\mathbf{q}^2, \mathbf{P}^2\right)$ and $\left(\mathbf{q}^1, \mathbf{P}^1\right)$ 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 that will occur when the customs union is adopted. The later depends on variables that are exogenous to the model, such as income and characteristics of the available car models.

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

are given by

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

$$
c_{jt}^{*b} = \begin{cases} c_{jt} & \text{for } j \in A'_{ft} \text{ and } j \in B'_{ft} \\ c_{jt}(1 + \tau_t^b) & \text{for } j \in W'_{ft} \end{cases} \tag{11}
$$

Adjusted costs in the full customs union equilibrium are

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

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

Since there are no NTBs in neither of the two computed equilibria, the Lagrange multipliers are zero.[16] 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 and 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 $q(\mathbf{P}, \theta)$ denote the demand function (with the demand parameters summarized by the vector θ), $\Delta(\mathbf{P}, \theta)$ 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[17]

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

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

---

[16]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.

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

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

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

Likewise, the estimator of $\left(\mathbf{q}^2, \mathbf{P}^2\right)$ is defined by

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

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

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 without NTBs and the observed convergence period equilibrium, such change in income for consumer i at time t and country h, $\Delta y_{it}^{1,h}$, satisfies

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

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, $\Delta y_{it}^{2,h}$, that solves

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

To compute the change in aggregate welfare I take a sample of 1,300 and 2,000 individuals for each time period-region combination in Argentina and Brazil, respectively (only time periods for Brazil since regional data is not available). 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 sampled individual and calculate the average change in income across individuals.[18] The aggregate change in welfare is the average change in income 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 $\widehat{\theta}$ from its asymptotic

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[18] 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.

distribution and recomputing all estimators for each sampled value of θ .[19],[20] The estimators are not normal because of the non-negativity constraint imposed in the estimation of the Lagrange multipliers in the cost side.

Results

Table 6 shows the proportional changes in prices of imports and trade volumes due to the changes in policy. The first two columns show the changes in external imports in Argentina and Brazil; 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 a sales-weighted average decrease in the price of external imports of 15 percent in Argentina and 10 percent in Brazil; the number of cars imported from other countries increases by 78 percent and 117 percent in Argentina and Brazil, respectively.

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 12 percent in Argentina and 0.7 percent in Brazil - the increase is small in Brazil because the counterfactual change in the tariff level is not high. The number of imported cars decreases by 72 percent in Argentina and 4 percent in Brazil. All these changes (both due to the elimination of NTBs and to the adoption of the common external tariff) are significant at the 10 percent level.[21]

Overall, the effect of the elimination of the NTBs predominates and there is a net increase in imports from 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. In Argentina the overall effect is relatively small - the average increase in price is 3 percent; the number of imported units increases by 6 percent - and not statistically significant. In Brazil the effect of the change in the external tariff is very small and the overall change is mostly

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[19]Berry, Linton and Pakes (2004) provide a formal proof of the consistency and asymptotic normality of the Berry (1994) and Berry, Levinsohh and Pakes (1995) estimator of demand.

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

[21]I do not compute 95 percent confidence intervals. This computation would involve the estimation of the 2.5 and 9.7 percentiles, which would require a large number of simulated draws as they are further away from the median. Additionally, as can be seen in the 90 percent confidence intervals, the distribution is not symmetric. The long tail on one side adds difficulty to the precise estimation of the limiting percentiles. Note also that this asymmetry makes it impossible to compare the variance of the estimators to the variance that would arise from a standard normal distribution. In particular, the 70 percent confidence intervals in the skewed distribution (not shown) are substantially smaller than the 70 percent intervals that would result from the hypothetical normal distributions that yield the 90 percent confidence intervals displayed in Table 6.

explained by the positive effect of the elimination of the NTBs.

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 (7 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 estimates are relatively large in magnitude (43 and 13 percent respectively) but not precisely estimated and zero falls within the 90 percent confidence interval. The net effect is an increase in bilateral trade (not shown in the table).

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 go down by 659 dollars in Argentina and up by 205 dollars 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 (not shown in table). Revenue increases in both countries since the counterfactual tariff level is higher and imports are also higher due to the removal of the NTBs. The aggregate domestic welfare change (compensating variation plus tariff revenue, without including firms' profits since they are foreign-owned) are positive in both countries (not shown). Firm profits decrease by 22 percent in Argentina and increase by 5.7 percent in Brazil; the net effect is a gain for firms, which can be interpreted as a shift in profits from one country to the other.[22]

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[22]The percentage increase in Brazil is smaller than the percentage decrease in Argentina, however, being that Brazil is a larger country, the opposite happens when considering levels.

7   Conclusions

After estimating a model of demand and supply for cars in Argentina and Brazil that incorporates two non-tariff barriers (a quota on bilateral net imports and a trade balance constraint), I predict the effects of fully including the automobile sector in the Mercosur agreement. The trade reform involves the removal of NTBs and the adoption of a common external tariff. One of the main findings is that the effects on prices, trade and welfare are driven by the removal of NTBs rather than by the convergence to a common external tariff.

The elimination of the NTBs comprises a movement towards free trade that leads to an increase in external imports (countries from outside the customs union) both in Argentina and Brazil. On the other hand, the interaction between the trade balance constraint and the ownership structure of the firms (multinational corporations with subsidiaries in both countries) leads to asymmetric effects on bilateral 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, I find that for most firms, the trade balance constraints create an incentive to export from Brazil to Argentina. When these particular NTBs are removed, bilateral 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.

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, from a methodological point of view, 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.

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Table 1: Market Share of Each Corporation. 1996-1999.

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

Source: own calculations based on sales data from ACARA (Argentina) and ANFAVEA (Brazil). Market shares of each corporation are expressed as percentages.

Table 2: Utility Function Parameters.

	Argentina	Brazil
Constant $(-u_o)$	-13.5	-7.7
	(27.4)	(33.4)
Constant*N(0,1) $(-u_1)$	0.9	0.8
	(0.6)	(0.9)
Price $(-\alpha_0)$	-0.19***	-0.09***
	(0.05)	(0.03)
Price*1/Income $(-\alpha_1)$	-0.17**	0.03***
	(0.08)	(0.01)
Length $(\beta_{Length,0})$	4.2***	0.4**
	(0.3)	(0.2)
Length*More than 2 children $(\beta_{Length,1})$	1.0	0.4
	(0.5)	(14.7)
Length Square	-0.5	0.1
	(1.5)	(3.0)
Horsepower	3.3***	0.4***
	(1.3)	(0.1)
Hatchback Dummy	0.1	0.4
	(0.5)	(1.0)
Station Wagon Dummy	-0.7**	-0.6***
	(0.3)	(0.2)
SUV or Minivan Dummy	0.5	0.5
	(1.5)	(0.5)
Category Dummies	Yes	Yes
Test of Overidentifying Restrictions Critical Value: 23.68	20.84	17.45
Mean price coefficient	-0.25	-0.08
	(0.11)	(0.03)

Standard errors are reported in parenthesis; *** significant at the 1% level; ** significant at the 5% level. The null hypothesis of the test of overidentifying restrictions sustains that the orthogonality conditions of the GMM estimator of the demand parameters are statistically not significantly different from zero.

Table 3: Price, Demand Elasticity, Production Cost, and Mark-ups. 1996-1999.

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

Prices and production costs are measure in thousands of dollars. The estimators of the production costs and mark-ups are not normally distributed; confidence intervals at the 10% significance level are reported between square brackets. Standard errors are displayed in parenthesis for the mean price elasticities.

Table 4: Global Trade Balance Constraint (GTB).

	Adjustment in Cost of External Imports		Adjustment in Cost of Imports from Partner	
	Argentina λ^a	Brazil λ^b	Argentina $\lambda^a - 1.2\lambda^b$	Brazil $\lambda^b - 1.2\lambda^a$
Chrysler	0.02	0.29**	-0.33*	0.27*
	(0.15)	(0.01)	[-4.36, -0.02]	[0.02, 0.35]
Fiat	0	0.15**	-0.19*	0.15*
	(0.87)	(0.03)	[-0.36, -1.2]	[0.01, 0.30]
Ford	0.50	0.62**	-0.25*	0.03
	(0.43)	(0.01)	[-0.30, -0.01]	[-0.25, 0.24]
General Motors	0.40	0.43**	-0.11	-0.05
	(0.15)	(0.00)	[-0.25, 0.09]	[-0.20, 0.21]
Honda	0	0.37**	-0.45*	0.37*
	(0.98)	(0.00)	[-0.71, -0.27]	[0.22, 0.59]
Mercedes Benz	0	0.15	-0.18	0.15
	(0.58)	(0.24)	[-0.61, 0.12]	[-0.15, 0.51]
Peugeot-Citroen	0.30	0.43*	-0.21	0.07
	(0.38)	(0.10)	[-2.00, 0.03]	[-0.05, 0.63]
Renault	0	0.48*	-0.57*	0.48*
	(0.99)	(0.00)	[-0.94, -0.36]	[0.30, 0.78]
Toyota	0	0.27**	-0.33*	0.27*
	(0.91)	(0.00)	[-1.00, -0.11]	[0.09, 0.84]
Volkswagen	0	0.14**	-0.16*	0.14
	(0.80)	(0.04)	[-0.44, -0.01]	[0.01, 0.37]

The first two columns display the estimates of the Lagrange Multipliers for the Global Trade Balance Constraint (GTB). They reflect the percentage additional cost on external imports imposed by the GTB. The estimators are constrained to be non-negative. The estimated probability that the estimator is equal to zero is displayed in parenthesis. ** indicates different from zero at the 5% significance level (one-sided test) and * at the 10% level.

The last two columns display the estimated additional cost that the GTB imposes on bilateral imports, taking into consideration that an imported unit involves a credit for the exporting partner country. The estimators are not normally distributed; 90% confidence intervals are reported in square brackets. * indicates that the estimator is significant at the 10% level.

Table 5: Quota on Bilateral Net Imports.

	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-Citroen	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

The table displays the Lagrange multipliers associated to the quota on net bilateral imports. They represent the additional cost, in thousands of dollars, imposed by the quota on imports from the partner country. A dash (-) indicates no bilateral trade. The estimators are not normally distributed; a star (*) indicates that zero does not fall into the 10 percent confidence interval.

Table 6: Counterfactual Changes in Prices of Imports and Trade Flows.

| | External Imports | |
	Argentina	Brazil
Elimination of NTBs		
Average change in price	-15% [-23, -9]	-10% [-23, -9]
Change in number of units	78% [31, 821]	117% [69, 399]
Adoption of common external tariff		
Average change in price	12% [10, 13]	0.7% [0.5, 0.8]
Change in number of units	-72% [-625, -45]	-4% [-10, -2]
Overall customs union effect		
Average change in price	-3% [-13, 5]	-9% [-21, -0.5]
Change in number of units	6% [-19, 252]	113% [67, 395]

| | Imports from Partner | |
	Argentina	Brazil
Elimination of NTBs		
Average change in price	7% [-21, 8]	5% [28, 2]
Change in number of units	-43% [-96, 15]	13% [-14, 20]
Adoption of common external tariff		
Average change in price	-0.12% [-0.55, 0.52]	0.007% [0.006, 0.03]
Change in number of units	7% [5, 33]	0.13% [0.10, 0.81]
Overall customs union effect		
Average change in price	7% [-21, 8]	-5% [-28, -2]
Change in number of units	-36% [-66, 23]	13% [-14, 21]

The average change in price is weighted by sales. The estimators are not normally distributed; 90% confidence intervals are reported in square brackets.

Table 7: Welfare Changes from Adopting a Customs Union.

	Argentina	Brazil
Change in prices (dollars)	-659	205
	[-2672, -551]	[-4248, 323]
Compensating variation	393	-204
	[-9398, 1386]	[-332, 607]
Change in revenue (percentage)	162%	210%
	[77, 619]	[158, 384]
Change in profits (percentage)	-22%	5.7%
	[-26, 14]	[-10, 4]

The compensating variation is computed per number of vehicles and reported in dollars. The estimators are not normally distributed; 90% confidence intervals are reported in square brackets.