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Abstract

We propose a decomposition of the border effect in international trade by controlling for differences in competition in local markets. An extension of the Hotelling (1929) model shows that the availability of local substitutes increases price dispersion and biases the estimation of the border effect. We test these predictions using detailed price database at the supermarket level for Uruguay. This stylized setting makes it possible to control for other potential explanations of the border effect (i.e., exchange rates, taxes, or transport costs). We find that for those goods without local competitors the border estimation increases substantially, while for those goods that do have local competitors the effect of border is negligible. As the literature suggests, results should be even larger for different countries than for different cities. The methodology developed in the paper allows a finer explanation for understanding the relevance of borders in price dispersion.

JEL CODE: F14; F15; L13.

Keywords: border effect, price dispersion, competition.

Resumen

El trabajo propone una descomposición del efecto frontera en el comercio controlando por las diferencias competitivas en los mercados locales. Una extensión del modelo de Hotelling (1929) muestra que la disponibilidad de sustitutos locales incrementa la dispersión de precios y sesga la estimación del efecto frontera. Se prueban estas predicciones utilizando una base detallada de precios a nivel de supermercados en Uruguay. Este marco estilizado permite controlar por otras potenciales explicaciones del efecto frontera (tipo de

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cambio, impuestos o costos de transporte). Se encuentra que para los bienes sin competidores locales el efecto frontera se incrementa en forma sustancial, mientras para aquellos bienes sometidos a competencia local el efecto frontera es insignificante. Los resultados deberían ser más importantes si la comparación fuera hecha entre distintos países en vez de distintas ciudades. La metodología desarrollada en el trabajo permite una explicación más afinada para entender la relevancia de las fronteras para la dispersión relativa de precios.

Códigos JEL: F14; F15; L13.

Palabras clave: efecto frontera, dispersión de precios, competencia.

1 Introduction

The impact of political borders on relative prices was empirically documented in a seminal paper by Engel and Rogers (1996). Using CPI data, the authors showed that the US–Canadian border had an effect on price dispersion equivalent to adding a distance of at least 1,780 miles between locations (approximately the distance between Miami and Quebec). A border is said to exist if, controlling for distance, the relative prices of the same good differs if the stores are in different geographical locations (either cities, states, or countries). Their work spurred a large stream of literature that found similarly large "border effects" across countries, states, and even cities.[1] These results have been heavily debated over the years. The emphasis of the debate has been on the bias in the estimation of the border estimation due to different measurement and methodological issues.

In the debate over measurement in border estimation, it was argued that the distances between cities have been mis-measured (see Head and Mayer, 2002), and that regressions suffer from aggregation bias (see Evans, 2003 and Broda and Weinstein, 2008). The main methodological criticism was issue by Gorodnichenko and Tesar (2009) and established that differences in price dispersion within countries may bias the estimation of the border (i.e., price dispersion between countries), which they called the country heterogeneity effect.[2] Borraz, Cavallo, Rigobon, and Zipitría (2016) also pointed to measurement bias in the estimation of the border effect due to the need to use maximum price distance (i.e., the upper quantile of price differences) to estimate transport costs. Previous papers found an upward bias in the estimation of the border effect, although a few found the border equal to zero after correcting for potential biases (see Broda and Weinstein 2008 and Borraz, Cavallo, Rigobon, and Zipitría, 2016).

One of the main debated issues that underlies most papers involves the differences in the implicit markups of prices between locations (see Coşar, Grieco, and Tintelnot, 2015a and Gopinath, Gourinchas, Hsieh, and Li, 2011). Building from insights in industrial organization, and using detailed cost information, some papers have overcome such limitations to estimate the impact of borders between countries. Gopinath, Gourinchas, Hsieh, and Li (2011) found a

[1] For example, see Parsley and Wei (2001) for results between the US and Japan and Ceglowski (2003) for the effects of provincial borders in Canada.

[2] The fact that countries will differ in their product basket could be traced back at least to Dixit and Stiglitz (1977).

median discontinuity in relative prices of 24 percent between US and Canada, after controlling for costs and markups. Coşar, Grieco, and Tintelnot (2015b) found that borders in the wind turbine industry explain up to half of the differences in producer market shares between their home country and neighboring ones.

The literature on the estimation of the border effect has also moved from cities to stores, and from aggregate goods to precisely defined ones –mainly at the UPC code. Therefore, a typical analysis estimates the distance between two stores, either in the same city or across cities. Then, it usually identifies the exact same item in both stores (i.e., regular Coke sold in cans) and compares both prices in the same monetary unit.[3] As a result, products not sold in both geographical locations under analysis are discarded.

Our paper is motivated by the fact that the previous analyses could be missing useful information that allow to control for differences in competition between countries that affect the estimation of borders. The availability of local goods, i.e., goods sold only in one store/country but not in another, should distort the relative price in different countries.[4] However, this distortion is independent of the border, at least for those goods available in both locations. As a result, the literature has concentrated on one dimension of product arbitrage –substitution: geographical distance. But, another arbitrage is possible for the consumer: to substitute for similar goods at the same location. Local competition will also influence markups, nor just geographical substitution.

Take the case of carbonated soft drinks as an example. When shopping at a store, the price consumers are charged for a given product puts them with a trade-off between moving to the next store –and buying the same preferred product– or purchasing a different good at the same store. Suppose a consumer is at a store to buy a Coke and she realizes its price is higher than the price charged at the next proximate store. She could either buy the Coke anyway -not moving to the next store- or she could move to the next store to buy the less expensive Coke. This is the classical analysis implied in the border literature. However, she could also buy Pepsi at the store she is currently in rather than buying Coke. Previous literature does not control for this dimension of substitution. We will study how the availability of local products affect the estimation of the border.

We analyze the border effect within a country. This methodology is adequate for avoiding the problems associated with exchange rates, taxes, language, non-price tariffs, factor market rigidities, and other restrictions that could affect the estimation of prices. Moreover, it also avoids the problems associated with transportation costs (see Gorodnichenko and Tesar, 2009). Uruguay is a small homogeneous country. People speak the same language, taxes are homogeneous at the country level, movements of goods and factors are free, and the maximum distance between stores in the sample is just 526 kilometers. No barriers between cities or states should be expected but rather a homogeneous convergence of prices. A similar analysis for different

[3]Gopinath, Gourinchas, Hsieh, and Li (2011) established, “Our first task consist in restricting the initial sample of 125,048 unique products to a set of products that appears on both sides on the border...” (page 2455). Nevertheless, Broda and Weinstein (2008) used the whole sample of products; see tables 3 and 4 in their Appendix.

[4]This was also established by Gopinath, Gourinchas, Hsieh, and Li (2011); see page 2451.

cities was made by Parsley and Wei (1996) and Yazgan and Yilmazkuday (2011) for the US, Crucini, Shintani, and Tsuruga (2010) for Japan, and Ceglowski (2003) for Canada.[5] These papers found a milder effect of intra-national borders for price convergence in relation to national borders.

The empirical approach and the nature of the data also address three additional sources of concerns that have been raised since the original Engel–Rogers analysis. First, we use product-level data with identical goods across locations. As suggested by Goldberg and Knetter (1997), product-level data is crucial to understanding deviations from the Law of One Price (LOP). Indeed, Evans (2003) and Broda and Weinstein (2008) argued that a significant problem in the border effect literature is the aggregation bias induced by price indexes. Second, the database has information on the exact location of each store. As pointed out by Head and Mayer (2002), using approximate distances (such as from one country capital to another) can greatly overestimate the border effect. Finally, the database has information for –nearly– all supermarket chains that sold the same basket of products. This make it possible to control for competition between stores that belongs to different chains, and reduces the possible sample bias due to pick a particular chain. [6]

Our paper is related to the work of Evans (2003), who addressed the problem of the relative substitution of similar goods across countries, Gorodnichenko and Tesar (2009), who established how differences in baskets of goods are a source of bias in the estimation of border effects, and Gopinath, Gourinchas, Hsieh, and Li (2011), who accounted for differences in markups to estimate borders. Nevertheless, it differ on several grounds. First, the paper explicitly introduces the substitution of goods within stores and relates it to the substitution across stores. Also, the empirical methodology allows to estimate the exact effect of local competition either on price dispersion or on borders. Second, the theoretical model makes it possible to disentangle the effect of competition and borders on relative prices, and how the effect depends on the location and size of the border. Third, as we analyze the convergence of prices within a small country, we can isolate problems associated with exchange rate, language, and tariff barriers, which usually make the comparison of prices difficult. The problem is reduced to one of distance, local product substitutes, and the characteristics of stores or cities. Fourth, the analysis is based on a database that comprises nearly all the supermarkets in Uruguay. This makes it possible to capture the influence of local competitors that affects the price setting by each store. Fifth, we provide a simple technique for unfolding trade –border– costs from local product competition conditions. This make it possible to estimate the relative importance of border costs –and local competition– on relative prices.

The model shows that relative prices will differ if local competition is different between geographical locations. It also shows that not taking into account these different competitive conditions bias the border estimation. As borders shift trade between countries, the direction of the change and its bias should be empirically determined.

The empirical section proposes a simple methodology for estimating the effect of local

[5]Papers for trade within countries include Hillberry and Hummels (2003) and Wolf (2000).

[6]As an example, Gopinath, Gourinchas, Hsieh, and Li (2011) provided information on just one chain store.

competition on the border estimation using a database for supermarkets in Uruguay. We show that the border estimation is affected by different competitive conditions. When local competition is controlled for the estimation of the border increases substantially. For those goods that have local competitors the border is not the main source of price dispersion. We perform different robustness test to check our results, and the bias of the border continues to hold.

The paper is organized as follows. The next section introduces the model and specifies the conditions that allows the prices of goods sold in different places to converge, when substitutes are available. Section 3 describes the database used to estimate the effect of the availability of substitutes on the estimation of the border effect. Section 4 introduces the equation to be estimated, the econometric results, and the robustness test to check the main results. Finally, Section 5 presents the conclusions of the analysis.

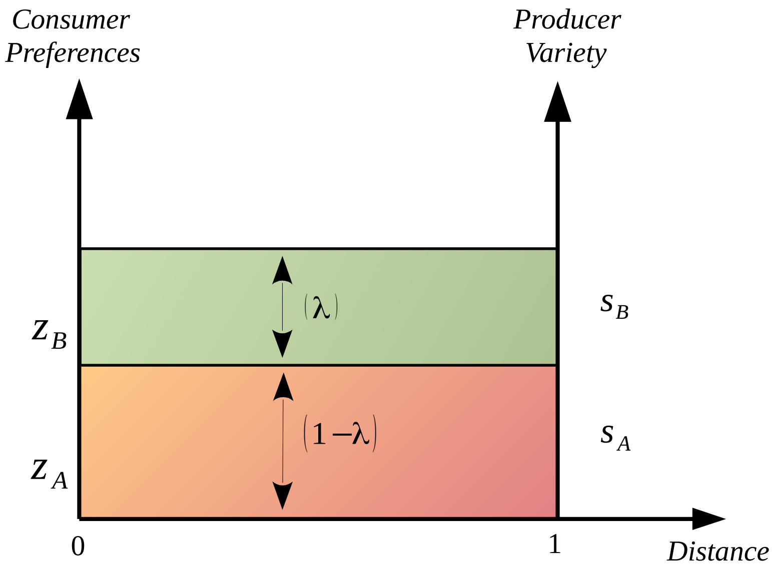
2 A Simple Model of Distance and Variety

We propose a simple extension of the Hotelling (1929) model, which has previously used in the literature (see Gopinath, Gourinchas, Hsieh, and Li, 2011), that incorporates a two way horizontal differentiation.[7] This extension allow to capture the distance dimension, but also the variety dimension of competition. The Hotelling (1929) linear city model of product differentiation could be though as representing either physical distance between stores, or variety distance between similar goods (see Belleflamme and Peitz (2015) page 114 for a textbook exposition). We develop a two dimensional version of the model developed in Irmen and Thisse (1998). The main setting is a road that has consumers uniformly located, and at each point two varieties of a given product can be sold; i.e., at a given location, two possible varieties of a good are available to consumers, say Coke and Pepsi.

More formally, we propose a modification of Irmen and Thisse (1998) and assume that there is a continuum of consumers uniformly located along a line of distance L. The locations are indexed from the beginning of the street, either for consumers or stores (i.e., the consumer/store located at 0 is at the beginning of the street). At each point in the line, there are two types of consumers that differ in their preference for varieties $z_i = \{z_A, z_B\}$. This imply that there is a continuum in the distance dimension, but variety is a discrete dimension. Also, at each point in the line there is a population λ of consumers that prefers variety z_A, and $1 - \lambda$ consumers that prefers variety z_B. The model could be represented as two lines of distance L, one on top of the other. The first line is for consumers that prefers variety z_A, its thickness is λ, and the total mass of consumers is $L \times \lambda$. The second line is for consumers that prefers variety z_B, its thickness is $(1 - \lambda)$, and there is a total mass of consumers of $L \times (1 - \lambda)$. Figure 1 below depicts the concept of the model. The left y axis represent the consumers preferences for variety (z_A, z_B), while the right y axis depict the possible varieties sold by firms (s_A, s_B).

[7] A previous version of this paper offer a model with vertical and horizontal differentiation. In the model, there were two qualities instead of two different varieties. That model shows the same results as the one shows here. The previous version of the paper is available upon request to the authors.

Figure 1: The two dimensional model.



Products have a physical –distance– identification (d) but also a variety identification (s). Producers are –exogenously– located at one point in the distance dimension, and they may sold different varieties of the good in a store. A consumers that prefers variety i and is located at distance j have an -indirect- utility function:

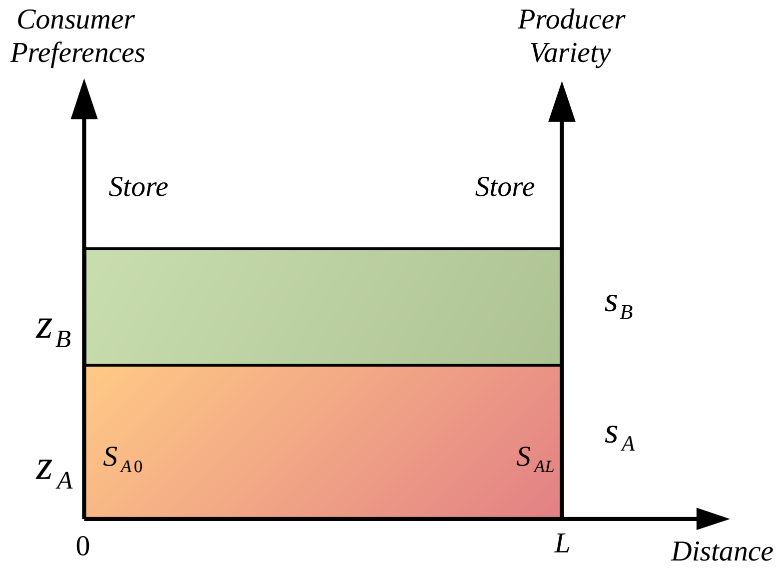
$$U_{ij} = r - \theta \{if \; z_i \neq s_q\} - t \, |x_j - x_d| - p_{qd},$$

where r is the reservation utility of the consumer –equal for all consumers–, i indicates the variety preference of the consumer ($ie.\, z_i = \{z_A, \, z_B\}$), θ is the cost that a consumer pay if he buys a good of variety s_q that differ from his preferred variety z_i at the store located at d, t is the transport cost the consumer located at j has to pay to buy at store located at d, and p_{qd} is the price of the good of variety q charged by a store located at d. As variety is discrete the consumer will pay a cost only if he buys a variety different from his preferred one. In the following analysis we will just subtract θ if the variety of consumer and producer differ. For simplicity, we assume that the production costs of firms is equal to zero.

First, we derive the equilibrium conditions for two goods of the same variety (i,e., the traditional Hotelling problem), and then we add a third good that differs in variety and derive the pricing equilibrium conditions. We assume that each good is sold by a different producer/store.

Suppose there are two stores that sell the same variety $z_A = s_A$ of the good. The stores are located in opposite places on the street. The first store is located at 0 and the second store at L, therefore L is also the distance between the stores. We label both stores selling variety s_A as S_{A0} if the store is located at 0 and S_{AL} if the store located at L. Fixing the location of the stores eliminates one variable in the analysis (i.e., distance). We fix the store location to concentrate on the effects of quality. The situation is depicted in Figure 2.

Figure 2: The model with two stores.



This is the traditional Hotelling (1929) model with two stores, were S_{A0} is the store located at the beginning of the line and S_{AL} is the one located at the end of the line. In order to find the price equilibrium, as we have assumed that the locations of both stores are exogenously given, the indifferent consumers must be found in order to establish the demand. We assume that the minimum valuation of quality is large enough such that all consumers on the street buy the good; i.e., that $r - \theta - tx - p_{A0} \geq 0$ or $r - \theta - t\,|L - x| - p_{AL} \geq 0$ or both, $\forall x \in [0,\, L]$. As consumers with different variety preference differ in θ if distance is fixed, we can find the indifferent consumer between both stores as:[8]

$$r - t\widehat{x} - p_{A0} = r - t\,|L - \widehat{x}| - p_{AL}, \tag{1}$$

and solving for $\widehat{x}$ we obtain:

$$\widehat{x} = \frac{p_{AL} - p_{A0} + tL}{2t}. \tag{2}$$

The demand for store S_{A0} is $\widehat{x}$: $D_{A0} = \widehat{x} = \frac{p_{AL} - p_{A0} + tL}{2t}$, as consumers at the left of $\widehat{x}$ bought at that store regardless of their valuation of variety, and the mass of consumers at each point is 1 (i.e., λ consumers of variety z_A and $1 - \lambda$ consumers of variety z_B) and for store S_{AL}: $D_{AL} = L - \widehat{x} = \frac{p_{A0} - p_{AL} + tL}{2t}$.

Then, profits are $\Pi_{A0} = p_{A0} \times D_{A0}$ and $\Pi_{AL} = p_{AL} \times D_{AL}$, as we have assumed that cost are zero. Maximizing profits we find the reaction functions in prices, $p_{A0} = \frac{p_{BL} + tL}{2}$ and $p_{AL} = \frac{p_{A0} + tL}{2}$, and solving for the reaction functions in prices, we find:

$$p_{A0} = p_{AL} = tL,$$

[8]Note that the same reasoning applies for the s_B consumer.

and prices of both firms converge. This result holds as both firms have the same costs (zero in this case) and the same demand –in this case, $L/2$–.

2.1 Variety

Now we assume that at location 0 there is another store that sell variety s_B to consumers. This store also has zero production cost. As the model is continuous in the distance dimension but not on the variety dimension, we need to introduce additional assumptions in order to consumers buying product s_B. We will assume that, at 0, consumers that have preference z_B will prefer to buy the variety s_B; but consumers that have preference z_A, will prefer to buy the variety s_A. This guarantees consumption for both goods, or entry of the new brand.

These assumptions add one additional restriction to the model. Consumers located at 0 that have preference for variety z_A will prefer to buy brand s_A at store S_{A0} if $r - p_{A0} > r - \theta - p_{B0} \iff p_{A0} - p_{B0} < \theta$. Consumers located at 0 that have preference for variety z_B will prefer to buy brand s_B at store S_{B0} if $r - p_{B0} > r - \theta - p_{A0} \iff p_{B0} - p_{A0} < \theta$ or $p_{A0} - p_{B0} > -\theta$. Both inequalities establish upper and lower bounds for the prices of brands s_A and s_B at stores S_{A0} and S_{B0} in order to both goods have demand:

$$|p_{A0} - p_{B0}| < \theta. \tag{3}$$

Now we find the consumers who are indifferent about buying from stores S_{B0} and S_{AL}. Take the case of a consumer located at $\widetilde{x}$ that prefers variety z_B. She will be indifferent between buying variety s_B at store S_{B0} or variety s_A at store $S_{AL} \iff$

$$r - t\widetilde{x} - p_{B0} = r - \theta - t\,|L - \widetilde{x}| - p_{AL}, \tag{4}$$

and

$$\widetilde{x} = \frac{p_{AL} - p_{B0} + \theta + tL}{2t}. \tag{5}$$

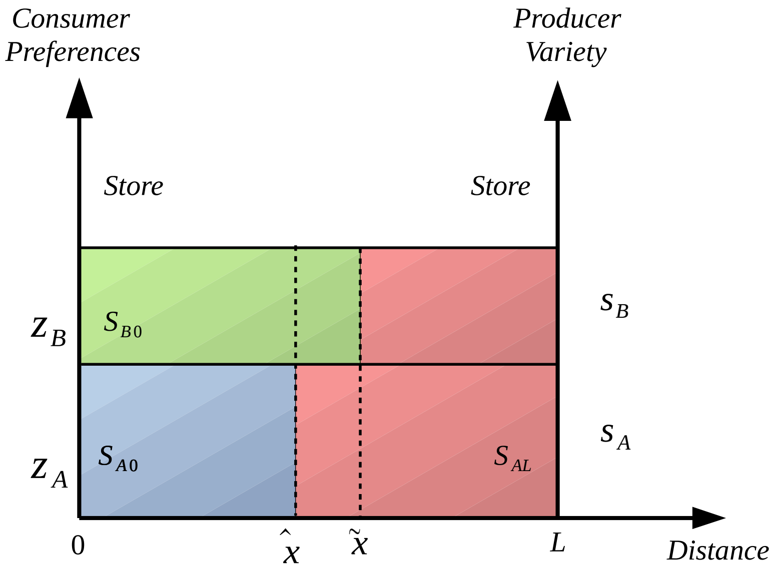
A comparison of equations 2 and 5 shows that $\widetilde{x} > \widehat{x} \iff p_{A0} - p_{B0} < \theta$. If instead we assume that $\widetilde{x} < \widehat{x}$, then equations 2 and 5 imply that $\theta < p_{B0} - p_{A0}$, and this result violate inequality 3. Figure 3 depicts the possible location of $\widetilde{x}$ for a given location of $\widehat{x}$ and the demand for each store.

Now we proceed to find the demand for each brand/store, taking into account the previous results. Demand for firm S_{A0} is: $D_{A0} = (1-\lambda)\,\widehat{x} = (1-\lambda)\,\frac{p_{AL}-p_{A0}+tL}{2t}$. Profits are $\Pi_{A0} = p_{A0} \times D_{A0}$. The first order constraint of the problem is $\frac{\partial \Pi_{A0}}{\partial p_{A0}} = 0 = \frac{(1-\lambda)}{2t}\left[p_{AL} - 2p_{A0} + tL\right]$, therefore the reaction function is

$$p_{A0} = \frac{p_{AL} + tL}{2}. \tag{6}$$

Note that the reaction function of store S_{A0} selling brand depends –increasingly– only on the price of firm S_{AL}, but not on the price of store S_{B0}. This result holds because of the discrete nature of the variety dimension.

Figure 3: Possible equilibrium values of $\tilde{x}$ and $\hat{x}$. Demand for variety s_A at store S_0 is depicted in blue, demand for variety s_A at store S_L in red, and demand for variety s_B at store S_0 in green.



For firm S_{AL}, as $\tilde{x} > \hat{x}$, its demand is affected by the entry of firm S_{B0}, that is, $D_{AL} = \underbrace{(1-\lambda) \times (L-\hat{x})}_{s_A \, consumers} + \underbrace{\lambda \times (L-\tilde{x})}_{s_B \, consumers} = (L-\hat{x}) - \lambda(\tilde{x}-\hat{x})$.

The profit function is: $\Pi_{AL} = p_{AL}\left[\left(\frac{p_{A0}-p_{AL}+tL}{2t}\right) - \lambda\left(\frac{\theta+p_{A0}-p_{B0}}{2t}\right)\right] = p_{AL}\left(\frac{(1-\lambda)p_{A0}-p_{AL}+\lambda p_{B0}-\lambda\theta+tL}{2t}\right)$. From the FOC we obtain:

$$p_{AL} = \frac{(1-\lambda)\,p_{A0} + \lambda p_{B0} - \lambda\theta + tL}{2}. \tag{7}$$

The reaction function of store S_{AL} is increasing in p_{A0} and p_{B0} as they are both substitutes.

Lastly, the demand for store S_{B0} is $D_{B0} = \lambda\tilde{x} = \lambda\frac{p_{AL}-p_{B0}+\theta+tL}{2t}$. Profits are $\Pi_{B0} = p_{B0} \times \left[\lambda\frac{p_{AL}-p_{B0}+\theta+tL}{2t}\right]$. The first order constraint is $\frac{\partial\Pi_{B0}}{\partial p_{B0}} = 0 = \frac{\lambda}{2t}(p_{AL} - 2p_{B0} + \theta + tL)$. The reaction function for store S_{B0} is

$$p_{B0} = \frac{p_{AL} + \theta + tL}{2}. \tag{8}$$

The solution to the three equations system is:

$$p^{'}_{A0} = tL - \frac{\lambda\theta}{6}, \tag{9}$$

$$p^{'}_{AL} = tL - \frac{\lambda\theta}{3}, \tag{10}$$

$$p^{'}_{B0} = tL + \frac{(3-\lambda)\,\theta}{6}. \tag{11}$$

The results show that the prices of stores S_{A0} and S_{AL} are now lower than if store S_{B0} is not in place. As competition increase, prices decrease. Also, in this model, the effect of variety is independent of the effect of distance.[9] The next Proposition summarizes the effect of variety on pricing.

Proposition 1. *Introducing variety into the distance model:*

1. *Decreases the price of goods of identical variety;*
2. *Makes prices more volatile (i.e., price convergence less likely to hold)*

Proof. For 1, it is sufficient to note that $p_A^{'} = p_A - \frac{\lambda\theta}{6}$ while $p_B^{'} = p_B - \frac{\lambda\theta}{3}$. For 2, $p_A^{'} = p_B^{'} \iff \lambda = 0$, which could not hold because there will be no demand for variety z_A, or $\theta = 0$, that is, if there are not costs for consumers to change variety. □

Although the reaction function of the price of store S_{A0} does not depend on the price of store S_{B0}, it has an effect through the reaction function of price of store S_{AL}. As store S_{B0} induces the price of store S_{AL} to decrease, this affects the price of store S_{A0} in equilibrium. The effect of competition is more intense for store S_{AL}. In the next section, a border is added between the stores, and its effect on price convergence is evaluated.

2.2 Border

We modify the previous analysis and introduce a cost for the consumer to cross a hypothetical border between stores. This border cost could be language, the use of different paper money, paying a tax, etc. We assume that any of these factors imposes a cost on the utility of consumers, which they avoid by not crossing the border. We also assume that the border is between both stores, at point z. The border imposes a cost b for consumers that cross it in order to buy from a store located on the other side. Formally:

$$U_{ij} = r - \theta \{if\ z_i \neq s_q\} - t\,|x_j - x_d| - \delta \times d - p_{qd},$$

and δ equals 1 if the consumer located at j needs to cross the border to buy at a store located d, and 0 otherwise. To understand the effect of the border, we return for a moment to the model with just one variety. Assume in that model a border located at point $\widehat{x}$, that is, where consumers are indifferent about which store they will buy from. Imposing a border implies that there is not one indifferent consumer but two: one located at the left of the border and the other at its right. In turn, this implies that the border does not play any role if it is located where the indifferent consumer is.

Lemma 1. *If the border is located at the same point where the indifferent consumer is, then the border cost is not relevant in the analysis.*

[9] Note that inequality 3 holds, as $\left|p_{A0}^{'} - p_{B0}^{'}\right| = \frac{\theta}{2} < \theta$.

Proof. Assume two consumers, each one located at ε of the border $\widehat{x}$. For the consumer at the left, his utility for buying in stores S_{A0} and S_{AL} is

$$r - t(\widehat{x} - \varepsilon) - p_{A0} > r - t[L - (\widehat{x} - \varepsilon)] - p_{AL} + d,$$

and solving for $(\widehat{x} - \varepsilon)$ we obtain $(\widehat{x} - \varepsilon) > \frac{p_{AL} - p_{A0} + tL}{2t} - \frac{d}{2t}$. For the consumer located at the right, his utility is

$$r - t(\widehat{x} + \varepsilon) - p_{A0} + d < r - t[L - (\widehat{x} - \varepsilon)] - p_{AL},$$

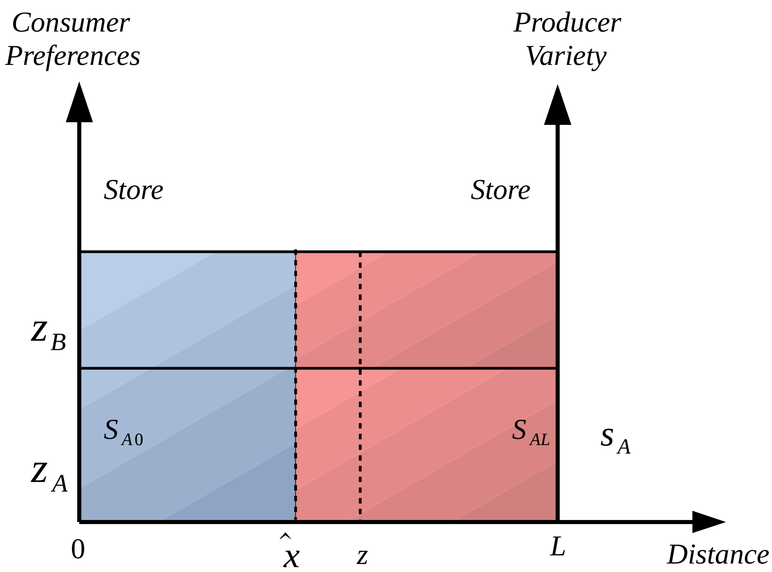
and solving for $(\widehat{x} + \varepsilon)$ we obtain $(\widehat{x} + \varepsilon) < \frac{p_{AL} - p_{A0} + tL}{2t} + \frac{d}{2t}$. As $\varepsilon \to 0$, we obtain $\frac{p_{AL} - p_{A0} + tL}{2t} - \frac{d}{2t} < \widehat{x} < \frac{p_{AL} - p_{A0} + tL}{2t} + \frac{d}{2t}$. Then, $\widehat{x} = \frac{p_B - p_A + tL}{2t}$. □

Lemma 1 says that the border is relevant only if it shifts consumers from buying in one store to buying in the other store. If consumer choice is not affected by the border then there is not border at all. But when the border shift the indifferent consumer, this movement has a limit equal to the location of the border itself. When the location of the border is reached, Lemma 1 establishes that no further displacement of the indifferent consumer occurs.

2.2.1 Border with One Variety

Assume that there is only one variety (s_A) and a border between stores. Assume also that the border is at z to the right of $\widehat{x}$, as the next figure shows.

Figure 4: A border at the right of $\widehat{x}$.



For every positive border cost, the indifferent consumer should move from $\widehat{x}$ through z. The new indifferent consumer $\widehat{x}'$ should be equal to $\widehat{x} + b$, as the utility is lineal in cost. As a result,

$\widehat{x}' = \widehat{x} + b = \frac{p_{AL} - p_{A0} + tL}{2t} + b$, where $b \in [0,\ (z - \widehat{x})]$. If b is bigger than $(z - \widehat{x})$, then Lemma 1 establishes that the demand for store S_{A0} should be z. Now $D_{A0} = \frac{p_{AL} - p_{A0} + tL + 2tb}{2t}$, and the new reaction function is $p_{A0} = \frac{p_{AL} + Lt + 2tb}{2}$. Demand for store S_{AL} is $D_{AL} = \frac{p_{A0} - p_{AL} + tL - 2tb}{2t}$, and the reaction function for price p_{AL} is $p_{AL} = \frac{p_{A0} + Lt - 2tb}{2}$. The new equilibrium prices are:

$$p^b_{A0} = tL + \frac{2tb}{3}, \tag{12}$$

$$p^b_{AL} = tL - \frac{2tb}{3}, \tag{13}$$

Lemma 2. *Borders make price convergence more difficult.*

Proof. Now $p^b_{A0} - p^b_{AL} = \frac{4}{3}tb$. □

If z is at the left of $\widehat{x}$, then the sign of the border coefficients in equations 12 and 13 reverse, but the Lemma remains unchanged by simply reversing the price difference. We now compute the size of the border by substituting p^b_{A0} and p^b_{AL} in $\widehat{x}' = \widehat{x} + b = \frac{5}{3}b + \frac{L}{2}$. As $\widehat{x}' \in \left[\frac{L}{2},\ L\right]$, then $b \in \left[0,\ \frac{3}{10}L\right]$.

Borders shift demand, therefore prices change with borders and price convergence becomes more difficult. This is the standard result found in the literature, where borders increase price variability in relation to the volatility of prices within countries. The main point is to show that price non-convergence in this case is due to a border, while in the previous section is due to differences in store competition due to different varieties, as shown in Proposition 1.

2.2.2 Variety and Border

Now we extend the analysis of the effect of borders to a setting with different varieties. We will analyze the case where the border z is at the right of $\widetilde{x}$, and show the results for the case where the border z is at the left of $\widehat{x}$.[10] As $\widehat{x} \neq \widetilde{x}$, the effect of the border will be different for the consumers of variety s_A than for consumers of variety s_B. The next figure shows the case.

The new indifferent consumers will be

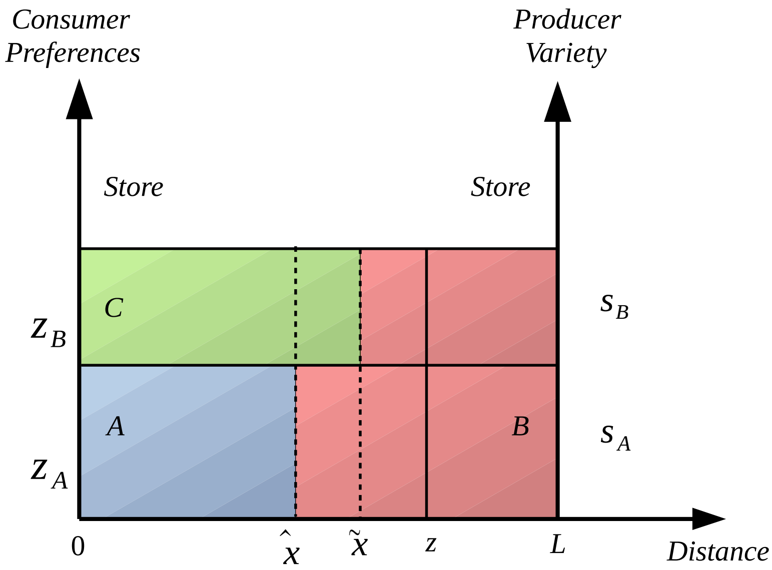
$$\widehat{x}' = \widehat{x} + \widehat{b} = \frac{p_{AL} - p_{A0} + tL}{2t} + \widehat{b}, \tag{14}$$

$$\widetilde{x}' = \widetilde{x} + \widetilde{b} = \frac{p_{AL} - p_{B0} + tL + \theta}{2t} + \widetilde{b}, \tag{15}$$

where $\widehat{b} \in [0,\ (z - \widehat{x})]$ and $\widetilde{b} \in [0,\ (z - \widetilde{x})]$ and $\widetilde{b} \leq \widehat{b}$.[11] The border coefficient will be subtracted if the border z is at the left of $\widehat{x}$. The reaction function for store S_{A0} is the same as in the previous subsection: $p_{A0} = \frac{p_{AL} + Lt + 2t\widehat{b}}{2}$. Demand for store S_{AL} will now be $D_{AL} = (1 - \lambda) \times \left(L - \widehat{x}'\right) + \lambda \times \left(L - \widetilde{x}'\right)$ and substituting equations 14 and 15 and rearranging terms we obtain

[10] The case where z is between both $\widehat{x}$ and $\widetilde{x}$ cancel out, as the analysis below shows.
[11] The inequality is reversed if the border z is at the left of $\widehat{x}$.

Figure 5: A border at the right of $\widehat{x}$ and $\widetilde{x}$ when there are two varieties.



$D_{AL} = \frac{(1-\lambda)p_{A0} - p_{AL} + \lambda p_{B0} + Lt - \lambda\theta - 2t\left[\widehat{b} - \lambda\left(\widehat{b} - \widetilde{b}\right)\right]}{2t}$.[12] Now the reaction function for firm S_{AL} is

$$p_{AL} = \frac{(1-\lambda)\, p_{A0} + \lambda p_{B0} + Lt - \lambda\theta - 2t\left[\widehat{b} + \lambda\left(\widetilde{b} - \widehat{b}\right)\right]}{2}.$$

Demand for store S_{B0} is $D_{B0} = \lambda \widetilde{x}' = \lambda\left[\frac{p_{AL} - p_{B0} + tL + \theta + 2t\widetilde{b}}{2t}\right]$,[13] and the new reaction function is

$$p_{B0} = \frac{p_{AL} + tL + \theta + 2t\widetilde{b}}{2}.$$

Substituting reaction functions we obtain:

$$p_{A0}^{bv} = tL - \frac{\lambda\theta}{6} + \frac{t\left[2\widehat{b} + \lambda\left(\widehat{b} - \widetilde{b}\right)\right]}{3},$$

$$p_{AL}^{bv} = tL - \frac{\lambda\theta}{3} - \frac{2t\left[\widehat{b} - \lambda\left(\widehat{b} - \widetilde{b}\right)\right]}{3},$$

$$p_{B0}^{bv} = Lt + \frac{(3-\lambda)\,\theta}{6} + \frac{t\left[(3-\lambda)\,\widetilde{b} - (1-\lambda)\,\widehat{b}\right]}{3}.$$

If the border z is at the left of $\widehat{x}$, the sign of the last term in the three price equations is reversed. This implies that the border coefficient could either be positive or negative, dependent upon where the border is displaced. As a result, the border effect could either reinforce or hinder the variety effect.

[12] If border z is at the left of $\widehat{x}$, then the border coefficients will be subtracting. Thus, we obtain $D_{AL} = \frac{(1-\lambda)p_{A0} - p_{AL} + \lambda p_{B0} + Lt - \lambda\theta + 2t\left[\widehat{b} - \lambda\left(\widehat{b} - \widetilde{b}\right)\right]}{2t}$

[13] Accordingly, $D_{B0} = \lambda\left[\frac{p_{AL} - p_{B0} + tL + \theta - 2t\widetilde{b}}{2t}\right]$ if the border z is at the left of $\widehat{x}$.

Lemma 3. *The border could diminish or augment the variety effect.*

Proof. Price difference $p^{bv}_{A0} - p^{bv}_{AL} = \frac{\lambda\theta}{6} + \frac{t\left[4\widehat{b}-\lambda\left(\widehat{b}-\widetilde{b}\right)\right]}{3}$ if the border z is at the right of $\widetilde{x}$. For the second case, if the border z is at the left of $\widehat{x}$, we have $p^{bv}_{A0} - p^{bv}_{AL} = \frac{\lambda\theta}{6} - \frac{t\left[4\widehat{b}-\lambda\left(\widehat{b}-\widetilde{b}\right)\right]}{3}$. □

When there are variety differences, the border effect always reinforces the variety effect. The main point of this section is twofold. First, the border coefficient changes when there is a competition –variety– effect. A comparison between price differences in Lemmas 2 and 3 shows that border coefficients change due to the variety effect. In Lemma 2, the border coefficient is $\frac{4}{3}b$ while in Lemma 3 it is $\frac{\left[4\widehat{b}-\lambda\left(\widehat{b}+3\widetilde{b}\right)\right]}{3}$ in absolute terms. Second, there is a variety effect in Lemma 3 that, if not accounted for, could bias the estimation of the border coefficient. In addition to the border coefficient, the term $\frac{\lambda\theta}{6}$ in Lemma 3 will be added to the border if not accounted for in the estimation. These results are shown in the paper's main proposition.

Proposition 2. *The availability of competitive –variety– substitutes bias the estimation of the border effect through two channels*

1. *A direct effect bias* $\left(e.g.,.\ \frac{4}{3}b \text{ vs. } \frac{t\left[4\widehat{b}-\lambda\left(\widehat{b}-\widetilde{b}\right)\right]}{3}\right)$
2. *An indirect effect bias* $\left(\frac{\lambda\theta}{6}\right)$ *due to the availability of different varieties*

The following table offers a summary of the results of the section.

Table 1: Results of the theoretical model.

	Equilibrium	Price diff.: $p_{A0} - p_{AL}$
Base Model	$p_{A0} = p_{AL} = tL$	0
Price Dispersion: Variety	$p^{v}_{A0} = tL - \frac{\lambda\theta}{6}$; $p^{v}_{AL} = tL - \frac{\lambda\theta}{3}$	$\frac{\lambda\theta}{6}$
Price Dispersion: Border	$p^{b}_{A0} = tL + \frac{2tb}{3}$; $p^{b}_{AL} = tL - \frac{2tb}{3}$	$\pm\frac{4}{3}tb$
Price Dispersion: Variety and Border	$p^{bv}_{A0} = tL - \frac{\lambda\theta}{6} + \frac{t\left[2\widehat{b}+\lambda\left(\widehat{b}-\widetilde{b}\right)\right]}{3}$ $p^{bv}_{AL} = tL - \frac{\lambda\theta}{3} - \frac{2t\left[\widetilde{b}-\lambda\left(\widehat{b}-\widetilde{b}\right)\right]}{3}$	$p^{bv}_{A0} - p^{bv}_{AL} = \frac{\lambda\theta}{6} \pm \frac{t\left[4\widehat{b}-\lambda\left(\widehat{b}-\widetilde{b}\right)\right]}{3}$

3 Data

We test the predictions of the model using a good-level database of daily prices compiled by The General Directorate of Commerce (DGC) in Uruguay, which comprises grocery stores all over the country.[14] The DGC is the authority responsible for the enforcement of the Consumer Protection Law at the Uruguayan Ministry of Economy and Finance.

In 2006 a new tax law was passed by the Uruguayan legislature that changed the tax base and rates of the value added tax (VAT). The Ministry of Economy and Finance was

[14]This is an updated database from Borraz and Zipitría (2012) and Borraz, Cavallo, Rigobon, and Zipitría (2016).

concerned about incomplete pass-through from tax reductions to consumer prices and hence decided to collect and publish the prices in different grocery stores and supermarkets across the country. The DGC issued Resolution Number 061/006, which mandates that grocery stores and supermarkets report their daily prices for a list of products if they meet the following two conditions: i) they sell more than 70% of the products listed, and ii) either have more than four grocery stores under the same brand name or have more than three cashiers in a store. The information sent by each retailer is a sworn statement, and there are penalties in case of misreporting it. The objective of the DGC is to ensure that prices posted on the DGC website reflect the real posted prices of the stores. In this regard, stores are free to set the prices they optimally choose, but they face a penalty if they try to misreport them to the DGC in an attempt to mislead costumers.

The data include daily prices from April 1st of 2007 to September 30th of 2014 for 154 products, most of them at the UPC code. The products in the sample represent 15.6% of the goods and services in the CPI basket. The DGC requires large retailers to report their daily prices once a month using an electronic survey. The three best-selling brands are reported for each product category, disregarding the supermarket's own brands. Most items have to be homogenized in order to be comparable, and each supermarket must always report the same item. For example, sparkling water of the local brand "Salus" is reported in its 2.25 liter variety by all stores. If this specific variety is not available at a store, then no price is reported. The data are then used on a public web site that allows consumers to check prices in different stores or cities and to compute the cost of different baskets of goods across locations.[15]

The 154 products in the database represent 50 markets defined at the product category level (e.g., sunflower oil and corn oil, and wheat flour 000 and wheat flour 0000 are different markets). For some of them, the information does not allow the identification of the goods at the UPC level; in the meat and bread markets products do not have brand. The detailed list of goods is in Appendix A. The database has a larger number of supermarket chains than in Gopinath, Gourinchas, Hsieh, and Li (2011), who provide information for only one supermarket chain, although they also had daily prices. Nevertheless, the database has information for the three best-selling goods in each market. Some small brands and supermarket own brands are not available in the database. In November of 2011 the list of products was updated, including some markets and reviewing the top brands.

Using this dataset we try to replicate the analysis that will be done if goods were selected for being in more than one country. For the list of goods in the database, we select those markets were at least one good is sold in Argentina, the neighboring country of Uruguay. To check which goods are sold in Argentina, we search if each good in our database is in any of the supermarkets in Table 1 of Cavallo (2017), that list a series of retailers that publish their price information on line.

For the five listed retailers in Argentina, two (Easy and Sodimac) do not sell food or cleaning products, and other two (Coto and Carrefour) do not have information on line for all their goods.

[15]See http://www.precios.uy/servicios/ciudadanos.html and Borraz and Zipitría (2012) for a detailed description of the database and an analysis on its price stickiness.

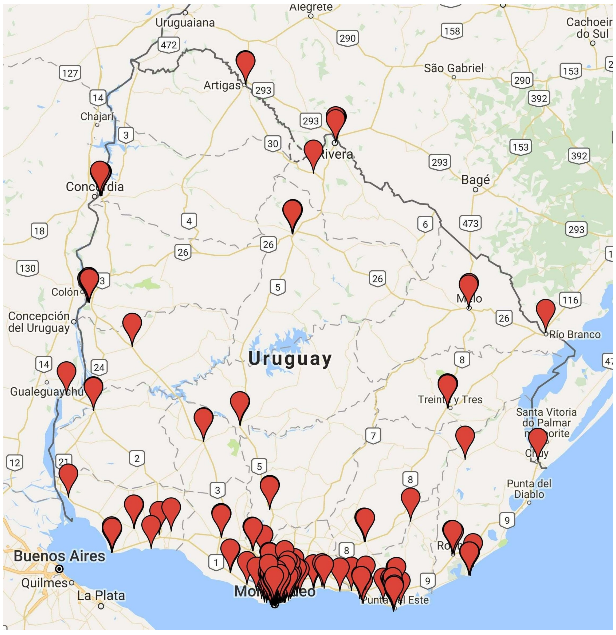
For each good in our database we check at WalMart Argentina if the good was sold. We select the good as being international if, for a given product category, that brand was sold in Argentina regardless of the specification. Interestingly, in most markets the main goods sold in Uruguay are not sold Argentina: only 22 in 154 goods (14%) were also sold in Argentina. In turn, we discard those markets – product categories – in which none of the good is sold in Argentina, following the approach of Gopinath, Gourinchas, Hsieh, and Li (2011). Nevertheless, for those markets were brands sold in Argentina were present, we also keep those goods sold only in the Uruguayan market. The database has 22 international brands and 16 local brands. The next table shows the detail of each market and brand.

Table 2: Products in the database.

Market	**Brand**	**Presentation**	**International / Local**
Soft Drinks	Coke	1.5 liters	*International*
Soft Drinks	Pepsi	1.5 liters	*International*
Soft Drinks	Nix	1.5 liters	Local
Mayonnaise	Hellmans	0.5 kilos	*International*
Mayonnaise	Fanacoa	0.5 kilos	Local
Mayonnaise	Uruguay	0.5 kilos	Local
Tea	Hornimans	Box (10 units)	Local
Tea	La Virginia	Box (10 units)	*International*
Tea	Lipton	Box (10 units)	Local
Shampoo	Fructis	0.35 L	Local
Shampoo	Sedal	0.35 L	*International*
Shampoo	Suave	0.93 L	*International*
Soap	Astral	0.125 Kg	Local
Soap	Palmolive	0.125 Kg	*International*
Soap	Suave	0.125 Kg	*International*
Peach jam	Dulciora	0.5 Kg	*International*
Peach jam	Limay	0.5 Kg	Local
Peach jam	Los Nietitos	0.5 Kg	Local
Laundry soap	Drive	0.8 Kg	*International*
Laundry soap	Nevex	0.8 Kg	Local
Laundry soap	Skip	0.8 Kg	*International*
Toilet paper	Higienol Export	4 units (25 M each)	*International*
Toilet paper	Personal	4 units (25 M each)	*International*
Toilet paper	Sin Fin	4 units (25 M each)	Local
Bread	Los Sorchantes	0.330 Kg	Local
Bread	Bimbo	0.330 Kg	*International*
Bread	Pan Catalan	0.330 Kg	Local
Toothpaste	Pico Jenner	0.09 Kg	Local
Toothpaste	Colgate Total	0.09 Kg	*International*
Toothpaste	Kolynos	0.09 Kg	*International*
Deodorant	Axe Musk	0.105 Kg	*International*
Deodorant	Dove Original	0.113 Kg	*International*
Deodorant	Rexona Active Emotion	0.100 Kg	*International*
Wheat Flour 000	Canuelas	1 Kg	*International*
Wheat Flour 000	Cololo	1 Kg	Local
Wheat Flour 0000	Puritas	1 Kg	Local
Wheat Flour 0000	Canuelas	1 Kg	*International*
Wheat Flour 0000	Cololo	1 Kg	Local

For each supermarket, we have detailed information about the exact location given by its Universal Transverse Mercator (UTM), its size –measured by the number of cashiers–, and if it belongs to a chain. Uruguay is divided into nineteen political states called "departamentos". The database has information for up to 386 supermarkets across all nineteen political states, comprising 54 cities. Montevideo, the capital city of Uruguay, is also the largest city, with nearly forty percent of the Uruguayan population.[16] The following figure shows the cities in the database and the supermarket distribution for Montevideo, which accounts for 54% of all supermarkets in the sample.

Figure 6: Cities covered in the sample and distribution of supermarkets.



Note: Each dot represents a store location across the 19 Uruguayan states.

For each brand and store, we choose the mode of the monthly prices to reduce the database dimension, although we tested the robustness of the results using the monthly median, average, and the observation at the first day of the month. According to Borraz and Zipitría (2012), prices change on the first day of the month 10 times more frequently than on any other day. As a result, the first observation will reasonably capture the main price changes in the database. This reduction in the dimension of the database is crucial because of the calculations that must be performed to obtain the results.

We check for outliers in the sample by filtering each series to exclude those observations above three times (or a third) the monthly median price.[17] We have 19,548,982 daily observations for the 38 goods, and 19,547,086 after deleting outliers (0.01%).

As the database has billions of price differences combinations we reduce the dimension of the database by using monthly data. We calculate the median, mode and average monthly prices and keep the price of the first day of the month to reduce the dimension of the database. We obtain 643,588 monthly observations after the reduction procedure. We lost 2,535 observations due to lack of information about two supermarkets. Lastly, as in the Soap market the local brand start reporting prices at November 2011, we discard the price information for international brands before that date. Therefore we delete those prices for international brands before that period. The final database contains 629,781 monthly observations.

[16] More information at http://www.ine.gub.uy/uruguay-en-cifras.

[17] This is similar to Borraz, Cavallo, Rigobon, and Zipitría (2016) and more stringent than Klenow and Kryvtsov (2008) that exclude those prices 10 times larger (see page 867).

3.1 Descriptive statistics

The empirical analysis is performed using the mode monthly price, although we test the robustness of the results using the median, the average, and the first day of the month. All descriptive statistics in this section are for the mode monthly price. We first show some statistics for the products in the database and then for supermarkets. The following table describes the products in each category: if it is local or international, the month/year when the sample start –all sample ends at September 2014–, the number of observations in each database (price and price differences), the share of supermarkets in which the product is available, [18] and the share of zero price differences (total, between cities, and within cities). The Annex B shows additional information for each product (descriptive statistics for the monthly price in Table 10), for supermarket chains (Table 11) and for Uruguayan states (Table 12).

[18] We count a supermarket if the product is available at that supermarket least one month in the sample.

Table 3: Sample information of the database.

				Price database		*Price diff. database*			
							% Zeroes		
Market	**Brand**	**Intern./ Local**	**Sample Start**	**# Observations**	**% Stores**	**# Observations**	**All**	**Between**	**Within**
Soft Drinks	Coke	*International*	2007/04	27,197	99	4,138,327	32	21	56
Soft Drinks	Nix	Local	2007/04	6,365	37	230,107	20	15	24
Soft Drinks	Pepsi	*International*	2010/11	13,095	97	1,846,893	19	12	34
Mayonnaise	Fanacoa	Local	2007/04	21,463	96	2,642,482	11	8	16
Mayonnaise	Hellmans	*International*	2007/04	26,497	99	3,930,531	12	9	16
Mayonnaise	Uruguay	Local	2007/07	12,649	56	933,449	6	5	11
Tea	Hornimans	Local	2007/04	26,859	99	4,028,278	16	13	24
Tea	La Virginia	*International*	2007/04	21,257	82	2,521,377	27	22	33
Tea	President	Local	2010/11	12,976	89	1,789,348	16	13	24
Shampoo	Fructis	Local	2007/04	17,938	85	1,827,732	14	10	21
Shampoo	Sedal	*International*	2007/04	21,640	99	2,667,262	11	9	15
Shampoo	Suave	*International*	2007/04	21,309	97	2,661,978	11	8	16
Soap*	Astral	Local	2010/11	14,840	99	2,345,636	11	9	15
Soap*	Palmolive	*International*	2007/04	13,583	96	1,968,329	11	9	16
Soap*	Suave	*International*	2012/12	4,645	74	495,916	15	11	21
Peach jam	Dulciora	*International*	2007/04	17,708	77	1,811,549	29	23	38
Peach jam	Limay	Local	2010/11	10,028	75	1,068,238	16	11	24
Peach jam	Los Nietitos	Local	2007/04	25,611	96	3,682,632	13	10	20
Laundry soap	Drive	*International*	2007/04	23,677	97	3,165,237	12	10	16
Laundry soap	Nevex	Local	2007/04	25,902	99	3,753,227	12	10	15
Laundry soap	Skip	*International*	2007/04	21,623	97	2,962,445	9	7	13
Toilet paper	Elite	*International*	2010/11	13,607	97	1,985,337	9	7	14
Toilet paper	Higienol Export	*International*	2007/04	25,267	100	3,576,168	10	8	15
Toilet paper	Sin Fin	Local	2007/04	25,286	99	3,601,187	10	8	14
Bread	Los Sorchantes	Local	2010/11	13,976	93	2,078,422	18	13	29
Bread	Bimbo	*International*	2010/11	13,086	91	1,830,266	16	12	23
Bread	Pan Catalan	Local	2010/11	9,015	68	870,704	20	16	28
Toothpaste	Colgate Herbal	*International*	2010/11	15,235	100	2,469,580	16	15	17
Toothpaste	Kolynos Triple acción	*International*	2010/11	14,117	97	2,125,720	12	10	15
Toothpaste	Pico Jenner	Local	2010/11	8,436	63	758,510	18	13	26
Deodorant	Axe Musk	*International*	2010/11	14,971	99	2,384,617	13	12	14
Deodorant	Dove Original	*International*	2010/11	14,797	98	2,329,426	12	12	14
Deodorant	Rexona Active Emotion	*International*	2010/11	14,623	99	2,274,701	12	11	14
Wheat Flour 000	Canuelas	*International*	2010/11	9,759	73	1,021,638	20	17	24
Wheat Flour 000	Cololo	Local	2010/11	4,524	38	216,129	24	23	44
Wheat Flour 0000	Canuelas	*International*	2007/04	21,156	84	2,515,242	17	13	23
Wheat Flour 0000	Cololo	Local	2007/04	17,643	87	1,735,960	15	12	27
Wheat Flour 0000	Primor	Local	2010/11	7,421	54	586,116	17	16	19
Total	-	-	-	629,781	–	82,840,696	15	12	22

*Except for sample start, information for the adjusted sample – 2010/11 – to match local brand availability.

The previous table depict a general picture: local brand tend to be less available in supermarkets –and have fewer observations–, and are more volatile –there are fewer exact zeroes for local brands.[19] Although not controlled for distance, borders seems to have an impact on relative prices as they are more volatile between cities than within cities. Distance between pairs of stores varies a lot, taking into account if stores are within or between cities. The next table shows statistics for the distance between supermarkets pairs.

[19]The exception being in the tea, soap, peach jam, laundry soap, and bread markets.

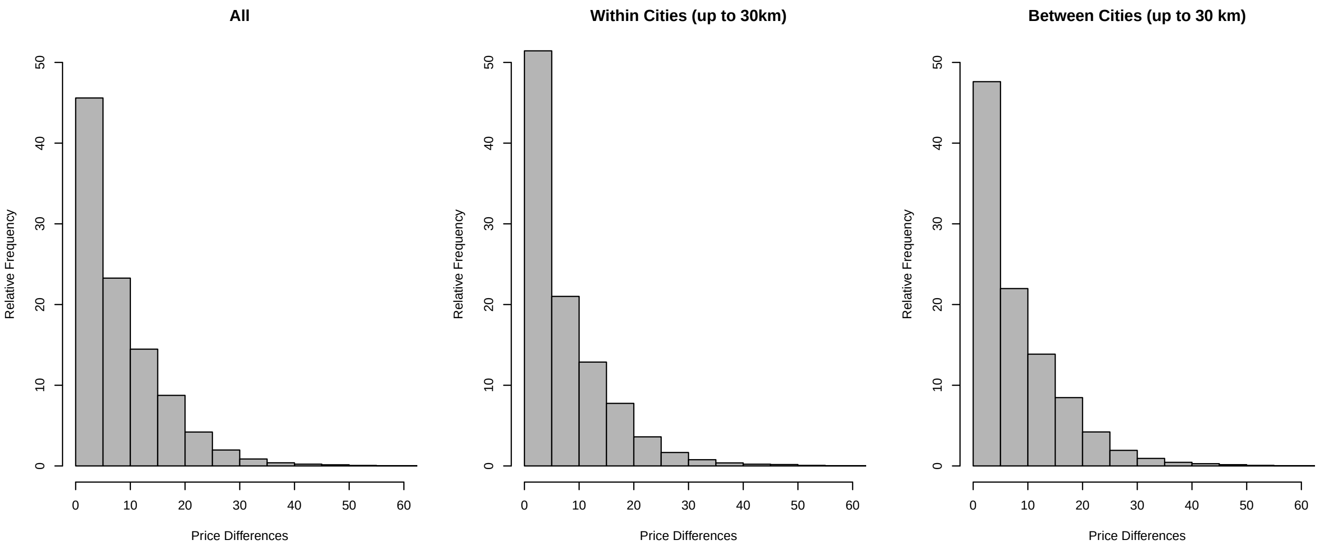
Table 4: Descriptive statistics for distance between supermarkets (in kilometers).

	Total	**Within City**	**Between cities**
Minimum	0.0	0.0	0.4
Median	78	6	119
Maximum	526	29	526

Source: authors calculation.

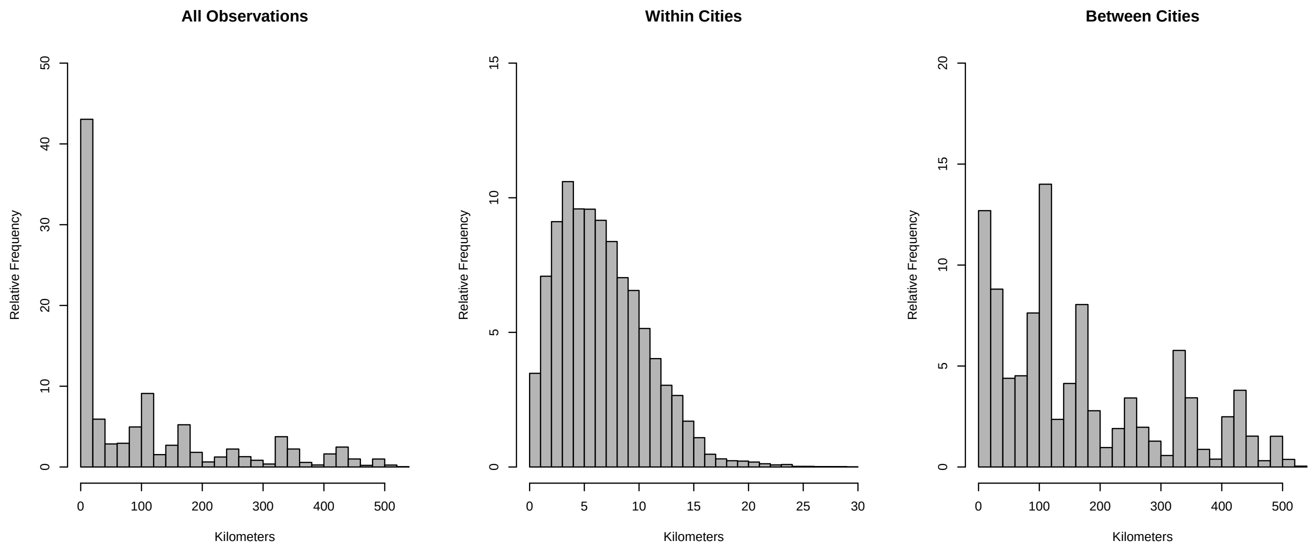
The next figure shows histograms of the distribution of price differences in the sample. The first histogram (left) shows the distribution of price differences for the whole sample, while the second (center) and third (right) show histograms for price differences within and between cities for distances up to 30 kilometers. After controlling for distance, the figures shows less price equality for stores in different cities.

Figure 7: Distribution of price differences.



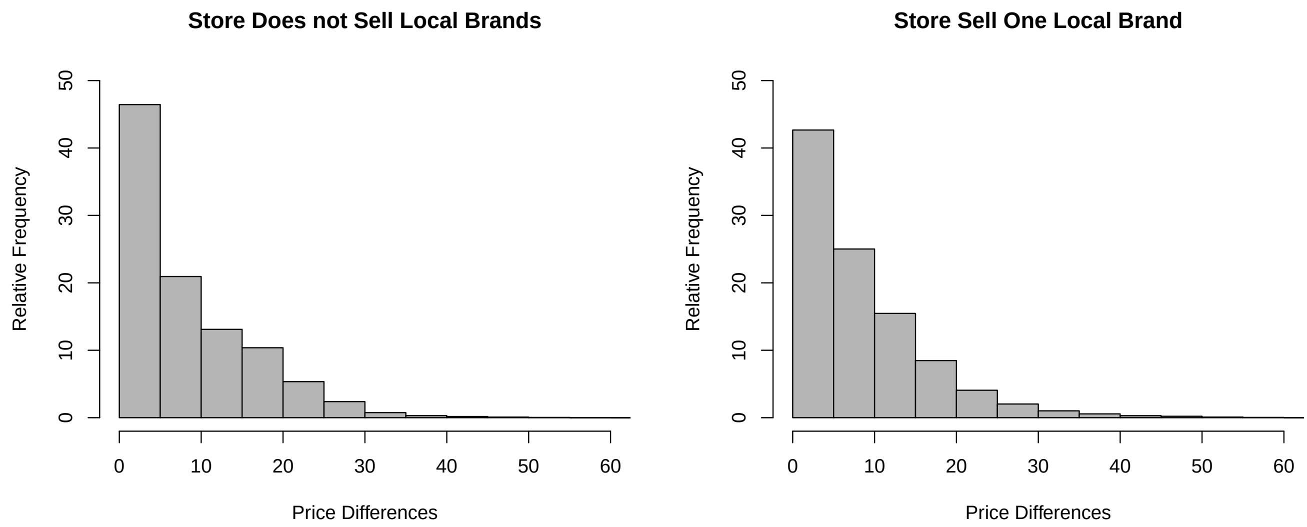
Next we plot the distribution of observations by distance in the sample. The first histogram (left) shows the distribution of observations for the whole sample, while the second (center) and third (right) show histograms of observations by distance within and between cities. Nearly forty percent of the observations in the database involve supermarkets that are less than twenty kilometers apart.

Figure 8: Observations by distance in the sample.



Lastly, we plot price differences controlling for different local competitive conditions. The left panel shows price differences when there are no local brands, while the right panel shows the distribution of price differences when there is a local brand in only one store. The right panel shows more price dispersion than the left panel.

Figure 9: Price differences and competitive conditions.



The next section presents the main estimation strategy to disentangle the effects of borders and local competitive conditions on relative prices. We exploit the previous variation in both dimensions to show how local competitive conditions affects the estimation of the border effect.

4 Estimation Strategy

The methodology for estimating the border effect and transport costs is standard in the literature. Based on Engel and Rogers (1996) we estimated the following equation:

$$|p_{ist} - p_{irt}| = \alpha_i + \alpha_{ch} + \alpha_t + \beta_1 \times Dist_{sr} + \beta_2 \times City_{sr} + \varepsilon_{isrt}, \tag{16}$$

where i is the indexed product and $i \in I$ is the product space; s, r are two stores, where s, $r \in S$ is the store's space in the sample and $s \neq r$; $|p_{ist} - p_{irt}|$ is the (absolute) difference of the logs of the price of good i between stores s, r at moment t;[20] α_i is a dummy variable for product i; α_{ch} is a dummy variable that takes the value one if stores s, r belong to the same chain; α_t is a time dummy; $Dist_{sr}$ measures the actual distance in (logs of) kilometers between stores s, r –as some distance are less than one kilometer and we want to avoid negative distance, we actually add 1 to the distance in kilometers–; $City_{sr}$ is a dummy variable that takes the value one if stores s, r are located in different cities; and ε_{isrt} is a stochastic error term. In a second estimation we add an interaction term for distance and border to the previous equation in order to control for nonlinear effects of the border parameter (see Borraz, Cavallo, Rigobon, and Zipitría (2016) for details):

$$|p_{ist} - p_{irt}| = \alpha_i + \alpha_{ch} + \alpha_t + \beta_1 \times Dist_{sr} + \beta_2 \times City_{sr} + \beta_3 \times Dist_{sr} \times City_{sr} + \varepsilon_{isrt}, \tag{17}$$

where the interaction term between distance and border ($Dist_{sr} \times City_{sr}$) is due to the fact that, according to Table 4, the median distances between and within cities are very different, and we have several cities to estimate a common border.

Our analysis proposes a simple modification of equation 17. The database has data for each good sold in each store for each month, therefore we compute a binary variable that takes the value one if a local competitor is present at one or both stores. This simple strategy makes it possible to introduce the competitive effect previously established in Section 2. Now equation 17 is:

$$\begin{aligned}|p_{ist} - p_{irt}| = \alpha_i + \alpha_{ch} + \alpha_t + \beta_1 \times Dist_{sr} + \beta_2 \times City_{sr} + \beta_3 \times Dist_{sr} \times City_{sr} + \\ \underbrace{\alpha_1 \times OneLocal_t + \beta_4 \times OneLocal_t \times City_{sr}}_{\text{One store has a local competitor}} + \underbrace{\alpha_2 \times BothLocal_t + \beta_5 \times BothLocal_t \times City_{sr}}_{\text{Both stores have a local competitor}} + \varepsilon_{isrt}\end{aligned}, \tag{18}$$

where $OneLocal$ takes the value one –at time t– if either store (s, r) sold the local brand, and $BothLocal$ takes the value of one if –at time t– both stores (s, r) sold the local brand. Equation 18 correct for the effect of local competition on the estimation of the border effect. In equations 17 and 18 the border parameter is interacted with distance, therefore a benchmark must

[20] The literature also studies the standard deviation of the price difference.

be established to calculate the –distance equivalent– size of the border. Distance equivalent measures, either of the border or the local competition effect, will be referred to as the size of the variable. In the analysis that follows, we set 29 kilometers –the maximum distance between two stores within a city, see Table 4– as the benchmark for calculating the border size.

The model in Section 2 show that while the border cost is fixed, the availability of different varieties of goods affect its estimation. Our first empirical goal is to to compare the results of the border estimation in equation 17 with the estimations of the border in equation 18 when controlling for local competitors. Our second empirical goal is to disentangle the effect of the border from the effect that local competition has on the relevance of the border, as shown in Proposition 1. In particular, the border estimation in equation 18 can be written as:

- $\beta_2 \times City_{sr} + \beta_3 \times Dist_{sr} \times City_{sr}$ if $OneLocal$ and $BothLocal$ are both zero
- $\beta_2 \times City_{sr} + \beta_3 \times Dist_{sr} \times City_{sr} + \beta_4 \times OneLocal \times City_{sr}$ if $OneLocal$ is one but $BothLocal$ is zero
- $\beta_2 \times City_{sr} + \beta_3 \times Dist_{sr} \times City_{sr} + \beta_5 \times BothLocal \times City_{sr}$ if $OneLocal$ is zero but $BothLocal$ is one

The interaction term between local competitors and the border allows to correct the estimation of the border due to the effect of local competitors. Lastly, as the availability of a local good in a store is not affected by distance, we could examine the effect of the border and of local competition in price dispersion.

Table 5 shows the results for the estimation of equations 16, 17, and 18 for the pooling of international products.[21]

[21] Price differences are multiplied by 100. The intercept dummy is omitted in all equations.

Table 5: Estimation of distance and border effect.

	Eq. 16	Eq. 17	Eq. 18
Distance	0.322***	0.168***	0.154***
	(0.001)	(0.003)	(0.003)
Border	0.214***	-0.185***	0.477***
	(0.004)	(0.008)	(0.009)
Distance×Border		0.177***	0.182***
		(0.003)	(0.003)
One Local			0.653***
			(0.005)
One Local ×Border			-1.154***
			(0.006)
Both Local			-0.758***
			(0.005)
Both Local ×Border			-0.803***
			(0.005)
# Observations	53,325,021	53,325,021	53,325,021
Time dummies	Yes	Yes	Yes
Product dummies	Yes	Yes	Yes
Same Chain Dummy	Yes	Yes	Yes
R square	0.08	0.08	0.08

*** $p < 0.01$.

To estimate the size border –and the local competition effect size– the following calculations are performed. For equation 17 the size of the border is calculated as $\beta_1 \times \ln(x+1) = \beta_2 + \beta_3 \times \ln(29+1) \Rightarrow x = distance = \exp\left(\frac{\beta_2+\beta_3\times\ln(29+1)}{\beta_1}\right) - 1$. For equation 18 we perform several calculations to calculate border and local competition effects. First, the size of the local competition effect when there is a local competitor in one store is $\beta_1 \times \ln(x+1) = \alpha_1 \Rightarrow x = distance = \exp\left(\frac{\alpha_1}{\beta_1}\right) - 1$, while if there are local competitors at both stores the size of the effect is $\beta_1 \times \ln(x+1) = \alpha_2 \Rightarrow x = distance = \exp\left(\frac{\alpha_2}{\beta_1}\right) - 1$. Second, we calculate the border and the adjustment due to local competition:

- If there is no local competition: $\beta_1 \times \ln(x+1) = \beta_2 + \beta_3 \times \ln(29+1) \Rightarrow x = distance = \exp\left(\frac{\beta_2+\beta_3\times\ln(29+1)}{\beta_1}\right) - 1$
- If there is one local competitor at any store: $\beta_1 \times \ln(x+1) = \beta_2 + \beta_4 + \beta_3 \times \ln(29+1) \Rightarrow x = distance = \exp\left(\frac{\beta_2+\beta_4+\beta_3\times\ln(29+1)}{\beta_1}\right) - 1$
- If both stores have a local competitor: $\beta_1 \times \ln(x+1) = \beta_2 + \beta_5 + \beta_3 \times \ln(29+1) \Rightarrow x = distance = \exp\left(\frac{\beta_2+\beta_5+\beta_3\times\ln(29+1)}{\beta_1}\right) - 1$

The results of performing the previous calculations show significant differences in the estimation of the size of the border. In line with the theoretical model in Section 2, controlling for local competition results in corrections of the estimated size of the border effect. Border coefficients are statistically different from zero in all equations. The traditional estimation of equation Engel and Rogers (1996), shows a positive value of the border which is consistent with the literature. When the interaction with distance is added to the regression (equation 17) the Border parameter became negative, but when the interaction with distance is added the Border estimation equal to 11 kilometers (i.e., two stores being in different cities at a distance of 29 kilometers have relative prices like two stores being at 40 kilometers).[22]

Results of equation 18 control for different competitive conditions in the market. When we re-estimate the Border coefficient, we find that now the distance equivalent of the border is 1,232 kilometers which is more than two times the maximum distance among the farthest stores in the sample. Borders matters quite a lot, and the size of the bias due to different competitive conditions in quite important.

The effect of local competition is to lower the economic impact of borders. When there is local competition at one store, the Border estimation shrink to zero, but the effect of the border is on the variety side: the distance equivalent of the effect on price dispersion of having one local competitor at a store is equivalent to 68 kilometers. If competition conditions differ between stores then they became the main source of price dispersion. Lastly, if there is the same competitor in both stores, then the effect of borders increase slightly to 6 kilometers, but the effect of local competition decrease and became negative.

Borders are quite larger when local competitive conditions are controlled for. Also, competitive conditions affect the estimation of the border, as shown in section 2.2. In the next section, we attempt different robustness test for our results.

4.1 Robustness

This section shows the results of several robustness tests for the main results. All results are summarized in the table 8 at the end of this section. First, we estimate equations 16, 17, and 18 using other central measures (e.g., monthly average and median price) and the first day of the month. When summary measures are used, price differences could be the result of contrasting prices in different days of the month. We pick the first day to calculate price differences, as the probability of price change on that day is nine times higher than on any other day of the month (see Borraz and Zipitría (2012)). Results –see table 13 in the Appendix– shows lower estimations for all variables than those of the baseline estimation using the mode. Nevertheless, the sharp increase in the border effect remains in all estimations when controlling for local competitive conditions.

Second, as shown in table 12 Montevideo (the capital city of Uruguay) accounts for nearly half of the supermarkets and observations in the sample. Thus, we run regressions 16, 17, and 18, adding a dummy that takes the value one if any supermarket is located in Montevideo. The border in this estimation is for those cities excluding Montevideo. As the next table shows, the border estimation in equation 17 is 24 kilometers, and 56 kilometers when it is estimated by equation 18.

[22] 11 kilometers $= exp\left(\frac{-0.185+0.177\times\ln(30)}{0{,}168}\right) - 1$.

Table 6: Estimation of distance and border effect (controlling for Montevideo city).

	Eq. 16	Eq. 17	Eq. 18
Distance	0.310***	0.175***	0.161***
	(0.001)	(0.003)	(0.003)
Border	0.203***	-0.149***	0.510***
	(0.004)	(0.008)	(0.009)
Montevideo	-0.186***	-0.171***	-0.161***
	(0.003)	(0.003)	(0.003)
Distance×Border		0.157***	0.163***
		(0.003)	(0.003)
One Local			0.652***
			(0.005)
One Local ×Border			-1.150***
			(0.006)
Both Local			-0.758***
			(0.005)
Both Local ×Border			-0.801***
			(0.006)
# Observations	53,325,021	53,325,021	53,325,021
Time dummies	Yes	Yes	Yes
Product dummies	Yes	Yes	Yes
Same Chain Dummy	Yes	Yes	Yes
R square	0.08	0.08	0.08

*** $p < 0.01$.

Third, we allow a different definition of border. Uruguay is a centralized country. Taxes, such as VAT, is set at the country level. But Uruguay has nineteen states, called "departamentos". States has some power to set rules locally, such as the public transport policies or to allow entry by new supermarkets. These policies could be the same for cities at the same state. As a result, we take states as an alternative definition of geographical region. More information about states can be found in Table 12 at the Appendix B. Next table estimations show that the border is minus 1 if estimated by equation 17 and jump to 461 kilometers if equation in equation 18 is used instead.[23]

[23]Although it may seem counter intuitive to find negative borders, they just say that if two stores are at 29 kilometers, if there is a border between them then price volatility will be equivalent to 28 kilometers.

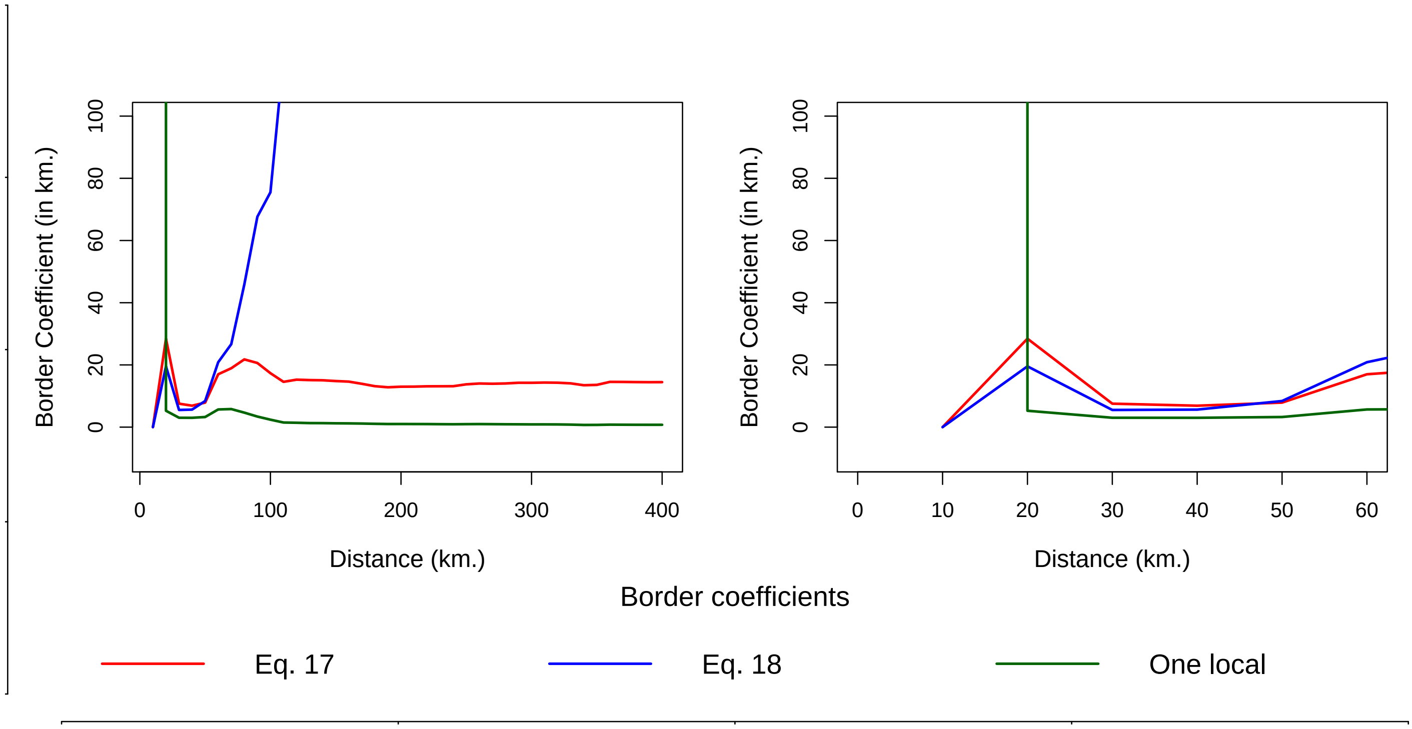
Table 7: Estimation of distance and border effect (using state).

	Eq. 16	Eq. 17	Eq. 18
Distance	0.321***	0.180***	0.173***
	(0.001)	(0.003)	(0.003)
Border	0.216***	-0.198***	0.490***
	(0.004)	(0.008)	(0.009)
Distance×Border		0.170***	0.168***
		(0.003)	(0.003)
One Local			0.648***
			(0.005)
One Local×Border			-1.176***
			(0.006)
Both Local			-0.764***
			(0.005)
Both Local×Border			-0.815***
			(0.005)
# Observations	53,325,021	53,325,021	53,325,021
Time dummies	Yes	Yes	Yes
Product dummies	Yes	Yes	Yes
Same Chain Dummy	Yes	Yes	Yes
R square	0.08	0.08	0.08

*** $p < 0.01$.

Fourth, we estimate equations 17 and 18 iteratively by increasing the distance between supermarkets. As distance increase, economic conditions that underlies the analysis could also change. In order to account for omitted variable that could bias the results we restrict distance to more homogeneous economic conditions. We start by fixing the maximum distance between two stores to 10 kilometers and repeat the estimation by adding 10 kilometers in each iteration. Figure 10 below show the estimations of the border for three specifications: equation 17, equation 18 when there are no local brands, and equation 18 when there are one local brand at one store. The left figure shows the estimated distance up to 400 kilometers, while the right figure zoom in at the start of the sample up to 60 kilometers.

Figure 10: Border estimation as distance between stores increases.



The results show that the estimated coefficient change significantly when distance between stores increase. The border coefficients in equations 17 and 18 differ except for distances between 30 and 50 kilometers. After 60 kilometers, the estimation of the border coefficient in equation 17 overshoot in relation to the border estimated in equation 18. On the other hand, the border coefficient when there is one local brand converge quickly to zero after 20 kilometers.

Next we sum up the results obtained in the previous estimations.

Table 8: Effect of local competition and border (in kilometers).

	Border (eq. 17)	**Border (eq. 18)**	**One local**	**Border (one local)**	**Both Local**	**Border (both local)**
Main regression (Table 5)	11	1,232	68	-1	-1	6
Controlling for Montevideo (Table 6)	-1	461	2,791	41	-1	3
Using state (Table 7)	-1	24	1,151	56	-1	-1
Average Price (Table 13)	7	420	43	-1	-1	5
Median Price (Table 13)	10	844	62	-1	-1	5
Day 1 (Table 13)	13	2,780	93	-1	-1	4

5 Conclusions

The literature has found that borders affect price dispersion between countries. Nevertheless, local competitive conditions differ between countries, as local brands compete with international brands. Local competition will affect price setting in local markets and influence relative prices between countries. This paper add to the literature that focus on controlling for country conditions to estimate the effect of borders. Previous literature has attempt to correct the estimate of the border effect by differences in costs (see Gopinath, Gourinchas, Hsieh, and Li (2011)) and demand conditions (see Gorodnichenko and Tesar (2009)).

We develop a stylized model that shows that the availability of local competitors not only affect price dispersion of goods but also the estimation of the border parameter. The model overcome the limitations of the linear city model traditionally used in the literature on border effect. In the model, borders could have either positive or negative effects on price dispersion, depending on the side to which the demand shifts. This ambiguous effect imply that borders could increase or offset the competitive effect. As a result, the model shows that the interrelation between distance, quality and border is much richer than previously found.

Using a database of supermarket prices in Uruguay, the paper develops a simple methodology to account for local competitive conditions. We found milder estimation of the border using the traditional Engel and Rogers (1996) approach. Nevertheless, when we disentangle different competitive conditions, the size of the border increases substantially. Also, the impact of local competition is sizable in affecting relative prices. The results are robust to different specifications of the variables (median, average, first day of the month), to different definitions of border (states, instead of cities), and to controls for Montevideo city. Lastly, we iterate our procedure by increasing the distance between supermarkets and found that the bias still hold, although distance between supermarkets may change the size of the bias.

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A List of Products

Product	**Brand**	**Specification***	**Share in CPI (percent)**
Beer	Pilsen	0.96 L	0.38
Beer	Zillertal	1 L	0.38
Wine	Faisán	1 L	0.80
Wine	Santa Teresa Clasico	1 L	0.80
Wine	Tango	1 L	0.80
Cola	Coca Cola	1.5 L	1.12
Cola	Nix	1.5 L	1.12
Cola	Pepsi	1.5 L	1.12
Cola	Coca Cola	2 L	1.12
Cola	Pepsi	2 L	1.12
Sparkling water	Matutina	2 L	0.81
Sparkling water	Nativa	2 L	0.81
Sparkling water	Salus	2.25 L	0.81
Beef (peceto)	No brand	1 Kg	0.16
Beef (nalga)	With bone, no brand	1 Kg	0.32
Beef (nalga)	Boneless, no brand	1 Kg	0.32
Beef (aguja)	With bone, no brand	1 Kg	0.23
Beef (aguja)	With bone, no brand	1 Kg	0.23
Beef (paleta)	With bone, no brand	1 Kg	0.20
Beef (paleta)	Boneless, no brand	1 Kg	0.20
Beef (rueda)	With bone, no brand	1 Kg	n/i
Mince	Up to 20 percent fat	1 Kg	0.98
Mince	Up to 5% fat	1 Kg	0.14
Bread	No brand	1 unit (≈ 0.215 Kg)	1.14
Bread Loaf	Los Sorchantes	0.33 Kg	0.06
Bread Loaf	Bimbo	0.33 Kg	0.06
Bread Loaf	Pan Catalán	0.33 Kg	0.06
Brown eggs	Super Huevo	1/2 dozen	0.46
Brown eggs	El Jefe	1/2 dozen	0.46
Brown eggs	Prodhin	1/2 dozen	0.46
Butter	Calcar	0.2 Kg	0.23
Butter	Conaprole sin sal	0.2 Kg	0.23
Butter	Kasdorf	0.2 Kg	0.23
Cacao	Copacabana	0.5 Kg	0.08
Cacao	Vascolet	0.5 Kg	0.08
Cheese	Cerros del Este	1 Kg	0.23

Product	Brand	Specification*	Share in CPI (percent)
Beer	Patricia	0.96 L	0.38
Cheese	Dispnat	1 Kg	0.23
Chicken	Avicola del Oeste	1 Kg	0.64
Chicken	Tenent	1 Kg	0.64
Coffee	Aguila	0.25 Kg	0.14
Coffee	Chana	0.25 Kg	0.14
Coffee	Saint	0.25 Kg	0.14
Corn Oil	Delicia	1 L	n/i
Corn Oil	Río de la Plata	1 L	n/i
Corn Oil	Salad	1 L	n/i
Dulce de leche	Conaprole	1 Kg	0.14
Dulce de leche	Los Nietitos	1 Kg	0.14
Dulce de leche	Manjar	1 Kg	0.14
Fish	No brand	1 Kg	0.11
Flour (corn)	Gourmet	0.4 Kg	n/i
Flour (corn)	Presto Pronta Arcor	0.5 Kg	n/i
Flour (corn)	Puritas	0.45 Kg	n/i
Flour 000 (wheat)	Cañuelas	1 Kg	0.21
Flour 000 (wheat)	Cololó	1 Kg	0.21
Flour 0000 (wheat)	Cañuelas	1 Kg	0.21
Flour 0000 (wheat)	Cololó	1 Kg	0.21
Flour 0000 (wheat)	Primor	1 Kg	0.21
Frankfurters	Centenario	8 units ($\approx$ 0.340 Kg)	0.23
Frankfurters	Ottonello	8 units ($\approx$ 0.340 Kg)	0.23
Frankfurters	Schneck	8 units ($\approx$ 0.340 Kg)	0.23
Grated cheese	Conaprole	0.08 Kg	0.16
Grated cheese	Artesano	0.08 Kg	0.16
Grated cheese	Milky	0.08 Kg	0.16
Deodorant	Axe Musk	0.105 Kg	0.34
Deodorant	Dove Original	0.113 Kg	0.34
Deodorant	Rexona Active Emotion	0.100 Kg	0.34
Ham	Ottonello	1 Kg	0.16
Ham	La Constancia	1 Kg	0.16
Ham	Schneck	1 Kg	0.16
Ham (cooked)	Ottonello	1 Kg	0.44
Ham (cooked)	Cattivelli	1 Kg	0.44
Hamburger	Burgy	0.2 Kg	n/i
Hamburger	Paty	0.2 Kg	n/i

Product	**Brand**	**Specification***	**Share in CPI (percent)**
Beer	Patricia	0.96 L	0.38
Hamburger	Schneck	0.2 Kg	n/i
Ice Cream	Conaprole	1 Kg	0.22
Ice Cream	Crufi	1 Kg	0.22
Ice Cream	Gebetto	1 Kg	0.22
Margarine	Flor	0.2 Kg	n/i
Margarine	Doriana nueva	0.25 Kg	n/i
Margarine	Primor	0.25 Kg	n/i
Mayonnaise	Fanacoa	0.5 Kg	0.21
Mayonnaise	Hellmans	0.5 Kg	0.21
Mayonnaise	Uruguay	0.5 Kg	0.21
Noodles	Cololo	0.5 Kg	0.43
Noodles	Adria	0.5 Kg	0.43
Noodles	Las Acacias	0.5 Kg	0.43
Peach jam	Dulciora	0.5 Kg	n/i
Peach jam	El Hogar	0.5 Kg	n/i
Peach jam	Los Nietitos	0.5 Kg	n/i
Peas	Campero	0.3 Kg	0.09
Peas	Cololó	0.3 Kg	0.09
Peas	Nidemar	0.3 Kg	0.09
Poultry	Avicola del Oeste	1 Kg	0.83
Poultry	Tenent	1 Kg	0.83
Poultry	Tres Arroyos	1 Kg	0.83
Quince Jam	Los Nietitos	0.4 Kg	0.13
Rice	Aruba tipo Patna	1 Kg	0.38
Rice	Blue Patna	1 Kg	0.38
Rice	Green Chef	1 Kg	0.38
Rice	Pony	1 Kg	0.38
Rice	Vidarroz	1 Kg	0.38
Rice	Saman Blanco	1 Kg	0.38
Crackers	Famosa	0.14 Kg	0.28
Crackers	Maestro Cubano	0.12 Kg	0.28
Salt	Sek	0.5 Kg	0.09
Salt	Torrevieja	0.5 Kg	0.09
Salt	Urusal	0.5 Kg	0.09
Sausage	Cattivelli	1 Kg	0.37
Sausage	Centenario	1 Kg	0.37
Sausage	La Familia	1 Kg	0.37

Product	**Brand**	**Specification***	**Share in CPI (percent)**
Beer	Patricia	0.96 L	0.38
Semolina pasta	Adria	0.5 Kg	0.43
Semolina pasta	Las Acacias	0.5 Kg	0.43
Semolina pasta	Puritas	0.5 Kg	0.43
Soybean oil	Condesa	0.9 L	0.11
Soybean oil	Río de la Plata	0.9 L	0.11
Soybean oil	Salad	0.9 L	0.11
Sugar	Azucarlito	1 Kg	0.35
Sugar	Bella Union	1 Kg	0.35
Sunflower oil	Optimo	0.9 L	0.37
Sunflower oil	Uruguay	0.9 L	0.37
Sunflower oil	Río de la Plata	0.9 L	0.37
Tea	Hornimans	Box (10 units)	0.08
Tea	La Virginia	Box (10 units)	0.08
Tea	President	Box (10 units)	0.08
Tomato paste	Conaprole	1 L	0.16
Tomato paste	De Ley	1 L	0.16
Tomato paste	Gourmet	1 L	0.16
Yerba	Canarias	1 Kg	0.64
Yerba	Del Cebador	1 Kg	0.64
Yerba	Baldo	1 Kg	0.64
Yogurt	Conaprole	0.5 Kg	0.13
Yogurt	Parmalat (Skim)	0.5 Kg	0.13
Yogurt	Calcar (Skim)	0.5 Kg	0.13
Bleach	Agua Jane	1 L	0.16
Bleach	Sello Rojo	1 L	0.16
Bleach	Solucion Cristal	1 L	0.16
Dishwashing detergent	Deterjane	1.25 L	0.13
Dishwashing detergent	Hurra Nevex Limon	1.25 L	0.13
Dishwashing detergent	Protergente	1.25 L	0.13
Laundry soap	Drive	0.8 Kg	0.45
Laundry soap	Nevex	0.8 Kg	0.45
Laundry soap	Skip, Paquete azul	0.8 Kg	0.45
Laundry soap, in bar	Bull Dog	0.3 Kg (1 unit)	n/i
Laundry soap, in bar	Nevex	0.2 Kg (1 unit)	n/i
Laundry soap, in bar	Primor	0.2 Kg (1 unit)	n/i
Shampoo	Fructis	0.35 L	0.36
Shampoo	Sedal	0.35 L	0.36

Product	**Brand**	**Specification***	**Share in CPI (percent)**
Beer	Patricia	0.96 L	0.38
Shampoo	Suave	0.93 L	0.36
Soap	Astral	0.125 Kg	0.16
Soap	Palmolive	0.125 Kg	0.16
Soap	Rexona	0.125 Kg	0.16
Toilet paper	Higienol Export	4 units (25 M each)	0.24
Toilet paper	Elite	4 units (25 M each)	0.24
Toilet paper	Sin Fin	4 units (25 M each)	0.24
Toothpaste	Pico Jenner	0.09 Kg	0.19
Toothpaste	Colgate Herbal	0.09 Kg	0.19
Toothpaste	Kolynos	0.09 Kg	0.19

* Kg = kilograms; L = liters; M = meters. n/i - No information.

B Additional Tables

Table 10: Descriptive statistics for each product in the database.

			Price database				*Price difference database*			
Market	**Brand**	**Intern./ Local**	**Minimum**	**Median**	**Maximum**	**SD**	**Minimum**	**Median**	**Maximum**	**SD**
Soft Drinks	Coke	*International*	13.0	42.0	68.0	9.2	0.0	2.5	93.0	6.0
Soft Drinks	Nix	Local	15.7	30.0	45.0	3.4	0.0	5.1	93.5	10.6
Soft Drinks	Pepsi	*International*	30.0	52.0	70.0	6.2	0.0	4.1	82.2	5.6
Mayonnaise	Fanacoa	Local	14.5	32.8	67.0	6.9	0.0	7.0	107.4	7.3
Mayonnaise	Hellmans	*International*	17.5	52.5	89.0	11.1	0.0	6.2	97.2	6.5
Mayonnaise	Uruguay	Local	9.9	31.0	53.0	5.4	101	7.5	110.5	7.8
Tea	Hornimans	Local	4.8	15.0	26.0	2.2	0.0	6.7	126.5	7.5
Tea	La Virginia	*International*	7.9	13.0	26.0	2.1	0.0	5.2	102.8	8.6
Tea	President	Local	16.9	23.0	34.0	2.5	0.0	8.0	64.8	8.3
Shampoo	Fructis	Local	32.0	94.5	169.0	16.1	0.0	6.0	116.7	7.5
Shampoo	Sedal	*International*	31.0	80.0	165.0	16.3	0.0	5.9	119.1	7.5
Shampoo	Suave	*International*	20.0	60.0	111.0	18.9	0.0	6.5	122.7	8.6
Soap*	Astral	Local	12.0	20.0	29.2	3.0	0.0	9.1	73.5	9.0
Soap*	Palmolive	*International*	12.0	19.6	48.0	2.9	0.0	9.5	80.2	9.0
Soap*	Suave	*International*	13.3	21.0	52.0	2.3	0.0	9.5	136.1	10.0
Peach jam	Dulciora	*International*	14.5	32.0	53.0	7.1	0.0	3.2	88.6	8.8
Peach jam	Limay	Local	26.0	43.0	64.0	5.3	0.0	7.8	90.1	9.8
Peach jam	Los Nietitos	Local	14.5	43.0	68.0	6.1	0.0	4.7	123.8	6.0
Laundry soap	Drive	*International*	25.0	48.0	99.0	6.1	0.0	5.0	100.6	6.5
Laundry soap	Nevex	Local	18.5	59.0	99.0	8.7	0.0	5.3	115.1	5.4
Laundry soap	Skip	*International*	50.0	76.5	136.0	10.3	0.0	4.8	78.8	6.1
Toilet paper	Elite	*International*	17.0	42.4	60.0	5.8	0.0	6.8	98.6	8.0
Toilet paper	Higienol Export	*International*	10.5	29.0	60.0	7.5	0.0	6.2	106.4	8.1
Toilet paper	Sin Fin	Local	10.5	37.0	62.0	10.3	0.0	7.1	101.7	7.4
Bread	Los Sorchantes	Local	29.0	46.0	67.0	8.0	0.0	3.3	47.8	4.5
Bread	Bimbo	*International*	31.0	49.0	71.0	7.5	0.0	3.5	56.3	5.1
Bread	Pan Catalan	Local	20.0	39.0	61.0	9.0	0.0	5.5	64.5	7.4
Toothpaste	Colgate Herbal	*International*	19.0	33.6	52.0	5.0	0.0	8.5	84.1	9.2
Toothpaste	Kolynos Triple acción	*International*	16.9	28.0	56.5	3.8	0.0	7.6	104.6	10.2
Toothpaste	Pico Jenner	Local	19.0	26.0	52.0	3.7	0.0	7.6	96.1	10.1
Deodorant	Axe Musk	*International*	55.0	79.0	112.0	9.3	0.0	7.9	49.1	7.7
Deodorant	Dove Original	*International*	60.0	93.0	141.0	12.5	0.0	7.1	82.2	8.3
Deodorant	Rexona Active Emotion	*International*	48.5	80.0	113.0	9.1	0.0	6.9	53.7	7.9
Wheat Flour 000	Canuelas	*International*	13.7	22.0	38.0	3.1	0.0	8.7	86.5	8.6
Wheat Flour 000	Cololo	Local	13.0	24.0	33.0	3.0	0.0	4.1	69.3	9.2
Wheat Flour 0000	Canuelas	*International*	10.0	24.0	41.0	4.9	0.0	6.6	97.2	8.1
Wheat Flour 0000	Cololo	Local	12.5	25.0	39.0	4.2	0.0	7.4	76.1	5.6
Wheat Flour 0000	Primor	Local	12.9	21.5	34.0	3.3	0.0	5.7	66.6	8.1

*All data for the adjusted sample to 2010/11 to match local brand availability.

Table 11: Chain description.

Chain	# Stores	# Stores in Montevideo	# Cities	# States	# Cashiers (Total)	Average size	# observations
Devoto	24	17	6	3	288	12	49,741
Disco	27	20	5	3	307	11	55,960
El Clon	12	8	5	4	59	4	8,142
El Dorado	38	0	20	6	158	4	50,839
Frigo	6	6	1	1	26	4	10,737
Géant	2	1	2	2	96	48	2,185
Iberpark	6	5	2	2	6	1	3,315
La Colonial	6	6	1	1	8	1	8,279
Los Jardines	4	2	3	2	17	4	4,284
Macromercado	7	4	3	3	127	18	12,008
Micro Macro	10	5	4	4	31	3	18,828
MultiAhorro	48	38	8	8	281	6	97,555
None	104	49	27	14	458	4	156,312
Red Market	12	9	3	2	38	3	16,546
Super XXI	4	0	2	1	12	3	8,196
Super Star	4	0	1	1	29	7	8,451
TATA	43	12	25	19	301	7	74,207
Tienda Inglesa	10	7	4	3	164	16	15,328
Ubesur	19	19	1	1	59	3	28,868
TOTAL	386	173	-	-	2,454	6	629,781

Table 12: Uruguayan States information.

	# Cities	# Stores	Average Stores per City
Artigas	1	2	2
Canelones	15	47	3
Cerro Largo	2	4	2
Colonia	6	12	2
Durazno	1	4	4
Flores	1	4	4
Florida	1	5	5
Lavalleja	1	4	4
Maldonado	8	36	4
Montevideo	1	209	209
Paysandú	1	7	7
Río Negro	2	3	1
Rivera	2	6	3
Rocha	5	14	3
Salto	1	9	9
San José	3	9	3
Soriano	1	2	2
Tacuarembó	1	5	5
Treinta y Tres	1	4	4
TOTAL	54	385	7

Table 13: Estimation of distance and border effect using Average, Median and First Day of the Month Price (no local product).

	First Day of the Month Price			**Median Monthly Price**			**Average Monthly Price**		
	Eq. 16	Eq. 17	Eq. 18	Eq. 16	Eq. 17	Eq. 18	Eq. 16	Eq. 17	Eq. 18
Distance	0.312^{***}	0.156^{***}	0.141^{***}	0.312^{***}	0.171^{***}	0.157^{***}	0.255^{***}	0.160^{***}	0.148^{***}
	(0.001)	(0.003)	(0.003)	(0.001)	(0.003)	(0.003)	(0.001)	(0.003)	(0.003)
Border	0.196^{***}	-0.212^{***}	0.489^{***}	0.222^{***}	-0.144^{***}	0.490^{***}	0.214^{***}	-0.032^{***}	0.510^{***}
	(0.004)	(0.008)	(0.009)	(0.004)	(0.009)	(0.009)	(0.004)	(0.008)	(0.008)
Distance×Border		0.182^{***}	0.185^{***}		0.163^{***}	0.167^{***}		0.110^{***}	0.113^{***}
		(0.003)	(0.003)		(0.003)	(0.003)		(0.004)	(0.003)
One Local			0.640^{***}			0.650^{***}			0.560^{***}
			(0.005)			(0.005)			(0.005)
One Local ×Border			-1.123^{***}			-1.109^{***}			-0.976^{***}
			(0.006)			(0.006)			(0.006)
Both Local			-0.695^{***}			-0.751^{***}			-0.853^{***}
			(0.005)			(0.005)			(0.005)
Both Local ×Border			-0.898^{***}			-0.767^{***}			-0.639^{***}
			(0.005)			(0.005)			(0.005)
# Observations	53,325,021	53,325,021	53,325,021	53,325,021	53,325,021	53,325,021	53,325,021	53,325,021	53,325,021
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Same Chain Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R square	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.08

*** $p < 0.01$.