Varieties as a Source of Law of One Price Deviations*

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Abstract

We explore a new mechanism for prices to deviate from the Law of One Price: differences in the number of varieties offered by stores. Stores chose the price of their goods but also the number of varieties to offer within a given market category. We extend the Hotelling (1929) model to show that the availability of different products between stores increases price dispersion. We test our prediction using a unique country-level database. To have a difference of one variety in a product market between two stores increase price volatility between 0.3% and 1.2%. The effect is robust to several controls and alternative specifications. Our results show that within store decisions on variety selection could have a great aggregate impact on the volatility of prices.

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Keywords: Law of One Price, Retail prices, Variety.

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1 Introduction

The convergence of prices across geographical regions, which gives rise to the Law of One Price (LOP), has been extensively debated in macroeconomics. Although there are nuances in the degree of the deviations, most of the literature points to a failure in the convergence of prices to the LOP.[1] There are several explanations in the literature for this failure of prices to match across different regions. Among others, this relative price divergence has been attributed to trade costs (see Anderson and van Wincoop, 2003, Anderson and van Wincoop, 2004, and Atkin and Donaldson, 2015), the existence of borders between regions or countries (see Engel and Rogers, 1996, Gorodnichenko and Tesar, 2009, and Gopinath, Gourinchas, Hsieh, and Li, 2011), the existence of high fixed costs of production for some goods (see Coşar, Grieco, and Tintelnot, 2015a, Coşar, Grieco, and Tintelnot, 2015a), price discrimination of consumers (see Haskel and Wolf, 2001, and Dvir and Strasser, 2018), or—within countries—sticky prices (see Crucini, Shintani, and Tsuruga, 2010, and Elberg, 2016).

This paper offers a novel explanation for the deviations to the LOP: differences in the varieties within a product category offered by stores. If stores differ in the varieties of goods offer, then the price of the same good at different stores does not need to converge, even after controlling for trade costs (i.e., distance). Although the literature has emphasized the role of the different basket of goods across countries (see Gorodnichenko and Tesar, 2009), to the best of our knowledge no paper explicitly examines the role of differences in varieties as a source of LOP deviations.[2]

The definition of variety is borrowed from the trade literature, in particular from models based on monopolistic competition (i.e., Dixit and Stiglitz (1977), Eaton and Kortum (2002), and Melitz (2003)). Within a given market or product category some goods offer similar characteristics to the consumer. A variety will be a collection of similar goods: i.e., in the beer market, there are varieties Bud Light, Budweiser, or Coors Light. In empirical papers of trade the narrow category for defining a market for substitute goods is usually referred to as product category (see Gopinath, Gourinchas, Hsieh, and Li (2011), Hong and Li (2017), or Atkin and Donaldson (2015)). We will refer to a specific product as a variety—interchangeably—, and the market to which it belongs as market or product category—interchangeably—.

The idea of price non-convergence due to differences in varieties is as follows. Assume two stores at 100 meters distance from each other both selling Coke. After controlling for distance, we should expect that the price of Coke should be equal between both stores. Now assume the same setting than before—two stores selling Coke at 100 meters distance—but one of the stores also has Pepsi available. Now, Coke competes with Pepsi at one store but not at the other store. The equilibrium price of Coke shall now not be equal between both stores, even after controlling

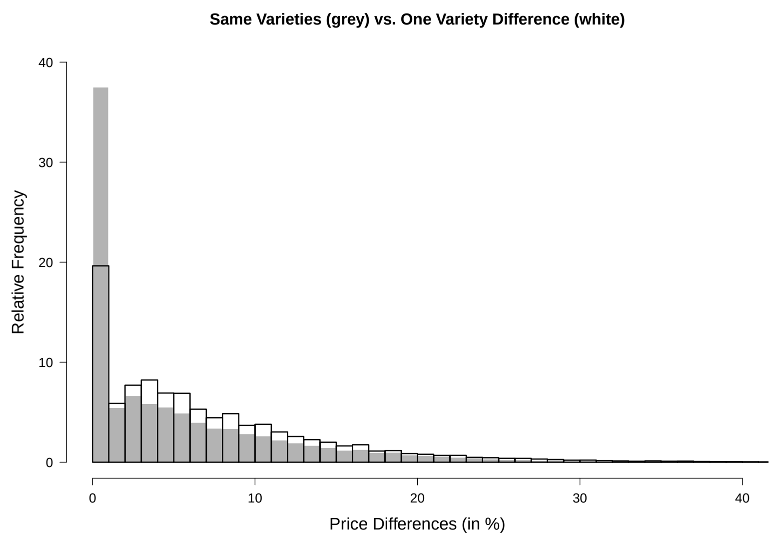
[1] Earlier texts in the literature include Isard (1977) and the review of Rogoff (1996) for macroeconomics and Varian (1980) for microeconomics.

[2] Gopinath, Gourinchas, Hsieh, and Li (2011) partially addresses this issue by controlling for the markup of firms using cost information.

for distance, because each product faces different competitive conditions within the store. As a result, differences in varieties within a product category at the stores will affect the price of similar products between stores, even after controlling for distance.

Figure 1 below motivates the main contribution of the paper. It plots the distribution of the (absolute) log price differences—pooled across products—of a given product for stores up to one-kilometer distance. In gray is plotted the distribution of price differences for store pairs that have the same number of varieties at the category level. On the other hand, boxes with heavy black trace show the distribution of price differences for stores that differ in one variety, as in our previous example. The plot shows that the larger the difference of varieties between stores for a given product category the less likely is that prices will converge. This empirical result is also confirmed by our theoretical model in Section 2.

Figure 1: Pooled Price Dispersion for Stores Up to One Kilometer.



The paper offers two contributions to the LOP literature. First, we offer a simple extension of the Hotelling (1929) model that accounts for different varieties. We show that there is a Nash equilibrium where stores offer different varieties and charge different prices for the goods that have in common. This result holds in an otherwise symmetrical scenario between stores. In addition, the model adds to the theoretical literature on price dispersion (see Varian (1980), Preston (1995), and recently Kaplan, Menzio, Rudanko, and Trachter (2019), among others), but does not require asymmetric information for price dispersion to hold. Second, using a detailed price database for Uruguay, a geographically small and economically homogeneous developing country, we present evidence that differences in varieties within stores in a given category have a significant economic impact on aggregate price dispersion. We propose an estimation for price dispersion in price differences, similar to Engel and Rogers (1996). A difference of one variety between two stores adds up to 0.5% of the price difference, even controlling for distance and store fixed effect. The result remains robust and significant for different specifications.

The model, an extension of Hotelling (1929)[3] based on Irmen and Thisse (1998), incorporates two competitive dimensions: the distance between stores for a homogeneous good and varieties of goods at the store level. As usual in the literature, the model builds on exogenous features of markets (i.e., number of varieties, entry conditions, the distance between stores) to show how the availability of different varieties at the store explains deviations from the LOP. This formalization is more realistic in capturing the competitive pressure for products, which results not only from substitution between similar goods—measured by distance—but also by the availability of substitute varieties at the same store, as measured by the varieties available to consumers. The model allows to arise differences in product markups due to differences in competing varieties at the store.

The empirical analysis is based on a detailed database on retail prices collected by the Ministry of Economy and Finance in Uruguay that contains daily data for 154 products, most of them defined at the UPC level, for eight years in nearly all supermarkets across the country. The database also has information on the exact locations of the stores, whether they belong to a chain, and on their sizes—measured by the number of cashiers. Our key methodological approach is to measure the number of varieties in a given category at a store. Our database has detailed price information for the three most selling brands—excluding supermarkets' own brands—for each product category. For each triple product/store/month-year we compute the number of varieties by counting the number of prices for each different variety of products within a given category.

Uruguay is an excellent country in which to perform this study. It is a small homogeneous country, where 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. As a result, no major deviations from the LOP should be expected. Nevertheless, we found a median price dispersion of 5%, which increases to 5.6% if stores differ in one variety in a given market. Also, while the unconditional probability of two prices to be equal when stores have the same number of varieties is one in five, it decreases to one in ten if stores differ in one variety.

Other papers have studied the LOP convergence within countries. Parsley and Wei (1996) and Yazgan and Yilmazkuday (2011) for the US, Ceglowski (2003) for Canada, and Fan and Wei (2006) for China found larger rates of dynamic convergence to the LOP within countries than between countries. Besides transport costs (see Atkin and Donaldson, 2015)–measured by distance–and borders, the main explanation for the relative divergence of prices within countries has been sticky prices. Engel and Rogers (2001) for the US, Crucini, Shintani, and Tsuruga (2010) for Japan, and Elberg (2016) for Mexico found that price rigidities are relevant in explaining the failure of the LOP within countries. Nevertheless, those papers typically use pooled data and as a result, could suffer from identification problems due to other goods characteristics—such as lower costs,

[3]A variation of this model is also used by Gopinath, Gourinchas, Hsieh, and Li (2011).

different distribution channels, or marketing strategies—that could bias the estimation of the price stickiness coefficient. In our empirical methodology, we control with product dummies for such unobserved product characteristics.

The paper is organized as follows. The next section shows that price dispersion arises in equilibrium if stores offer different varieties. Section 3 describes the database used to estimate the effect of varieties on deviations from the LOP. Section 4 introduces the equations to be estimated, the econometric results, while Section 5 show robustness test to check the main results and address some further limitations. Finally, Section 6 presents the conclusions of the analysis.

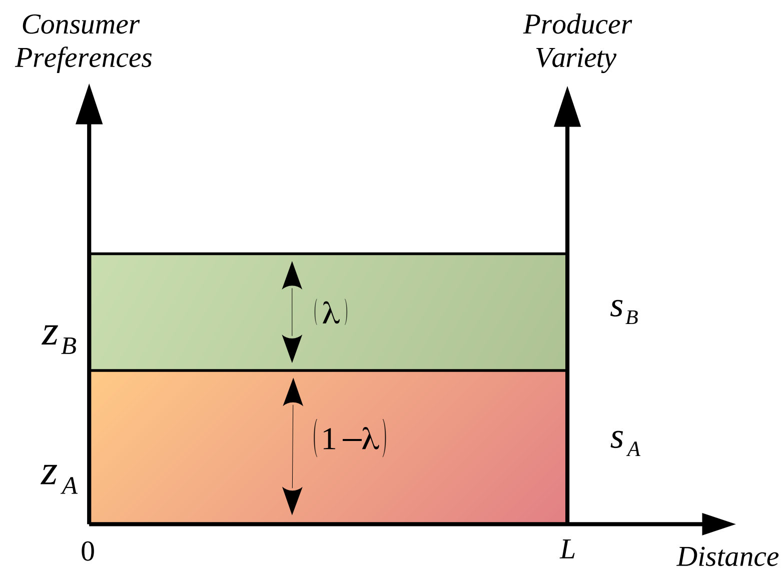
2 A Simple Model of LOP Deviations

This section offer a simple model to explain sources of deviations from the LOP. We propose an 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 product differentiation.[4] This extension allows to capture trade costs—the distance dimension—, but also competition between varieties at the store—the variety dimension. 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. In the model stores choose first the number of varieties of a good that will offer and then set the price for the selected varieties.

The main setting is a road that has two types of consumers uniformly located, and at each store two potential varieties that can be sold of a given product; say Coke and Pepsi. More formally, we propose an extension 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 mass $(1 - \lambda)$ of consumers that prefers variety z_A, and a mass λ 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 $1 - \lambda$, and the total mass of consumers is $L \times (1 - \lambda)$. The second line is for consumers that prefers variety z_B, its thickness is λ, and there is a total mass of consumers of $L \times \lambda$. Figure 2 below depicts the main setting 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 stores (s_{Ai}, s_{Bi}).

[4] A previous version of this paper offers 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 2: The two dimensional model.



Products have a physical—distance—identification (d) but also a variety identification (s). Stores 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:

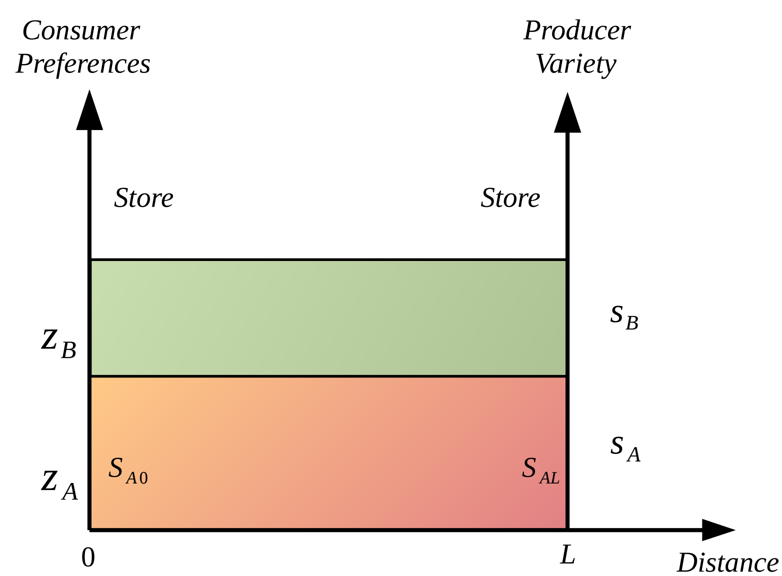
$$U_{ij} = r - \theta \{if\, z_i \neq s_q\} - t\,|x_j - x_d| - p_{qd},$$

where r is the reservation utility of the consumer—equal for all consumers—, i indicates the variety preference of the consumer ($i.e.,.\, z_i = \{z_A,\, z_B\}$), 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, but that there is a fixed cost for each variety equal to F. Although not formalized in the model, fixed costs represent the opportunity cots each variety impose on the store because the limited slotting space. Each variety a store choose to sell will leave less space available to other varieties or products. In turn, this opportunity cost will allow us to be used as an exogenous instrument for varieties in the empirical section.

This simple setting will allow us to show that there exists a Nash equilibrium in which one firm sold two varieties and the other sell just one. This equilibrium under symmetrical demand and cost conditions will result in different prices being charged for the same product. First, we will show that, under the previous assumptions, stores will prefer to sell only one brand. This is due to the fact that having two brands do not increase income for the store but double its fixed costs. Secondly, using the previous conditions, we show that prices will differ in equilibrium if varieties differ between stores. Varieties will differ in equilibrium because a store that has two varieties will increase its cost but also expand the demand at the expense of the store that sold just one brand. On the contrary, although the firm that sold one brand lose market share—and income—it also saves fixed costs.

Suppose there are two stores that sell the same variety $z_A = s_A$. The stores are located in opposite sides on the street. The first store is located at 0 and the second store at L, being L also the distance between the stores. We label store 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 variety on price dispersion. The situation is depicted in Figure 3.

Figure 3: The model with two stores and one variety.



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 for each variety 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:

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

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

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

The demand for product A at store located at 0 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 $\Pi_{A0} = p_{A0} \times D_{A0} - F$ and $\Pi_{AL} = p_{AL} \times D_{AL} - F$, as only one brand is sold at each store. 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:

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

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, $L/2$–. Profits if both firms sell one variety will be:

$$\Pi_0^{11} = \Pi_{A0} = \Pi_L^{11} = \Pi_{AL} = \frac{tL^2}{2} - F,$$

where the superscripts denote the number of varieties of each firm, with the first superscript being that of the firm and the second superscript the number of varieties of the rival store.

Under these assumptions, stores will not find optimal to sell both varieties. The problem with two varieties is symmetrical to the one with one variety: the indifferent consumer will be at $\widehat{x}$ for each variety. For this result to hold, we will assume that at 0 and L 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.

As a result, the price of each variety will be the same as before: $p_{A0} = p_{AL} = p_{B0} = p_{BL} = tL$, and the indifferent consumer will be again located at $L/2$. Profits will now be:

$$\Pi_0^{22} = \Pi_{A0} + \Pi_{B0} = \Pi_L^{22} = \Pi_{AL} = \Pi_{BL} = \frac{tL^2}{2} - 2F$$

From the above results it follows that stores prefer to sell only one variety of the good. This is due to the assumption of consumers being discrete in their variety dimension.

2.1 Stores Differ in the Number of Varieties

In this simple model prices will diverge if the symmetry between stores is broken. We accomplish this by introducing a second variety at just one of the stores. Specifically, assume that at location 0 the store also offers variety s_B to consumers. Previously we 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 assumption add one additional restriction to the model. Consumers located at 0 that have preference for variety z_A will prefer to buy variety s_A to variety s_B at store S_0 if $r - p_{A0} > r - \theta - p_{B0} \iff p_{A0} - p_{B0} < \theta$. On the contrary, consumers located at 0 that have preference for variety z_B will prefer to buy variety s_B to variety s_A at store S_0 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 store S_0 in order to both goods have positive demand:

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

The availability of a new variety does not change the indifference condition for consumers that prefer variety z_A. Now we find the consumers who are indifferent about buying from variety B at store 0 and variety A at store L. Take the case of a consumer located at $\widetilde{x}$ that prefers variety z_B. She will be indifferent between buying variety B at store 0 or variety A at store $L \iff$

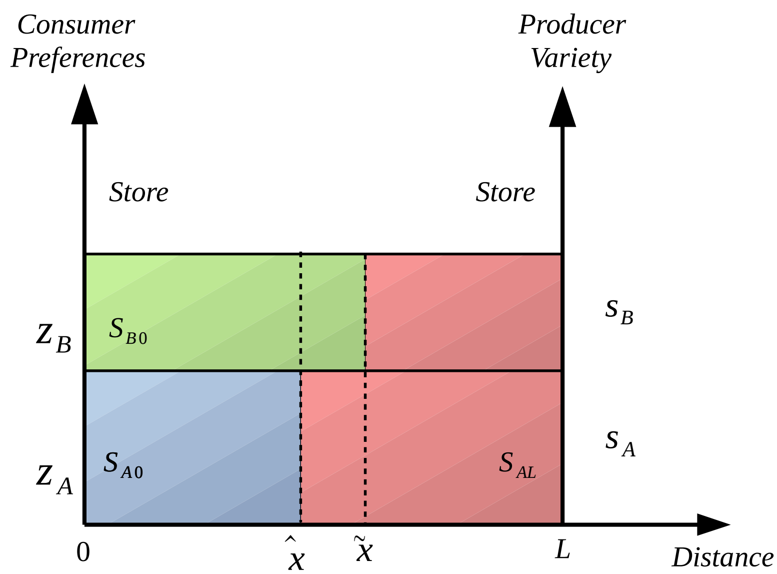
$$r - t\widetilde{x} - p_{B0} = r - \theta - t\,|L - \widetilde{x}| - p_{AL}, \tag{4}$$

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 4 depicts the possible location of $\widetilde{x}$ for a given location of $\widehat{x}$ and the demand for each store.

Figure 4: Possible equilibrium values of $\widetilde{x}$ and $\widehat{x}$.



Note: 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.

Now we proceed to find the demand for each store, taking into account the previous results. Store S_0 will have demand for varieties A and B. Profits will be $\Pi_0^{21} = (1-\lambda)\,\widehat{x}\times p_{A0}+\lambda\widetilde{x}\times p_{B0}-2F$ $= (1-\lambda)\,\frac{p_{AL}-p_{A0}+tL}{2t}p_{A0} + \lambda\frac{p_{AL}-p_{B0}+\theta+tL}{2t}p_{B0}$. Note that the maximization problem is separable in p_{A0} and p_{B0}. The first order constraints of the problem are $\frac{\partial\Pi_0}{\partial p_{A0}} = 0 = \frac{(1-\lambda)}{2t}\left[p_{AL} - 2p_{A0} + tL\right]$ and $\frac{\partial\Pi_0}{\partial p_{B0}} = 0 = \frac{\lambda}{2t}\left(p_{AL} - 2p_{B0} + \theta + tL\right)$. Therefore the reaction functions are

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

$$p_{B0} = \frac{p_{AL} + \theta + tL}{2}. \tag{7}$$

Note that the reaction function of product A for store S_0 depends only—increasingly—on the price of variety A sold by firm S_L, but not on the price it set for product B. This result holds because of the discrete nature of the variety dimension.

For store S_L, as $\widetilde{x} > \widehat{x}$, its demand is affected by variety B sold by store S_0. The demand of store L is, $D_{AL} = \underbrace{(1-\lambda)\times(L-\widehat{x})}_{s_A\ consumers} + \underbrace{\lambda\times(L-\widetilde{x})}_{s_B\ consumers} = (L-\widehat{x}) - \lambda\,(\widetilde{x}-\widehat{x})$.

The profit function is: $\Pi_L = p_{AL}\left[\left(\frac{p_{A0}-p_{AL}+tL}{2t}\right) - \lambda\left(\frac{\theta+p_{A0}-p_{B0}}{2t}\right)\right] - F = p_{AL}\left(\frac{(1-\lambda)p_{A0}-p_{AL}+\lambda p_{B0}-\lambda\theta+tL}{2t}\right) -$

F. From the FOC we obtain:

$$p_{AL} = \frac{(1-\lambda)\, p_{A0} + \lambda p_{B0} - \lambda\theta + tL}{2}. \tag{8}$$

The reaction function of store S_{AL} is increasing in p_{A0} and p_{B0} as they are both substitutes. 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 variety A sold at stores 0 and L are now lower than if variety B were not available. As competition increase, prices decrease. Also, in this model, the effect of variety is independent of the effect of distance.[5]

The next Proposition establish the conditions for the above prices to be a Nash equilibrium.

Proposition 1. *One store will offer two varieties and the other store will offer one variety if the following inequalities hold:* $\frac{3F}{\lambda\theta} - \frac{\theta}{12t}\left(9 - \frac{5}{2}\lambda\right) \leq L \leq \frac{3F}{\lambda\theta} - \frac{\lambda\theta}{6t}$. *This double inequality holds for all* $\lambda \in [0,1]$.

Proof. See Appendix C. □

The next Proposition summarizes the effect of variety on pricing.

Proposition 2. *Introducing varieties into the distance model:*

1. *Decreases the price of goods;*
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. □

This simple model allows us to introduce price dispersion in equilibrium without relying on differences in demand at the store level (e.g., differences in the number of consumers z_A and z_B) nor differences in production costs. Differences in varieties imply differences in markups for firms. The model is perfectly symmetric and the result relies only on the assumption of positive fixed costs and a discrete number of varieties. The trade-off between markup and fixed costs of varieties is the key for the model to have an asymmetric equilibrium in the number of varieties. As

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

Proposition 2 showed, store decision on the number of varieties offered will have an impact on the equilibrium price of the product sold. The price difference between stores in the previous example will be $\left|p'_{A0} - p'_{B0}\right| = \frac{\theta}{2}$ due to the symmetry of the model in terms of distance—and also costs—. Nevertheless, in Section 4 we allow for a more flexible estimation.

3 Data

This section offers a detailed description and descriptive statistics of the database used in the empirical section, as well as some preliminary results on the relative convergence to the LOP. We perform the analysis using a detailed good-level database of daily posted prices compiled by The General Directorate of Commerce (DGC), a unit of the Ministry of Economy and Finance in Uruguay, which comprises information about grocery stores all over the country.[6] Moreover, the DGC is the authority responsible for the enforcement of the Consumer Protection Law. The DGC requires retailers to report their daily prices once a month using an electronic survey.

The database has its origins in a tax law passed by the Uruguayan legislature in 2006, which changed the tax base and rates of the value-added tax (VAT). The Ministry of Economy and Finance was 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) they 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 for misreporting. The objective of the DGC is to ensure that prices posted on the DGC website reflect the actual posted prices at 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 is an unbalanced panel for up to 386 stores and includes daily prices from April 1st of 2007 to September 30th of 2014 for 154 products, most of them defined by UPC code. This detailed information allows us to track the exact same good in stores across the country, avoiding measurement problems resulting from different products being compared (see the discussion in Atkin and Donaldson, 2015). The markets for the goods included in the sample represent 15.6% of the CPI basket. Most items have been homogenized to make them comparable, and each supermarket must always report the same item. For example, the soft drink of the brand Coca Cola is reported in its 1.5-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

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

to check prices in different stores or cities and to compute the cost of different baskets of goods across locations.[7]

The three best-selling brands are reported for each market, disregarding the supermarket's own brands. Products were selected after a survey of some of the largest supermarket chains in the year 2006. In November 2011, the list of products was updated, including some markets and reviewing the top brands for others. The price information for the goods that were discarded was deleted from the database, so we lose part of the information in some markets. Two characteristics of the database are critical to our analysis. On the one hand, due to its construction, the database has the most relevant products in each market, simplifying the task of finding them or defining which goods should affect product pricing decisions. On the other hand, eliminating supermarkets' own brands could induce noise in our variety variable. Although supermarkets' own brands are not comparable across different chains, they could induce variation not completely captured by the prices of the other varieties relieved at the store. Nevertheless, this omission would imply that our results are a lower bound on the effect of varieties, as more varieties should be available at the store.

The 154 products in the database represent 50 markets or product categories (e.g., sunflower oil and corn oil and wheat flour 000 and wheat flour 0000 are different markets in our analysis). 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 brands. In other cases, products could be open and sold in pieces; such as hot dogs, or ham. In both cases, we exclude those products from the analysis. Lastly, we delete information on one quince jam brand, as there were no varieties in the database. The detailed list of goods used in the empirical analysis can be found in Appendix B. The list includes the market of the good, its presentation, when the product appears for the first time in the database, and the producer for each brand.

For each store in the database we have detailed information about their exact location given by its Universal Transverse Mercator (UTM) as well as about whether it belongs to a supermarket chain. We use the UTM information to calculate the linear distance between each pair of supermarkets in the database. 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 country's largest city, with nearly forty percent of the Uruguayan population.[8] Figure 7 in Annex A shows the cities in the database and the supermarket distribution for Montevideo, which accounts for 54% of all supermarkets in the sample.

We construct two databases. First, a price level database using the information from the DGC. For each product and store, we calculate the monthly mode of the daily prices to avoid introducing

[7]See http://www.precios.uy/sipc2Web/ and Borraz and Zipitría (2012) for a detailed description of the database and an analysis of price stickiness.

[8]More information is available at http://www.ine.gub.uy/uruguay-en-cifras (in Spanish).

variations in LOP due to sales (see Eichenbaum, Jaimovich, and Rebelo, 2011, Nakamura and Steinsson, 2008, and Nakamura and Steinsson, 2013).[9] The inclusion of sales in the analysis will induce spurious deviations related to a producer or retail commercial policies that introduce noise in the analysis of deviations of prices to the LOP. The final price database contains 2,096,310 monthly observations for 125 goods—varieties—in 42 product categories. Descriptive statistics of prices—including minimum, median, maximum, standard deviation, number of observations, and the maximum share of stores where the product is available—can be found in Table 7 in Annex A.

Secondly, a price difference database, which is used to analyze the role of distance in price convergence. For each triple product/store/month, we calculate the (absolute) price difference, (absolute) variety difference, and distance between stores, and obtain 272,370,229 observations. Descriptive statistics of price differences—including minimum, median, maximum, standard deviation, number of observations, and the exact number of zeroes—can be found in Table 9 in Annex A. As a result of the large size of the database we will perform the empirical analysis by using a random sample of 10% of the observations in the database. Also, we check the results against the year 2011, which has the cross-distribution of varieties that closely mimics that of database. Nevertheless, the next subsection shows descriptive statistics for the complete price difference database.

Our measure of variety is the key variable in the empirical analysis. We propose a very simple measure to capture the role of different varieties on prices. For each triple market/store/month we count the number of prices—less one—listed in the database. So if in a given month/store/market we have two listed prices, our variety measure will take the value of one for both goods in the market, indicating that for each one there is another variety available to consumers. This simple measure trade-off aggregation *across* markets with variation *within* markets. As an example, assume in market Z there are up to three products—as in our database–. Our variety variable will have a value of one if any of the following situations holds: brands A and B are available, brands A and C are available; or brands B and C are available. Clearly, to have brand A competing with brand B could be a very different competitive setting than brand A competing with brand C. As a result, our measure loses some variation within markets.

On the contrary, our measure allows us to aggregate *between* markets. Different markets with a value of one in the variety variable just state that two product are available in each one, or that another variety could be chosen by consumers. If instead, we differentiate within a market each of the possible combination of products as previously stated, then we will not be able to aggregate differences between markets. As a result, to represent each possible combinations of products in each market will end with thousands of different measures of variety that will hide the general picture. With our simple measure of variety, a value of one for that variable implies that there is another product available at the store, whatever the market. Nevertheless, by construction, the

[9]Previously, we delete outliers, defined as those prices lower than one third or larger than three times the median monthly price for each product. This procedure eliminates less than 0.01% of the daily prices.

variety measure will be noisy.

Our variety variable is suited to compare different markets. All products in the same market at a given month and store will have the same value of the variety variable, by definition. As a result, our variety variable does not vary with store/month/product, but by store/month/market.

3.1 Descriptive statistics

First, we offer some statistics on the variation in the number of varieties in the database. Table 1 below show the share of observations by the number of varieties in the price database and in the price difference database. In the price database most observations are up to two varieties, while a larger number of varieties are for the rice market only. The price difference database shows that nearly two-third of the observations have the exact same number of varieties—although not the same number of products, due to our noisy measure—, but a nonnegligible 30% of observations differ in one variety, and nearly 5% in two varieties.

Table 1: Number of Varieties in the Price Level and Difference Database (in percentage).

Price Database		Price Difference Database	
# Varieties	Share	△ # Varieties	Share
0	10.6	0	65.5
1	42.4	1	29.3
2	43.9	2	4.5
3	1.2	3	0.5
4	1.7	4	0.2
5	0.2	5	0.0

Source: Author's calculation.

One of the goals of the paper is to compare the effect of varieties vis-à-vis the effect of distance in explaining deviations from the LOP. Using the location of each store we calculate the distance for each pair of supermarkets (74,305 combinations). The distance between pairs of stores varies considerably in the database, taking into account if the stores are within or between cities. The next table shows statistics for the distance between supermarket's pairs.

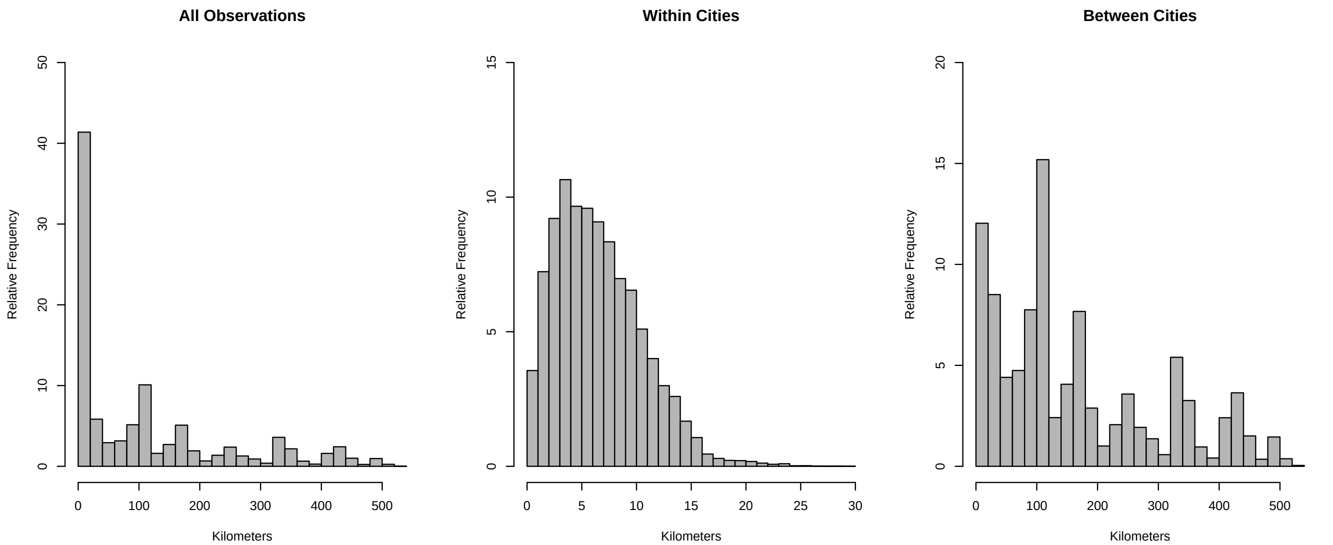
Table 2: Descriptive statistics for distance between supermarkets (in kilometers).

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

Source: author's calculation.

Figure 5 plots the distribution of observations in the price difference database 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. The number of observations in the price difference database is not evenly distributed along the distance. As with distance between supermarkets, nearly 40% of the observations in the database are supermarkets that are less than 20 kilometers apart.

Figure 5: Observations by distance in the sample.



Divergences from the LOP—even within countries—have mainly being associated with the effect of borders. Next, we show histograms of the distribution of price differences for stores in the same and different cities 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. The figure shows that there seems to be more convergence within cities than between them, although the effect is mild. Nevertheless, differences are much less significant than those due to varieties as shown in Figure 1.

Figure 6: Distribution of Price Differences.

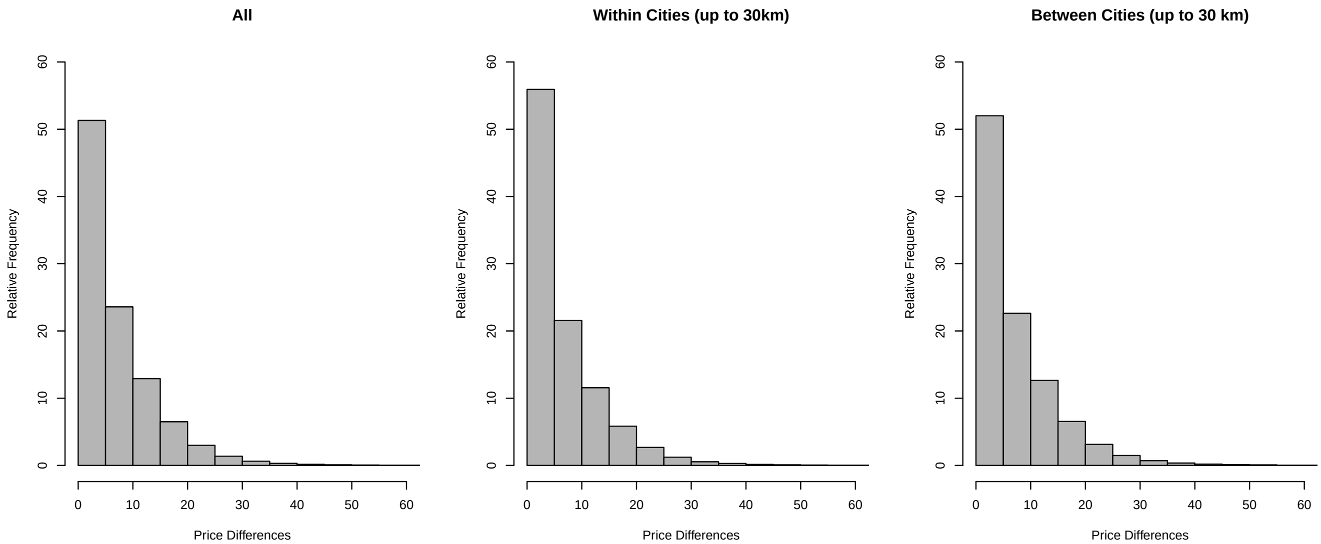


Table 3 below shows summary statistics—median, standard deviation, and the number of exact zeroes—of price differences to illustrate the main message of the paper. The median price difference is about 5% and prices are equal nearly a fifth of the time. The price difference is a bit lower than those reported by Elberg (2016) for Mexico (7.6%) and Parsley and Wei (1996) (14.4% for perishables and 12.5% for nonperishable goods) for the US. Nevertheless, the figures are quite large if the size of the country is taken into account. The maximum distance between stores in Uruguay is eight times smaller than in the US and at least three times smaller than for the cities reported by Elberg (2016) in Mexico. Within cities, prices are equal to a fourth of the time. The key differences emerge when varieties are taken into account. For products having the same number of varieties price dispersion is 4.3% and the share of equal prices is about 22%. Nevertheless, when products in two stores differ in one variety the median price difference increase by nearly 30%, and the share of equal prices decreases to half. Thus, when products between stores have the same number of varieties the unconditional probability of the product having the same price is twice as large as if products differ by one in the number of varieties.

Table 3: Deviations of Law of One Price Under Different Configurations.

	Median	**St. dev.**	**% Exact Zeroes**	**# of obs.**
Total	4.8	7.3	18.2	272,370,229
Between Cities	5.1	7.4	14.5	180,944,726
Within Cities	4.1	7.2	25.4	91,425,503
Same Number of Varieties	4.3	7.3	21.6	178,487,138
One Variety of Difference	5.6	7.4	11.9	79,607,477

Source: author's calculation.

The table summarizes the main message of the paper: when stores differ in the number of varieties they offer, prices will diverge more often. The next section presents several measures of the effect of varieties on relative prices, exploiting the variability in varieties in the database. It is also interesting to note that the standard deviation of prices in quite the same in the different samples. This is quite relevant after Gorodnichenko and Tesar (2009), who showed that the distribution of prices matters to estimate across the different samples of products.

4 Empirical Strategy

Proposition 2 in Section 2 established that if stores differ in the number of varieties in a given market, then prices will diverge more often. Evidence of price divergence has been shown in Figure 1 and Table 3 in the previous section apply. But Proposition 2 in Section 2 also established that prices will be lower if there are additional varieties in the market.

We propose an estimation of the relative LOP deviation standard in the literature (see Atkin and Donaldson, 2015, Crucini, Shintani, and Tsuruga, 2010, Dvir and Strasser, 2018, Engel and Rogers, 1996, Goldberg and Knetter, 1997, and—with some differences—Coşar, Grieco, and Tintelnot (2015b), among others). Our base estimation for LOP deviation—adapted from Engel and Rogers (1996)—is as follows:

$$|p_{ist} - p_{irt}| = \alpha_i + \alpha_t + \beta_1 \times Dist_{sr} + \gamma X_{isr} + \varepsilon_{isrt}, \tag{12}$$

where i is product where $i \in I$ 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 log of the price of good i between stores s, r at moment t;[10] α_i is a dummy variable for product i; α_t are time dummies; $Dist_{sr}$ measures the linear distance in (logs of) kilometers between stores s, r—as some distances are less than one kilometer, and as we want to avoid negative distances, we add 1 to the distance in kilometers—and ε_{isrt} is a stochastic error term.

We add different controls, represented by X_{isr}, that include: a dummy variable α_{ch} that takes the value one if stores s, r belong to the same chain; $Border_{sr}$ is a dummy variable that takes the value one if stores s and r are located in different cities; and $\alpha_s + \alpha_r$ store dummies. The equation includes controls for unobserved differences across cities–border–(see Engel and Rogers, 1996), distance as a measure of trade costs (see Anderson and van Wincoop, 2003 and Anderson and van Wincoop, 2004), product dummies that account for unobserved differences across products, such as differences in relative rigidity of prices (Crucini, Shintani, and Tsuruga, 2010) or production costs (Goldberg and Knetter, 1997), or a dummy that accounts for uniform prices in chains (DellaVigna and Gentzkow, 2019 for the US, Borraz and Zipitría, 2012 for Uruguay).

Our analysis proposes a simple modification that add to Equation 12 the differences in varieties

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

between stores at the category level. We define $DVar_{isrt} = |Var_{ist} - Var_{irt}|$, as the differences in the number of varieties between stores s, r for product i in period t. Now, equation 12 transforms into the following:

$$|p_{ist} - p_{irt}| = \sum \alpha_i + \alpha_{ch} + \sum \alpha_t + \beta_1 \times Dist_{sr} + \beta_2 \times DVar_{isrt} + \\ + \gamma X_{isr} + \varepsilon_{isrt} \ , \tag{13}$$

Due to the size of the database—273 million observations—and the high number of controls, we decide to take a random sample of the database for 10% of the observations.[11] We also control the results by running the same regressions for year 2011, which has a distribution of varieties similar to the whole database. Table 4 shows the main results for the estimation of equations 12 and 13 for the random sample database (Panel A) and for the year 2011 (Panel B). All equations have standard errors clustered by store pair—i.e., store s and r—and time.[12] The estimation uses a within transformation to absorb a large number of fixed effects in the regression.[13]

[11] A sample procedure was also used in DellaVigna and Gentzkow (2019).

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

[13] See Wooldridge (2010) chapter 10.5. We use package lfe in R. See Gaure (2013) for details.

Table 4: Estimation of LOP deviation. Robustness Estimation of the Impact of Varieties by Different Distances.

Panel A: Random Sample	*Dependent variable: difference in log of prices (times 100)*							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance	0.273***	0.134**	0.383***				0.122**	0.374***
	(0.044)	(0.063)	(0.040)				(0.062)	(0.039)
Variety				0.904***	0.631***	0.430***	0.624***	0.411***
				(0.073)	(0.050)	(0.042)	(0.049)	(0.040)
# Observations	27,237,023	27,237,023	27,237,023	27,237,023	27,237,023	27,237,023	27,237,023	27,237,023
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Different City Dummy	No	Yes	No	No	Yes	No	Yes	No
Same Chain Dummy	No	Yes	No	No	Yes	No	Yes	No
Stores s, r Dummies	No	No	Yes	No	No	Yes	No	Yes
R square	0.106	0.126	0.174	0.128	0.128	0.174	0.128	0.175

Panel B: Year 2011	*Dependent variable: difference in log of prices (times 100)*							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance	0.310***	0.154**	0.380***				0.142**	0.372***
	(0.046)	(0.067)	(0.039)				(0.066)	(0.037)
Variety				0.842***	0.595***	0.398***	0.586***	0.380***
				(0.084)	(0.063)	(0.055)	(0.062)	(0.054)
# Observations	49,383,990	49,383,990	49,383,990	49,383,990	49,383,990	49,383,990	49,383,990	49,383,990
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Different City Dummy	No	Yes	No	No	Yes	No	Yes	No
Same Chain Dummy	No	Yes	No	No	Yes	No	Yes	No
Stores s, r Dummies	No	No	Yes	No	No	Yes	No	Yes
R square	0.132	0.151	0.201	0.132	0.153	0.200	0.153	0.201

*** $p < 0.01$, ** $p < 0.05$. Standard errors in parentheses. Clustered standard errors (by store s and r, and time) in parentheses.

Both panels show similar results, so we report the results for the random sample database. Columns (1) to (3) show the estimation of the Distance parameter with different controls. Column (1) shows the result for the Distance parameter with only time and product dummies controls. When Border and same chains are added, the estimated parameter decrease by half. Nevertheless, when store dummies are added the Distance parameter increase again. The Distance parameter is sizable: adding 14 kilometers of distance equals to adding 1% of price dispersion. This sizable result of distance is similar to the one found in Atkin and Donaldson (2015).

Columns (4) to (6) shows the estimation of the impact of differences in varieties on price dispersion but without including distance in the regressions. Adding controls imply a decrease in the estimated parameter. In all cases, the parameter is statistically significant. Next, the results of Columns (7) and (8) show the results of differences in varieties but adding the distance parameter. First, it is useful to note that adding distance does not change the estimated variety coefficient—Column (5) vs. (7), and Column (6) vs. (8)—, while the reversal also holds—Column (2) vs. (7), and Column (3) vs. (8)—. So distance does not seem to affect the estimation of variety and vice versa. Adding controls reduce the relevance of the variety effect, mainly due to the association of varieties to stores. Nevertheless, a sizable 0.41% of price variation is due to having an additional variety. In this extreme scenario, a difference in one variety is equivalent to an increase in price dispersion of 2 kilometers, [14] which seems like a milder walk between stores just for adding a product to a store's shelf. But this effect is the result of an increase in the cost of distance: when controlling for store characteristics, the value of distance increases. With three varieties of difference, we obtain a price variation equivalent to 26 kilometers, similar to the largest distance between stores within a city.[15]

5 Robustness

We repeat our exercise to different distances as a robustness check. First, we run equations 12 and 13 for those stores up to 30 kilometers. These stores should be under similar economic conditions—i.e., transport costs and demand characteristics—, as the maximum distance within a city is 29 kilometers (see Table 2). On the contrary, we run equations 12 and 13 for those stores further away to 100 kilometers (see the peak in the right of Figure 5). These stores are all in different cities and, as a result, face different economic conditions.

[14]The calculation is $2 = exp\,(0.411/0.374) - 1$.

[15]The calculation is $26 = exp\,(3 \times 0.411/0.374) - 1$.

Table 5: Estimation of LOP deviation.

Panel A: Stores up to 30 kms.	Dependent variable: difference in log of prices (times 100)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance	0.419***	0.158	0.172***				0.142	0.171***
	(0.116)	(0.099)	(0.038)				(0.066)	(0.038)
Variety				1.550***	1.194***	0.569***	1.164***	0.569***
				(0.144)	(0.111)	(0.092)	(0.111)	(0.092)
# Observations	125,170,128	125,170,128	125,170,128	125,170,128	125,170,128	125,170,128	125,170,128	125,170,128
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Different City Dummy	No	Yes	No	No	Yes	No	Yes	No
Same Chain Dummy	No	Yes	No	No	Yes	No	Yes	No
Stores s, r Dummies	No	No	Yes	No	No	Yes	No	Yes
R square	0.113	0.145	0.204	0.115	0.146	0.204	0.146	0.205

Panel B: Stores further away from 100 kms	Dependent variable: difference in log of prices (times 100)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance	-0.086	-0.010	0.432***				-0.011	0.430***
	(0.146)	(0.137)	(0.120)				(0.137)	(0.120)
Variety				0.520***	0.418***	0.299***	0.418***	0.298***
				(0.088)	(0.075)	(0.066)	(0.075)	(0.066)
# Observations	113,183,208	113,183,208	113,183,208	113,183,208	113,183,208	113,183,208	113,183,208	113,183,208
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Same Chain Dummy	No	Yes	No	No	Yes	No	Yes	No
Stores s, r Dummies	No	No	Yes	No	No	Yes	No	Yes
R square	0.102	0.145	0.157	0.102	0.113	0.157	0.113	0.157

*** $p < 0.01$, ** $p < 0.05$. No asterisk, no significant. Standard errors in parentheses. Clustered standard errors (by store s and r, and time) in parentheses.

Now, both tables show very different results. Panel A shows a large decline—when statistically significant—in the value of the distance parameter. Also, there is no large increase in the estimated value of distance once store characteristics are accounted for. On the other side, there is a sharp increase in the estimation of varieties as a source of deviations from the LOP. In the most restrictive scenario—Column (8)—the variation in prices accounted for differences in the number of varieties equals 29 kilometers, which is nearly the maximum distance in the sample.[16] Columns (5) and (7) show that price dispersion that could be accounted for differences in varieties between stores is as large as 1.2%. Panel B shows that the distance parameter is only significant when store characteristics are controlled for and its value more than double (Column (8) in Panel A and B). Nevertheless, the variety coefficient remains statistically significant in all specifications, accounting for roughly a third of one percent of price difference even for stores that are farther away from a fifth of the total distance between supermarkets in the country. This result remains significant even when controlling for store characteristics.

Finally, we repeat our estimation for Montevideo, Uruguay's capital city. Montevideo is the largest city in the country with nearly a 1.3 million inhabitants and 45% of the supermarkets. The second largest city is a collection of small urbanizations called "*Ciudad de la Costa*" which has a tenth of Montevideo population. Although there are differences in the distribution of the supermarkets across the city and of consumer characteristics, there are fewer barriers to movement within the city than across cities. The next table shows the results of the estimation of equations 12 and 13.

[16] The calculation is $27 = exp\,(0.569/0.171) - 1$.

Table 6: Estimation of LOP deviation: Montevideo City.

	Dependent variable: difference in log of prices (times 100)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance	0.312**	0.191*	0.150***				0.195*	0.148***
	(0.137)	(0.011)	(0.045)				(0.113)	(0.038)
Variety				1.703***	1.283***	0.612***	1.285***	0.611***
				(0.164)	(0.124)	(0.103)	(0.124)	(0.103)
# Observations	89,655,896	89,655,896	89,655,896	89,655,896	89,655,896	89,655,896	89,655,896	89,655,896
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Same Chain Dummy	No	Yes	No	No	Yes	No	Yes	No
Stores s, r Dummies	No	No	Yes	No	No	Yes	No	Yes
R square	0.113	0.150	0.204	0.116	0.151	0.205	0.152	0.205

*** $p < 0.01$, ** $p < 0.05$. No asterisk, no significant. Standard errors in parentheses. Clustered standard errors (by store s and r, and time) in parentheses.

The results are similar to those of Panel A of Table 5. On the contrary to the general picture of Table 4, the estimated value of distance decreases when controls are added. The impact of differences of varieties across stores ranges from 0.6% (Column 8) to 1.3% (Column 7). In terms of equivalent distance, a difference of one variety adds between 61 (Column 8) and 726 kilometers (Column 7).[17] The impact of differences in varieties remains statistically significant and economically relevant.

Finally, a potential bias to the previous results could result from endogeneity, mainly through two channels: measurement error in our variety variable and reverse causality. Measurement errors arise as a result of the restricted number of varieties of our database and from the procedure to construct the variety variable. Our database is restricted to the three most selling brands in each market, disregarding supermarkets' own brands. As a result, there could be more differences not accounted in the database as some varieties are not included in the analysis. Also, as the construction of the variety variable detailed in Section 3, we treat different situations as similar (e.g., store 1 having varieties A and B in a market are equal to store 2 having varieties A and C). Nevertheless, both scenarios tend to bias downward the effect of varieties as there is less variability in the variety variable. Our baseline of both stores having the same number of varieties could be less frequent in the database and there could be situations where there is variability in varieties but assigned to both stores having the same number of varieties. As a result, there could be much variety in the baseline scenario of both stores having the same number of varieties that are not captured by our variety measure.

The problem of reverse causality is a more serious concern. This implies that prices will affect the selection of the number of varieties. As a result, our estimation of the effect of varieties β_2 will be biased. Nevertheless, we believe this problem is attenuated by the fact that we are calculating the differences for *all supermarket pairs*. Its impossible for a supermarket to take into account the prices of all stores in the country to decide on choosing its number of varieties for a given product category: to take all of them into account is equal to take none into account. More plausible, each store s must take into account only a subset $V \subset S$—with $V \neq S$—of stores whose prices affect on its variety decision. As a result, the larger the number of stores $r \in S$ for which $r \notin V$, the lower the number of observations that will be affected by reverse causality. To put in another way, there is no reverse causality for all the observations of price differences on varieties, but only for a subset of them. Our results in Table 5, mainly in Panel B, shows that our variable is significant, although its impact is lower as distance increases. But at the same time, for those observations, it is less likely that reverse causality could be an issue. Why a store will take into account what happens with the price of another store more than 100 kilometers away when they have plenty of options closer enough? That the variety coefficient sign and statistical significance remains for that sub-sample is an indication that the reverse causality issue should not be a great concern in the analysis. As a result, it is not crystal clear whether β_2 will be biased.

[17]The calculations are $61 = exp\,(0.611/0.148) - 1$ and $726 = exp\,(1.285/0.195) - 1$.

A remaining issue is for stores belonging to a chain. DellaVigna and Gentzkow (2019) showed that supermarket chains set similar prices and have the same varieties for all their stores. If this is the case, less is know to which other supermarket chains they are reacting to when selecting prices and varieties. This implies that the set V could be larger for supermarket chains than just a couple of stores. But our point is not that the set V es empty, but that is not equal to S. In other words, there will always be some store pairs for which there will potentially be reverse causality of prices to varieties, but others who does not.

6 Conclusions

The literature has shown deviations from the LOP either across or within countries. The literature offers different sources for this phenomenon. This paper adds to the burgeoning literature on the macroeconomic effects of retail decisions. We present a new source of relative price divergence: difference in the varieties offered by stores at the product market. We show that price dispersion arises in equilibrium if stores differ in the number of varieties, even with symmetric information. We provide evidence that price volatility increases by 0.3% and 1.2% for each additional difference in varieties between stores. This price dispersion is equivalent to adding 2 to 26 kilometers, and much larger when distances are lower. The variety effect is robust to several controls and different specifications.

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A Additional Tables

Table 7: Price Database Descriptive Statistics.

Market	**Brand**	**Minimum**	**Median**	**Maximum**	**Standard Deviation**	**N**	**Share Stores (%)**
Sunflower Oil	Optimo	17.90	51.00	84.00	6.72	27,531	100.00
Sunflower Oil	Rio de la Plata	29.50	52.00	83.00	4.99	7,510	59.00
Sunflower Oil	Uruguay	24.90	50.00	73.00	6.22	16,067	68.00
Corn Oil	Delicia	39.90	59.00	99.00	5.81	14,725	97.00
Corn Oil	Rio de la Plata	37.90	58.00	79.00	6.03	12,736	86.00
Corn Oil	Salad	32.00	55.00	65.80	5.56	2,672	22.00
Soybean Oil	Condesa	19.90	36.00	51.50	4.09	21,297	95.00
Soybean Oil	Rio de la Plata	26.80	38.00	62.00	3.50	10,475	84.00
Soybean Oil	Salad	27.90	37.00	49.90	3.34	3,339	31.00
Sparkling Water	Matutina	12.90	19.00	32.50	3.15	24,855	98.00
Sparkling Water	Nativa	13.00	23.00	33.00	3.36	17,773	77.00
Sparkling Water	Salus	14.50	26.00	37.00	4.14	27,049	100.00
Rice	Blue Patna	10.90	28.90	49.80	4.44	23,223	87.00
Rice	Green Chef	10.50	26.50	38.00	4.14	22,571	84.00
Rice	Saman	16.60	28.00	42.00	2.80	12,908	87.00
Rice	Aruba	9.90	19.90	34.00	3.17	19,353	86.00
Rice	Pony	12.00	20.00	30.00	2.34	10,646	68.00
Rice	Vidarroz	9.90	18.90	30.00	3.02	11,172	63.00
Peas	Campero	7.50	10.90	17.00	1.42	1,690	35.00
Peas	Cololo	7.90	19.00	31.50	2.82	10,472	74.00
Peas	Nidemar	7.00	12.50	20.00	2.81	5,418	51.00
Sugar	Azucarlito	12.50	29.00	39.00	6.65	23,142	96.00
Sugar	Bella Union	11.50	29.00	39.00	6.50	25,226	99.00
Coffee	Aguila	31.90	68.00	109.00	9.31	25,293	97.00
Coffee	Chana	32.50	78.50	170.00	11.99	26,158	99.00
Coffee	Saint	34.90	69.00	108.00	12.61	5,474	53.00
Beer	Patricia	31.50	48.00	80.00	10.48	27,422	99.00
Beer	Pilsen	28.80	44.00	76.00	8.72	27,425	99.00
Beer	Zillertal	46.00	61.50	89.00	7.06	14,728	95.00
Shampoo	Fructis	31.90	94.50	169.00	16.03	18,015	85.00
Shampoo	Sedal	31.00	80.00	139.00	16.41	21,747	99.00
Shampoo	Suave	19.90	61.50	111.00	19.02	21,497	97.00
Cacao	Copacabana	21.90	78.00	149.00	13.80	25,580	99.00
Cacao	Vascolet	26.50	76.90	119.00	15.08	25,086	98.00
Deodorant	Axe Musk	54.90	79.00	112.00	9.39	15,154	99.00
Deodorant	Dove	60.00	92.50	141.00	12.56	14,972	98.00
Deodorant	Rexona	48.50	80.00	113.20	9.09	14,792	99.00
Dishwashing Detergent	Deterjane	19.90	38.00	69.00	8.60	18,299	98.00
Dishwashing Detergent	Hurra Nevex	23.50	38.50	90.00	6.55	27,550	100.00
Dishwashing Detergent	Protergente	14.50	25.50	48.00	3.53	9,628	78.00
Dulce de Leche	Conaprole	32.50	104.00	157.00	15.44	26,518	96.00
Dulce de Leche	Los Nietitos	23.90	78.50	132.00	14.52	24,786	94.00
Dulce de Leche	Manjar	24.50	77.00	117.00	11.19	25,403	96.00
Noodles	Adria	15.90	31.00	53.00	5.22	24,370	95.00
Noodles	Cololo	14.90	29.00	49.90	6.24	16,769	77.00
Noodles	Las Acacias	14.00	27.50	59.90	4.70	21,578	94.00
Semolina Pasta	Adria	12.90	24.00	43.00	5.08	14,843	85.00
Semolina Pasta	Las Acacias	11.90	22.00	41.00	4.16	20,471	93.00
Semolina Pasta	Puritas	11.90	25.00	46.90	4.28	3,968	35.00

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Market	Brand	Minimum	Median	Maximum	Standard Deviation	N	Share Stores (%)
Crackers	Famosa	9.90	19.00	37.90	4.16	21,265	83.00
Crackers	Maestro Cubano	8.90	17.00	39.50	3.53	16,419	93.00
Cola Drink	Coca Cola	16.10	42.00	68.00	9.28	27,357	99.00
Cola Drink	Nix	15.70	30.00	45.00	3.41	6,404	37.00
Cola Drink	Pepsi	29.90	52.90	70.00	6.09	13,267	97.00
Hamburger	Burgy	10.00	15.90	30.90	2.26	9,825	75.00
Hamburger	Paty	17.90	36.00	46.00	3.89	12,113	82.00
Hamburger	Schneck	13.00	37.00	52.50	4.24	13,326	89.00
Flour (corn)	Gourmet	8.00	13.90	21.90	1.78	4,695	48.00
Flour (corn)	Arcor	6.00	20.00	37.00	3.59	13,905	94.00
Flour (corn)	Puritas	11.00	18.00	41.00	1.88	14,877	99.00
Flour 000 (wheat)	Cañuelas	13.70	22.00	38.00	3.10	9,824	73.00
Flour 000 (wheat)	Cololo	13.00	24.00	33.00	3.06	4,627	38.00
Flour 000 (wheat)	Cañuelas	11.80	24.00	41.00	4.89	21,218	84.00
Flour 000 (wheat)	Cololo	12.50	25.00	39.50	4.20	17,795	87.00
Flour 000 (wheat)	Primor	12.90	22.00	34.00	3.30	7,560	54.00
Ice Cream	Conaprole	79.00	106.50	149.00	12.78	14,438	98.00
Ice Cream	Crufi	59.90	95.00	188.00	11.79	11,243	85.00
Ice Cream	Gebetto	45.00	83.00	103.60	12.78	4,185	70.00
Bleach	Agua Jane	11.90	26.00	47.00	5.79	26,987	99.00
Bleach	Sello Rojo	12.90	22.50	39.00	3.96	23,832	98.00
Bleach	Solucion Cristal	9.00	20.00	34.40	4.56	11,652	60.00
Eggs	El Jefe	23.00	33.00	38.00	2.27	3,676	47.00
Eggs	Prodhin	11.50	23.00	36.00	5.41	12,645	60.00
Eggs	Super Huevo	14.90	29.00	39.00	4.66	7,028	51.00
Soap	Astral Plata	12.00	20.00	29.20	3.04	15,052	99.00
Soap	Palmolive	9.90	17.00	47.50	3.23	25,001	99.00
Soap	Rexona	13.33	21.00	52.00	2.36	4,775	74.00
Laundry Soap	Drive	25.00	48.00	99.00	6.10	23,736	97.00
Laundry Soap	Nevex	18.50	59.50	99.00	8.68	25,982	99.00
Laundry Soap	Skip	50.00	76.50	136.00	10.37	21,667	97.00
Laundry Soap (in bar)	Bull Dog	11.90	22.00	40.00	4.80	26,844	99.00
Laundry Soap (in bar)	Nevex	8.70	15.20	29.00	3.80	27,083	99.00
Laundry Soap (in bar)	Primor	7.90	12.00	23.90	1.24	7,776	60.00
Butter	Calcar	15.90	34.00	65.00	8.20	18,150	85.00
Butter	Conaprole	13.50	41.90	69.30	7.95	26,919	96.00
Butter	Kasdorf	21.60	42.00	56.70	3.10	11,655	77.00
Margarine	Doriana	11.60	36.00	81.00	9.57	24,915	98.00
Margarine	Flor	14.90	20.90	35.70	2.11	4,351	50.00
Margarine	Primor	8.90	25.00	69.00	5.45	17,773	93.00
Mayonnaise	Fanacoa	14.50	32.90	67.00	6.95	21,556	96.00
Mayonnaise	Hellmans	19.90	52.90	89.00	11.12	26,582	99.00
Mayonnaise	Uruguay	9.90	31.00	52.00	5.34	12,794	56.00
Peach Jam	Dulciora	14.50	32.00	53.00	7.11	17,744	77.00
Peach Jam	El Hogar	26.00	43.00	64.00	5.32	10,215	75.00
Peach Jam	Los Nietitos	14.50	43.00	68.00	6.22	25,796	96.00
Bread Loaf	Los Sorchantes	29.00	46.00	68.00	7.97	14,126	93.00
Bread Loaf	Bimbo	31.00	49.00	71.00	7.47	13,198	91.00
Bread Loaf	Pan Catalan	20.00	39.00	61.00	8.96	9,153	68.00
Toilet Paper	Eite	16.90	43.00	60.00	5.74	13,820	97.00
Toilet Paper	Higienol	11.00	29.00	59.90	7.55	25,497	100.00
Toilet Paper	Sin Fin	11.50	37.00	62.00	10.32	25,514	99.00
Toothpaste	Colgate	20.90	33.00	52.00	4.96	15,388	100.00
Toothpaste	Kolynos	16.00	28.00	56.00	3.83	14,281	97.00
Toothpaste	Pico Jenner	19.00	26.00	52.00	3.66	8,576	63.00

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Market	Brand	Minimum	Median	Maximum	Standard Deviation	N	Share Stores (%)
Tomato Pulp	Conaprole	24.50	41.90	62.00	5.71	26,810	97.00
Tomato Pulp	De Ley	17.50	34.90	49.00	4.50	19,243	94.00
Tomato Pulp	Gourmet	29.00	41.00	58.00	3.81	12,356	83.00
Grated Cheese	Artesano	21.00	38.00	57.00	6.28	2,859	22.00
Grated Cheese	Conaprole	12.80	33.90	56.00	7.06	24,984	95.00
Grated Cheese	Milky	11.90	36.50	61.40	6.92	11,594	65.00
Salt	Sal Sek	9.60	18.90	39.40	3.87	17,054	84.00
Salt	Torrevieja	6.90	17.90	30.00	4.13	8,038	35.00
Salt	Urusal	10.90	18.00	33.00	3.53	12,927	59.00
Te	Hornimans	4.80	15.00	26.00	2.25	27,015	99.00
Te	La Virginia	7.90	13.00	26.00	2.08	21,324	82.00
Te	President	14.90	23.00	32.00	2.50	13,140	89.00
Wine	Faisan	35.90	57.00	75.10	4.62	10,733	72.00
Wine	Santa Teresa	23.50	57.90	78.00	8.36	26,724	99.00
Wine	Tango	21.50	49.00	67.00	7.80	21,091	90.00
Yerba	Baldo	59.90	76.00	157.00	26.09	14,846	97.00
Yerba	Canarias	34.80	68.00	166.00	24.76	27,468	100.00
Yerba	Del Cebador	31.90	67.50	175.00	25.17	25,686	99.00
Yogurt	Calcar	26.60	39.00	73.00	4.97	9,711	68.00
Yogurt	Bio Top	32.00	42.00	73.00	5.09	14,644	95.00
Yogurt	Parmalat	22.80	39.00	60.00	5.06	12,605	92.00
TOTAL	-	-	-	-	-	2,096,310	-

Source: author's calculation.

Table 9: Price Difference Database Descriptive Statistics.

Market	Brand	Minimum	Median	Maximum	Standard Deviation	N	Exact Zeroes (%)
Sunflower Oil	Optimo	0	4.46	121.40	5.38	4,243,083	12.00
Sunflower Oil	Rio de la Plata	0	5.94	78.39	7.71	601,857	20.00
Sunflower Oil	Uruguay	0	4.83	79.06	5.27	1,480,029	8.00
Corn Oil	Delicia	0	4.96	62.98	5.76	2,306,349	13.00
Corn Oil	Rio de la Plata	0	5.64	73.45	6.84	1,724,741	14.00
Corn Oil	Salad	0	0.04	70.87	7.43	74,983	49.00
Soybean Oil	Condesa	0	5.26	87.84	6.07	2,987,108	14.00
Soybean Oil	Rio de la Plata	0	5.72	66.45	7.49	1,176,822	21.00
Soybean Oil	Salad	0	3.08	50.88	7.42	117,470	32.00
Sparkling Water	Matutina	0	4.45	91.63	5.48	3,502,297	31.00
Sparkling Water	Nativa	0	3.51	55.73	5.79	1,769,043	36.00
Sparkling Water	Salus	0	0.00	70.19	3.77	4,105,926	51.00
Rice	Blue Patna	0	5.88	113.54	7.40	3,009,720	17.00
Rice	Green Chef	0	5.61	71.98	6.49	2,842,015	16.00
Rice	Saman	0	6.45	65.63	7.64	1,773,185	20.00
Rice	Aruba	0	5.26	82.50	7.65	2,093,020	21.00
Rice	Pony	0	4.88	65.54	7.23	766,118	31.00
Rice	Vidarroz	0	4.45	92.63	8.00	813,347	32.00
Peas	Campero	0	10.54	81.83	11.07	52,441	18.00
Peas	Cololo	0	7.12	97.29	8.49	1,164,240	16.00
Peas	Nidemar	0	10.18	69.31	12.58	315,091	20.00
Sugar	Azucarlito	0	0.37	72.18	3.99	2,999,800	43.00
Sugar	Bella Union	0	0.98	76.00	3.94	3,608,445	41.00
Coffee	Aguila	0	3.13	70.42	4.54	3,587,543	16.00
Coffee	Chana	0	4.53	96.14	5.00	3,824,719	12.00

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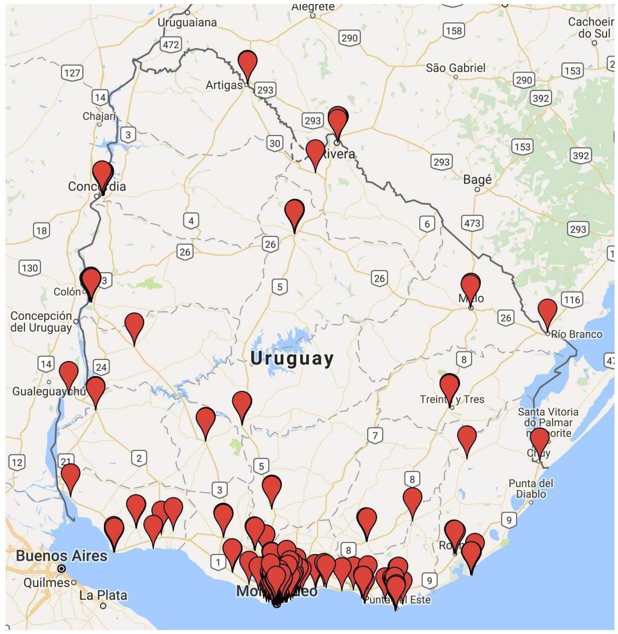
Market	Brand	Minimum	Median	Maximum	Standard Deviation	N	Exact Zeroes (%)
Coffee	Saint	0	8.49	97.10	13.02	321,851	10.00
Beer	Patricia	0	1.94	61.14	3.49	4,209,560	36.00
Beer	Pilsen	0	2.15	50.21	3.68	4,207,370	32.00
Beer	Zillertal	0	1.71	42.55	3.59	2,306,851	28.00
Shampoo	Fructis	0	5.98	116.73	7.47	1,841,510	14.00
Shampoo	Sedal	0	5.88	119.10	7.49	2,694,728	11.00
Shampoo	Suave	0	6.54	122.73	8.79	2,710,586	11.00
Cacao	Copacabana	0	4.41	135.52	5.22	3,691,390	10.00
Cacao	Vascolet	0	5.78	102.72	6.18	3,599,107	12.00
Deodorant	Axe Musk	0	7.90	49.13	7.68	2,442,879	13.00
Deodorant	Dove	0	7.18	82.16	8.28	2,384,323	12.00
Deodorant	Rexona	0	6.90	53.73	7.94	2,327,191	12.00
Dishwashing Detergent	Deterjane	0	7.02	79.35	6.78	2,596,608	12.00
Dishwashing Detergent	Hurra Nevex	0	6.06	117.12	6.23	4,253,674	12.00
Dishwashing Detergent	Protergente	0	8.34	88.12	10.39	993,622	14.00
Dulce de Leche	Conaprole	0	3.92	113.09	4.93	3,944,439	12.00
Dulce de Leche	Los Nietitos	0	4.32	136.41	5.79	3,461,011	14.00
Dulce de Leche	Manjar	0	3.35	92.85	5.30	3,684,604	13.00
Noodles	Adria	0	3.94	106.01	4.84	3,473,718	16.00
Noodles	Cololo	0	5.72	76.12	6.31	1,627,630	16.00
Noodles	Las Acacias	0	4.47	126.54	7.16	2,728,963	19.00
Semolina Pasta	Adria	0	3.92	93.39	10.27	1,272,218	30.00
Semolina Pasta	Las Acacias	0	4.45	88.63	9.70	2,414,009	22.00
Semolina Pasta	Puritas	0	3.39	110.70	11.91	171,149	48.00
Crackers	Famosa	0	3.49	126.69	7.55	2,554,714	33.00
Crackers	Maestro Cubano	0	8.56	138.38	15.16	1,523,436	20.00
Cola Drink	Coca Cola	0	2.53	92.99	5.95	4,188,627	32.00
Cola Drink	Nix	0	5.13	93.52	10.54	232,643	20.00
Cola Drink	Pepsi	0	4.08	82.16	5.63	1,901,584	19.00
Hamburger	Burgy	0	11.46	107.16	10.58	1,030,180	13.00
Hamburger	Paty	0	5.95	65.03	7.90	1,559,491	14.00
Hamburger	Schneck	0	8.00	112.39	7.97	1,888,688	14.00
Flour (corn)	Gourmet	0	8.84	85.44	12.25	234,912	26.00
Flour (corn)	Arcor	0	6.31	116.11	8.34	2,056,773	18.00
Flour (corn)	Puritas	0	5.47	100.55	6.02	2,354,097	19.00
Flour 000 (wheat)	Cañuelas	0	8.70	86.50	8.77	1,035,182	20.00
Flour 000 (wheat)	Cololo	0	4.01	69.31	9.14	225,978	24.00
Flour 000 (wheat)	Cañuelas	0	6.57	97.23	8.09	2,531,227	17.00
Flour 000 (wheat)	Cololo	0	7.55	76.12	8.59	1,767,500	15.00
Flour 000 (wheat)	Primor	0	5.72	66.59	8.06	608,866	17.00
Ice Cream	Conaprole	0	4.55	59.72	5.22	2,218,302	11.00
Ice Cream	Crufi	0	3.39	78.40	5.60	1,354,563	23.00
Ice Cream	Gebetto	0	7.87	69.31	14.95	315,252	19.00
Bleach	Agua Jane	0	4.42	92.20	7.83	4,070,785	15.00
Bleach	Sello Rojo	0	6.67	105.37	7.15	3,274,677	13.00
Bleach	Solucion Cristal	0	9.84	93.39	11.96	779,560	22.00
Eggs	El Jefe	0	2.99	46.37	6.03	305,435	33.00
Eggs	Prodhin	0	0.44	73.57	5.80	928,768	46.00
Eggs	Super Huevo	0	4.08	71.91	5.86	529,487	24.00
Soap	Astral Plata	0	9.10	73.54	8.96	2,412,373	11.00
Soap	Palmolive	0	8.65	130.35	8.72	3,491,878	13.00
Soap	Rexona	0	9.10	136.12	9.87	525,073	15.00
Laundry Soap	Drive	0	5.04	100.55	6.45	3,180,105	12.00
Laundry Soap	Nevex	0	5.34	115.13	5.42	3,775,676	12.00
Laundry Soap	Skip	0	4.83	78.85	6.12	2,966,113	9.00

Continued on next page

Market	Brand	Minimum	Median	Maximum	Standard Deviation	N	Exact Zeroes (%)
Laundry Soap (in bar)	Bull Dog	0	6.67	69.31	6.95	4,035,897	14.00
Laundry Soap (in bar)	Nevex	0	5.72	80.71	6.48	4,108,829	15.00
Laundry Soap (in bar)	Primor	0	8.70	103.38	9.59	648,293	22.00
Butter	Calcar	0	8.29	118.60	10.73	1,940,699	14.00
Butter	Conaprole	0	4.88	71.29	5.23	4,047,868	13.00
Butter	Kasdorf	0	4.08	72.73	4.90	1,443,391	19.00
Margarine	Doriana	0	7.64	168.07	8.62	3,474,331	10.00
Margarine	Flor	0	6.74	80.88	8.23	212,062	13.00
Margarine	Primor	0	8.34	156.35	11.38	1,780,292	11.00
Mayonnaise	Fanacoa	0	6.97	107.36	7.34	2,663,703	11.00
Mayonnaise	Hellmans	0	6.16	91.21	6.48	3,957,463	12.00
Mayonnaise	Uruguay	0	7.52	110.53	7.84	956,546	6.00
Peach Jam	Dulciora	0	3.16	88.55	8.76	1,819,721	29.00
Peach Jam	El Hogar	0	7.85	90.08	9.80	1,107,398	15.00
Peach Jam	Los Nietitos	0	4.77	123.79	6.04	3,739,500	13.00
Bread Loaf	Los Sorchantes	0	3.33	47.75	4.53	2,122,642	18.00
Bread Loaf	Bimbo	0	3.51	56.35	5.12	1,861,109	16.00
Bread Loaf	Pan Catalan	0	5.54	64.51	7.41	897,944	20.00
Toilet Paper	Eite	0	6.75	98.60	8.02	2,045,690	9.00
Toilet Paper	Higienol	0	6.28	106.44	8.10	3,640,465	10.00
Toilet Paper	Sin Fin	0	7.14	101.71	7.35	3,665,841	10.00
Toothpaste	Colgate	0	8.46	84.08	9.11	2,519,109	16.00
Toothpaste	Kolynos	0	7.47	104.95	10.22	2,175,216	12.00
Toothpaste	Pico Jenner	0	7.70	96.05	10.23	783,813	18.00
Tomato Pulp	Conaprole	0	5.28	61.70	5.73	4,013,016	12.00
Tomato Pulp	De Ley	0	5.84	85.14	8.28	2,125,708	11.00
Tomato Pulp	Gourmet	0	6.54	67.58	7.15	1,625,433	11.00
Grated Cheese	Artesano	0	8.70	71.08	9.83	86,801	6.00
Grated Cheese	Conaprole	0	6.60	108.17	7.94	3,492,344	12.00
Grated Cheese	Milky	0	6.80	121.23	7.82	772,477	17.00
Salt	Sal Sek	0	8.66	141.20	9.40	1,667,943	13.00
Salt	Torrevieja	0	3.70	104.98	10.22	356,014	36.00
Salt	Urusal	0	6.76	79.51	9.50	938,777	19.00
Te	Hornimans	0	6.67	126.46	7.49	4,088,459	16.00
Te	La Virginia	0	5.27	102.81	8.59	2,538,170	27.00
Te	President	0	8.10	64.85	8.29	1,834,506	16.00
Wine	Faisan	0	3.45	61.13	4.46	1,192,638	23.00
Wine	Santa Teresa	0	3.89	85.73	4.88	4,006,714	13.00
Wine	Tango	0	4.51	74.40	5.81	2,495,152	20.00
Yerba	Baldo	0	1.29	69.97	3.26	2,344,120	37.00
Yerba	Canarias	0	0.15	69.60	3.37	4,223,912	47.00
Yerba	Del Cebador	0	3.87	86.90	5.42	3,821,864	12.00
Yogurt	Calcar	0	7.41	82.47	8.48	1,003,687	17.00
Yogurt	Bio Top	0	4.65	66.61	5.60	2,281,480	17.00
Yogurt	Parmalat	0	4.74	62.40	6.64	1,692,864	23.00
TOTAL	-	-	-	-	-	272,370,229	-

Source: author's calculation.

Figure 7: Cities covered in the sample and distribution of supermarkets.



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

Table 13: Chain description.

Chain	# Stores	# Stores in Montevideo	# Cities	# States	Average Cashier p/Store	# Observations
Devoto	24	17	6	3	12	169,646
Disco	27	20	5	3	11	189,100
El Clon	12	8	5	4	4	24,154
El Dorado	38	0	20	6	4	187,283
Frigo	6	6	1	1	4	39,748
Géant	2	1	2	2	48	7,491
Iberpark	6	5	2	2	1	10,781
La Colonial	6	6	1	1	1	30,564
Los Jardines	4	2	3	2	4	13,524
Macromercado	7	4	3	3	18	38,848
Micro Macro	10	5	4	4	3	63,129
MultiAhorro	48	38	8	8	6	321,525
Red Market	12	9	3	2	3	53,044
Super XXI	4	0	2	1	3	24,628
Super Star	4	0	1	1	7	27,705
TATA	43	12	25	19	7	245,469
Tienda Inglesa	10	7	4	3	16	56,174
Ubesur	19	19	1	1	3	91,626
None	104	49	27	14	4	501,871
TOTAL	386	173	-	-	6	2,096,310

Table 14: 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	386	7

B List of Products

Product	Brand	Specification*	% Share in CPI	Sample Start	Owner (/merger)
Beer	Pilsen	0.96 L	0.38	2007/04	FNC
Beer	Zillertal	1 L	0.38	2010/11	FNC
Wine	Faisán	1 L	0.80	2007/04	Grupo Traversa
Wine	Santa Teresa	1 L	0.80	2007/04	Santa Teresa SA
Wine	Tango	1 L	0.80	2007/04	Almena SA
Cola Drink	Coca Cola	1.5 L	1.12	2007/04	Coca Cola
Cola Drink	Nix	1.5 L	1.12	2007/04	Milotur (CCU)
Cola Drink	Pepsi	1.5 L	1.12	2010/11	Pepsi
Sparkling water	Matutina	2 L	0.81	2007/04	Salus
Sparkling water	Nativa	2 L	0.81	2007/04	Milotur
Sparkling water	Salus	2.25 L	0.81	2007/04	Salus
Bread Loaf	Los Sorchantes	0.33 Kg	0.06	2010/11	Bimbo / Los Sorchantes
Bread Loaf	Bimbo	0.33 Kg	0.06	2010/11	Bimbo
Bread Loaf	Pan Catalán	0.33 Kg	0.06	2010/11	Bimbo
Brown eggs	Super Huevo	1/2 dozen	0.46	2010/11	Super Huevo
Brown eggs	El Jefe	1/2 dozen	0.46	2010/12	El Jefe
Brown eggs	Prodhin	1/2 dozen	0.46	2007/07	Prodhin
Butter	Calcar	0.2 Kg	0.23	2007/04	Calcar
Butter	Conaprole (no salt)	0.2 Kg	0.23	2007/04	Conaprole
Butter	Kasdorf	0.2 Kg	0.23	2010/11	Conaprole
Cacao	Copacabana	0.5 Kg	0.08	2007/04	Nestlé
Cacao	Vascolet	0.5 Kg	0.08	2007/06	Nestlé
Coffee	Aguila	0.25 Kg	0.14	2007/04	Nestlé
Coffee	Chana	0.25 Kg	0.14	2007/04	Nestlé
Coffee	Saint	0.25 Kg	0.14	2010/11	Saint Hnos.
Corn Oil	Delicia	1 L	n/i	2010/11	Cousa
Corn Oil	Río de la Plata	1 L	n/i	2010/11	Soldo
Corn Oil	Salad	1 L	n/i	2010/11	Nidera
Dulce de leche	Conaprole	1 Kg	0.14	2007/04	Conaprole
Dulce de leche	Los Nietitos	1 Kg	0.14	2007/04	Los Nietitos
Dulce de leche	Manjar	1 Kg	0.14	2007/04	Manjar
Flour (corn)	Gourmet	0.4 Kg	n/i	2010/11	Barraca Deambrosi
Flour (corn)	Presto Pronta Arcor	0.5 Kg	n/i	2010/11	ARCOR

Product	Brand	Specification*	% Share in CPI	Sample Start	Owner (/merger)
Beer	Patricia	0.96 L	0.38	2007/04	FNC
Flour (corn)	Puritas	0.45 Kg	n/i	2010/11	Molino Puritas
Flour 000 (wheat)	Cañuelas	1 Kg	0.21	2010/11	Molino Cañuelas
Flour 000 (wheat)	Cololó	1 Kg	0.21	2010/11	Distribuidora San José
Flour 0000 (wheat)	Cañuelas	1 Kg	0.21	2007/04	Molino Cañuelas
Flour 0000 (wheat)	Cololó	1 Kg	0.21	2007/04	Distribuidora San José
Flour 0000 (wheat)	Primor	1 Kg	0.21	2010/11	Molino San José
Grated Cheese	Conaprole	0.08 Kg	0.16	2007/04	Conaprole
Grated Cheese	Artesano	0.08 Kg	0.16	2010/11	Artesano
Grated Cheese	Milky	0.08 Kg	0.16	2007/04	Milky
Hamburger	Burgy	0.2 Kg	n/i	2010/11	Schneck
Hamburger	Paty	0.2 Kg	n/i	2010/11	Sadia Uruguay
Hamburger	Schneck	0.2 Kg	n/i	2010/11	Schneck
Ice Cream	Conaprole	1 Kg	0.22	2010/11	Conaprole
Ice Cream	Crufi	1 Kg	0.22	2010/11	Crufi
Ice Cream	Gebetto	1 Kg	0.22	2010/11	Conaprole
Margarine	Flor	0.2 Kg	n/i	2010/11	COUSA
Margarine	Doriana nueva	0.25 Kg	n/i	2007/04	Unilever
Margarine	Primor	0.25 Kg	n/i	2007/04	COUSA
Mayonnaise	Fanacoa	0.5 Kg	0.21	2007/04	Unilever
Mayonnaise	Hellmans	0.5 Kg	0.21	2007/04	Unilever
Mayonnaise	Uruguay	0.5 Kg	0.21	2007/04	COUSA
Noodles	Cololo	0.5 Kg	0.43	2007/04	Distribuidora San José
Noodles	Adria	0.5 Kg	0.43	2007/04	La Nueva Cerro
Noodles	Las Acacias	0.5 Kg	0.43	2007/04	Alimentos Las Acacias
Peach Jam	Dulciora	0.5 Kg	n/i	2007/04	ARCOR
Peach Jam	El Hogar	0.5 Kg	n/i	2010/11	Libafel SA
Peach Jam	Los Nietitos	0.5 Kg	n/i	2007/04	Los Nietitos
Peas	Campero	0.3 Kg	0.09	2010/11	Regional Sur
Peas	Cololó	0.3 Kg	0.09	2010/11	Distribuidora San José
Peas	Nidemar	0.3 Kg	0.09	2010/11	Nidera
Rice	Aruba tipo Patna	1 Kg	0.38	2007/04	Saman
Rice	Blue Patna	1 Kg	0.38	2007/04	Coopar
Rice	Green Chef	1 Kg	0.38	2007/04	Coopar
Rice	Pony	1 Kg	0.38	2010/11	Saman
Rice	Vidarroz	1 Kg	0.38	2008/05	Coopar
Rice	Saman Blanco	1 Kg	0.38	2010/11	Saman
Crackers	Famosa	0.14 Kg	0.28	2007/04	Mondelez

Product	Brand	Specification*	% Share in CPI	Sample Start	Owner (/merger)
Beer	Patricia	0.96 L	0.38	2007/04	FNC
Crackers	Maestro Cubano	0.12 Kg	0.28	2007/04	Bimbo
Salt	Sek	0.5 Kg	0.09	2007/04	Barraca Deambrosi
Salt	Torrevieja	0.5 Kg	0.09	2007/04	Torrevieja
Salt	Urusal	0.5 Kg	0.09	2007/04	UruSal
Semolina Pasta	Adria	0.5 Kg	0.43	2007/04	La Nueva Cerro
Semolina Pasta	Las Acacias	0.5 Kg	0.43	2007/04	Alimentos Las Acacias
Semolina Pasta	Puritas	0.5 Kg	0.43	2007/04	Molino Puritas
Soybean oil	Condesa	0.9 L	0.11	2008/05	Cousa
Soybean oil	Río de la Plata	0.9 L	0.11	2010/11	Soldo
Soybean oil	Salad	0.9 L	0.11	2010/11	Nidera
Sugar	Azucarlito	1 Kg	0.35	2007/04	Azucarlito
Sugar	Bella Union	1 Kg	0.35	2007/04	ALUR
Sunflower Oil	Optimo	0.9 L	0.37	2007/04	Cousa
Sunflower Oil	Uruguay	0.9 L	0.37	2007/04	Cousa
Sunflower Oil	Río de la Plata	0.9 L	0.37	2010/11	Soldo
Tea	Hornimans	Box (10 units)	0.08	2007/04	Jose Aldao
Tea	La Virginia	Box (10 units)	0.08	2007/04	La Virginia
Tea	President	Box (10 units)	0.08	2010/11	Carrau
Tomato Pulp	Conaprole	1 L	0.16	2007/04	Conaprole
Tomato Pulp	De Ley	1 L	0.16	2007/04	Barraca Deambrosi
Tomato Pulp	Gourmet	1 L	0.16	2010/11	Barraca Deambrosi
Yerba	Canarias	1 Kg	0.64	2007/04	Canarias
Yerba	Del Cebador	1 Kg	0.64	2007/04	Molino Puritas
Yerba	Baldo	1 Kg	0.64	2010/11	Canarias
Yogurt	Conaprole	0.5 Kg	0.13	2010/11	Conaprole
Yogurt	Parmalat (Skim)	0.5 Kg	0.13	2010/11	Parmalat
Yogurt	Calcar (Skim)	0.5 Kg	0.13	2010/11	Calcar
Bleach	Agua Jane	1 L	0.16	2007/04	Electroquímica
Bleach	Sello Rojo	1 L	0.16	2007/04	Electroquímica
Bleach	Solucion Cristal	1 L	0.16	2007/04	Vessena SA
Deodorant	Axe Musk	0.105 Kg	0.34	2010/11	Unilever
Deodorant	Dove Original	0.113 Kg	0.34	2010/11	Unilever
Deodorant	Rexona Active Emotion	0.100 Kg	0.34	2010/11	Unilever
Dishwashing Detergent	Deterjane	1.25 L	0.13	2007/04	Clorox Company
Dishwashing Detergent	Hurra Nevex Limon	1.25 L	0.13	2007/04	Unilever

Product	Brand	Specification*	% Share in CPI	Sample Start	Owner (/merger)
Beer	Patricia	0.96 L	0.38	2007/04	FNC
Dishwashing Detergent	Protergente	1.25 L	0.13	2010/11	Electroquímica
Laundry Soap	Drive	0.8 Kg	0.45	2007/04	Unilever
Laundry Soap	Nevex	0.8 Kg	0.45	2007/04	Unilever
Laundry Soap	Skip, Paquete azul	0.8 Kg	0.45	2007/04	Unilever
Laundry Soap, in bar	Bull Dog	0.3 Kg (1 unit)	n/i	2007/04	Unilever
Laundry Soap, in bar	Nevex	0.2 Kg (1 unit)	n/i	2007/04	Unilever
Laundry Soap, in bar	Primor	0.2 Kg (1 unit)	n/i	2010/11	Soldo
Shampoo	Fructis	0.35 L	0.36	2007/04	Garnier
Shampoo	Sedal	0.35 L	0.36	2007/04	Unilever
Shampoo	Suave	0.93 L	0.36	2007/04	Unilever
Soap	Astral	0.125 Kg	0.16	2010/11	Colgate
Soap	Palmolive	0.125 Kg	0.16	2007/04	Colgate
Soap	Rexona	0.125 Kg	0.16	2012/12	Unilever
Toilet paper	Higienol Export	4 units (25 M each)	0.24	2007/04	Ipusa
Toilet paper	Elite	4 units (25 M each)	0.24	2010/11	Ipusa
Toilet paper	Sin Fin	4 units (25 M each)	0.24	2007/04	Ipusa
Toothpaste	Pico Jenner	0.09 Kg	0.19	2010/11	Colgate
Toothpaste	Colgate Herbal	0.09 Kg	0.19	2010/11	Colgate
Toothpaste	Kolynos	0.09 Kg	0.19	2010/11	Colgate / Abarly

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

C Proof of Proposition 1

To find a Nash equilibrium we must show that store S_0 prefers to sell two brands when store S_L sells one to sell just one brand, and that store S_L prefers to sell one brand when store S_0 sells two, rather than sell also two brands. We first present the main results of the analysis to be used in the proof. If each store sold one variety, then $p_{A0} = p_{AL} = tL$ and demand is $L/2$. Profits are $\Pi_i^{11} = \frac{tL^2}{2} - F$. If both stores sold one both varieties instead, then we have that $\Pi_i^{22} = \frac{tL^2}{2} - 2F$.

For the case when store 0 sell two varieties and store L just one, we have that $\widehat{x} = \frac{L}{2} - \frac{\lambda\theta}{12t}$ and $\widetilde{x} = \frac{L}{2} + \frac{(3-\lambda)\theta}{12t}$, and prices are $p_{A0} = tL - \frac{\lambda\theta}{6}$, $p_{B0} = tL + \frac{(3-\lambda)\theta}{6}$, $p_{AL} = tL - \frac{\lambda\theta}{3}$.

Lets start the analysis for store S_L selling one brand.

Profits are $\Pi_L^{12} = (1-\lambda)(L-\widehat{x})\,p_{AL} + \lambda(L-\widetilde{x})\,p_{AL} - F$ which could be rewriten as $\Pi_L^{12} = (L-\widetilde{x})\,p_{AL} + (1-\lambda)(\widetilde{x}-\widehat{x})\,p_{AL} - F = p_{AL}\left[L - \widehat{x} - \lambda(\widetilde{x}-\widehat{x})\right]p_{AL} - F$. Substituting we obtain $\Pi_L^{12} = \left(tL - \frac{\lambda\theta}{3}\right)\left[L - \frac{L}{2} + \frac{\lambda\theta}{12t} - \lambda\left(\right.\right.$ $F = \left(tL - \frac{\lambda\theta}{3}\right)\left[\frac{L}{2} - \frac{\lambda\theta}{6t}\right] - F \Rightarrow \Pi_L^{12} = \frac{tL^2}{2} - \frac{\lambda\theta L}{3} - \frac{(\lambda\theta)^2}{18t} - F$.

Now we check that the incentive compatibility condition holds: $\Pi_L^{12} \geq \Pi_L^{22} \iff \frac{tL^2}{2} - \frac{\lambda\theta L}{3} - \frac{(\lambda\theta)^2}{18t} - F \geq \frac{tL^2}{2} - 2F$, which holds if and only if $F - \frac{\lambda\theta L}{3} - \frac{(\lambda\theta)^2}{18t} \geq 0$. Rearranging terms we obtain

$$\frac{3F}{\theta\lambda} - \frac{\lambda\theta}{6t} \geq L. \tag{14}$$

Now we turn to store S_0 which sells two brands. Instead of finding the profits and then postulate the incentive compatibility condition, we will start by this condition.

Profits if store S_0 sell both varieties are $\Pi_0^{12} = (1-\lambda)\,\widehat{x}p_{0A} + \lambda\widetilde{x}p_{0B} - 2F$, while if it sells only one variety profits could be written as $\Pi_0^{11} = (1-\lambda)\frac{tL^2}{2} + \lambda\frac{tL^2}{2} - F$. Then, we can write the incentive compatibility condition as $\Pi_0^{12} \geq \Pi_0^{11} \iff \triangle\Pi = (1-\lambda)\left(\underbrace{\widehat{x}p_{0A} - \frac{tL^2}{2}}_{(*)}\right) + \lambda\left(\underbrace{\widetilde{x}p_{0B} - \frac{tL^2}{2}}_{(\square)}\right) - F \geq 0.$

We can write (*) as $\left[\left(\frac{L}{2} - \frac{\lambda\theta}{12t}\right)\left(tL - \frac{\lambda\theta}{6}\right) - \frac{tL^2}{2}\right]$ and ($\square$) as $\left[\left(\frac{L}{2} - \frac{\lambda\theta}{12t} + \frac{3\theta}{12t}\right)\left(tL - \frac{\lambda\theta}{6} + \frac{3\theta}{6}\right) - \frac{tL^2}{2}\right]$. Now, noting that (*) is in ($\square$), rearranging terms we obtain that $(\square) = (*) + \frac{3\theta}{6}\left(L + \frac{3\theta}{6t} - \frac{\lambda\theta}{6t}\right)$.

Now, we plug all the previous result into $\triangle\Pi$ and obtain $\triangle\Pi = (1-\lambda)(*) + \lambda\left((*) + \frac{3\theta}{6}\left(L + \frac{3\theta}{6t} - \frac{\lambda\theta}{6t}\right)\right) - F$, and now we have that $\triangle\Pi = (*) + \frac{3\theta\lambda}{6}\left(L + \frac{3\theta}{6t} - \frac{\lambda\theta}{6t}\right) - F$. Now, operating in (*) we obtain $(*) = \frac{\lambda\theta}{6}\left[\frac{\lambda\theta}{12t} - L\right]$ and plugging back into $\triangle\Pi$, we obtain $\triangle\Pi = \frac{\lambda\theta}{6}\left[\frac{\lambda\theta}{12t} - L\right] + \frac{3\theta\lambda}{6}\left(L + \frac{3\theta}{6t} - \frac{\lambda\theta}{6t}\right) - F$. Simplifying again, we obtain

$$\triangle\Pi = \frac{\lambda\theta}{6}\left[2L + \frac{\theta}{6t}\left(9 - \frac{5}{2}\lambda\right)\right] - F \geq 0.$$

Condition for existence of equilibrium reduces to

$$L \geq \frac{3F}{\lambda\theta} - \frac{\theta}{12t}\left(9 - \frac{5}{2}\lambda\right). \tag{15}$$

From equations 14 and 15, we obtain that a Nash equilibrium exist $\iff$

$$\frac{3F}{\lambda\theta} - \frac{\theta}{12t}\left(9 - \frac{5}{2}\lambda\right) \leq L \leq \frac{3F}{\theta\lambda} - \frac{\lambda\theta}{6t},$$

and this equations holds $\iff$ $\frac{\theta}{12t}\left(9 - \frac{5}{2}\lambda\right) \geq \frac{\lambda\theta}{6t}$, which holds $\iff$ $\lambda \leq 2$. As $\lambda \in [0, 1]$, the previous inequality always hold.