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# Price dispersion in Uruguay

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**Abstract**

Retail prices for a product vary across time and places. The sources that drive price dispersion can be grouped into three categories: (i) price differences across markets, (ii) price differences across stores in a market, and (iii) within-store price variation over time. I find there is price dispersion in the retail market in Uruguay. The decomposition shows that 39.16 percent is across-markets, 36.90 percent corresponds to across-store, and 23.94 percent over time. These results highlight the relevance of intertemporal pricing strategies of chains and how they set prices at the local market to understand price dispersion. Nevertheless, across-market price dispersion has been increasing in recent years, which can imply a structural change in price dispersion sources. The price dispersion phenomenon and its decomposition are heterogeneous. I find differences in price dispersion and the sources behind it across products, stores, and over time.

**Keywords:** price dispersion, regular prices, variance decomposition, Uruguay.

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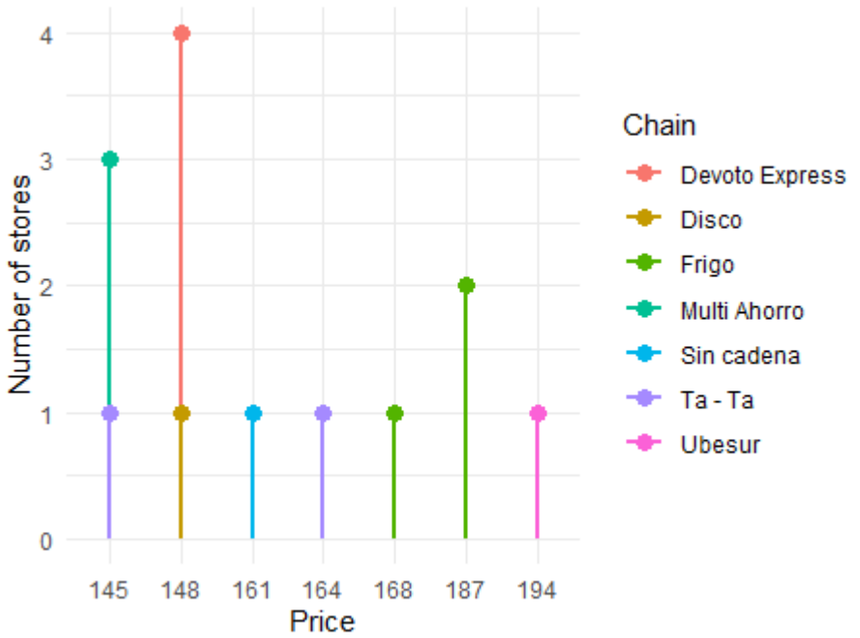
# 1. Introduction

Recent empirical work has focused on the behaviour of prices in an economy. As more micro-level price data have become available, it has been possible to measure the degree of price dispersion, the frequency of price changes, the presence of price change seasonality, and price synchronisation. These insights help us understand how prices are related to economic cycles and monetary policy, how firms set their prices, and the competitive implications of these practices. This paper focuses on the magnitude and sources of price dispersion in the retail market in Uruguay. I analyse the price dispersion and its sources across different products, stores, and periods.

If we look for a specific product at a given moment and place (i.e., city or neighbourhood), it is not surprising to find it sold at different prices, as shown in Figure 1. This phenomenon is called price dispersion.

Figure 1: *Number of stores for each regular 'Dulce de leche Conaprole 1kg.' price*




Source: author's calculation.Notes: Each line represents the number of stores for each price of Dulce de leche Conaprole 1kg. in CCZ 1 (Montevideo) in March 2019. Each colour represents a chain.

As shown in Figure 1, 'Dulce de leche Conaprole 1kg.' can be found at seven different prices for a given time and place. Its price ranges from $145 to $194 in March 2019 in CCZ 1 [1] of Montevideo, which means you can buy it in some store downtown 34% cheaper than in the most expensive one. Even if we look at the chain level (represented by colour in the graph), we can see that stores from the same chain (i.e., Ta - Ta) set different prices. On the other hand, we can see stores of different chains that set the same price. This phenomenon remains for other products, periods, and places. A more extensive list of products is in Figures 13 to 16 of the Appendix.

[1] CCZ is an administrative division that groups neighbourhoods in Montevideo, which the local government defines.

To address the price dispersion phenomenon in Uruguay, I begin by measuring the degree of price dispersion. Borraz and Saldain (2017) calculate it for Montevideo using the same data but another methodology. Although it is impossible to compare magnitudes, they found substantial price dispersion as I do. For the United States, Hitsch et al. (2019) found price dispersion is between 9.9 percent, and 11 percent at the local level, while Daruich and Kozlowski (2017) found that price dispersion for a specific geographic region ranges from 6.7 percent to 9.6 percent in Argentina. In this paper, I find the average price dispersion in Uruguay is 5.6 percent, which is lower than that found for Argentina and the United States. These comparisons also have to be made cautiously because of the differences in the distribution of stores and the level of aggregation of markets, which are not the same between the three papers.

Then, I analyse the drivers behind price dispersion. Following Hitsch et al. (2019), I apply a variance decomposition analysis to break down price dispersion into three sources: i) price differences across geographic markets, ii) price differences across stores within the same market, and iii) within-store price variation over time. The main sources of price dispersion are price level differences across and within stores. However, the relative share of the across-market source has increased steadily. For the United States, Hitsch et al. (2019) found that the main sources of price dispersion are also persistent differences across and within stores. For Argentina, the differences primarily occur across chains. The results show a similar degree of price dispersion to Argentina, with the main sources behind it being similar to those of the United States. This suggests that, as in the United States, price dispersion in Uruguay is related to pricing strategies applied by chains in local markets.

Then, I analyse the heterogeneity of price dispersion across products, stores, and time. There is a wide variety of products, stores, and periods, so I analyse whether this heterogeneity has implications for the degree of price dispersion. I apply a variance decomposition analysis to different products and stores dimensions to determine whether sources across those dimensions are heterogeneous. Finally, I study if the main sources of price dispersion remain unchanged over time.

The results show that price dispersion and its sources are heterogeneous across products, stores, and time in Uruguay. Heterogeneity across chains sheds light on their behaviour, it seems chains have uniform pricing. Heterogeneity over time shows a striking increase in price dispersion.

# 2. Literature review

The literature on price dispersion can be divided into two groups: one that is related to its macroeconomic implications and another that analyses the microeconomic foundations of price dispersion, to which this paper is highly related. Moreover, the empirical literature about price dispersion, in which this paper fits, is extensive for developed countries but remains incipient for developing countries.

Bils and Klenow (2004) analyse price rigidity by measuring the frequency of price change. They found that in the United States, prices last between 4.3 and 5.5 months and that the price rigidity is heterogeneous across product categories.

Nakamura and Steinsson (2008) also analyse price behaviour using a larger dataset than Bils and Klenow (2004). They also measure how frequently prices change, and add other characteristics of price behaviour: the percentage of price changes that correspond to price decreases, the covariation of prices with the inflation rate, the seasonality of price change and how the hazard functions of price changes. They found that the duration of regular prices ranged from 8 to 11 months, higher than the one established by Bils and Klenow (2004).

Several papers on price dispersion and its sources apply variance decomposition for prices in the United States but differ on the sources for decomposing variance. Kaplan and Menzio (2015) decompose price

variation into a source specific to the store, a second source specific to the store and the product, and a third one specific to the transaction. They found that price dispersion occurs because of differences within-store. Kaplan et al. (2019) analyse price dispersion using a different variance decomposition and provide a theoretical model to explain it. In this case, the variance decomposition distinguishes two sources of price dispersion: a store component and a store-good component. They show that persistent differences across stores are the main source of variation.

Hitsch et al. (2019) provide a decomposition of the price variance using scanner weekly prices for the United States. They decompose price dispersion into three sources: i) price differences across geographic markets, ii) price differences in the same market and iii) within-store price differences over time. I adopt the same decomposition in this paper. The key difference with their paper is that they have weekly data for a non-representative sample, while my data is for monthly prices for a sample that represents the three top-selling brands for each product category and product categories included are part of the CPI basic basket. They found that the main sources of price dispersion for the United States are persistent local differences, the same as I found for Uruguay. In their paper, heterogeneity in price dispersion across products is explained by the number of households that buy each product and the number of retail chains that sell each product.

There have been few attempts to measure price dispersion and look for its sources in developing countries. Borraz and Zipitria (2012) characterise price behaviour in Uruguay using the same dataset but for a shorter period. Some of their key findings are used as a general benchmark during this paper since we use the same data, precisely results related to structural aspects since they only cover up to 2010, and I have data up to 2019. According to Borraz and Zipitria (2012), retail prices in Uruguay are less sticky than in the United States, the average price duration is 2.5 months, there is no seasonality on price adjustments, the probability of price change is not constant over time, and there is high synchronization of price changes.

Related to sources of price variation, Borraz and Saldain (2017) apply a variance decomposition analysis to understand if price dispersion in the city of Montevideo is related to demand and supply shocks. They decompose price variation into retailer and manufacturer shocks and find that, like in the United States, chain shocks explain most of the price variation, which means price strategies applied by chains are relevant to understanding price behaviour.

Daruich and Kozlowski (2017) analyse price dispersion in Argentina using a large dataset of daily prices and decompose price variation into the same sources as Kaplan and Menzio (2015). Contrary to what is found in Kaplan and Menzio (2015), chains are the main source behind price variation in Argentina. Borraz and Saldain (2017) found the same result for Uruguay.

Heterogeneous price dispersion across product categories and periods has been broadly explored in the literature for developed countries. Nakamura and Steinsson (2008) found heterogeneity in the frequency of price change across sectors and product categories in the U.S. economy. Bils and Klenow (2004) also found heterogeneity in the frequency of price change across product categories and years. This paper analyses the heterogeneity across other relevant dimensions, including product categories, time, and other product and store characteristics for a developing country. It also explores heterogeneity in the sources of price dispersion. This heterogeneity analysis can help detect whether prices behaviour is related to the results of different theories about price dispersion. To the best of my knowledge, this has not been done before.

# 3. Data

I use a dataset of daily posted prices of the retail sector in Uruguay from March 2007 to December 2019. This dataset is gathered by the General Directorate of Commerce (DGC for its Spanish acronym) and includes all stores that meet the following two conditions: 1) they sell more than 70% of the products listed, and 2) they

either have more than four stores under the same name or have more than three cashiers in a store. Products are defined at the universal product code (UPC) level. The three top-selling brands are reported for each product category, and each supermarket must report always the same products. The product categories included in this dataset are part of the categories of food and beverages, cleaning and personal care of the CPI (Consumption Price Index). This implies the dataset covers a part of the consumption basket of Uruguayan households.

To focus on regular prices, I use the monthly mode for each product in a store. The final monthly database has 4,931,909 observations for 154 products in 424 stores that belong to 20 chains or are independent stores[2]. For each store, geographical information about the city and department where it is located is available. For Montevideo, there is also information at a more detailed level about the "Centro Comunal Zonal" (CCZ, for its Spanish acronym). This is an administrative division, defined by the local government, that groups neighborhoods in Montevideo for decentralization purposes. For the analysis, geographic markets are defined according to the number of stores in each CCZ for Montevideo and in each city or department for the rest of the country, as some cities and even departments have a few stores in the database. Table 5 in the Appendix details the number of stores by the minimum geographic level. As a result, I define a geographic market as a department except for Montevideo, where I use CCZ to identify markets, and for Canelones and Maldonado, where I define markets as their main cities. There are 46 markets with at least two stores each, and the maximum number of stores in a market is 30. Table 6 in the Appendix shows a detailed list of stores distributed along markets using the definition mentioned above. Regarding stores, 75.2% of them belong to a chain, while 75% of the stores are multi-region, or what it is the same, belong to the same chain and have stores in different markets. Table 1 shows summary statistics of the data.

Table 1: *Data summary.*

| | Frequency |
|---|---|
| Products | 154 |
| Stores | 424 |
| Chains | 20 |
| Cities | 59 |
| Departments | 19 |
| Markets | 46 |
| Months | 156 |
| Observations | 4,931,909 |
| | Stores |
| Chains | 75.2% |
| Multi-region | 75% |

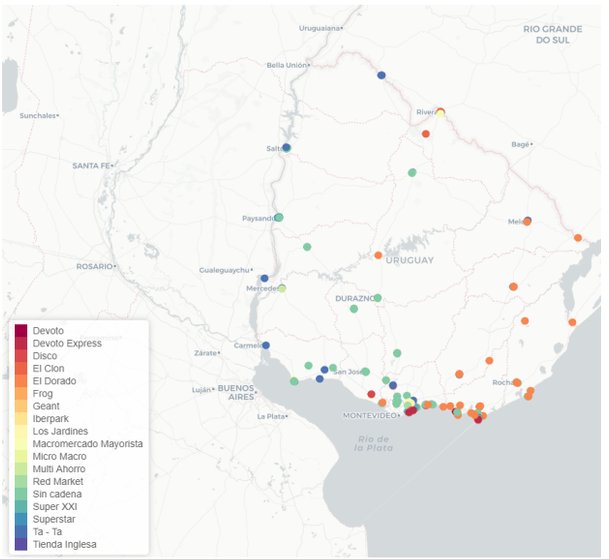
Source: author's calculation.

Stores are distributed all over the country but are highly concentrated in Montevideo, the capital city of Uruguay – where 45% of the population lives – and have 55% of the stores. Figure 2 shows the geographic distribution of the stores in the dataset coloured by the chain in every department but Montevideo, which is plotted in a separate map, see Figure 3, for visualisation purposes.

Products are characterised by categories, brands, producers, and whether they are locally produced or imported. There are 43 product categories, grouping products that share a standard feature regardless of

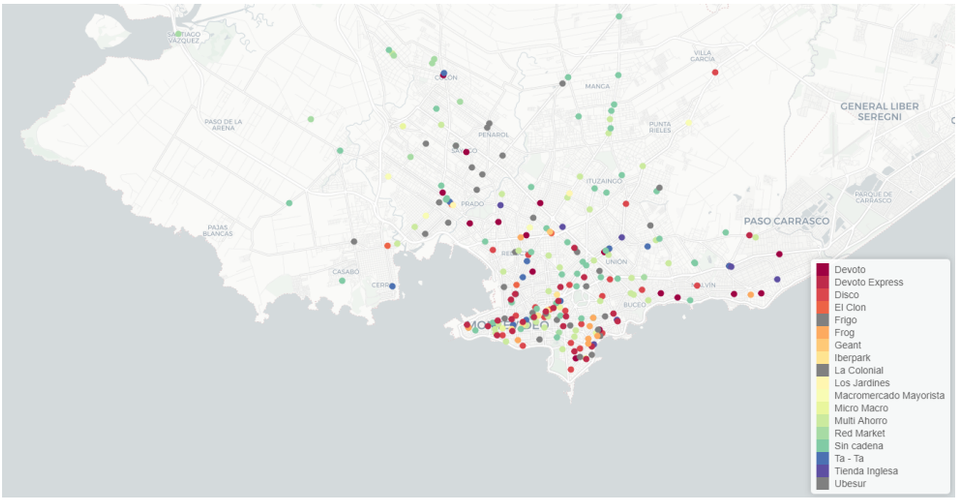
[2]Some stores do not belong to any chain, these are mainly stores with only one branch included in the sample because they have more than three cashiers.

Figure 2: *Stores geographic distribution.*




Notes: Map of Uruguay. Each dot represents a store location, colours represent the chain to which the store belongs. Montevideo is excluded.

Figure 3: *Stores distribution in Montevideo.*




Source: author's calculation. Notes: Each dot represents a store location in Montevideo, colours represent the chain to which the store belongs to.

the brand (e.g., sunflower oil is a product category different from maize oil). Table 2 summarises product characteristics.

Table 2: *Product characteristics.*

| | |
|---|---|
| Products | 154 |
| Product categories | 43 |
| Brands | 105 |
| Producers | 69 |
| Origins | 3 |

Source: author's calculation.

For robustness and to control for attrition, I use three different samples: the complete database, a restricted database for stores that post prices every month, and the third one for products and stores that appear throughout the period.

# 4. Price dispersion

It is important to distinguish between two groups of prices: regular and sales. Regular prices are the underlying prices that persist when temporal sales are not considered, and sales prices result from offering a discount over the regular prices. Nakamura and Steinsson (2008) have shown that regular prices change more infrequently than posted prices, which implies that they are related to persistent characteristics. Whether to include sales prices or not depends on the analysis goal. The main focus of this paper is to analyse the structural patterns related to price dispersion. For that reason, I focus on regular prices, defined as the monthly mode prices taken from a dataset of daily posted prices. In this way, regular persistent prices are considered since it is highly improbable that the most often posted price for a given product in a specific month will be a sales price.

I use the standard deviation of the log of prices from the overall mean as a measure of price dispersion, which is the measure proposed by Hitsch et al. (2019).

$$\sigma_{jt} = \sqrt{\frac{1}{N_{jt}-1}\sum_{s\in S_{jt}}\left(log(p_{jst}) - \overline{log(p_{jt})}\right)^2}. \tag{1}$$

$\sigma_{jt}$ measures the dispersion of prices as percentage differences from the geometric mean of prices across stores, where *j* is the product, *t* is for month/year, and *s* is for each store.

I calculate $\sigma_{jt}$ for each month within each year $t$, and take the weighted mean to report the national average using CPI weights. At the national level, price dispersion can be related to price differences across different geographic areas. Following Hitsch et al. (2019), I look into local market price differences. First, I calculate $\sigma_{jt}$ for each market *m*. Then take the weighted average for product *j* using the number of observations in each market as weights.

I find there is price dispersion in the retail market in Uruguay. The log-price standard deviation ranges between 0.079 and 0.088 at the national level, depending on the sample considered. Results are shown in Table 3 for the three different samples defined in the previous section.

Table 3: *Price dispersion.*

| | Log-price standard deviation | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| National | 0.088 | 0.079 | 0.087 |
| Local | 0.056 | 0.047 | 0.052 |
| Observations | 4,931,909 | 3,399,571 | 2,703,491 |

Source: author's calculation. Notes: (1) complete database, (2) subsample for stores that post prices every period, (3) subsample for products and stores that appear during the whole period.

To measure price dispersion at local markets, I use the definition of geographic markets described in the previous section, which implies that at least two stores are in each market. The average degree of price dispersion at the local market level is half that at the national level - between 0.047 and 0.056-. This implies a large dispersion of prices, even in small geographic markets. Results are shown in Table 3.

Compared to the United States, the degree of price dispersion at the national level and the local market level is lower in Uruguay. According to Hitsch et al. (2019), the average log-price standard deviation is 0.163 at the national level and between 0.103 and 0.114 at the local level for the United States. It is important to note, especially at the local level, that Hitsch et al. (2019) use a more aggregate definition of markets, so price dispersion is expected to increase as markets get larger. At the national level, this comparison also needs to be taken carefully because stores in Uruguay are highly concentrated, while in the United States, it is not necessarily the case.

# 5. Variance decomposition

Next, following Hitsch et al. (2019), I decompose the price variance into three sources: (i) price differences across geographic markets, (ii) price differences across stores at the same market, and (iii) price differences over time within a specific store. The procedure is as follows. First, I calculate the overall variance for each product *j* for a specific month/year *t*,

$$var\left(p_{st}\right) = \frac{1}{N}\sum_{s\in S}\sum_{t\in T}\left(p_{st}-\overline{p}\right)^2. \tag{2}$$

This overall variance can be decomposed into the three mentioned sources, as shown in Hitsch et al. (2019),

$$var\left(p_{st}\right) = var\left(\overline{p}_m\right) + \frac{1}{N}\sum_{m\in M} N_m var\left(\overline{p}_s|m\right) + \frac{1}{N}\sum_{s\in S} N_s var\left(p_{st}|s\right) \tag{3}$$

The first term, $var\left(\overline{p}_m\right)$, is the average variance of the average market-level prices. It is the weighted variance of the average price level in each market, using the number of markets as weights. The second term, $var\left(\overline{p}_s|m\right)$, is the within-market variance of average store-level prices weighted by stores. It is the

weighted variance across stores, using the number of markets as weights. Finally, $var\left(p_{st}|s\right)$ is the within-store variance of prices over time. I calculate price variance decomposition separately for each product $j$ and then drop the $j$ subscript for simplicity.

The variance decomposition shows that price dispersion is mainly explained by across-market price differences (39.16%), then by across-store price differences within a market (36.90%), and lastly by within-store dispersion (23.94%). The sources of price dispersion can be divided into two groups, one related to the local level, and another related to the national level. Differences across stores and within stores belong to the first group, while differences across-market represent differences at the national level. According to these results, 60.84% of the price dispersion is driven by the pricing strategies of stores at the local market and over time. Thus, to understand price dispersion in Uruguay, the pricing strategies of stores are key. Results are summarised in Table 4.

Table 4: *Price variance decomposition.*

| | (1) | (2) | (3) |
|---|---|---|---|
| Across-market | 39.16 | 44.31 | 36.50 |
| Across-store | 36.90 | 30.82 | 43.64 |
| Within-store | 23.94 | 24.87 | 19.86 |
| Observations | 4,931,909 | 3,399,571 | 2,703,491 |

Source: author's calculation. Notes: (1) complete database, (2) subsample for stores that post prices every period, (3) subsample for all products and stores that appear during the whole period.

For robustness, I apply the same variance decomposition to the three different samples defined, the results remain unchanged among the three of them. Around 60% of price dispersion is related to differences at the local level. This emphasizes the fact that in Uruguay, price dispersion is mainly explained by local factors.

Differences at the local level are also the primary source of price dispersion in the U.S. Hitsch et al. (2019). However, if we look at each source, the main source of price dispersion in Uruguay is represented by the differences across different geographic markets, contrary to the United States, where it is the within-store component. These cases are not precisely comparable since definitions of markets and stores concentration are different. Uruguay store's concentration is higher, and my market definition is less aggregated than the one used in Hitsch et al. (2019).

# 6. Heterogeneity

The average price dispersion shown in the previous section can differ between products, stores or periods. To analyse possible variation in price dispersion and its sources, I define different subsamples, and then apply Equations 1 and 3 to each of them. The subsamples are defined to identify variation across products, stores, and different periods.

To study differences across products, I group goods by their product category, origin, or producer. I explore heterogeneity between stores by looking at the chain, location, and income quintile for the area where the store is located. Finally, I explore time heterogeneity by looking at years, quarters, and months.

The analysis of heterogeneity is done in two steps. First, I apply Equation 1 for each subsample to see

whether there is heterogeneity in the degree of price dispersion or not. Then, I calculate Equation 3 for each subsample to analyse heterogeneity in the sources of price dispersion.

## *6.1. Price dispersion variation*

This section explores whether price dispersion differs between products, stores, and time. Across all the three, I find heterogeneity in price dispersion. It changes depending on products and stores and increases over time, but does not show seasonality. The heterogeneity found here fits with the results of theory models like search frictions.

### *6.1.1 Across products*

Products differ in price dispersion level depending on product category, producer, or whether they are imported, as shown in Figures 4, 5, and 6. Table 8 in the Appendix details these results. These findings are in line with the heterogeneity in the relative rigidity of prices found in Borraz and Zipitria (2012).

According to Varian (1980), the existence of search frictions can explain price dispersion, so heterogeneity across product characteristics is consistent with that theory when sellers randomized over products. If there are search frictions for buyers and sellers in a market, buyers pay different prices and sellers fix different ones. I do not find a clear pattern between product categories or between producers. Those categories and producers that are close to the average price dispersion are a mixed group of groceries, cleaning products, and producers that sell a wide variety of products. Regarding product origin, there are clear differences, for national products price dispersion is 21% higher than for imported ones. This is an interesting result because the reverse should be expected, as imported prices should be more volatile due to exchange rate changes and international price volatility. Regarding Uruguayan imported goods, 54% of them are intermediate goods[3]. Thus, national products have a significant imported component, which contributes to understanding why they are more volatile than imported ones.

### *6.1.2 Across stores*

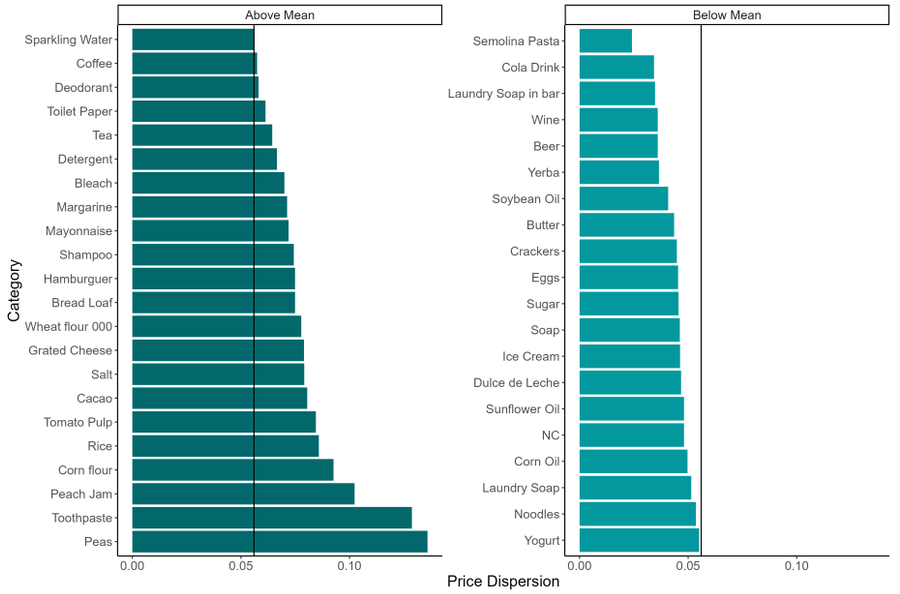
Stores show heterogeneity across all characteristics considered: chains, location, and income level of the area where the store is. Price dispersion is considerably heterogeneous across chains, mostly below average. There is also heterogeneity across departments and income level. These results are summarised in Figure 7.

Most chains have no price dispersion, while independent stores show the highest price dispersion (up to 0.028), Table 8 in the Appendix shows details. In general, price dispersion within chains is small and much lower than average. This implies that most price dispersion arises from differences between chains rather than within chains, as Della Vigna and Gentzkow (2019) suggest. This result is in line with Borraz and Saldain (2017) findings for Uruguay and is consistent with the existence of search frictions due to randomization over products.

Across departments, price dispersion shows heterogeneity. Montevideo, the department with the largest population and number of stores, has a lower price dispersion than San Jose and Colonia, which have around

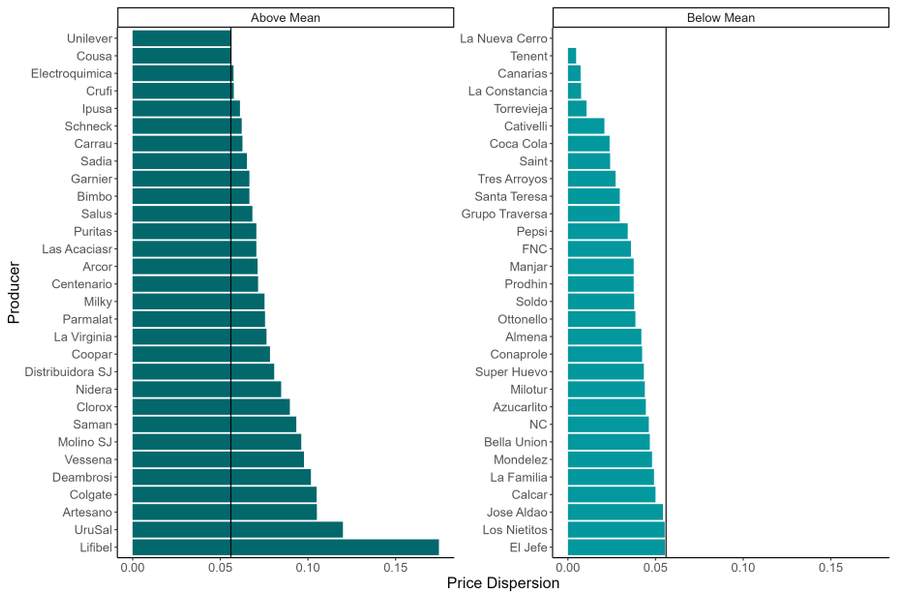
[3] According to the Central Bank of Uruguay annual report.

Figure 4: *Price dispersion ($\sigma_{jt}$) variation across product categories*



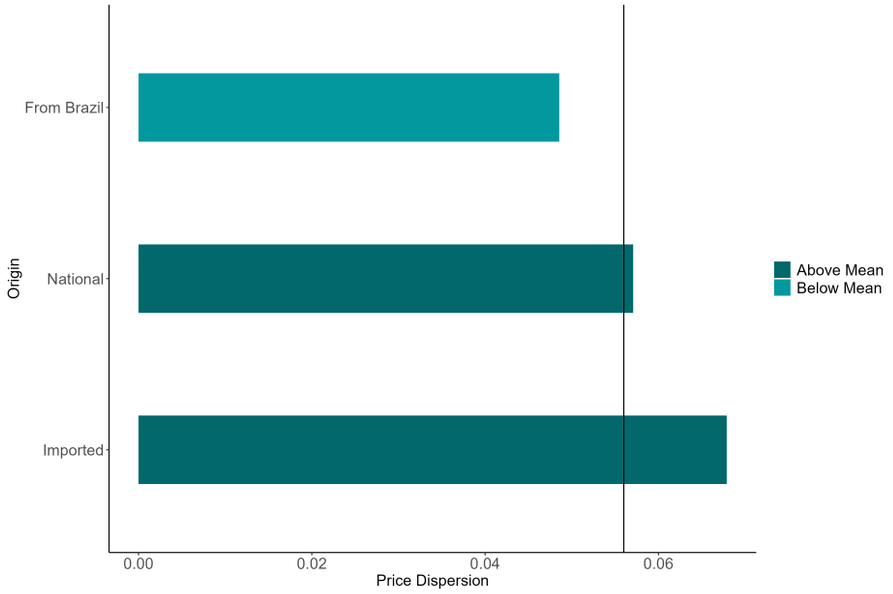

Source: Author's calculation. Notes: Each bar represents the log-price standard deviation in 2019 for product categories. The vertical line represents the average degree of price dispersion.

Figure 5: *Price dispersion variation across producer*




Notes: Each bar represents the log-price standard deviation in 2019 for each producer. The vertical line represents the average degree of price dispersion.

Figure 6: *Price dispersion ($\sigma_{jt}$) variation across products origin*




Notes: Each bar represents the log-price standard deviation in 2019 for product origin. The vertical line represents the average degree of price dispersion.

ten times less population than the capital city, and 11 and 12 stores respectively (in Montevideo there are an average of 13 stores by market).

Finally, when I look for the heterogeneity of price dispersion according to the income level of the area of each store, I find it is higher in stores located at higher income level areas. For the first two quintiles, the poorest, price dispersion is lower than for the richest ones, and below the average. This could imply that in the wealthiest areas, there is higher competition between stores, in line with Hitsch et al. (2019) that find a positive relationship between price dispersion and the distribution of a product, measured by the number of retail chains that carry the product, and the level of product penetration. In the dataset used here, a third of the stores are located in the wealthiest areas, while in the poorest areas, only 11% of the stores are located. If I look at chains, 90% of the chains in the data are located in the wealthiest areas, while 50% are in the poorest ones. On average, stores in the most affluent areas sell 98 products, while this decreases to 33 in the poorest areas. This increases the possibility for supermarkets to segment their customers in the wealthiest neighbourhoods as they have more products and stores. Moreover, there are products with no price dispersion in all areas, and those with the highest are in the wealthiest areas. This heterogeneity over different income areas also could be interpreted according to Benabou (1992), where lower-income customers have higher search activity. If that is the case, price dispersion gets lower as search activity increases.

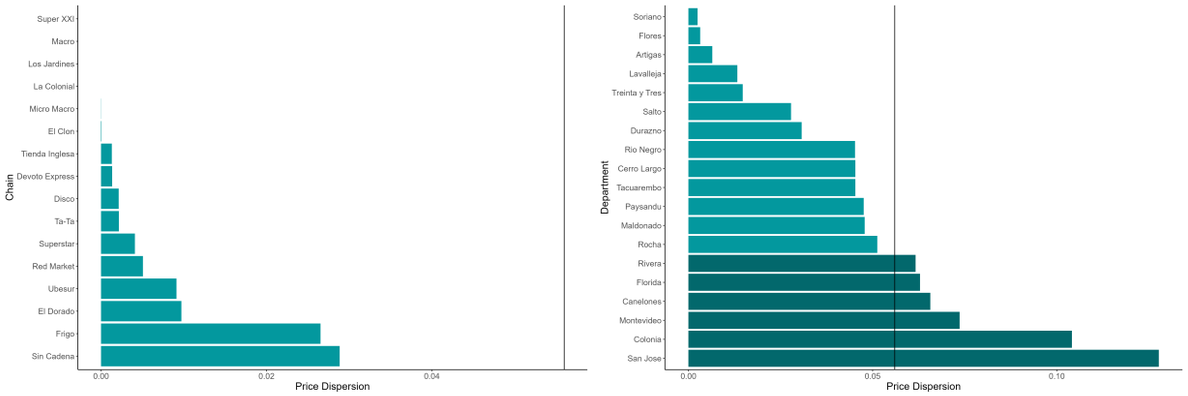
### *6.1.3 Over time*

Price dispersion has been sustainably increasing over the years. This remains true even if I control for store entry, and consider only stores that report prices during all periods. If we look at all quarters and months in the sample, there are not many differences in price dispersion, which implies there is no seasonality. These results are summarised in Figure 8.

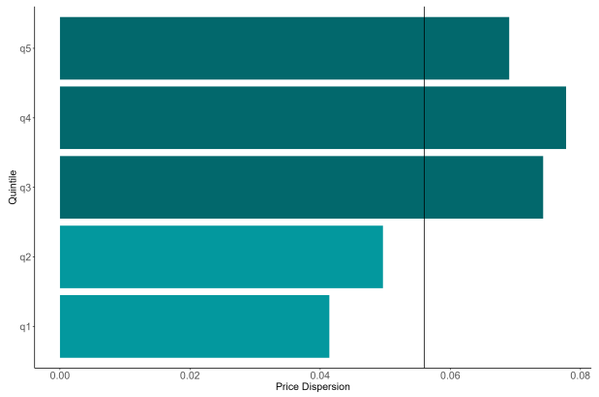
Figure 7: *Price dispersion variation across stores*

(a) $\sigma_{jt}$ within chain

(b) $\sigma_{jt}$ across store department




(c) $\sigma_{jt}$ across income level of the store area




Notes: Each bar represents each producer's log-price standard deviation in 2019 for store chains in panel (a), store department in panel (b), and the income level of the area where the store is in panel (c). The vertical line represents the average degree of price dispersion.

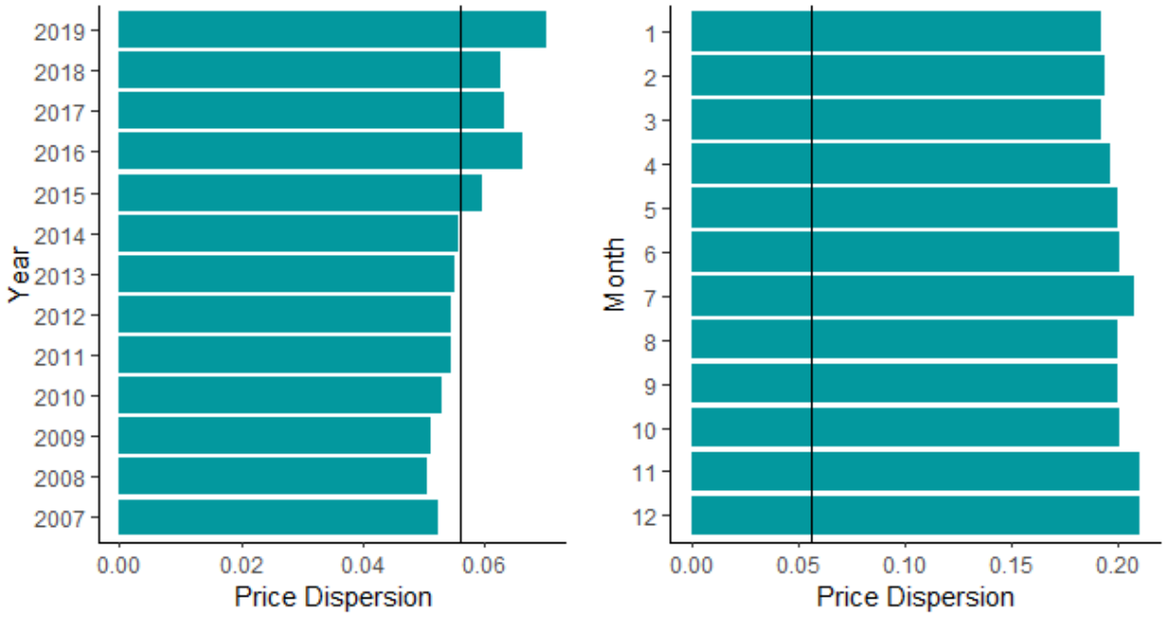
Price dispersion is not constant over time, increasing by 35% in twelve years. It is interesting to look at price dispersion along with the inflation rate. In this period, the average annual inflation rate was 8.02%, according to the Central Bank of Uruguay statistics. Figure 9 shows the evolution of both variables, in periods when the inflation rate increases, price dispersion increases, and vice versa. Thus, they seem to move together despite price dispersion having a clear increasing tendency while the inflation rate is more volatile.

This is a striking result, as far as I know, no other papers have detected such an increase in price dispersion over time. Empirical literature about the relationship between inflation and price dispersion is scarce and ambiguous. While Tommasi (1992) finds a positive correlation between inflation and price dispersion for a reduced group of products in Argentina, Reinsdorf (1994) finds they are negatively correlated in the United States, and Sara-Zaror (2024) finds price dispersion increases around zero and becomes flatter as inflation increases. Macroeconomics theory also presents mixed results, Golosov and Lucas (2007) menu costs model predicts that price dispersion is almost constant for low to moderate inflation, and increases smoothly with inflation. On the other hand, New Keynesian models, like in Calvo (1983), state that price dispersion increases rapidly with inflation. It is beyond the scope of this paper to establish the empirical relationship between

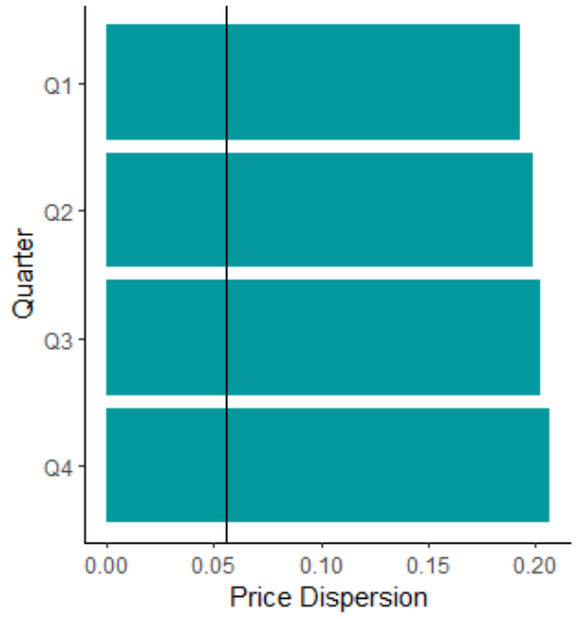
Figure 8: *Price dispersion variation over time*

(a) $\sigma_{jt}$ across years

(b) $\sigma_{jt}$ across months



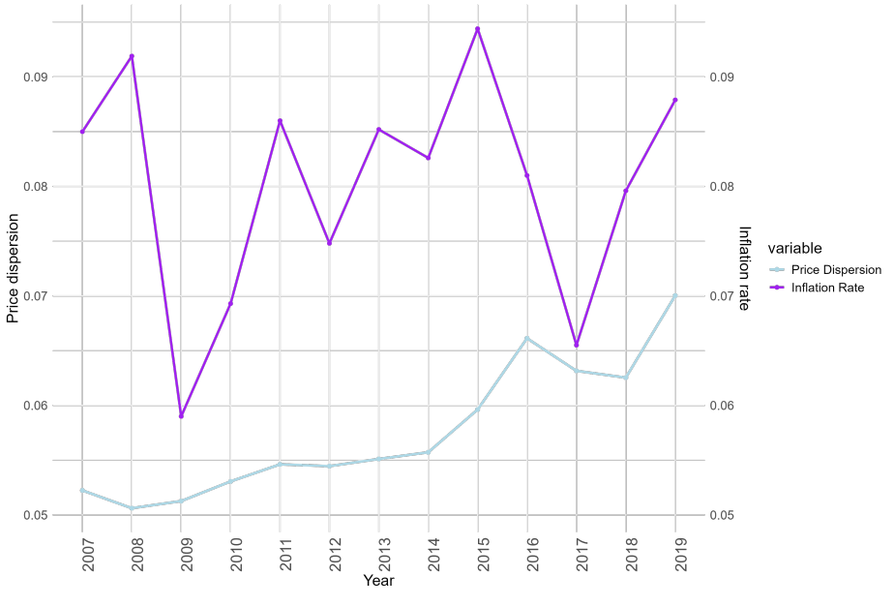

(c) $\sigma_{jt}$ across quarters




Notes: Each bar represents the log-price standard deviation for years in panel (a), months in panel (b), and quarters in panel (c). The vertical line represents the average degree of price dispersion.

inflation and price dispersion, and it is hard to conclude based on the graph analysis of both variables. Since these models have different welfare implications, analysing this relationship in depth would be worthwhile.

Figure 9: *Price dispersion and inflation rate*




Notes: The Figure plots the annual evolution of the weighted price dispersion (of the more restricted sample, constant stores and products) and the inflation rate.

To sum up, the key insights price dispersion heterogeneity reveals are as follows. The heterogeneity found across product categories and chains can be interpreted in a search friction model where stores randomize prices across different products. Chains can set uniform pricing within their stores while randomizing prices across their products. Besides those results, I find heterogeneity between different incomes, which the existence of search frictions could also explain. However, in this case, as people are poorer, their search activity increases, and price dispersion decreases in lower-income level areas. Finally, a significant and persistent increase in price dispersion over time (35% over the last twelve years) needs further analysis to be concluded, but it is also consistent with the existence of search frictions.

## *6.2. Variance decomposition variation*

Finally, I look for heterogeneity in the sources of price dispersion across products, stores, and time. I apply the variance decomposition explained in Section 4 for each dimension. The results also show heterogeneity in the sources of price dispersion.

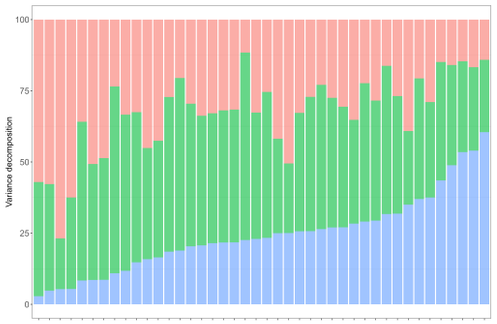
### *6.2.1 Across products*

When I look across product categories and producers, variance decomposition shows heterogeneity. The main sources are not always across-store and within-store together, like was found for price dispersion at an aggregate level. Figure 10 summarises these results. For some product categories, across-market rises as the main price dispersion source, as well as in the case of some producers. Regarding product origin, there is also heterogeneity. However, variation of prices over time (within-store source) has the least relative weight for

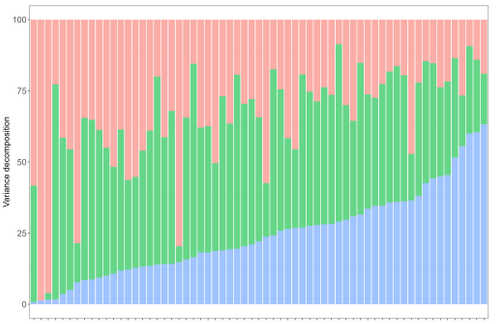
the three origins. This implies that inflation does not affect price dispersion across product origins, but it does when we compare producers and product categories.

Figure 10: *Sources of price dispersion variation across products*

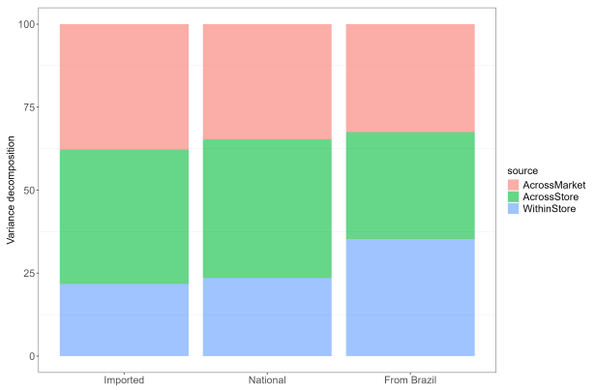
(a) $\sigma_{jt}$ Across product category




(b) $\sigma_{jt}$ Across product producer




(c) $\sigma_{jt}$ Across product origin




Notes: Panels (a) to (c) show variance decomposition across product categories, product producers, and product origins, respectively.

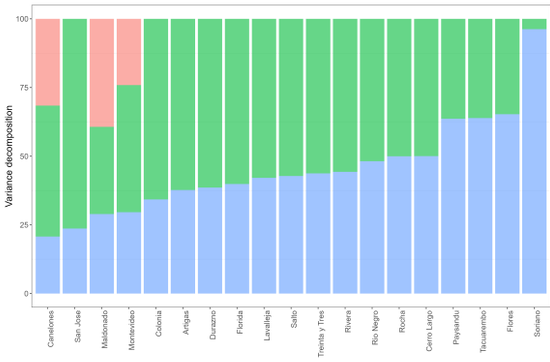
### *6.2.2 Across stores*

I find the same result across stores: there is heterogeneity in the variance decomposition of any of the store characteristics analysed. When I look across departments, the main sources of price dispersion are not always related to local markets, chains, and income levels of the area where the store is, as shown in Figure 11.

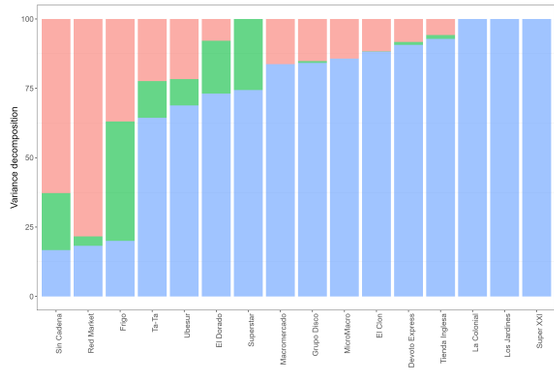
Across store locations, we can see clearly that the across-market source does not have a role at all. This implies that geographic markets are highly segmented. While there is almost no between-market competition, within-market competition explains almost half of the price dispersion. Within chains this changes, the main source of price dispersion is within-store for those stores that belong to a chain. Stores that do not belong to any chain are more affected by across-market competition. Finally, if we look for the heterogeneity across the store's area average income, we find once again, a huge heterogeneity between the poorest and the richest quintiles. For the first ones, price dispersion is mainly explained by differences in prices across markets, while for the richest, it is mainly explained by local market characteristics such as price evolution and competition between stores located nearby.

Figure 11: *Sources of price dispersion variation across stores*

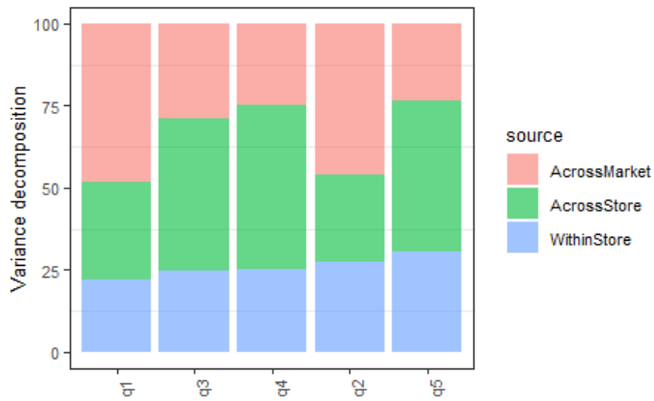
(a) Across store location




(b) Within chains




(c) Across the income level of the store's area




Notes: Panels (a) to (c) show variance decomposition across store chain, store location, and income level of the area where the store is, respectively.

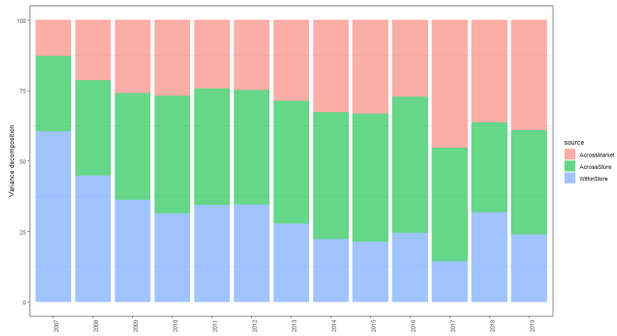
### *6.2.3 Across time*

The sources of price dispersion have changed over time. For every year in the sample, both across-store and within-store represent the main sources behind price variance. Nevertheless, in recent years, the across-market source has been growing, and now represents nearly half of the price variance. Figure 12 shows these results.

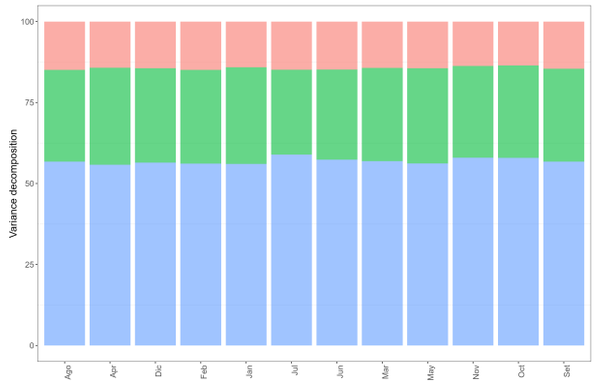
The heterogeneity found in the sources of price dispersion can be interpreted as follows. The heterogeneity across store characteristics indicates a high segmentation of markets, especially in lower-income level areas, where the main source of price dispersion is across-market. Price dispersion at the chain level stems mainly from within-market competition, reinforcing that competition between stores of different chains is more significant than competition within chains. This is because across-market source has the lowest weight, and most stores belong to a chain with a presence in different regions. Finally, the heterogeneity of sources over time, especially across-store source, suggests that price dispersion does not arise from differences in store amenities. Since amenities tend to be permanent features, the across-store source should not vary over time, yet it does. The relative weight of sources of price dispersion has been changing steadily, while within-store is decreasing, across-market is increasing.

Figure 12: *Sources of price dispersion variation over time*

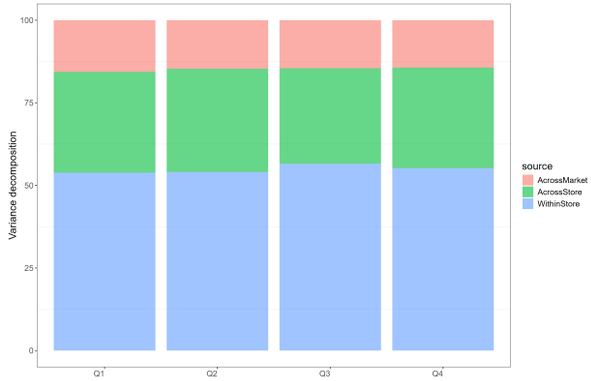
(a) Over years




(b) Over months




(c) Over quarters




Notes: panels (a) to (c) show variance decomposition across years, months, and quarters respectively.

# 7. Concluding remarks

The main contribution of this work is providing evidence of price dispersion, its sources, and heterogeneity, in a small developing, open economy.

The degree of price dispersion in Uruguay is mainly found at the local market level. The intertemporal pricing strategies of chains and how chains at the same geographic market set prices are the main sources behind price dispersion between 2007 and 2019. These findings are similar to those found for Argentina and the United States. Moreover, the main sources behind price dispersion in the United States are the same ones I found for Uruguay.

The analysis of variation in the sources of price dispersion reveals that the drivers behind this phenomenon in Uruguay have been unchanged for more than a decade, but in recent years they have started to change. This can be an indicator of a change in the underlying structure of the sources of price dispersion. Across-market differences in prices may become the main source of price dispersion in Uruguay in the next years.

When I analyse price dispersion across products and store characteristics, the following dimensions show heterogeneity: product categories, producers, product origin, geographic area, and the income level of the area where the store is located. On the other hand, price dispersion within chains is low, while there are differences

in the level of price dispersion between chains. These results are in line with those found in Argentina and the United States, where chains tend to apply uniform pricing. This highlights that the relevant level of analysis is chains rather than individual stores.

The variance decomposition also shows the heterogeneity observed across every dimension of price dispersion. When analysing all the dimensions of the heterogeneity together, it becomes clear that the price dispersion found here could be related to the existence of search frictions, where stores within the same chain randomize prices across different products. Finally, I find a significant increase in price dispersion over the years despite the stability in inflation levels. This is an interesting result that needs further analysis.

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# Appendix

Figure 13: *Number of stores for each regular price of every product in the Rice category*

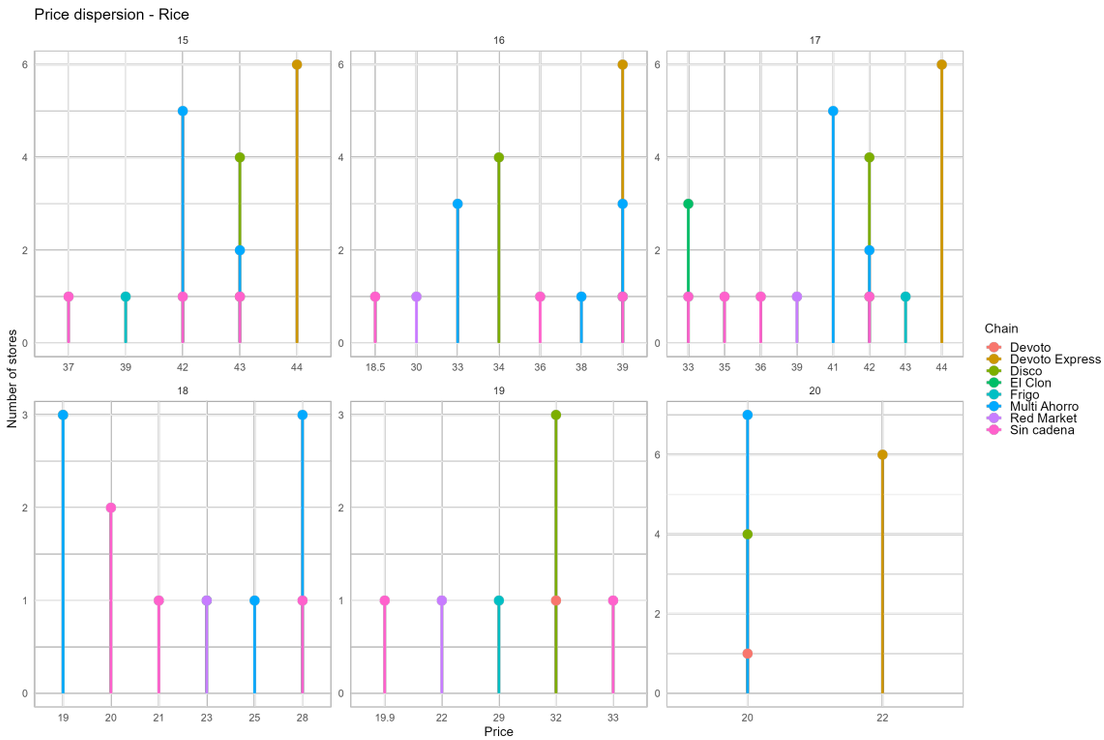

Figure 14: *Number of stores for each regular price of every product in the Yerba category*

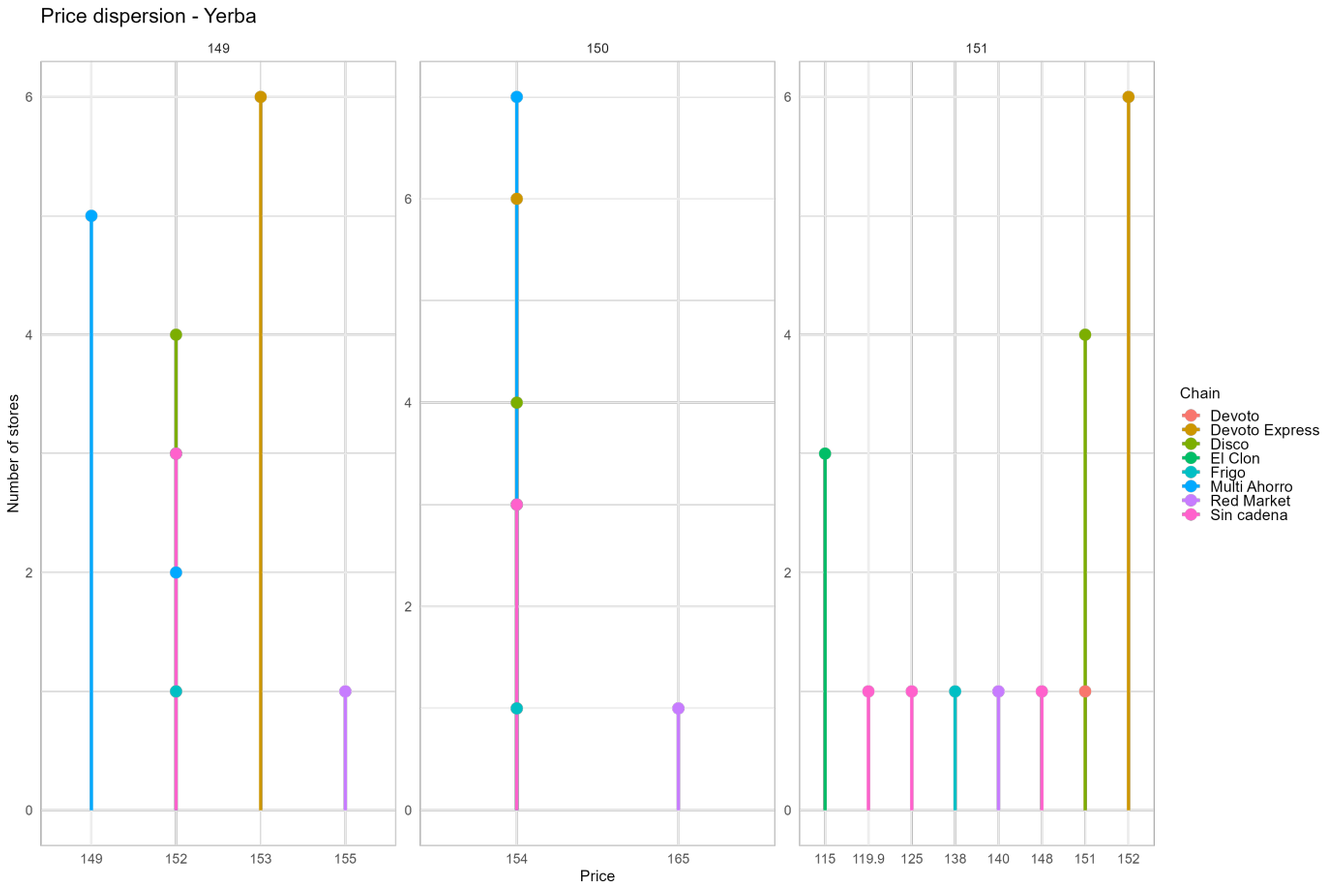

Figure 15: *Number of stores for each regular price of every product in the Sugar category*

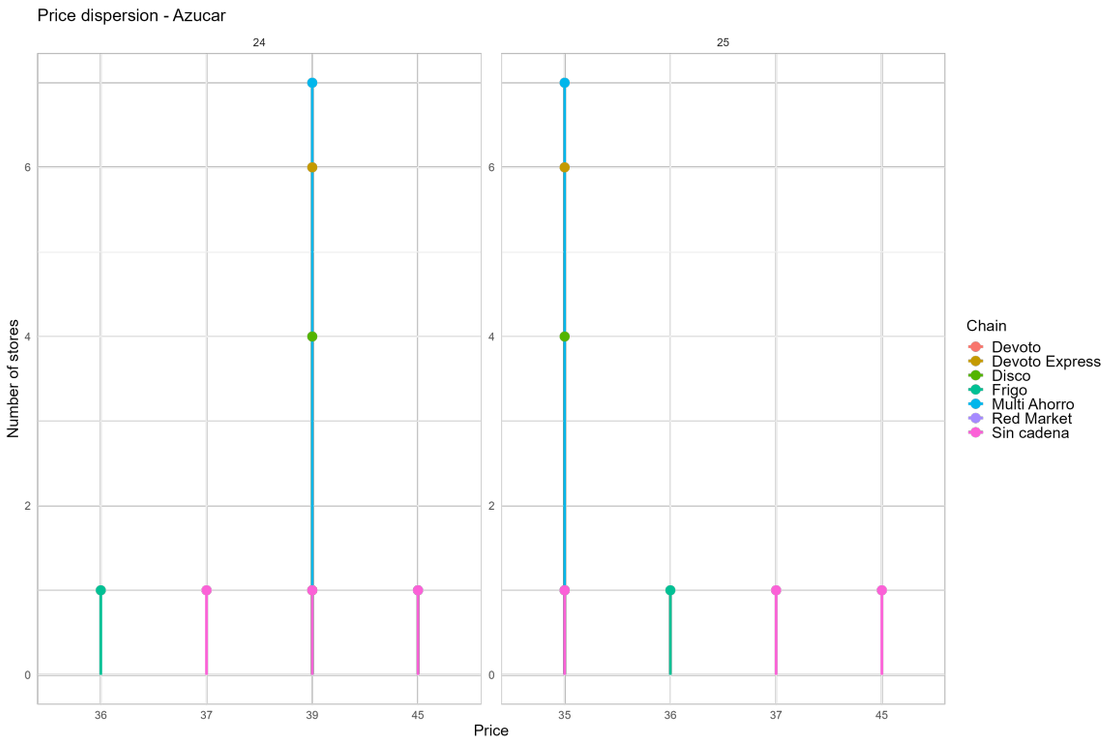


Table 5: *Stores by city or county.*

| Department | City or county | Number of stores |
|---|---|---|
| Artigas | Artigas | 2 |
| Canelones | Santa Lucia | 2 |
| Canelones | Las Piedras | 9 |
| Canelones | Progreso | 2 |
| Canelones | Pando | 2 |
| Canelones | Atlantida | 3 |
| Canelones | Ciudad de la Costa | 16 |
| Canelones | Canelones | 2 |
| Canelones | Cuchilla Alta | 1 |
| Canelones | Paso Carrasco | 3 |
| Canelones | La Floresta | 2 |
| Canelones | La Paz | 3 |
| Canelones | Las Toscas | 1 |
| Canelones | Suarez | 1 |
| Canelones | Sauce | 1 |
| Canelones | Cap. Juan A. Artigas | 3 |
| Canelones | Pinares | 1 |
| Cerro Largo | Melo | 3 |
| Cerro Largo | Rio Branco | 3 |
| Colonia | Nueva Helvecia | 1 |

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Table 5 – *Continued from previous page*

| Department | City or county | Number of stores |
|---|---|---|
| Colonia | Colonia del Sacramento | 6 |
| Colonia | Carmelo | 15 |
| Colonia | Tarariras | 2 |
| Colonia | J. Lacaze | 1 |
| Colonia | Rosario | 1 |
| Durazno | Durazno | 4 |
| Flores | Trinidad | 4 |
| Florida | Florida | 5 |
| Lavalleja | Minas | 4 |
| Maldonado | Balneario Solis | 1 |
| Maldonado | Maldonado | 15 |
| Maldonado | Piriapolis | 6 |
| Maldonado | Punta del Este | 9 |
| Maldonado | Barra de Maldonado | 9 |
| Maldonado | Aigua | 1 |
| Maldonado | Pan de Azucar | 8 |
| Maldonado | San Carlos | 3 |
| Paysandú | Paysandu | 7 |
| Rio Negro | Young | 2 |
| Rio Negro | Fray Bentos | 1 |
| Rivera | Rivera | 5 |
| Rivera | Tranqueras | 1 |
| Rocha | La Pedrera | 1 |
| Rocha | Lascano | 1 |
| Rocha | Rocha | 7 |
| Rocha | La Paloma | 6 |
| Rocha | Chuy | 1 |
| Salto | Salto | 10 |
| San Jose | San Jose de Mayo | 6 |
| San Jose | Libertad | 3 |
| San Jose | Delta del Tigre | 1 |
| San Jose | Ciudad del Plata | 1 |
| Soriano | Mercedes | 2 |
| Tacuarembo | Tacuarembo | 5 |
| Tacuarembo | Paso de los Toros | 1 |
| Treinta y Tres | Treinta y Tres | 4 |
| Montevideo | CCZ1 | 25 |
| Montevideo | CCZ2 | 35 |
| Montevideo | CCZ3 | 14 |
| Montevideo | CCZ4 | 16 |
| Montevideo | CCZ5 | 30 |
| Montevideo | CCZ6 | 14 |
| Montevideo | CCZ7 | 8 |
| Montevideo | CCZ8 | 11 |
| Montevideo | CCZ9 | 10 |
| Montevideo | CCZ10 | 5 |

*Continued on next page*

Table 5 – *Continued from previous page*

| Department | City or county | Number of stores |
|---|---|---|
| Montevideo | CCZ11 | 13 |
| Montevideo | CCZ12 | 7 |
| Montevideo | CCZ13 | 12 |
| Montevideo | CCZ14 | 15 |
| Montevideo | CCZ15 | 5 |
| Montevideo | CCZ16 | 5 |
| Montevideo | CCZ17 | 4 |
| Montevideo | CCZ18 | 5 |

Source: author's calculation.

Table 7: *Price dispersion across products.*

| | log-price sd |
|---|---|
| Category | |
| Semolina Pasta | 0.02410454 |
| Cola Drink | 0.03425806 |
| Laundry Soap in bar | 0.03471741 |
| Wine | 0.03599485 |
| Beer | 0.03601091 |
| Yerba | 0.03659805 |
| Soybean Oil | 0.04077593 |
| Butter | 0.04348759 |
| Crackers | 0.04477334 |
| Eggs | 0.04538255 |
| Sugar | 0.04561987 |
| Soap | 0.04615341 |
| Ice Cream | 0.04629028 |
| Dulce de Leche | 0.04678349 |
| Sunflower Oil | 0.04807447 |
| NC | 0.04815167 |
| Corn Oil | 0.04965847 |
| Laundry Soap | 0.05146180 |
| Noodles | 0.05364501 |
| Yogurt | 0.05506839 |
| Sparkling Water | 0.05624801 |
| Coffee | 0.05745576 |
| Deodorant | 0.05812618 |
| Toilet Paper | 0.06128982 |
| Tea | 0.06438615 |
| Detergent | 0.06654721 |
| Bleach | 0.06997933 |
| Margarine | 0.07129941 |
| Mayonnaise | 0.07193064 |
| Shampoo | 0.07435244 |
| Hamburguer | 0.07493103 |
| Bread Loaf | 0.07495752 |
| Wheat flour 000 | 0.07779620 |

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Table 7 – *Continued from previous page*

| | **log-price sd** |
|---|---|
| Grated Cheese | 0.07899734 |
| Salt | 0.07914668 |
| Cacao | 0.08054559 |
| Tomato Pulp | 0.08445332 |
| Rice | 0.08586679 |
| Corn flour | 0.09265612 |
| Peach Jam | 0.10230290 |
| Toothpaste | 0.12874476 |
| Peas | 0.13591030 |
| Producer | |
| La Nueva Cerro | 0.00000 |
| Tenent | 0.004681997 |
| Canarias | 0.007229969 |
| La Constancia | 0.007473429 |
| Torrevieja | 0.010572032 |
| Cativelli | 0.020780874 |
| Coca Cola | 0.023741380 |
| Saint | 0.024104544 |
| Tres Arroyos | 0.027221273 |
| Grupo Traversa | 0.029644508 |
| Santa Teresa | 0.029644508 |
| Pepsi | 0.034123527 |
| FNC | 0.036010911 |
| Manjar | 0.037466151 |
| Prodhin | 0.037516096 |
| Soldo | 0.037748914 |
| Ottonello | 0.038469539 |
| Almena | 0.041977400 |
| Conaprole | 0.042321267 |
| Super Huevo | 0.043305348 |
| Milotur | 0.043919583 |
| Azucarlito | 0.044504036 |
| NC | 0.046153405 |
| Bella Union | 0.046735709 |
| Mondelez | 0.047939059 |
| La Familia | 0.049169804 |
| Calcar | 0.049919499 |
| Jose Aldao | 0.054225366 |
| Los Nietitos | 0.055275843 |
| El Jefe | 0.055326202 |
| Unilever | 0.056445657 |
| Cousa | 0.056458230 |
| Electroquimica | 0.057476818 |
| Crufi | 0.057617872 |
| Ipusa | 0.061289816 |
| Schneck | 0.062144395 |
| Carrau | 0.062601357 |
| Sadia | 0.065243726 |
| Garnier | 0.066549830 |
| Bimbo | 0.066620041 |
| Salus | 0.068232658 |
| Puritas | 0.070500536 |
| Las Acaciasr | 0.070547360 |

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Table 7 – *Continued from previous page*

| | **log-price sd** |
|---|---|
| Arcor | 0.071260559 |
| Centenario | 0.071505475 |
| Milky | 0.075274478 |
| Parmalat | 0.075581457 |
| La Virginia | 0.076331731 |
| Coopar | 0.078381333 |
| Distribuidora SJ | 0.080683839 |
| Nidera | 0.084650339 |
| Clorox | 0.089597813 |
| Saman | 0.093352245 |
| Molino SJ | 0.096114899 |
| Vessena | 0.097793464 |
| Deambrosi | 0.101714290 |
| Colgate | 0.104938902 |
| Artesano | 0.105077412 |
| UruSal | 0.119960081 |
| Lifibel | 0.174736121 |
| Origin | |
| National | 0.06663629 |
| Imported | 0.05515353 |
| From Brazil | 0.04841437 |

Source: author's calculation.

Figure 16: *Number of stores for each regular price of every product in the Dulce de leche category*

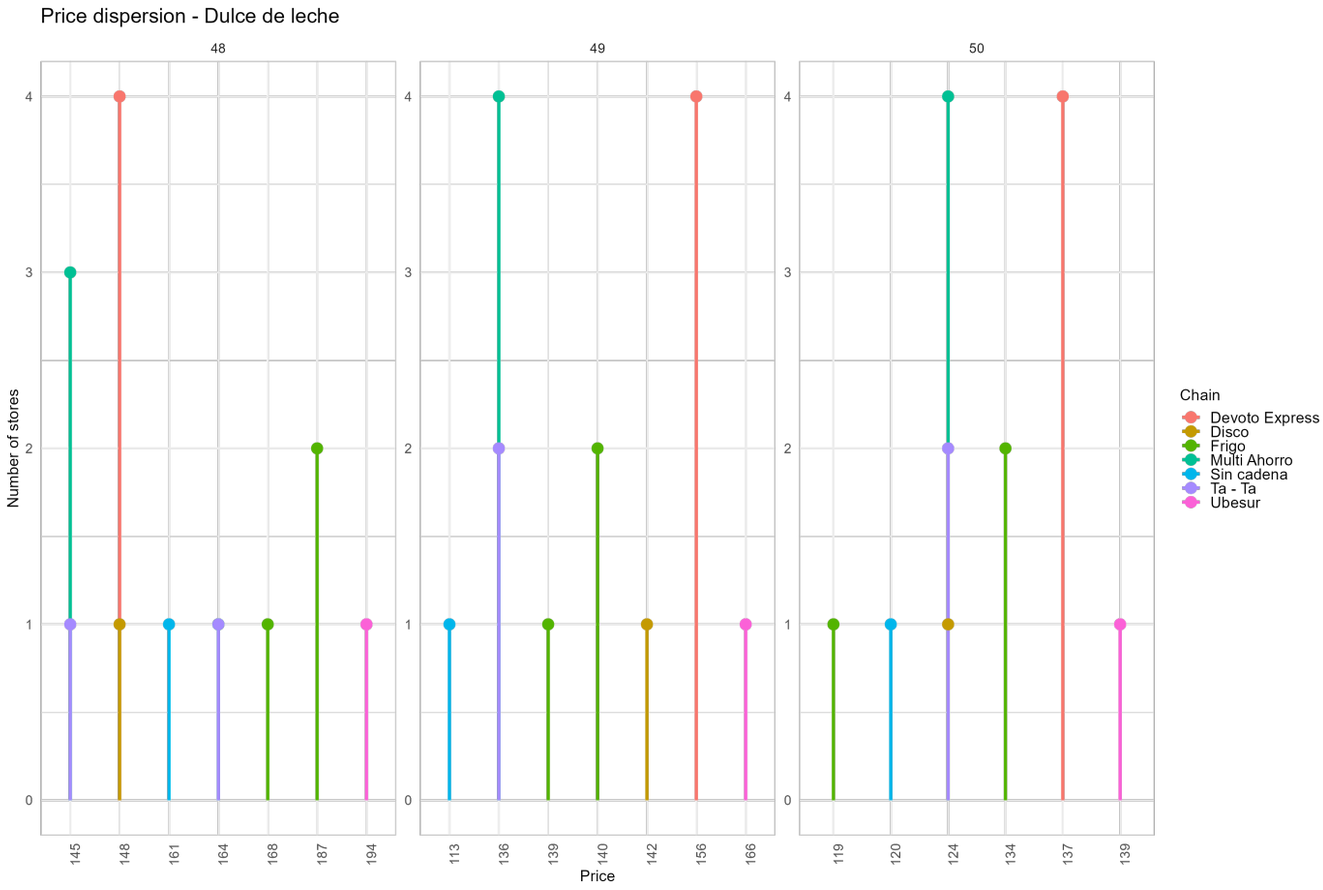

Table 6: *Stores by geographic markets.*

| | Number of stores |
|---|---|
| CCZ 2 | 35 |
| CCZ 5 | 30 |
| CCZ 1 | 25 |
| Maldonado | 19 |
| CCZ 4 | 16 |
| Canelones | 16 |
| Rocha | 16 |
| CCZ 14 | 15 |
| Ciudad de la Costa | 15 |
| CCZ 6 | 14 |
| CCZ 3 | 14 |
| CCZ 11 | 13 |
| Colonia | 12 |
| CCZ | 12 |
| CCZ 8 | 11 |
| San José | 11 |
| Salto | 10 |
| CCZ 9 | 10 |
| Punta del Este | 9 |
| Las Piedras | 9 |
| CCZ 7 | 8 |
| Paysandú | 7 |
| CCZ 12 | 7 |
| Tacuarembó | 6 |
| Piriápolis | 6 |
| CCZ 10 | 5 |
| CCZ 15 | 5 |
| CCZ 18 | 5 |
| CCZ 16 | 5 |
| Florida | 5 |
| CCZ 17 | 4 |
| Treinta y Tres | 4 |
| Lavalleja | 4 |
| Flores | 4 |
| Cerro Largo | 4 |
| Durazno | 4 |
| Atlántida | 3 |
| Río Negro | 3 |
| Paso de Carrasco | 3 |
| La Paz | 3 |
| San Carlos | 3 |
| Artigas | 2 |
| Santa Lucía | 2 |
| Pando | 2 |
| Soriano | 2 |

Source: author's calculation.

Table 8: *Price dispersion across stores.*

| | log-price sd |
|---|---|
| Chain | |
| Sin cadena | 0.0288495600 |
| Frigo | 0.0265379400 |
| Ubesur | 0.0091256710 |
| El Dorado | 0.0009093525 |
| Red Market | 0.0005067754 |
| Superstar | 0.0004085630 |
| Ta-Ta | 0.0002144605 |
| Devoto Express | 0.0001342381 |
| Tienda Inglesa | 0.0001306921 |
| Disco | 0.0000193819 |
| El Clon | 0.0000602144 |
| Micro Macro | 0.0000018960 |
| Macro | 0.00 |
| Los Jardines | 0.00 |
| Super XXI | 0.00 |
| La Colonial | 0.00 |
| | log-price sd |
| Department | |
| Montevideo | 0.0288495600 |
| Frigo | 0.0265379400 |
| Ubesur | 0.0091256710 |
| El Dorado | 0.0009093525 |
| Red Market | 0.0005067754 |
| Superstar | 0.0004085630 |
| Ta-Ta | 0.0002144605 |
| Devoto Express | 0.0001342381 |
| Tienda Inglesa | 0.0001306921 |
| Disco | 0.0000193819 |
| El Clon | 0.0000602144 |
| Micro Macro | 0.0000018960 |
| Macro | 0.00 |
| Los Jardines | 0.00 |
| Super XXI | 0.00 |
| La Colonial | 0.00 |
| La Colonial | 0.00 |
| La Colonial | 0.00 |
| La Colonial | 0.00 |
| | log-price sd |
| Income level | |
| Q1 | 0.04118788 |
| Q2 | 0.04924703 |
| Q3 | 0.07400207 |
| Q4 | 0.07747025 |
| Q5 | 0.06873581 |

Source: author's calculation.