Price Setting in Retailing: the Case of Uruguay

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1. INTRODUCTION

In recent years there has been a large increase in the empirical literature of price behavior. As new and detailed datasets become available we observe an important number of studies on the microeconomic fundamentals of price setting of firms –mainly retailers– and their impact on inflation. This analysis allows a better understanding of the behavior, dispersion and volatility of prices.

In this paper, we use a rich and unique dataset of 30 million daily prices in grocery stores and supermarkets across the country to analyze

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stylized facts about consumer price behavior. Our findings are as follows: *i)* The median duration of prices is two and one-half months. Therefore, retail prices in Uruguay are less sticky than in the United States (USA) and Brazil, but stickier than in Chile and the UK. *ii)* We do not find evidence of a seasonal pattern in the likelihood of price adjustments. *iii)* The frequency of price adjustment is only correlated with expected inflation for the personal care product category. However, for the food category we find that firms change the percentage points of the adjustment and not their frequency. *iv)* The probability of price change on the first day of the month is nine times higher than on any another day. *v)* The probability of a price change is not constant over time. *vi)* There exists a high synchronization of price changes in our database, either at the city level or chain level. Overall, our analysis seems to be consistent with time dependent models, although the high synchronization of price changes on the first day of the month awaits a better theoretical formalization.

1.1 A Brief Review of the Empirical Literature

Although there are different theoretical models that explain these issues in the macroeconomic literature –such as menu cost models, sticky price, sticky information models, and time or state-dependent pricing strategies–, the stylized facts pointed out in the literature avoid a unique formalization. Klenow and Malin (2010) provide an up-to-date and concise overview of the empirical evidence, and confront the data with different theoretical models. They stress ten facts of the microeconomic behavior of prices. The primary facts are that prices do change at least once a year; that the main instrument for downward price adjustment is sales; that most markets have a stickier reference price; that goods prices differ in their frequency of adjustment and their changes are asynchronous between them; that there exist microeconomic forces which explain the behavior of prices that differ from aggregate inflation and, finally, that prices adjust mainly when wages change.

Gopinath and Rigobon (2008) study the stickiness of traded goods using micro data on US import and export prices at-the-dock for the period 1994-2005. They find long price duration of traded goods –10.6 months for imports, and 12.8 months for exports–; great heterogeneity in price stickiness across goods at the disaggregated level; a declining probability of price adjustment over time for imports; and a rather low exchange rate pass-through into US import prices.

Nakamura and Steinsson (2008) use the Consumer Price Index (CPI) and the Producer Price Index (PPI) from the Bureau of Labor Statistics (BLS) in the USA for the period 1988-2005 to study price stickiness. Their results show that there is a duration of regular prices of between 8 and 11 months, after excluding price sales; that temporary sales are an important source of price flexibility –mainly downward price flexibility–; that, excluding sales, roughly one-third of price changes are price decreases; that price increases function strongly as covariates with inflation, but price decreases do not; and that price changes are highly seasonal –mainly in the first quarter. Finally, they find that the hazard function of price changes, which estimates the probability of a price change after t periods without changing, is slightly downward sloping, which implies that the probability of a price change occurring decreases the longer the time span since the last change.

Some of these conclusions are relativized by Klenow and Kryvtsov (2008). Using monthly price information from the BLS for the period 1988-2004, they find that prices change quite frequently, every 3.7 months if sales are included and up to 7.2 months if excluded. They compare their results with those of other papers for the USA and conclude that different methodologies on how to include or not include sales and how to take into account prices of substituted goods, change the estimated rigidity of prices. Price changes are quite large, up to an average of 10% a year in their sample. Also, they find a large number of small price changes: nearly 44% of price changes are smaller than 5% in absolute value, with 12% being smaller than 1%. The distribution of the size of price changes is similar between price increases and decreases. Hazard rate estimates for a given item are quite flat, after taking into account the mix of heterogeneous hazard rates for different goods, that is, survival bias.

Ellis (2009) studies the behavior of prices using weekly data for the UK. He finds low price rigidities in the UK retailing industry. Prices change frequently (the mean duration is about two weeks) even after discarding promotions and sales. When analyzing the sign of the price change in price reversals –that is, price changes that later reverted to the original price–, he finds that there is a prevalence of price decreases, which is consistent with sales. Also the range of price changes is very wide: there are some products that display large changes in prices, and a large number that show small changes. Lastly, he finds that all products have declining hazard functions, as do Nakamura and Steinnson (2008).

Studies for Latin America are scarce due to the lack of available scan data, and they have concentrated on micro CPI data. Barros et al. (2009) and Medina et al. (2007) analyze price formation in Brazil and Chile, respectively. They show that the frequency of adjustment is different from the one obtained using macro data. They estimate median duration of four and three months for Brazil and Chile, respectively. Because their data is monthly, they cannot capture price changes within a month. Also, the CPI data must deal with a higher measurement error than does scan data. Chaumont et al. (2010) study price setting behavior in Chile using weekly scan data. They find significant heterogeneity in price behavior by supermarkets. One salient finding is the relative price flexibility of Chilean supermarkets in their database; price duration is about 1.3 weeks, even lower than in the UK, see Ellis (2009). In contrast to Nakamura (2008), they find that nearly 35% of price changes are idiosyncratic to product or chain shocks, and 65% of prices changes are common shocks that affect all products in a category and all stores in the country at the same time. The only paper that compares price rigidities across Latin American countries is that of Cavallo (2010). He uses scraped online data from Argentina, Brazil, Chile, Colombia, and Uruguay. He finds price stickiness in Chile and relative price flexibility in Brazil.

To the best of our knowledge, our paper is the first to analyze price behavior of retailers in a small open economy using daily price data from across all country regions. The objective of this study is to describe stylized facts of price formation in Uruguay and to compare them with those of the existing literature. The paper is organized as follows: The next section provides a detailed description of the database. After that, we present the main findings of the analysis, and offer a brief comparison with the available evidence. Then, we discuss the implication of our findings for the existing theoretical literature. Finally, the last section shows the study's main conclusions.

2. DATA

We analyze a micro dataset with a daily frequency compiled by the General Directorate of Commerce (DGC, by its Spanish acronym) which includes more than 300 grocery stores all over the country and 155 products (see Annex 1 for a map with the cities covered in the dataset). The product brands were chosen to be the most representative of the product being

described, and they were selected as the best selling brand in each category. The products in the sample represent at least 12.6% of the goods and services in the CPI basket (see Annex 2).

The DGC is the authority responsible for the enforcement of the Consumer Protection Law at the Ministry of Economy and Finance. In 2006 a new tax law was passed by the legislature which changed the tax base and rates of the value added tax (VAT). The basic rate was reduced from 23% to 22% and its minimum rate (staple foods, hotel rooms in high season, certain health related services and electricity for public consumption) from 14% to 10%. In addition, exemptions were eliminated (e.g. health sector, passengers transport, sales of new homes). A tax on intermediate consumption of goods (COFIS) at a 3% rate was eliminated. The tax reform also reduced the asymmetries between sectors of activity regarding the employer contribution to social security and introduced a personal income tax.

As the Ministry of Economy and Finance is concerned about incomplete pass-through from tax reduction to consumer prices, it publishes an open public dataset of prices in different grocery stores and supermarkets in order to inform consumers. In this regard, the DGC issued Resolution Number 061/006 which mandates that grocery stores and supermarkets must report the daily prices for a list of products if they fulfill the following two conditions: *i)* they sell more than 70% of the products listed in Annex 2 of said Resolution, and *ii)* they have more than four grocery stores under the same name, or have more than three cashiers in a store. The information sent by each supermarket is a sworn statement, which means that they are subject to penalties in case of misreport.

The DGC makes the information public through a webpage that publishes the average monthly prices of each product for each store in the defined basket (see http://www.precios.gub.uy/publico/). This information is available within the first ten days of the next month. It should be noted that there is no further use for the information; e.g. no price control, nor are any further policies implemented to control supermarkets or producers. The idea is to give consumers adequate information about prices so they can do their shopping at the cheapest store.

The products that are to be reported to the DGC were initially established per the results of a survey distributed to the main supermarket chains inquiring about their annual sales for each item and brand. After discarding supermarkets' own brands, the three highest-selling brands were chosen to be reported for each item. Most items had to be homogenized in

order to be comparable, and each supermarket must always report the same item. For example, bottled sparkling water of the Salus brand is reported in its 2.25 liters variety by all stores. If this specific variety is not available at a store, then no price is reported.

Each item is defined by its universal product code (UPC) with the exception of meat, eggs, ham, some types of cheese, and bread. In some instances, as in the case of meat and various types of cheese, general definitions were set, but because of the nature of the products, the items could not be homogenized. In the case of bread, most grocery stores buy frozen bread and bake it, rather than produce it at the store. Grocery stores differ in the kinds of bread they sell, so in some cases the reported bread does not coincide with the definition, and grocery stores prorate the price submitted to the DGC; i.e. if the store sells bread that is 450 grams per unit, and the requested bread is 225 grams, it submits half the price of its own bread.

Each month, the DGC issues a brief report with general details of the price evolution. This report counts the number of products that increase or decrease their prices. The prices used for these calculations are the simple average market prices for each product.

The database records began in March 2007, and the new tax base was put into place in July 2007. A few months later, new products were added to the database, after a push of inflation in basic consumer products in 2008. The government made "voluntary sectoral price agreements" with producers in the salad oil, rice and meat markets. Additionally, in the second semester of 2010, newer goods were added to the dataset in order to expand its representation.

Within two days of the end of the month, each supermarket uploads its price information to the DGC. After that, it begins a process of *price consistency checking*. This process starts by calculating the average price for each item in the basket. Each price 40% greater or less than the average price is selected. Then, the supermarket is contacted in order to check whether the submitted price is right. If there is no answer from the supermarket, or if the supermarket confirms the price submitted, the price is posted online as reported. If the supermarket corrects the price, which is an exception, the price is corrected in the database and posted online.

Our database contains daily prices from April 2007 to December 2010 on 155 items. From the database, we eliminated: *i)* those items that were not correctly categorized (marked as "XXX" and "0"); *ii)* ham, as different products mistakenly share the same UPC; and *iii)* one brand of cheap ham

"Leonesa" and meat that also share the same UPC. The complete list of products can be found in Annex 2. We also eliminated March 2007 observations, because they were preliminary and had not been posted online. Finally, we eliminated those products –and supermarkets– for which there are no observations for more than half of the period.

We end up with data for 117 products in 303 grocery stores from 45 cities in the 19 Uruguayan departments (see Annex 1). These cities represent 80% of the total population of Uruguay. The capital city, Montevideo, with 45% of the population contains 60% of the supermarkets in the sample.

Table 1 summarizes the total number of price observations (30 million) according to four product categories: *food*, *soft drinks*, *alcohol*, and *personal care and cleaning items* (named *personal*). Food is the main category, followed by products of personal cleaning, and lastly beverages.

TABLE 1. NUMBER OF DAILY PRICE OBSERVATIONS BY CATEGORY, APRIL 2007 TO DECEMBER 2010

Category	*Number of observations*	*Percentage of total*
Food	20,380,541	66
Soft drinks	1,814,628	6
Alcohol	1,486,176	5
Personal	7,038,089	23
Total	*30,719,434*	*100*

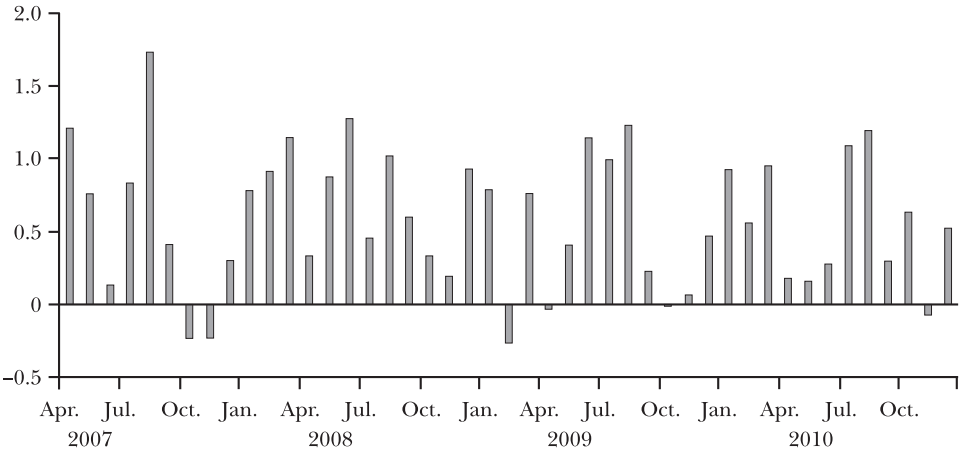
SOURCE: Own elaboration from data of the Uruguayan Ministry of Economy and Finance.

Finally, as our results could be driven by differences in the overall inflation in the sample, we plot the monthly variation of prices. This period is characterized by inflation pushes (the median monthly inflation rate is 0.56%), as the government was worried that inflation would reach a high level in the medium term.

3. RESULTS

This section shows the main results of the analysis, and it is divided into six facts. The first section reviews the frequency of price adjustment. The second section studies the existence of seasonality in the pricing adjustment of supermarkets. In the third, we study the nexus between individual price changes and expected overall inflation. The fourth section analyzes price changes by day of the month, which is new in the literature. The

FIGURE 1. MONTHLY INFLATION RATE, 2007-1010 (%)



SOURCE: Instituto Nacional de Estadística.

fifth computes the joint hazard rate of price changes. Lastly, we study the synchronization of prices at the chain and city level.

3.1 Frequency of Price Adjustments

As is standard in the literature, we first study the rigidity of prices by computing the median probability of daily price changes and the median duration of prices in months, and by contrasting the results of price increases and decreases. It should be noted that we study the whole sample and do not differentiate between sales and the absence of sales. From a theoretical point of view, if there is a price decrease because of a sale this shows evidence of price flexibility and we do not want to eliminate such an observation (see Klenow and Kryvtsov, 2008).

The median daily price change for the whole sample is a non-trivial 1.3%. This implies a medium price change every 75 days, or every two and one-half months, on average, which is considerably lower than the estimates of Nakamura and Steinsson (2008) and Nakamura (2008), but greater than the results of Chaumont et al. (2010) for Chile and Ellis (2009) by about two weeks. This result is slightly less than the median durations of three and four months found by Barros et al. (2009) and Medina et al. (2007) for Brazil and Chile, respectively.

We offer two explanations for this behavior: First, this is a period of relatively high inflation, so one could expect prices to change more quickly: the median monthly inflation in the period in Uruguay was 0.56%.

Second, as our database has daily prices, we can calculate price changes more accurately than in previous studies that use weekly or monthly data. In this case, we can detect earlier price changes and our measure of price rigidity would be more sensitive to them. This would result in less price stickiness for our database.

In line with Nakamura and Steinsson (2008), 40% of the price changes are price decreases. Table 2 presents the median probability of price changes, the percentage of price decreases and the median monthly duration by product category.

TABLE 2. PRICE VARIATION AND DURATION BY CATEGORY

Category	*Median probability of daily variation*	*Percentage decrease*	*Monthly duration*
Food	0.013	40.6	2.5
Soft drinks	0.010	33.3	3.2
Alcohol	0.009	30.0	3.5
Personal	0.017	42.0	1.9
Total	*0.013*	*40.4*	*2.5*

SOURCE: Own elaboration from data of the Uruguayan Ministry of Economy and Finance.

Our results show that the personal cleaning category is that which changes price most frequently, and that the alcohol category is the opposite. There is a significant variation in price stickiness across product categories, ranging from 1.9 months for personal to 3.5 months for alcohol.

In Annex 3 we present a detailed analysis of this result for each product in the sample. There is a high variability of results across products. For example, we find products that change prices quite frequently, such as cheese "Disnapt" and "Cerros del Este," for which prices change five and two times a month, respectively. Other products change prices more slowly, like brown eggs "El Ecologito" and salt "Torrevieja," whose prices can remain the same up to five months.

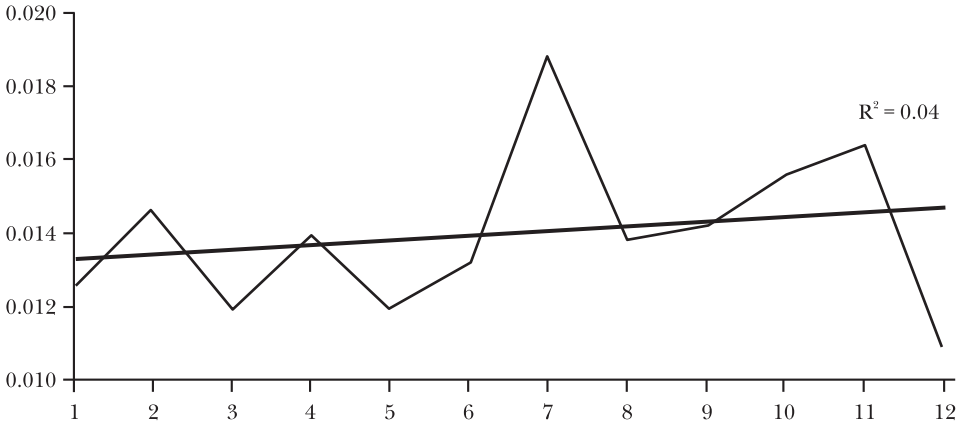
3.2 Seasonality of Price Changes

Secondly, we study the existence of a seasonal adjustment pattern of prices. Nakamura and Steinsson (2008) find that price changes in the USA are highly seasonal, and are concentrated in the first quarter and then decrease. This seasonality of Nakamura and Steinsson (2008) is consistent with their price rigidity calculation of about eihht months. In contrast,

Ellis (2009) finds no monthly seasonality in his study, a result in line with his finding of just two weeks of price rigidity. As we find price duration of two and one-half months, we should expect to find no seasonality in the data.

Figure 2 shows that there is not a clear pattern of seasonality in the price adjustment of firms.

FIGURE 2. PROBABILITY OF PRICE CHANGE BY MONTH



SOURCE: Own elaboration from data of the Ministry of Economy and Finance.

Additionally, we do not find a seasonal pattern in price changes looking at data on a quarterly basis. The percentage of daily price changes in the first quarter is 1.28%, 1.29% in the second, 1.58% in the third, and 1.49% in the fourth quarter. The greatest price change seems to be concentrated in the third quarter. Next, we look at the seasonal behavior of prices by categories (see Table 3).

All categories but personal have the greatest number of price changes in the third quarter, although there is no clear tendency in the data. Therefore, we cannot conclude that seasonality exists in the speed of price adjustments.

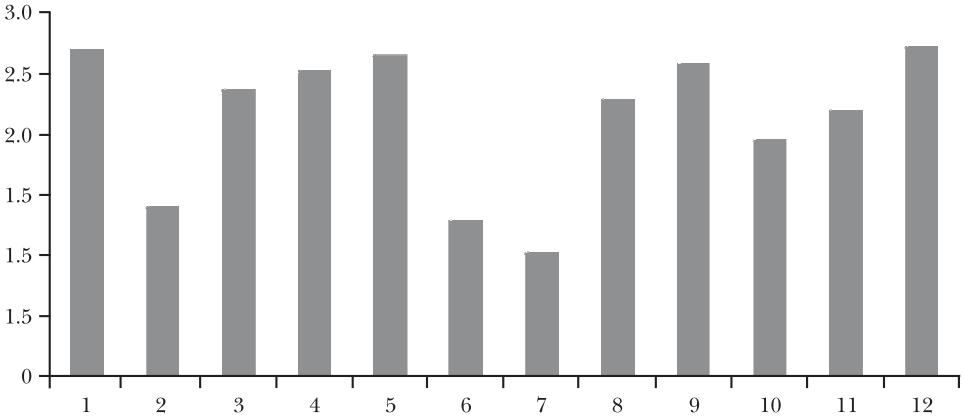
TABLE 3. SEASONAL PROBABILITY OF PRICE CHANGE BY PRODUCT CATEGORY AND QUARTER

Quarter / Category	*Food*	*Soft Drinks*	*Alcohol*	*Personal*
1	0.013	0.008	0.006	0.013
2	0.012	0.009	0.008	0.017
3	0.016	0.012	0.010	0.018
4	0.015	0.010	0.009	0.019

SOURCE: Own elaboration from data of the Uruguayan Ministry of Economy and Finance.

Next, we study whether seasonality exists in the level of the price adjustments. Figure 3 shows the rate of price growth conditional on price change by month. Again, we do not observe a clear pattern of seasonality. It should be stated that in Uruguay workers receive an extra half month's wages in June and December. Also, during December's New Year festivities, supermarkets' sales generally receive a boost.[1] In summary, we do not find demand driven seasonal price changes in the data.

FIGURE 3. PRICES GROWTH RATE GIVING PRICE CHANGE BY MONTH (%)



SOURCE: Own elaboration from data of the Ministry of Economy and Finance.

3.3 Individual Price Changes and Inflation Perceptions

One interesting issue is whether price changes and inflation expectations move together. Ellis (2009) suggests a positive relationship between the frequency of price changes in his sample and the inflation perception surveyed by Bank of England. Table 4 shows the result of an ordinary least square (OLS) regression estimation where the dependent variable is the median probability of price change and the exploratory variables are expected inflation and indicator variables for the July 2007 tax reform. The expected inflation variable is the median forecast from a survey of experts performed by the Central Bank of Uruguay. We include an indicator variable before and after the tax reform to capture anticipated effects of the reform.

[1] In Uruguay, supermarkets' sales usually soar the day before they close. The 1st and 6th of January, the 1st of May, and the 25th of December are usually the days that supermarkets do not open.

The regression shows no correlation between changes in prices and inflation perception. One would suggest that if prices tend to be stickier, then the inflation expectations should not be of inflation acceleration. It is interesting to point out that we only observe correlation between inflation and the percent variation in individual prices when considering price decreases. The tax reform indicator variables suggest that firms anticipated the reform and changed prices before the implementation of the reform in July 2007.

TABLE 4. INDIVIDUAL PRICE CHANGES AND INFLATION PERCEPTIONS: OLS REGRESSION, APRIL, 2007 TO DECEMBER, 2010

	Dependent variable			
	Probability of price change	*Price change in percentage*		
Variables		*All*	*Increases*	*Decreases*
Expected yearly inflation	0.001	–0.024	0.449	–0.640[a]
	(0.001)	(0.412)	(0.369)	(0.194)
Tax reform indicator variable, May 2007	0.008[c]	3.052[c]	3.659[b]	–1.043
	(0.004)	(1.792)	(1.604)	(0.844)
Tax reform indicator variable, June 2007	0.012[b]	–4.102[b]	2.500	–0.288
	(0.004)	(1.790)	(1.602)	(0.843)
Tax reform indicator variable, July 2007	0.011[b]	–1.371	–4.849[a]	2.740[a]
	(0.004)	(1.789)	(1.602)	(0.843)
Tax reform indicator variable, August 2007	–0.018[a]	3.396[c]	–0.550	–1.401
	(0.004)	(1.793)	(1.605)	(0.845)
Tax reform indicator variable, September 2007	–0.009[a]	–0.390	0.183	0.479
	(0.003)	(1.293)	(1.158)	(0.609)
Constant	–0.001	1.520	5.090[b]	–4.304[a]
	(0.007)	(2.780)	(2.488)	(1.309)
Observations	45	45	45	45
R-squared	0.733	0.229	0.405	0.399

SOURCE: Own elaboration from data of the Uruguayan Ministry of Economics and Finance and the Central Bank of Uruguay.

NOTES: Standard errors in parentheses. [a] p<0.01, [b] p<0.05, [c] p<0.1.

For a better understanding of the relation between individual daily prices and inflation, we estimate the previous equation by product category. Table 5 shows the results of the coefficient on expected inflation.

Interestingly, results indicate that there is a positive association between probability of price changes and expected inflation only for the *personal* product category. For the other product categories, the correlation is zero. This means that expectations about future inflation do not influence the price strategies of firms in those markets. We do find an association between changes in prices and the average rate of price decreases in the *food* product category.

TABLE 5. INDIVIDUAL PRICE CHANGES AND INFLATION PERCEPTIONS: OLS REGRESSION BY PRODUCT CATEGORY, APRIL 2007 TO DECEMBER 2010

	Dependent variable			
	Probability of price change	*Price change in percentage*		
Category		*All*	*Increases*	*Decreases*
	Coefficient - Standard Error on Expected Yearly Inflation			
Food	0.001	–0.168	0.700	–0.771[a]
	(0.001)	(0.522)	(0.456)	(0.221)
Soft drinks	–0.001	–1.644[c]	–1.678	0.393
	(0.001)	(0.924)	(1.997)	(0.513)
Alcohol	0.003	0.298	0.256	–0.064
	(0.002)	(0.790)	(0.781)	(0.552)
Personal	0.003[b]	0.839	0.195	–0.602
	(0.001)	(0.527)	(0.477)	(0.361)
Observations	45	45	45	45

SOURCE: Own elaboration from data of the Uruguayan Ministry of Economics and Finance and the Central Bank of Uruguay.

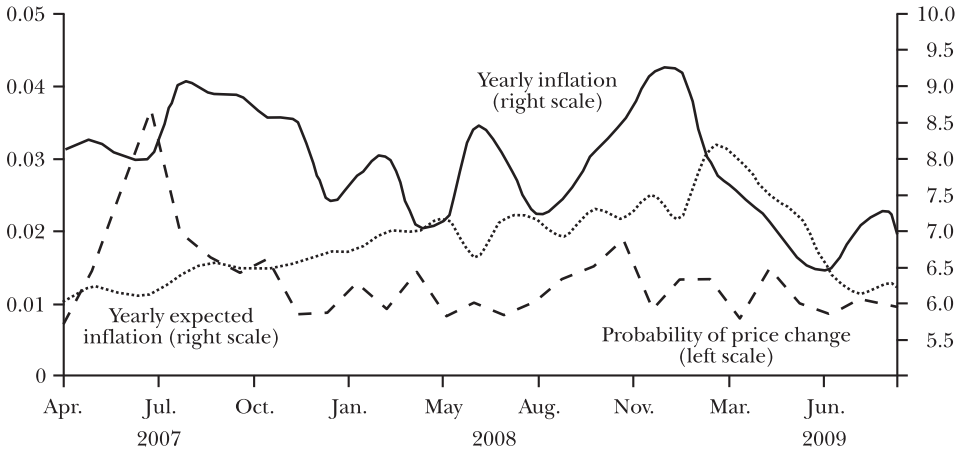
NOTES: Standard errors in parentheses. [a] $p<0.01$, [b] $p<0.05$, [c] $p<0.1$.

To provide more evidence for this topic Figure 4 plots the probability of price adjustment (left scale), and the inflation and expected inflation rate (left scale). We observe no association between price changes and inflation perceptions.

3.4 Prices Changes by Day of the Month

Given the fact that we have daily data we can analyze the pricing decision of firms by day of the month. Figure 5a shows the probability of a price change by day of the month. Interestingly, the probability of price

FIGURE 4. PROBABILITY OF PRICE CHANGE, INFLATION AND EXPECTED INFLATION, 2007-2009



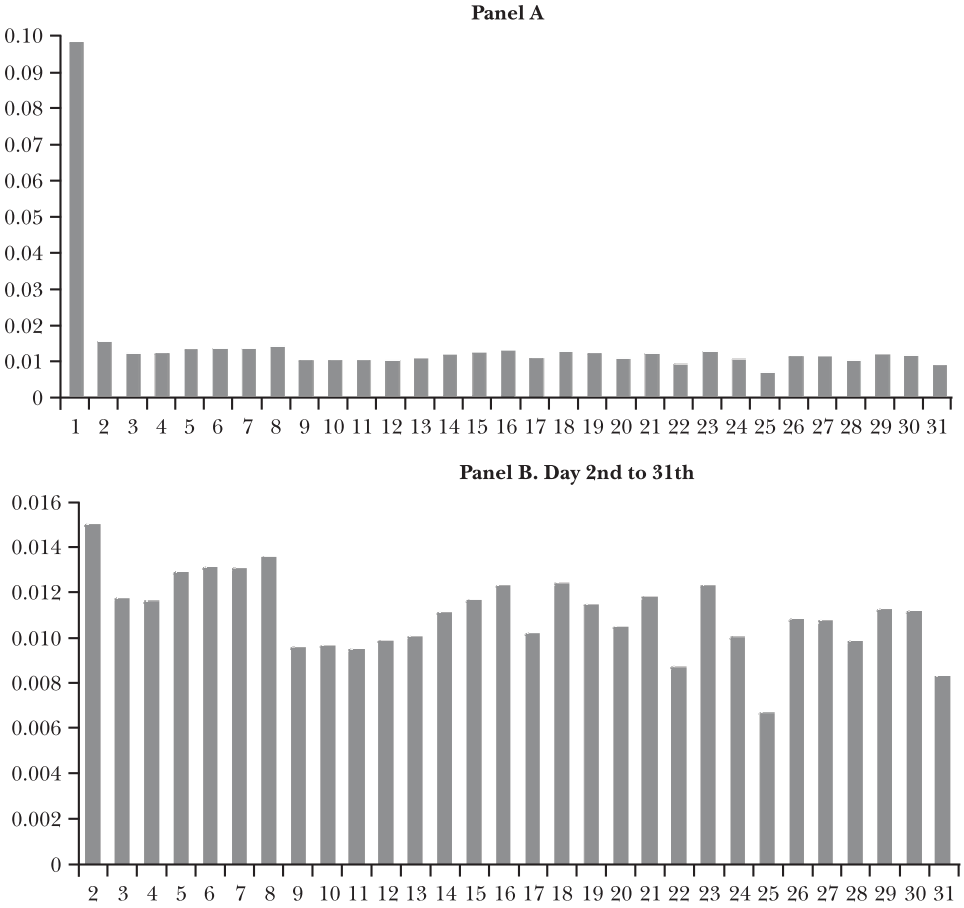
SOURCE: Own elaboration from data of the Ministry of Economy and Finance and the Central Bank of Uruguay.

change on the first day of the month is nine times higher than on any other day.

Figure 5b plots the daily probability of a price change from the second day to the last day of the month. In this case, we do not observe a clear pattern in the data.

Figure 6 shows that price increases and decreases also are concentrated on the first day of the month. Also, Figure 7 shows that the fact that price changes are concentrated on the first day of the month is a general result valid to all product categories. This is one of the most remarkable findings of our paper, since to the best of our knowledge no other study analyzes the distribution of price changes by day of the month. One supermarket manager told us that this pricing behavior is related to producers, which tend to adjust their prices the first day of the month. In this case, the observed behavior could be a response to cost increases by supermarkets. This pattern is the same for price increases and price decreases. As price decreases are associated with sales, this implies that supermarkets tend to follow a pattern of price changes that concentrates most of them in one day, which may indicate the existence of menu costs associated with pricing behavior or some other rigidity that prevents the supermarkets from changing prices.

FIGURE 5. PROBABILITY OF PRICE CHANGES BY DAY

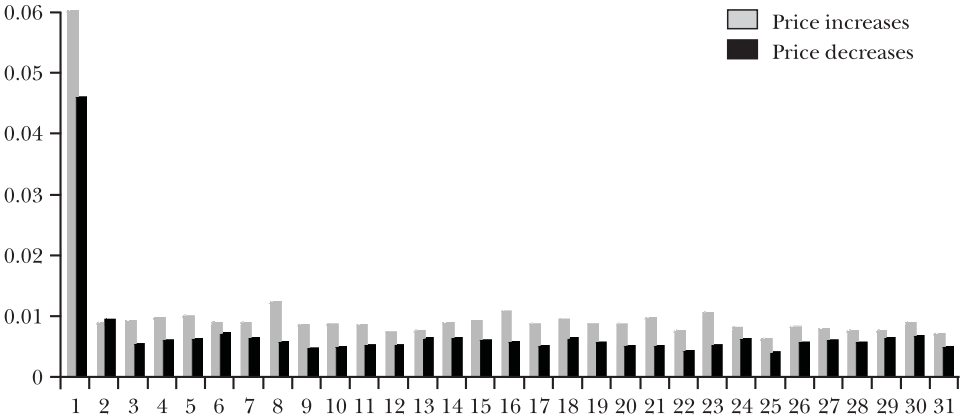


SOURCE: Own elaboration from data of the Ministry of Economy and Finance.

3.5 Hazard Rate Estimates

In order to study whether price changes are time dependent we estimate the hazard rate. The hazard rate at moment t is calculated as the quotient of the number of prices that change in t, given that they do not change until that moment, over the number of prices that have not changed until moment t. As the greatest price duration is half a year (see Annex 3) we calculate the hazard function up to two hundred days. Figure 8 shows the smoothed hazard rates. We observe a non-constant over time hazard rate. This result is consistent with Nakamura (2008) and Ellis (2009),

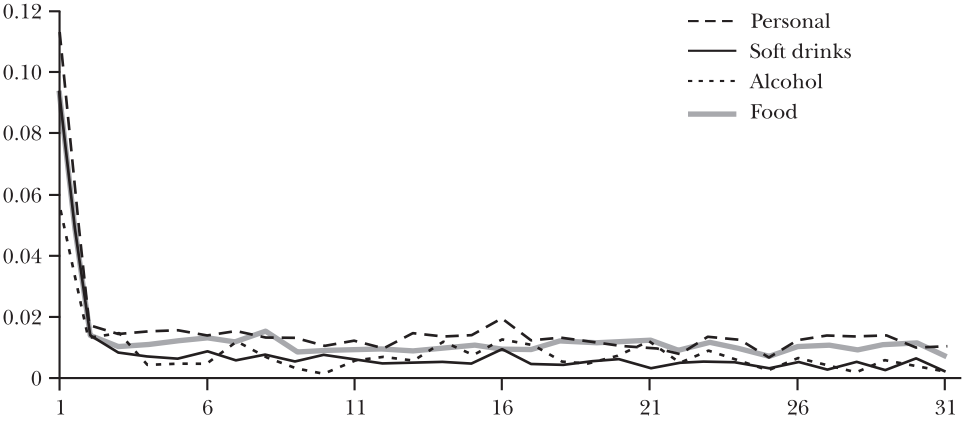
FIGURE 6. PROBABILITY OF PRICE INCREASES AND DECREASES BY DAY OF THE MONTH



SOURCE: Own elaboration from data of the Ministry of Economy and Finance.

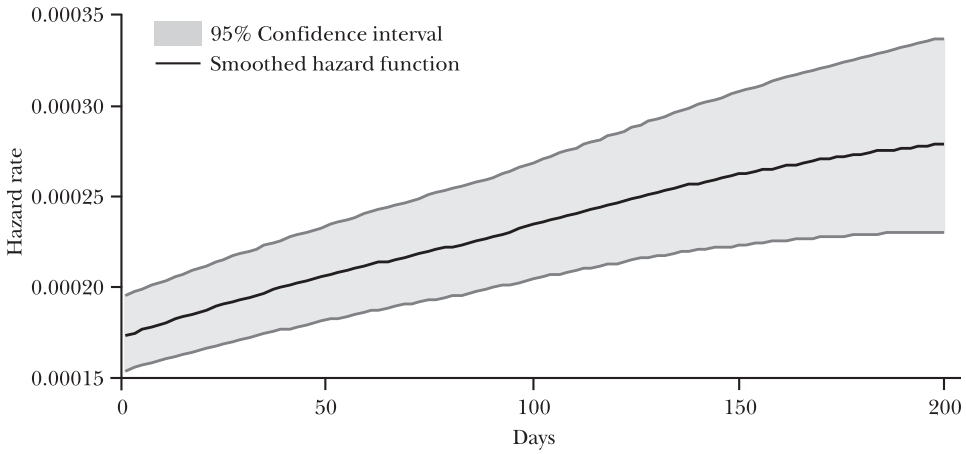
although they find hazard rates to be decreasing, and we find increasing rates. The upward-sloping hazard rate is consistent with state-dependent pricing. This fact invalidates the modeling of a constant probability of price change, and implies that supermarkets do not follow a time dependent strategy for price setting. In turn, this result is in line with our finding of no seasonality in price changes.

FIGURE 7. DAILY PROBABILITY OF PRICE CHANGES BY PRODUCT CATEGORY



SOURCE: Own elaboration from data of the Ministry of Economy and Finance and the Central Bank of Uruguay.

FIGURE 8. SMOOTHED HAZARD ESTIMATE



SOURCE: Own elaboration from data of the Ministry of Economy and Finance, and the Central Bank.

3.6 Price Synchronization

Finally, we estimate price synchronization in two ways: across firms that belong to the same chain, and across firms in each city. To estimate price synchronization we calculate the Fisher and Konieczny (2000) estimator (FK). Table 6 indicates that price changes across supermarkets of the same chain[2] are highly synchronized.

For this result two remarks are in order. First, our database consists of daily observations and we find that prices change on average after about

TABLE 6. PRICE SYNCHRONIZATION ACROSS SUPERMARKETS THAT BELONGS TO THE SAME CHAIN

Chain	*Fisher and Konieczny indicator*
Devoto	0.94
Tienda Inglesa	0.92
Macromercado Mayorista	0.96
El Dorado	0.92
Multiahorro	0.91
Disco	0.96
Ta Ta	0.84

SOURCE: Own elaboration from data of the Uruguayan Ministry of Economy and Finance.

[2] We estimate the FK indicator just for the major chains: those that have more than five stores and also more than three cashiers per store on average.

two and one-half months. Second, we also find that price changes are concentrated on the first day of the month. Therefore, our database has a great deal of synchronized 'no price changes' and as a consequence a high FK. To control for this effect, we also estimate the FK synchronization indicator, conditional on price change (see table 7).

TABLE 7. ADJUSTED PRICE SYNCHRONIZATION SUPERMARKETS CHAINS THAT BELONGS TO THE SAME CHAIN CONDITIONAL ON PRICE CHANGE

Chain	*Synchronization indicator*
Devoto	0.54
Tienda Inglesa	0.56
Macromercado Mayorista	0.75
El Dorado	0.51
Multiahorro	0.56
Disco	0.61
Ta Ta	0.36

SOURCE: Own elaboration from data of the Uruguayan Ministry of Economy and Finance.

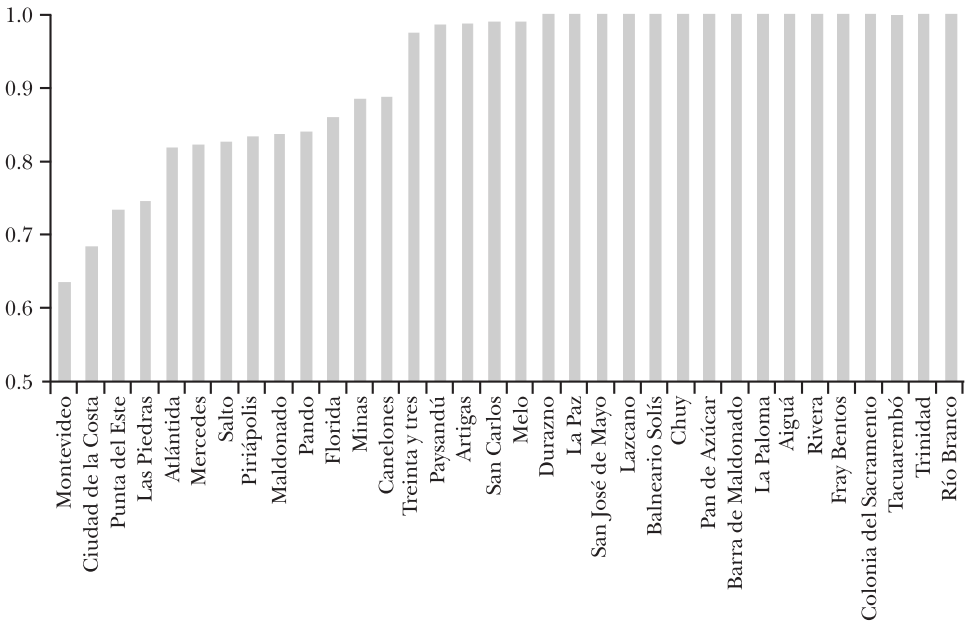
In this case, the synchronization estimates are lower than before, but the main result of high synchronization of price adjustments in supermarkets that belong to the same chain remains. This result is in contrast to that of Chaumont et al. (2010), who finds much lower price synchronization for Chile.

Additionally, we estimate the FK synchronization indicator across the cities in our sample. Figure 9 shows the FK estimator for each city. As it can be seen, synchronization is by itself large, with a minimum of 0.63 for Montevideo –which has the greatest number of supermarkets– and one for a large number of cities which have few supermarkets.

4. CONTRASTING THE RESULTS WITH THEORY

In this section we compare the results of the analysis with the main theoretical predictions of menu costs, time-dependent and state-dependent theories. We discuss each stylized fact found in the previous analysis and review how it fits the theoretical explanations. Table 8 presents a brief summary of the analysis, in a similar vein to Table 14 of Klenow and Malin (2010).

FIGURE 9. FISHER AND KONIECZNY SYNCHRONIZATION INDICATOR BY CITY



SOURCE: Own elaboration from data of the Ministry of Economy and Finance.

As can be shown from the Table 8, the empirical evidence seems to point to state-dependent models as the main explanation of the inflation phenomena in Uruguay. The flexibility of prices remains a disputed issue in the empirical literature; as we have considered sales in our database, the relative flexibility could be less if we take them out.

In contrast to the empirical literature, we have found a high synchronization of prices even at the chain and city level. This result could be

TABLE 8. STYLIZED FACTS AND MODEL FEATURES

Fact	*Consistent Features*	*Inconsistent Features*
Price change are somewhat flexible	Small menu cost	Large menu cost
No seasonality of price changes	State dependent models	Time dependent models
Price change mainly the first day of the month	Time dependent models	State dependent models – common shocks
Upward-slopping hazard rates	State dependent models	Time dependent models
Price changes are highly synchronized	State dependent models –common shocks– strategic complementarities	Big idiosyncratic shocks

driven by the particularity of our database which consists of daily observations. In the same vein, we have discovered that prices tend to change on the first day of the month. Additionally, this result is not surprising considering the fact that Uruguay is a highly centralized country. This result reflects that common shocks may be an important part of price adjustment policies of firms.

We think that this result could not be explained in full using macro models. As all the items in our database are the highest-selling brands, and most markets are oligopolies –even the supermarket industry– price setting behavior needs to be analyzed using micro modeling. As for the matter of prices changing mostly on the first day of the month, we think that this could serve as a reference point for price setting of firms. This particular day, in turn, could reduce menu costs in the event of price changes.

5. CONCLUSIONS

We present evidence on price formation at the retail level in Uruguay. We use a rich and unique dataset of 30 million daily prices in grocery stores and supermarkets across the country to analyze the behavior of consumer prices in Uruguay. We find that retail prices in Uruguay change frequently. Prices are less sticky than in the USA and Brazil but stickier than in the UK and Chile. The median duration of prices in Uruguay is two and one-half months.

We do not find evidence of a seasonal pattern in the adjustment of prices. The probability of price changes varies positively with expected inflation only for the personal care product category. However, for the food category we find an association between price changes and the percentage rate of price decreases. Also, the probability of price changes on the first day of the month is nine times higher than on any other day of the month, and the probability of price adjustments is not constant over time. Finally, we find very high synchronization of price changes.

This evidence seems to point to a state-dependent model of price changes. Nonetheless, the high synchronization of price changes is a newer element in the empirical literature, which could be the result of analyzing daily data. Lastly, the high concentration of price changes on the first day of the month needs further theoretical analysis, as one possible interpretation could be that this day serves as a reference point for price adjustment.

Annex 1

URUGUAY: CITIES INCLUDED IN THIS STUDY

Annex 2

LIST OF PRODUCTS

Product	*Brand*	*Specification*	*Share in CPI (%)*	*Category*
Beer	Patricia	0.96 l	0.3	Alcohol
Beer	Pilsen	0.96 l	0.3	Alcohol
Common red wine	Roses	1 l	0.34	Alcohol
Common red wine	Santa Teresa Clásico	1 l	0.34	Alcohol
Common red wine	Tango	1 l	0.34	Alcohol
Beef "peceto"	No brand	1 kg	0.90	Food
Beef "nalga"	Boneless - no brand	1 kg	0.43	Food
Beef "nalga"	With bone - no brand	1 kg	0.43	Food
Beef "aguja" meat	Boneless - no brand	1 kg	0.86	Food
Beef "aguja" meat	With bone - no brand	1 kg	0.86	Food
Beef "paleta"	With bone - no brand	1 kg	n/i	Food
Beef "rueda"	With bone - no brand	1 kg	n/i	Food
Ground beef	Up to 20% Fat	1 kg	0.29	Food
Ground beef	Up to 5% Fat	1 kg	0.29	Food
Bread	No brand	1 Unit Aprox. 0.215 kg	1.21	Food
Brown eggs	El Ecologito	1/2 Dozen	0.34	Food
Brown eggs	El Jefe	1/2 Dozen	0.34	Food
Brown eggs	Prodhin	1/2 Dozen	0.34	Food
Butter	Calcar	0.2 kg	0.15	Food
Butter	Conaprole sin sal	0.2 kg	0.15	Food
Butter	Lacterma	0.2 kg	0.15	Food
Cacao	Copacabana	0.5 kg	0.04	Food
Cacao	Vascolet	0.5 kg	0.04	Food
Cheese Colonia	Cerros del Este	1 kg	0.23	Food
Cheese Colonia	Dispnat	1 kg	0.23	Food
Chicken	Avícola del Oeste	1 kg	0.64	Food
Chicken	Tenent	1 kg	0.64	Food
Coffee (non-instant)	Águila	0.25 kg	0.10	Food
Coffee (non-instant)	Chana	0.25 kg	0.10	Food
Caramel spread	Conaprole	1 kg	0.14	Food
Caramel spread	Los Nietitos	1 kg	0.14	Food
Caramel spread	Manjar	1 kg	0.14	Food
Flour	Canuelas	1 kg	0.16	Food
Flour	Cololo	1 kg	0.16	Food
Flour	Puritas	1 kg	0.16	Food
Frankfurters (short)	Cattivelli	8 Units - Aprox. 0.340 kg	0.26	Food
Frankfurters (short)	Ottonello	8 Units - Aprox. 0.330 kg	0.26	Food
Frankfurters (short)	Schneck	8 Units - Aprox. 0.330 kg	0.26	Food
Grated cheese	Conaprole	0.08 kg	0.15	Food
Grated cheese	El Trébol	0.08 kg	0.15	Food
Grated cheese	Milky	0.08 kg	0.15	Food
Semolina noodles	Adria	0.5 kg	n/i	Food
Semolina noodles	Las Acacias	0.5 kg	n/i	Food
Ham	Centenario	1 kg	0.21	Food
Ham	La Constancia	1 kg	0.21	Food

Product	*Brand*	*Specification*	*Share in CPI (%)*	*Category*
Ham	Schneck	1 kg	0.21	Food
Margarine	Danica dorada	0.2 kg	0.02	Food
Margarine	Doriana nueva	0.25 kg	0.02	Food
Margarine	Primor	0.25 kg	0.02	Food
Mayonnaise	Fanacoa	0.5 kg	0.09	Food
Mayonnaise	Hellmans	0.5 kg	0.09	Food
Mayonnaise	Uruguay	0.5 kg	0.09	Food
Noodles	Cololo	0.5 kg	0.3	Food
Peach jam	Dulciora	0.5 kg	0.17	Food
Peach jam	Limay	0.5 kg	0.17	Food
Peach jam	Los Nietitos	0.5 kg	0.17	Food
Canned peas	Arcor	0.35 kg	0.05	Food
Canned peas	El Hogar	0.35 kg	0.05	Food
Canned peas	Trofeo	0.35 kg	0.05	Food
Quince jam	Los Nietitos	0.4 kg	n/i	Food
Rice	Aruba type Patna	1 kg	0.20	Food
Rice	Blue Patna	1 kg	0.20	Food
Rice	Green Chef	1 kg	0.20	Food
Rice	Pony	1 kg	0.20	Food
Rice	Vidarroz	1 kg	0.20	Food
Crackers	El Trigal	0.15 kg	0.17	Food
Crackers	Famosa	0.14 kg	0.17	Food
Crackers	Maestro Cubano	0.12 kg	0.17	Food
Salt	Sek	0.5 kg	0.05	Food
Salt	Torrevieja	0.5 kg	0.05	Food
Salt	Urusal	0.5 kg	0.05	Food
Semolina pasta	Adria	0.5 kg	n/i	Food
Semolina pasta	Las Acacias - franja celeste	0.5 kg	n/i	Food
Soybean oil	Condesa	0.9 l	n/i	Food
Sugar	Azucarlito	1 kg	0.25	Food
Sugar	Bella Union	1 kg	0.25	Food
Sunflower oil	Optimo	0.9 l	0.25	Food
Sunflower oil	Uruguay	0.9 l	0.25	Food
Tea	Hornimans	Box 10 units	0.09	Food
Tea	La Virginia	Box 10 units	0.09	Food
Tea	Lipton	Box 10 units	0.09	Food
Tomato paste	Conaprole	1 l	0.08	Food
Tomato paste	De Ley	1 l	0.08	Food
Tomato paste	Qualitas	1 l	0.08	Food
Yerba mate	Canarias	1 kg	0.34	Food
Yerba mate	Del Cebador	1 kg	0.34	Food
Yerba mate	Sara	1 kg	0.34	Food
Yogurt	Conaprole	0.5 kg	0.06	Food
Yogurt	Parmalat (Skim)	0.5 kg	0.06	Food
Sodium hypoclorite	Agua Jane	1 l	0.08	Personal
Sodium hypoclorite	Sello Rojo	1 l	0.08	Personal
Sodium hypoclorite	Solucion Cristal	1 l	0.08	Personal
Diswashing detergent	Deterjane	1.25 l	0.20	Personal
Diswashing detergent	Hurra Nevex Limon	1.25 l	0.20	Personal

Product	*Brand*	*Specification*	*Share in CPI (%)*	*Category*
Laundry soap	Drive	0.8 kg	n/i	Personal
Laundry soap	Nevex	0.8 kg	n/i	Personal
Laundry soap	Skip - Paquete azul	0.8 kg	n/i	Personal
Laundry soap in bar	Bull Dog	0.3 k - 1 unit	0.45	Personal
Laundry soap in bar	Nevex	0.2 k - 1 unit	0.45	Personal
Shampoo	Fructis	0.35 l	n/i	Personal
Shampoo	Sedal	0.35 l	n/i	Personal
Shampoo	Suave	0.93 l	n/i	Personal
Soap	Astral	0.125 kg	0.16	Personal
Soap	Palmolive	0.125 kg	0.16	Personal
Soap	Suave	0.125 kg	0.16	Personal
Toilet paper	Higienol Export	4 unit - 25 m each	0.24	Personal
Toilet paper	Personal	4 unit - 25 m each	0.24	Personal
Toilet paper	Sin Fin	4 unit - 25 m each	0.24	Personal
Toothpaste	Closeup Triple	0.09 kg	0.49	Personal
Toothpaste	Colgate Total	0.09 kg	0.49	Personal
Toothpaste	Kolynos	0.09 kg	0.49	Personal
Cola	Coca Cola	1.5 l	1.94	Soft drinks
Cola	Nix	1.5 l	1.94	Soft drinks
Cola	Pepsi	1.5 l	1.94	Soft drinks
Sparkling water	Matutina	2 l	0.70	Soft drinks
Sparkling water	Nativa	2 l	0.70	Soft drinks
Sparkling water	Salus	2.25 l	0.70	Soft drinks

SOURCE: Own elaboration from data of the Uruguayan Ministry of Economy and Finance.
NOTE: n/i means not included in the CPI. k: kilogram, l: liter and m: meter.

Annex 3

PROBABILITY OF PRICE CHANGES AND DURATION BY PRODUCT

Product	*Brand*	*Probability of daily variation*	*Monthly price duration*	*Percentage decrease*
Beer	Patricia	0.008	3.9	20.4
Beer	Pilsen	0.009	3.5	23.2
Common red wine	Roses	0.008	4.0	22.1
Common red wine	Santa Teresa Clásico	0.012	2.7	38.3
Common red wine	Tango	0.011	2.9	39.4
Beef "peceto"	No brand	0.026	1.2	40.3
Beef "nalga"	Boneless - no brand	0.027	1.2	43.1
Beef "nalga"	With bone - no brand	0.015	2.2	34.2
Beef "aguja" meat	Boneless - no brand	0.018	1.8	34.7
Beef "aguja" meat	With bone - no brand	0.027	1.2	40.1
Beef "paleta"	With bone - no brand	0.028	1.2	39.9
Beef "rueda"	With bone - no brand	0.013	2.5	34.2
Ground beef	Up to 20% fat	0.022	1.5	37.5
Ground beef	Up to 5% fat	0.019	1.7	36.6

Product	*Brand*	*Probability of daily variation*	*Monthly price duration*	*Percentage decrease*
Bread	No brand	0.011	2.9	28.6
Brown eggs	El Ecologito	0.007	5.0	24.7
Brown eggs	El Jefe	0.008	4.2	29.5
Brown eggs	Prodhin	0.012	2.8	33.8
Butter	Calcar	0.018	1.8	41.8
Butter	Conaprole sin sal	0.016	2.0	32.3
Butter	Lacterma	0.007	4.7	43.2
Cacao	Copacabana	0.011	2.9	34.4
Cacao	Vascolet	0.019	1.7	40.7
Cheese Colonia	Cerros del Este	0.068	0.5	45.0
Cheese Colonia	Dispnat	0.145	0.2	48.4
Chicken	Avícola del Oeste	0.041	0.8	42.8
Chicken	Tenent	0.039	0.8	44.6
Coffee (non-instant)	Águila	0.009	3.7	34.0
Coffee (non-instant)	Chana	0.007	4.6	42.6
Caramel spread	Conaprole	0.013	2.5	33.3
Caramel spread	Los Nietitos	0.013	2.6	40.0
Caramel spread	Manjar	0.013	2.6	31.4
Flour	Canuelas	0.027	1.2	43.7
Flour	Cololo	0.024	1.4	39.6
Flour	Puritas	0.015	2.2	36.3
Frankfurters (short)	Cattivelli	0.010	3.2	45.7
Frankfurters (short)	Ottonello	0.012	2.7	42.4
Frankfurters (short)	Schneck	0.015	2.1	36.1
Grated cheese	Conaprole	0.009	3.8	25.1
Grated cheese	El Trébol	0.009	3.5	36.9
Grated cheese	Milky	0.007	4.4	30.0
Semolina noodles	Adria	0.015	2.2	36.6
Semolina noodles	Las Acacias	0.019	1.7	40.2
Ham	Centenario	0.008	4.2	29.0
Ham	La Constancia	0.034	1.0	46.1
Ham	Schneck	0.015	2.2	35.8
Margarine	Danica dorada	0.012	2.7	39.0
Margarine	Doriana nueva	0.013	2.6	42.6
Margarine	Primor	0.016	2.1	41.2
Mayonnaise	Fanacoa	0.011	3.0	39.5
Mayonnaise	Hellmans	0.021	1.5	41.9
Mayonnaise	Uruguay	0.024	1.3	42.3
Noodles	Cololo	0.017	1.9	38.8
Peach jam	Dulciora	0.012	2.6	35.9
Peach jam	Limay	0.008	4.1	30.4
Peach jam	Los Nietitos	0.011	3.0	37.9
Canned peas	Arcor	0.010	3.3	42.9
Canned peas	El Hogar	0.009	3.5	25.3
Canned peas	Trofeo	0.017	1.9	44.4
Quince jam	Los Nietitos	0.011	2.9	38.6
Rice	Aruba tipo Patna	0.018	1.8	43.4
Rice	Blue Patna	0.024	1.4	41.4

Product	*Brand*	*Probability of daily variation*	*Monthly price duration*	*Percentage decrease*
Rice	Green Chef	0.027	1.2	42.6
Rice	Pony	0.009	3.5	41.1
Rice	Vidarroz	0.012	2.7	49.3
Crackers	El Trigal	0.009	3.6	32.4
Crackers	Famosa	0.010	3.2	29.5
Crackers	Maestro Cubano	0.012	2.6	41.1
Salt	Sek	0.011	3.1	41.9
Salt	Torrevieja	0.007	4.7	30.4
Salt	Urusal	0.012	2.7	41.7
Semolina pasta	Adria	0.015	2.2	35.6
Semolina pasta	Las Acacias	0.018	1.9	41.1
Soybean oil	Condesa	0.029	1.1	56.2
Sugar	Azucarlito	0.017	1.9	35.3
Sugar	Bella Union	0.017	2.0	34.7
Sunflower oil	Óptimo	0.033	1.0	42.1
Sunflower oil	Uruguay	0.032	1.0	40.9
Tea	Hornimans	0.009	3.5	46.5
Tea	La Virginia	0.010	3.2	46.8
Tea	Lipton	0.009	3.8	40.6
Tomato paste	Conaprole	0.017	1.9	36.3
Tomato paste	De Ley	0.012	2.7	34.4
Tomato paste	Qualitas	0.012	2.8	45.8
Yerba mate	Canarias	0.013	2.5	38.1
Yerba mate	Del Cebador	0.013	2.5	36.4
Yerba mate	Sara	0.015	2.2	40.4
Yogurt	Conaprole	0.013	2.6	29.5
Yogurt	Parmalat (Skim)	0.012	2.8	34.1
Sodium hypoclorite	Agua Jane	0.018	1.8	37.7
Sodium hypoclorite	Sello Rojo	0.015	2.2	33.6
Sodium hypoclorite	Solucion Cristal	0.018	1.8	43.3
Diswashing detergent	Deterjane	0.024	1.3	44.1
Diswashing detergent	Hurra Nevex Limon	0.024	1.4	43.3
Laundry soap	Drive	0.015	2.2	43.1
Laundry soap	Nevex	0.023	1.4	44.8
Laundry soap	Skip - Paquete azul	0.018	1.8	45.3
Laundry soap in bar	Bull Dog	0.016	2.0	39.6
Laundry soap in bar	Nevex	0.015	2.2	39.8
Shampoo	Fructis	0.022	1.5	44.5
Shampoo	Sedal	0.016	2.1	47.3
Shampoo	Suave	0.011	3.0	45.0
Soap	Astral	0.018	1.8	46.3
Soap	Palmolive	0.023	1.4	50.0
Soap	Suave	0.013	2.5	46.6
Toilet paper	Higienol Export	0.016	2.1	32.7
Toilet paper	Personal	0.013	2.5	31.8
Toilet paper	Sin Fin	0.021	1.6	41.8
Toothpaste	Closeup Triple	0.009	3.7	38.1
Toothpaste	Colgate Total	0.023	1.4	39.1

Product	*Brand*	*Probability of daily variation*	*Monthly price duration*	*Percentage decrease*
Toothpaste	Kolynos	0.013	2.5	34.6
Cola	Coca Cola	0.010	3.3	25.5
Cola	Nix	0.008	4.0	34.6
Cola	Pepsi	0.010	3.2	31.7
Sparkling water	Matutina	0.011	3.0	43.0
Sparkling water	Nativa	0.007	4.6	27.0
Sparkling water	Salus	0.013	2.6	35.0

SOURCE: Own elaboration from data of the Uruguayan Ministry of Economy and Finance.

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