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Small Price Changes, Sales Volume, and Menu Cost*

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Abstract

The finding of small price changes in many retail price datasets is often considered a puzzle. We show that a possible explanation for the presence of small price changes is related to sales volume, an observation that has been overlooked in the existing literature. Analyzing a large retail scanner price dataset that contains information on both prices and sales volume, we find that small price changes are more frequent when products' sales volume is high. This finding holds across product categories, within product categories, and for individual products. It is also robust to various sensitivity analyses such as measurement errors, the definition of "small" price changes, the inclusion of measures of price synchronization, the size of producers, the time horizon used to compute the average sales volume, the revenues, the competition, and shoppers' characteristics.

1. Introduction

Extensive empirical analyses of price-setting behavior using micro-level data show individual prices change at a lower frequency than the corresponding market conditions.[1] A leading model offered to explain the sluggish response of prices to underlying shocks is the menu cost model, which posits that each time a firm changes a price, it incurs a lump sum cost that is independent of the size or the direction of the price change.[2]

A key prediction of the simple menu cost model is that firms make infrequent but relatively large price changes because frequent small price changes are less economical (Caplin and Spulber 1987). However, empirical studies find that 20%–44% of price changes are small, which studies cite as evidence against the simple menu cost model.[3]

To reconcile the existence of small price changes with menu costs, Dotsey et al. (1999) model stochastic menu costs, which lead to small price changes when the realized menu cost is small. Lach and Tsiddon (2007), Klenow and Malin (2011), Midrigan (2011), Alvarez and Lippi (2014), and Alvarez et al. (2016) suggest economies of scope in price adjustments, allowing both small and large price changes, as long as the average price change is larger than the menu cost.[4] Chakraborty et al. (2015), Rotemberg (1982), and Chen et al. (2008) suggest that consumer inattention can explain small price changes.

In this paper, we argue that sales volume can be another explanation for small price changes. We use a large scanner dataset with over 98 million weekly observations to show that small price changes are far more likely for products with high sales volumes than for products with low sales volumes. This result is robust. It holds across product categories, within product categories, and at the level of individual products across stores. It is also robust to various sensitivity analyses such as the definition of "small" price changes in relative vs. absolute terms, measurement errors, the time horizon used to compute the average sales volume, and the inclusion of controls for competition, markups, pricing zones, and producers' size.

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[1] Examples include Carlton (1986), Cecchetti (1986), Lach and Tsiddon (1992, 1996, 2007), Kashyap (1995), Blinder et al. (1998), Slade (1998), Eden (2001, 2018), Dutta et al. (1999, 2002), Fisher and Konieczny (2000, 2006), Owen and Trzepacz (2002), Chevalier et al. (2003), Baharad and Eden (2004), Bils and Klenow (2004), Levy and Young (2004), Zbaracki et al. (2004), Álvarez et al. (2006), Dhyne et al. (2006), Knotek (2008, 2024), Nakamura and Steinsson (2008), Campbell and Eden (2014), Kehoe and Midrigan (2015), Konieczny and Skrzypacz (2005, 2015), Gorodnichenko and Talavera (2017), Anderson et al. (2015, 2017), Giulietti et al. (2020), and studies cited therein. For older surveys, see Romer (1993), Weiss (1993), Taylor (1999), Willis (2003), and Wolman (2007). More recent surveys include Klenow and Malin (2011), Leahy (2011), and Nakamura and Steinsson (2013).

[2] See, for example, Barro (1972), Sheshinski and Weiss (1977 and 1992), Akerlof and Yellen (1985), Mankiw (1985), and Konieczny and Rumler (2006).

[3] See, for example, Bils and Klenow (2004), Nakamura and Steinsson (2008), Chen et al. (2008), Klenow and Kryvtsov (2008), Midrigan (2011), Bhattarai and Schoenle (2014), Klenow and Malin (2011), and Gautier et al. (2024).

[4] Alvarez et al. (2014), Eichenbaum et al. (2014), Cavallo and Rigobon (2016), and Cavallo (2018) suggest that many of the reported small price changes are due to measurement errors. Even these studies, however, find a non-negligible share of small price changes that cannot be explained by measurement errors.

Sales volumes as an explanation for small price changes have been overlooked by the existing literature, although it has a straightforward intuition. Under a menu cost, the firm incurs the same price adjustment cost regardless of the number of units sold because it pays the menu cost once to change the price of all units sold. If it sells one unit, it will change the price only if the benefit from the change exceeds the menu cost. If it sells many units, the benefit from changing the price accumulates across all units sold, while the menu cost is the same, which will make a small price change more profitable. Thus, comparing products that differ only in sales volume, we expect that (1) high sales volume products will have more price changes and that (2) their price changes will be smaller, on average, than low sales volume products. In the paper, we test these two predictions.

Particularly relevant to our work are Bhattarai and Schoenle (2014) and Kang and Usher (2023). Bhattarai and Schoenle (2014) use the BLS micro-level price data underlying the PPI to show that the average size of price changes is negatively correlated with the number of products offered by a producer. They also present evidence suggesting that producers that offer many products tend to have high sales volume.

We check if our results could be driven by large firms having higher sales volume or more price changes. We find that controlling for (a) the number of products offered by each producer, (b) the percentage of prices that change, and (c) the average size of all price changes (excluding the current price change), has little effect on the estimated coefficients of the sales volume.

Kang and Usher (2023) construct a model based on the assumption that the size of price changes is negatively correlated with the revenue and therefore, small price changes are possible if the revenue is sufficiently large. Because there is a strong correlation between sales volume and revenues (in our data, the correlation is 0.68), our findings are consistent with their findings. Indeed, we find a positive and significant correlation between the likelihood of small changes and revenues. However, our empirical results further suggest that the positive correlation between revenues and small price changes is driven by the sales volume component of the revenue, and not by the price component.

Importantly, our results suggest that a lack of correlation between the price gap and the likelihood of a price change, as reported by Karadi et al. (2024), for example, is not necessarily evidence against selection. We show that the distribution of the size of price changes of high sales volume products has a high share of small price changes, as expected under a Calvo-type model. The distribution of the size of price changes of low sales volume products, on the other hand, resembles the one predicted by Golosov and

Lucas (2007)—it is bimodal with a low share of small price changes. Yet, a small monetary shock that would hit an economy populated with high sales volume products is expected to have a smaller effect than a similar shock hitting an economy populated with low sales volume products. Thus, and as emphasized by Alvarez et al. (2016), selection is a function of both the distribution of the size of price changes and the frequency of price changes. A distribution with a high share of small price changes, therefore, does not necessarily indicate the absence of selection.

We proceed as follows. In section 2, we discuss the data. In section 3, we present the empirical findings. In section 4, we discuss robustness. We conclude in section 5. In the Appendix, we discuss the details of numerous robustness tests we run.

3. Data

Two critical variables for exploring our hypothesis are prices and quantities (sales volume). We, therefore, use Dominick's data because it contains these two key variables. Dominick's was a large retail food chain with 93 stores in the greater Chicago area and a market share of 25%. The data contain 98+ million weekly observations over 8 years, from Sept. 14, 1989–May 8, 1997, for 13,504 products, in 29 categories, including food, cleaning products, and pharmaceutical and hygienic products.[5] Each weekly observation includes the retail price, the number of units sold, the revenue, the retailer's markup, and some product attributes, making Dominick's data especially well-suited for our analysis.

Dominick's prices were set on a weekly basis, and thus each week, there was one price. If manufacturer coupons were used, we cannot account for these. During the sample period, however, the use of such coupons was limited.[6]

4. Empirical findings

4a. Results of pooled analysis

To study the correlation between sales volumes and small price changes, we follow Midrigan (2011) and Bhattarai and Schoenle (2014) to define a price change of product i in store s on week t, $\Delta p_{i,s,t}$, as small if $\left|\Delta p_{i,s,t}\right| < \kappa\left|\overline{\Delta p_{\iota,s}}\right|$, where $\overline{\Delta p_{\iota,s}}$ is the average size of a price change of product i in store s, and $\kappa = 0.5$.[7] In Appendix A, we show that our

[5] Dominick's data contains observations on 18,035 UPCs. However, some of the UPCs are re-launches of the same product. See Mehrhoff (2018), and Dominick's Data Manual (p. 9), available at https://www.chicagobooth.edu/-/media/enterprise/centers/kilts/datasets/dominicks-dataset/dominicks-manual-and-codebook_kiltscenter.aspx.

[6] For more details about the data, see Barsky et al. (2003), Chen et al. (2008), Levy et al. (2010) and (2011), Chahrour (2011), Midrigan (2011), and Alvarez et al. (2016).

[7] We define a price change of product i offered in store s in week t, $\Delta p_{i,s,t}$, as $ln\left(p_{i,s,t}/p_{i,s,t-1}\right)$, conditional on $\left|\Delta p_{i,s,t}\right| > 0$, and on observing the price on both week $t-1$ and week t.

findings are robust to alternative definitions of small price changes, including smaller than 5¢, 10¢, 15¢, 2%, and 5%, and $\kappa = \{0.1, 0.25, 0.33\}$.

Another possible noise source in our data is measurement errors (Alvarez et al., 2016). Prices reported in scanner datasets are weekly averages (Eichenbaum et al. 2014). This can lead to spurious small price changes if shoppers pay different prices, when some shoppers use coupons, for example.[8] To account for this, we exclude observations on price changes of less than 1¢ (Alvarez et al. 2016). In addition, following Strulov-Shlain (2023), we require that the post-change price last for at least two consecutive weeks.

Finally, a "unit" in our data may contain multiple units, e.g., a 6-pack of beer. In such cases, we count each pack as a single unit, because the consumer pays once for the entire pack. In Appendix B, we show that our results hold if we exclude multi-unit packs.

As a first test of our hypothesis, we merge the observations in all 29 categories. We find that overall, 30.3% of the price changes are small (i.e., $\left|\Delta p_{i,s,t}\right| < 0.5\left|\overline{\Delta p_{i,s}}\right|$), and the average sales volume is 6.9 units per week.[9] Next, we divide store-products into deciles according to their sales volume. Figure 1, depicting the share of small price changes by deciles of sales volume, shows that an increase in the sales volume is associated with an increase in the share of small price changes. The positive relation appears monotonic. The share of small price changes in the 10th decile, 34.3%, is 5.4 times higher than the share of small price changes in the 1st decile, 6.3%.

As a second test, we estimate a fixed effect regression model using the pooled data:

$$small\ price\ change_{i,s,t} = \alpha + \beta ln\left(average\ sales\ volume_{i,s}\right) + \gamma \mathbf{X}_{i,s,t} + month_t + year_t + \lambda_i + \delta_s + \mu_i + u_{i,s,t} \quad (1)$$

where small price change is a dummy that equals 1 if $\left|\Delta p_{i,s,t}\right| < \kappa\left|\overline{\Delta p_{i,s}}\right|$, and 0 otherwise. The average sales volume is for product *i* in store *s* over the sample period. By taking the average over a long period, we obtain an estimate of the expected sales volume that does not depend on transitory shocks or sales. **X** is a matrix of control variables. Month and year are fixed effects for the month (to control for seasonality) and the year of

[8] Consider the following example. In week *t*, the price of a good was \$1.99 and all units were sold at the posted price. In week *t*+1, the posted price remained \$1.99. 9 consumers bought at the posted price, and one used a coupon and paid 1.79. The price that would be recorded in the scanner dataset is \$1.97, i.e, a 2 cents change relative to week *t*.

[9] In calculating the average sales volume, we need to account for missing observations, because a missing observation in week *t* implies that the product was either out of stock or had 0 sales on that week. Thus, averaging over the available observations can lead to an upward bias for products that are sold in small numbers. Therefore, for each product in each store, we calculate the average by first determining the total number of units sold over all available observations. We then identify the first and last week for which we have observations, and calculate the average for each product-store as $\frac{total\ no.\ of\ units\ sold}{last\ week - first\ week}$. The resulting figure is smaller than we would obtain if we averaged over all available observations (which would not include obsservations on weeks with 0 sales).

the price change. To control for differences across stores and products, we add λ, δ and μ, which are fixed effects for categories, stores, and products, respectively. *u* is an i.i.d error term. We cluster the standard errors at the product level.

The first row of Table 1 reports the estimates of the coefficients of the key variable, average sales volume. Column 1 reports the baseline regression results that include only the average sales volume and fixed effects for months, years, stores, and products. The coefficient of the sales volume is 0.024, and it is statistically significant, suggesting that a 1% increase in the sales volume is associated with a 2.4 percentage point increase in the likelihood of a small price change. In column 2, the matrix **X** includes the following controls: the log of the average price, to control for the price level effect on the size of price changes, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a dummy for sale- and bounce-back prices. We include the 9-ending dummy because when the pre-change price is 9-ending, price changes tend to be larger than when the pre-change price ends in other digits (Levy et al. 2020). We add the dummy for sale and bounce-back prices because they, too, are associated with large price changes (Nakamura and Steinsson 2008).[10]

The coefficient of the sales volume remains positive and statistically significant. Its value is 0.020, suggesting that a 1% increase in the sales volume is associated with a 2.0 percentage points increase in the likelihood of a small price change.

In column 3, we keep the same controls as in column 3, but we focus on regular prices by excluding the sale- and bounce-back prices. We do this for two reasons. First, sale- and bounce-back prices tend to be large, and therefore, we need to account for them properly. Second, it is often argued that changes in sale prices have a smaller effect on inflation than changes in regular prices.[11]

We find that the estimate of the coefficient of the sales volume is 0.042 and is statistically significant The effect of sales volumes on the likelihood of observing a small price change seems, therefore, to be larger for regular prices than for transaction prices.

4b. Results of category-level analyses

Estimation using pooled data can hide differences across categories. Therefore, we estimate a series of category-level fixed-effect regressions, similar to (1), except that now

[10] To identify sale prices, we do not use the sales indicator that is included in Dominick's data because it was not set on a consistent basis (Peltzman 2000). Instead, we use the sales filter algorithm of Fox and Syed (2016) to identify sales. This algorithm has the advantage that it was calibrated using Dominick's data and, consequently, it is particularly useful for identifying sales in Dominick's data.

[11] See Nakamura and Steinsson (2008), Midrigan (2011), Anderson et al. (2017), and Ray et al. (2023).

we exclude the category fixed effects. The columns of Table 1 report the coefficients of the key variable, average sales volume, for each of the 29 product categories. Column 1 (starting from the 2nd row) reports the results of baseline regressions that include only the average sales volume and fixed effects for months, years, stores, and products.

We find that in all 29 product categories, the coefficients are positive, and 26 are statistically significant. Thus, in 26 of 29 product categories, there is a positive and statistically significant correlation between the average sales volume and the likelihood that a price change is small. The effect has economic significance: the average coefficient is 0.027, suggesting that a 1% increase in the sales volume is associated with an increase of 2.7 percentage points in the likelihood that a price change will be small.

In column 2, we add the **X** matrix of the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, all as defined above. The results are similar to column 1. The coefficients of the average sales volume are positive in 28 categories, and statistically significant in 23. The one negative coefficient is not statistically significant. The average coefficient is 0.023. Thus, even after including the controls, we still find that increasing the average sales volume by 1% is associated with an increase of 2.3 percentage points in the likelihood of a small price change.

In column 3, we focus on regular prices by excluding the sale- and bounce-back prices. We find that all the coefficients are positive. 26 are statistically significant, and one more is significant at the 10% level. The average coefficient is 0.049, implying that for regular prices, an increase of 1% in the average sales volume is associated with an increase of 4.9 percentage points in the likelihood of a small price change.

4c. Results of product-level analysis

A possible explanation for the correlation between sales volume and small price changes is that products with high sales volume have some unobserved attributes that make them prone to small price changes. We explore this possibility by estimating for each product a separate regression. If the correlation between sales volume and small price changes is found at the level of individual products, then it cannot be explained by unobserved attributes, since in each regression we have data on only one product.

Before presenting the full regression results, consider the front-end candies category as an example. In Figure 2, we show a scatter plot for each of the 20 front-end candies products that have data for all 93 Dominick's stores. In each panel, there are 93 dots, one for each store. In each figure, the *x*-axis gives the log average weekly sales volume, and

the *y*-axis gives the share of small price changes. The straight lines are regression lines. The red straight (black dotted) lines represent regression lines with statistically significant (insignificant) coefficients.

We find that the correlation between sales volume and the share of small price changes is positive for 15 of the 20 (75%) individual products. Out of the statistically significant coefficients, 6 of 7 are positive (86%).

Table 2 summarizes the results of replicating this exercise for all products in the 29 categories. Many products in the sample were offered for only short periods or only in a small number of stores. To avoid biases, we drop products for which we do not have information for at least 30 stores. We then estimate an OLS regression with robust standard errors for each product. The dependent variable is the share of small price changes for the product in each store. The independent variable is the average sales volume of the product in each store.[12]

Column 1 gives, for each product category, the average of the estimated coefficients. Columns 2–5 give information on the distribution of the estimated coefficients: the total number of coefficients, the % of positive coefficients, the total number of coefficients that are statistically significant at the 5% level, and the % of coefficients that are both positive and statistically significant at the 5% level.

According to the figures in the table, the results for the front-end candies category are representative of the full sample. The average coefficients are positive in 26 of the 29 product categories. In addition, overall, more than 76.0% of the coefficients are positive. Out of the statistically significant coefficients, 87.8% are positive. In other words, for the overwhelming majority of the individual products in our sample, we find a positive relationship between sales volume and the share of small price changes. It seems unlikely, therefore, that the correlation is due to unobserved characteristics of the products. In Appendix C, we show that these results do not change if we add controls for the shoppers' socio-demographics and competition.

Thus, the correlation between sales volume and the share of small price changes is positive across product categories, within product categories, and for individual products.

4d. Sales volume versus revenue

Kang and Usher (2023) find that the size of price changes is negatively correlated with revenues. In column 1 of Table 3, we report the Pearson correlation coefficient

[12] For robustness, we have also conducted an analysis using LPM regressions, as in the previous section. See the discussion in Appendix C.

between the average sales volume and the average revenue for product-stores for each category. In the pooled sample, the correlation is 0.68, which is quite high.

In column 2, we replicate one of Kang and Usher's (2023) key findings by reporting for each category, as well as for the pooled sample, the coefficient estimates of regression (1), where we replace the log of the average sales volume with the log of the average revenue. The controls include fixed effects for months, years, stores, and products. The estimated coefficients are positive for the pooled data, as well as for all 29 categories. 24 of these 29 coefficients are statistically significant, and one more is significant at the 10% level. Thus, Kang and Usher's (2023) findings hold in our data: there is a strong positive correlation between revenue and the likelihood of a small price change.

Revenue, however, is a product of sales volume and price. Our hypothesis implies that the revenue is correlated with the likelihood of a small price change via sales volume, rather than price. To test this, in columns 3 and 4, we show the results of regressions that include both the sales volume and the revenue as independent variables. Once we add the sales volume to the regression, the coefficients of the revenue turn negative in the pooled data, as well as in 24 of the 29 categories. The coefficients of the sales volume, on the other hand, are positive in the pooled data, as well as in 27 of the 29 categories. 24 of the positive coefficients are statistically significant.

These results suggest that holding the sales volume constant, the higher the price level, the less frequent small price changes are. In other words, the positive correlation between revenues and the frequency of small price changes seems to materialize through the sales volume and not through the price.

4e. Sales volume, producer size, and price synchronization

According to Lach and Tsiddon (2007), Midrigan (2011), Alvarez and Lippi (2014), Letterie and Nilsen (2014), and Alvarez et al. (2016), small price changes can be explained by economies of scale in price adjustment, which makes small price changes profitable if the average price change exceeds the menu cost. Lach and Tsiddon (2007) and Bhattarai and Schoenle (2014) show that: (a) producers offering a large number of products are more likely to make small price changes than producers offering a small number of products, (b) small price changes are more likely when price changes are more synchronized, and (c) small price changes are more likely when the average size of all other contemporaneous price changes is high. In addition, Bhattarai and Schoenle (2014) provide evidence suggesting that producers offering more products are more likely to have a large sales volume. It is therefore of interest to examine whether our results hold

when accounting for economies of scope by adding controls for price changes synchronization and the number of products per producer.

In column 1 of Table 4, we report the coefficients of the log of sales volume in regression (1), where we also include the average number of products per category offered by the same producer, as a proxy for the producer's size.[13] The regression also includes fixed effects for months, years, stores, and products. We find that the coefficient of the sales volume in the pooled sample and all 29 category-level coefficients are positive, 28 of them statistically significant. Thus, the effect of sales volume on the likelihood of small price changes is unrelated to the effect of the size of the producers.

In column 2, we add a control for the percentage of the products that changed the price in the same week, excluding the current observation. The coefficients remain almost unchanged in comparison to the figures in column 1.

In column 3, we further add the average size of contemporaneous price changes, excluding the current observation. Lach and Tsiddon (2007) show that when price changes are synchronized, a small price change is correlated with a large average contemporaneous price change. However, we find that adding the average size of price change has little effect on the size of the coefficients of the sales volume. Also in this specification, all 29 coefficients are positive, and 28 are statistically significant.

Finally, in column 4, we add the percentage of the products that are produced by the same producer and changed price in the same week, excluding the current observation. This forces us to drop some observations because we can only use an observation if the producer offers at least two products in the relevant week. The upshot is that most of the remaining observations pertain to the products produced by relatively large producers which are most likely to make small price changes (Bhattarai and Schoenle 2014).

If our results are driven by the size of the producers rather than by sales volume, then focusing on large producers should lead to a sizeable drop in the coefficients of the sales volume. We find, however, that our results are robust. All the coefficients are positive, 27 of the 29 of them are statistically significant, and one more is marginally significant.

As another test, we follow Bonomo et al. (2022), who show that a large share of price changes takes place on "peak days." We follow their methodology to create a dummy for peak days and add it as a control to the regressions. The estimation results, discussed in Appendix D, show that the correlation between sales volumes and small price changes

[13] To calculate the average number of products offered by a producer, we follow Bhattarai and Schoenle (2014), by first determining the number of products offered by a producer each week, and then averaging over all weeks.

holds also when we control for peak days.

5. Sales volumes and the likelihood of a price change

Our results suggest that there is a robust correlation between sales volumes and small price changes, which, we have argued above, is driven by accumulated profits. For high sales volume products, even a small change in the price can have a large effect on total profits, making the price change worthwhile. Under this hypothesis, we should observe a positive correlation between sales volumes and the likelihood of a price change.

Figure 3, which shows the share of price changes out of all observations by sales volume centiles, corroborates this hypothesis. The likelihood of a price change increases with the sales volume monotonically. The likelihood of a price change in the 10^{th} centile, 11.9%, is 8.3 times higher than in the 1^{st} centile, 1.4%.

As a formal test, Table 5 presents the results of regressions similar to regression (1), where we replace the dependent variable with a dummy for price changes. The first row presents the results of the pooled data. The remaining rows present category-level results.

The first column presents the results when the only controls are the log of the average sales volume, and dummies for stores, products, years, and months. For pooled data, we find that an increase of 1% in the sales volume is correlated with an increase of 1.5% in the likelihood of a price change. At the category-level, we find that all the coefficients are positive and 28 are statistically significant.

In column 2, we add the same controls as in column 2 of Table 2: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices. The results are similar to what we report in column 1. In column 3, we keep all the variables as in column 2, but exclude the sale- and bounce-back prices. The results are even stronger. The coefficients of all 29 categories are positive and statistically significant.

In Appendix E, we show that the correlation between the likelihood of a price change and sales volumes holds also at the product level. Thus, we conclude that the results confirm our hypothesis: high sales volume makes small price changes more profitable.

6. Macroeconomic implications

To assess the implications of our findings, we look at the ratio of the kurtosis of the distribution of the size of price changes and the average number of annual price changes. Alvarez et al. (2016) show that in many sticky price models, this ratio is proportional to a sufficient statistic measuring the effects of a small monetary shock on the real economy.

We pool the entire data and divide the products-stores into three groups, by their sales volume. Figure 4 depicts kernel density estimators of the distributions of the size of price changes by sales groups.[14] The top panel depicts the distribution of sale prices and the lower panel—the distribution of regular prices, which we derive by removing sales and bounce-back prices. For both the sale and regular prices, the low sales volume products (black dotted line) have a bi-modal distribution with a low share of small price changes. I.e., low sales volume products have a distribution of price changes similar to the one predicted by Golosov and Lucas (2007). High sales volume products (red solid line), on the other hand, have a Calvo-like distribution. It is single-peaked, with small price changes (i.e., the changes that fall around 0) being the most common. The middle sale volume products (green dashed line), have a distribution that is in-between.[15]

Table 7 summarizes the results. Among high sales volume products, the likelihood of sale price changes less than 1% is 1.2%, 2.4 times higher than the likelihood among low sales volume products, 0.5%. The likelihood of price changes less than 2% and 3% are also higher among high sales volume products than among low sales volume products.

For regular prices, the shares of small price changes are higher because we exclude sale prices which tend to be characterized by large changes (Nakamura and Steinsson, 2008). However, we find the same pattern. The likelihood of a small price change is higher among high sales volume products than among low sales volume products.

The gap in the share of small price changes leads to large differences in the kurtoses of the distributions. For transaction (regular) prices, the kurtosis of the distribution of low sales volume products is 2.07 (2.59), vs. 3.14 (4.32) for high sales volume products.

The average annual number of price changes for the low, medium, and high sales volume products, is calculated as $-52/\ln\left(1-\bar{f}_{i,s}\right)$, where $\bar{f}_{i,s}$ is the is the average frequency of price changes of product i in store s (Nakamura and Steinsson, 2008). We then average over all products in each group. The column labeled $N\left(\Delta p_{i,s}\right)$ in Table 7 reports the results. We find that for sale (regular) prices, the average number of price changes of a product in the high sales volume group, 5.8 (1.7), is 4.1 (2.4) times higher than in the low sales volume group, 1.4 (0.7).

Figure 5 presents the ratio of the kurtosis and the number of price changes per year.

[14] As in Alvarez et al. (2016), we draw the distribution of the size of price changes, $z_{is,t}=\frac{\Delta p_{i,s,t}-\overline{\Delta p_{i,s}}}{\sigma_{i,s,t}}$, normalized, where $\Delta p_{i,s,t}$ is log price change of product i in store s in week t, $\overline{\Delta p_{i,s}}$ is the average price change of product i in store s, and $\sigma_{i,s,t}$ is the standard deviation of the price changes of product i in store s. As in Alvarez et al. (2016) and Bonomo et al. (2022), we exclude 1% of the observations in the tails.

[15] In Appendix F, we show that these properties hold also if we draw separate distributions for each product category.

The top (bottom) panel depicts the ratio for sale (regular) prices. The black vertical lines represent 95% confidence bounds obtained by bootstrapping with 1,000 repetitions. We find that for each group of products, the expected effect of a monetary shock is higher for regular prices than for sale prices, which is consistent with the findings that regular prices are more rigid than sale prices (Nakamura and Steinsson, 2008).

More importantly, for both the transaction and the regular prices, the ratio of the kurtosis and the average number of price changes is the highest for products with low sales volumes and the lowest for products with high sales volumes.[16] Figure 4 shows that the distribution of the size of price changes of low sales volume products is consistent with selection, as in Golosov and Lucas (2007), while the corresponding distributions of high sales volume products are "Calvoish." Yet, a small monetary shock is expected to have a smaller effect in an economy populated with high sales volume products than in an economy populated with low sales volume products. Selection, therefore, is not necessarily inconsistent with small price changes. if the increase in the number of price changes compensates for an increase in the kurtosis of the size of price changes, we can have both, many small price changes and a quick response to monetary shocks.

7. Robustness and further analysis

We run the following robustness tests. In Appendix G, we add controls for shoppers' demographics and for competition. In Appendix H, we consider profit margins to control for the possibility that retailers are concerned about profit margins rather than profits.

In Appendix I, we reconsider the definition of the average sales volume. Above, we use the average sales volume over the entire period as a proxy for the expected sales volume based on 8 years of data. However, this assumes that in the first years, the retailer could predict future sales. As an alternative, we repeat the analyses by calculating the average sales volume based on a rolling 52-week window of past observations.

In Appendix J, we assess the symmetry of the effect by checking if the correlation between sales volumes and small price changes holds for price increases and decreases.

In appendix K, we look at the correlation between sales volumes and the likelihood of small price changes during holidays. Levy et al. (2010) suggest that menu costs might be higher in holidays than at other times. Therefore, the correlation between sales volumes and the likelihood of small price changes may differ between holidays and other times.

The results we report are robust. In Appendix L, we show that the positive correlation

[16] For regular prices, the difference between the ratio for high sales volume and the ratio for medium sales volume products is not statistically significant.

between sales volumes and small price changes holds in Barro's (1972) menu cost model.

8. Conclusion and policy implications

The finding of frequent small price changes in many retail price datasets has been interpreted by authors as prima facie evidence against simple menu cost models. We argue that sales volume can explain it. When a retailer expects to sell many units, small price changes can be profitable even in the presence of lump sum menu costs.

We use Dominick's dataset to show a strong positive correlation between products' sales volume and the frequency of small price changes. This finding is robust. It holds across and within product categories, and for individual products. It is also robust to a variety of sensitivity analyses such as the definition of small price changes, the inclusion of control variables, measurement errors, price synchronization, firms' size, and the time horizon used to compute the average sales volume. In addition, our findings hold irrespective of how we measure price changes—in absolute or relative terms.

Our Dominick's data is from the 1990s, which is a shortcoming. However, the dataset is rich. In addition to prices and sales volume, *two critical variables for our analysis*, it also contains information on wholesale prices, sales, pricing zones, shoppers' socio-demographics, markups, etc. We use these additional variables to check robustness.

Going forward, we believe there is a need for models that will account for sales volumes, perhaps along the lines of Golosov and Lucas (2007). It would then be possible to evaluate the implications of heterogeneity in sales volumes for aggregate price rigidity. Such a model can yield important insights. First, it may produce a non-trivial distribution of the size of price changes, even when all producers sell one product, and the menu costs are fixed. Second, if the size of price changes depends on the sales volume, then the existence of small price changes does not rule out selection. Therefore, for a given frequency of price changes, monetary shock may have a small real effect even in the presence of many small price changes (Kang and Usher, 2023). Related to this, Karadi et al. (2024) find that the likelihood of a price change does not depend on the gap between the price and the optimal price, which they interpret as evidence against selection. In a model where price changes depend on sales volumes, however, we may have selection along with both small and large price changes in response to monetary shocks.

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Table 1. Category-level regressions of small price changes and sales volume

Category		(1)	(2)	(3)
Pooled Data	Coefficient	0.0236***	0.0203***	0.0419***
	(Std.)	(0.0006)	(0.0006)	(0.0012)
	Observations	9,395,668	9,395,668	2,198,344
Analgesics	Coefficient	0.0453***	0.0343***	0.064***
	(Std.)	(0.0051)	(0.0051)	(0.0094)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient	0.0776***	0.0724***	0.1789***
	(Std.)	(0.0102)	(0.0097)	(0.0236)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient	0.0102**	0.0028	0.0252***
	(Std.)	(0.0046)	(0.005)	(0.0073)
	Observations	141,801	141,801	39,815
Beer	Coefficient	0.0236***	0.0266***	0.0971***
	(Std.)	(0.0017)	(0.0018)	(0.0072)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient	0.0228***	0.0182***	0.0337***
	(Std.)	(0.003)	(0.0032)	(0.0056)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient	0.001	0.0047	0.0041
	(Std.)	(0.0042)	(0.0039)	(0.0052)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient	0.0116***	0.0071	0.0142**
	(Std.)	(0.0042)	(0.0044)	(0.0069)
	Observations	208,198	208,198	60,298
Cereals	Coefficient	0.0095***	0.0053	0.0082*
	(Std.)	(0.0037)	(0.0038)	(0.0043)
	Observations	352,779	352,779	151,201
Cheese	Coefficient	0.0215***	0.0126***	0.0199***
	(Std.)	(0.0025)	(0.0027)	(0.0044)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient	0.0901***	0.0906***	0.1071***
	(Std.)	(0.0066)	(0.0065)	(0.0077)
	Observations	35,826	35,826	29,931
Cookies	Coefficient	0.0222***	0.0167***	0.0463***
	(Std.)	(0.0019)	(0.002)	(0.0039)
	Observations	684,672	684,672	129,854
Crackers	Coefficient	0.0212***	0.0123***	0.0313***
	(Std.)	(0.004)	(0.0038)	(0.0061)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient	0.018***	0.0079***	0.0257***
	(Std.)	(0.0028)	(0.0029)	(0.0049)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient	0.021***	0.0144***	0.0447***
	(Std.)	(0.0051)	(0.0052)	(0.0069)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient	0.0269***	0.0239***	0.0164***
	(Std.)	(0.004)	(0.0038)	(0.0042)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient	0.0251***	0.0208***	0.0626***
	(Std.)	(0.004)	(0.0044)	(0.009)
	Observations	199,209	199,209	34,111

Table 1. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient (Std.)	0.0088*** (0.0039)	0.0009*** (0.0039)	0.0215*** (0.0071)
	Observations	300,483	300,483	80,926
Frozen Juices	Coefficient (Std.)	0.0464*** (0.0025)	0.0488*** (0.003)	0.083*** (0.0067)
	Observations	269,278	269,278	51,539
Grooming Products	Coefficient (Std.)	0.0262*** (0.0035)	0.0159*** (0.0032)	0.0399*** (0.0058)
	Observations	272,143	272,143	84,651
Laundry Detergents	Coefficient (Std.)	0.0091 (0.0063)	–0.0035 (0.0066)	0.0059 (0.007)
	Observations	78,407	78,407	34,570
Oatmeal	Coefficient (Std.)	0.0151 (0.0096)	0.0202** (0.0084)	0.0358*** (0.0121)
	Observations	111,381	111,381	24,711
Paper Towels	Coefficient (Std.)	0.0208*** (0.0043)	0.0091** (0.004)	0.0238*** (0.0063)
	Observations	302,858	302,858	68,444
Refrigerated Juices	Coefficient (Std.)	0.0525*** (0.0024)	0.0593*** (0.0025)	0.1128*** (0.0073)
	Observations	261,723	261,723	40,970
Shampoos	Coefficient (Std.)	0.0127*** (0.0031)	0.0082*** (0.0032)	0.0382*** (0.0054)
	Observations	395,641	395,641	76,710
Snack Crackers	Coefficient (Std.)	0.0279*** (0.0047)	0.016*** (0.0046)	0.0359*** (0.0081)
	Observations	150,082	150,082	44,723
Soaps	Coefficient (Std.)	0.0221*** (0.0016)	0.0229*** (0.0013)	0.0398*** (0.0035)
	Observations	1,336,429	1,336,429	146,635
Soft Drinks	Coefficient (Std.)	0.0347*** (0.0035)	0.0341*** (0.0034)	0.0862*** (0.0102)
	Observations	125,225	125,225	24,869
Toothbrushes	Coefficient (Std.)	0.0302*** (0.0031)	0.029*** (0.0031)	0.0804*** (0.0068)
	Observations	263,420	263,420	56,160
Toothpastes	Coefficient (Std.)	0.0088*** (0.0039)	0.0009*** (0.0039)	0.0215*** (0.0071)
	Observations	300,483	300,483	80,926

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50\left|\overline{\Delta p}_{i,s}\right|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes only the log of the average sales volume and the fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a dummy for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product.

* $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Table 2. Product-level regressions of the % of small price changes and sales volume by categories

Product Category	Average coefficient estimate (1)	Number of coefficients (2)	Percentage of positive coefficients (3)	Number of significant coefficients (4)	% of positive and significant coefficients (5)
Pooled Data	0.022	9,515	76.0%	3,594	87.4%
Analgesics	0.055	278	92.1%	133	97.7%
Bath Soaps	0.055	40	100.0%	22	100.0%
Bathroom tissues	−0.001	102	45.1%	33	48.5%
Beers	0.023	294	93.9%	155	100.0%
Bottled juices	0.003	369	56.9%	118	59.3%
Canned soups	0.001	346	47.1%	103	46.6%
Canned tuna	0.014	190	65.3%	64	79.7%
Cereals	0.000	337	48.1%	99	40.4%
Cheese	0.008	470	59.1%	141	69.5%
Cigarettes	0.091	139	99.3%	113	100.0%
Cookies	0.029	682	78.2%	255	87.1%
Crackers	0.024	212	82.1%	91	92.3%
Dish detergents	0.012	201	68.2%	31	90.3%
Fabric softeners	0.021	225	68.0%	63	82.5%
Front end candies	0.025	268	75.7%	89	95.5%
Frozen dinners	0.025	213	81.2%	85	97.6%
Frozen entrees	0.029	684	89.0%	244	97.5%
Frozen juices	0.001	141	54.6%	40	60.0%
Grooming products	0.037	648	91.4%	312	99.7%
Laundry detergents	0.016	435	65.5%	108	83.3%
Oatmeal	0.001	69	50.7%	20	55.0%
Paper towels	−0.010	87	36.8%	19	42.1%
Refrigerated juices	−0.002	174	49.4%	59	49.2%
Shampoos	0.038	857	94.6%	431	100.0%
Snack crackers	0.019	291	68.0%	89	82.0%
Soaps	0.018	221	68.3%	67	76.1%
Soft drinks	0.012	965	83.0%	374	92.0%
Toothbrushes	0.037	232	90.5%	119	100.0%
Toothpastes	0.027	345	80.9%	117	98.3%

Notes: The table presents the results of estimating for each product an OLS regression with robust standard errors. The dependent variable is the share of small price changes for the product in each store. The independent variable is the average sales volume of the product in each store. For each product category, column 1 presents the average of the estimated coefficients. Column 2 presents the total number of coefficients. Column 3 presents the % of positive coefficients out of all coefficients. Column 4 presents the total number of coefficients that are statistically significant at the 5% level. Column 5 presents the % of coefficients that are positive and statistically significant, at the 5% level. Products are identified by their UPCs.

Table 3. Category-level regressions of small price changes, sales volume, and revenue

Category		Correlation	Revenue	Sales volume and revenue	
		(1)	(2)	(3)	(4)
Pooled Data	Coefficient (Std.)	0.6796	0.0207*** (0.0009)	0.0543*** (0.0009)	–0.0387*** (0.0039)
	Observations		9,395,668		
Analgesics	Coefficient (Std.)	0.5418	0.0432*** (0.0076)	0.0783*** (0.0093)	–0.0567*** (0.0134)
	Observations		144,201		
Bath Soap	Coefficient (Std.)	0.4285	0.1194*** (0.0185)	0.0765*** (0.02)	0.0028 (0.0359)
	Observations		15,222		
Bathroom Tissues	Coefficient (Std.)	0.7316	0.0087* (0.0045)	0.0348*** (0.0157)	–0.0273** (0.0157)
	Observations		141,801		
Beer	Coefficient (Std.)	0.7121	0.0263*** (0.0024)	0.0318*** (0.0039)	–0.0112* (0.0054)
	Observations		290,313		
Bottled Juice	Coefficient (Std.)	0.8648	0.0234*** (0.0033)	0.0323*** (0.0113)	–0.0114 (0.0123)
	Observations		489,123		
Canned Soup	Coefficient (Std.)	0.5014	0.0041 (0.0043)	–0.0405*** (0.0213)	0.0471*** (0.0226)
	Observations		474,214		
Canned Tuna	Coefficient (Std.)	0.7277	0.0073 (0.0047)	0.06*** (0.0122)	–0.058*** (0.014)
	Observations		208,198		
Cereals	Coefficient (Std.)	0.7553	0.008** (0.004)	0.0257*** (0.0088)	–0.0187* (0.0099)
	Observations		352,779		
Cheese	Coefficient (Std.)	0.8465	0.0205*** (0.0026)	0.0505*** (0.0144)	–0.033** (0.0155)
	Observations		773,222		
Cigarettes	Coefficient (Std.)	0.9599	0.0862*** (0.009)	0.1586*** (0.0126)	–0.1227*** (0.0164)
	Observations		35,826		
Cookies	Coefficient (Std.)	0.8232	0.02*** (0.002)	0.0539*** (0.0112)	–0.039*** (0.013)
	Observations		684,672		
Crackers	Coefficient (Std.)	0.7787	0.021*** (0.0048)	0.0469*** (0.0099)	–0.0318*** (0.0126)
	Observations		243,435		
Dish Detergent	Coefficient (Std.)	0.85	0.0192*** (0.0033)	0.0261*** (0.0118)	–0.0099 (0.0135)
	Observations		186,800		
Fabric Softener	Coefficient (Std.)	0.7175	0.0165*** (0.0058)	0.0556*** (0.0127)	–0.0434*** (0.0141)
	Observations		178,936		
Front-End-Candies	Coefficient (Std.)	0.6861	0.0187*** (0.0045)	0.0789*** (0.012)	–0.0656*** (0.0134)
	Observations		264,936		
Frozen Dinners	Coefficient (Std.)	0.6496	0.0225*** (0.0045)	0.0656*** (0.0125)	–0.0514*** (0.0146)
	Observations		199,209		

Table 3. (Cont.)

Category		Correlation	Revenue	Sales volume and revenue	
		(1)	(2)	(3)	(4)
Frozen Entrees	Coefficient (Std.)	0.8172	0.0333*** (0.0023)	0.0507*** (0.0059)	–0.0227*** (0.007)
	Observations		845,711		
Frozen Juices	Coefficient (Std.)	0.9602	0.0123*** (0.0043)	–0.0222*** (0.0166)	0.0355** (0.018)
	Observations		300,483		
Grooming Products	Coefficient (Std.)	0.6431	0.0498*** (0.0047)	0.0581*** (0.0046)	–0.0237*** (0.0074)
	Observations		269,278		
Laundry Detergents	Coefficient (Std.)	0.8879	0.0212*** (0.0039)	0.0652*** (0.0096)	–0.05*** (0.0106)
	Observations		272,143		
Oatmeal	Coefficient (Std.)	0.7807	0.0102 (0.0067)	0.004*** (0.0238)	0.0059 (0.0252)
	Observations		78,407		
Paper Towels	Coefficient (Std.)	0.6499	0.0104 (0.0073)	0.0383*** (0.036)	–0.0285 (0.0364)
	Observations		111,381		
Refrigerated Juices	Coefficient (Std.)	0.9186	0.0205*** (0.0047)	0.029*** (0.0128)	–0.0093 (0.014)
	Observations		302,858		
Shampoos	Coefficient (Std.)	0.5583	0.0565*** (0.0046)	0.0714*** (0.0039)	–0.0419*** (0.0069)
	Observations		261,723		
Snack Crackers	Coefficient (Std.)	0.4937	0.01*** (0.0035)	0.061*** (0.0117)	–0.0566*** (0.0132)
	Observations		395,641		
Soaps	Coefficient (Std.)	0.5475	0.0237*** (0.0061)	0.0511*** (0.0114)	–0.0318** (0.0143)
	Observations		150,082		
Soft Drinks	Coefficient (Std.)	0.6798	0.0255*** (0.0016)	0.0086*** (0.0088)	0.0163* (0.0096)
	Observations		1,336,429		
Toothbrushes	Coefficient (Std.)	0.7039	0.0303*** (0.0054)	0.054*** (0.0063)	–0.0394*** (0.0094)
	Observations		125,225		
Toothpastes	Coefficient (Std.)	0.7081	0.0283*** (0.0041)	0.0479*** (0.0087)	–0.029** (0.0115)
	Observations		263,420		

Notes: Column 1 reports the Pearson correlation coefficient between the sales volume and revenues for each category. Columns 2–4 report the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable in all columns is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50\left|\overline{\Delta p}_{i,s}\right|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product *i* in store *s*, and 0 otherwise. In column 2, the main independent variable is the log of average revenue for product *i* in store *s* over the sample period. In columns 3 and 4, we report the results of a regression that includes both the log of the sales volume and the log of the revenue as independent variables. Column 3 reports the coefficients of the sales volume. Column 4 reports the coefficients of the revenue. All regressions also include fixed effects for months, years, stores, and products. We estimate separate regressions for each product category, clustering the errors by product. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Table 4. Category-level regressions of small price changes and synchronization

Category		(1)	(2)	(3)	(4)
Pooled Data	Coefficient	0.0232***	0.0228***	0.0227***	0.0226***
	(Std.)	(0.0008)	(0.0008)	(0.0008)	(0.0008)
	Observations	9,395,668	9,395,668	9,395,662	9,249,267
Analgesics	Coefficient	0.0451***	0.0436***	0.0394***	0.04***
	(Std.)	(0.0051)	(0.0051)	(0.0049)	(0.005)
	Observations	144,201	144,201	143,520	138,970
Bath Soap	Coefficient	0.082***	0.082***	0.0789***	0.0753***
	(Std.)	(0.0111)	(0.011)	(0.011)	(0.0133)
	Observations	15,222	15,215	13,169	10,484
Bathroom Tissues	Coefficient	0.011***	0.0105***	0.0101***	0.0116***
	(Std.)	(0.0045)	(0.0045)	(0.0045)	(0.0047)
	Observations	141,801	141,801	141,287	131,814
Beer	Coefficient	0.0229***	0.0218***	0.021***	0.021***
	(Std.)	(0.0016)	(0.0016)	(0.0016)	(0.0016)
	Observations	290,313	290,310	290,217	267,003
Bottled Juice	Coefficient	0.0235***	0.0232***	0.0221***	0.023***
	(Std.)	(0.0031)	(0.0031)	(0.0032)	(0.0032)
	Observations	489,123	489,121	489,027	478,512
Canned Soup	Coefficient	0.0031	0.0031	0.0029	0.003
	(Std.)	(0.004)	(0.004)	(0.004)	(0.0041)
	Observations	474,214	474,214	473,953	469,700
Canned Tuna	Coefficient	0.0109***	0.0107***	0.0108***	0.0102***
	(Std.)	(0.004)	(0.004)	(0.004)	(0.0042)
	Observations	208,198	208,198	207,727	198,397
Cereals	Coefficient	0.0094***	0.0093***	0.008***	0.0078***
	(Std.)	(0.0037)	(0.0036)	(0.0035)	(0.0036)
	Observations	352,779	352,779	352,737	348,257
Cheese	Coefficient	0.0223***	0.0221***	0.0222***	0.0212***
	(Std.)	(0.0025)	(0.0025)	(0.0025)	(0.0026)
	Observations	773,222	773,220	773,214	747,789
Cigarettes	Coefficient	0.0897***	0.0919***	0.093***	0.0936***
	(Std.)	(0.0067)	(0.0066)	(0.0065)	(0.0067)
	Observations	35,826	35,821	35,527	35,119
Cookies	Coefficient	0.0231***	0.0234***	0.0229***	0.0226***
	(Std.)	(0.0018)	(0.0019)	(0.0019)	(0.0019)
	Observations	684,672	684,670	684,637	677,839
Crackers	Coefficient	0.0222***	0.0214***	0.0196***	0.0192***
	(Std.)	(0.0039)	(0.0039)	(0.0037)	(0.0036)
	Observations	243,435	243,433	243,148	234,437
Dish Detergent	Coefficient	0.018***	0.0169***	0.0153***	0.0158***
	(Std.)	(0.0028)	(0.0028)	(0.0027)	(0.0028)
	Observations	186,800	186,800	186,349	183,179
Fabric Softener	Coefficient	0.0212***	0.0208***	0.018***	0.02***
	(Std.)	(0.0052)	(0.0052)	(0.0051)	(0.0055)
	Observations	178,936	178,936	178,601	166,438
Front-End-Candies	Coefficient	0.0241***	0.0235***	0.0244***	0.0242***
	(Std.)	(0.0041)	(0.0041)	(0.004)	(0.0041)
	Observations	264,936	264,936	264,152	255,268
Frozen Dinners	Coefficient	0.0218***	0.0221***	0.0195***	0.0195***
	(Std.)	(0.0041)	(0.0041)	(0.0041)	(0.0041)
	Observations	199,209	199,209	199,092	198,981

Table 4. (Cont.)

Category		(1)	(2)	(3)	(4)
Frozen Entrees	Coefficient	0.0336***	0.0338***	0.0319***	0.0318***
	(Std.)	(0.0021)	(0.0021)	(0.002)	(0.002)
	Observations	845,711	845,711	845,698	843,085
Frozen Juices	Coefficient	0.0115***	0.0113***	0.0105***	0.0093***
	(Std.)	(0.0041)	(0.0041)	(0.0042)	(0.0044)
	Observations	300,483	300,483	300,468	290,947
Grooming Products	Coefficient	0.0472***	0.0463***	0.0457***	0.0454***
	(Std.)	(0.0025)	(0.0025)	(0.0025)	(0.0025)
	Observations	269,278	269,277	269,185	267,531
Laundry Detergents	Coefficient	0.0267***	0.0257***	0.0205***	0.0199***
	(Std.)	(0.0034)	(0.0034)	(0.0034)	(0.0034)
	Observations	272,143	272,143	272,073	268,958
Oatmeal	Coefficient	0.0096**	0.0095**	0.0123**	0.0072*
	(Std.)	(0.0063)	(0.0063)	(0.0063)	(0.0072)
	Observations	78,407	78,407	76,910	70,038
Paper Towels	Coefficient	0.0192**	0.0191**	0.0188**	0.0172**
	(Std.)	(0.0094)	(0.0094)	(0.0095)	(0.0102)
	Observations	111,381	111,381	110,962	103,528
Refrigerated Juices	Coefficient	0.0213***	0.0214***	0.0196***	0.0207***
	(Std.)	(0.0042)	(0.0041)	(0.004)	(0.0041)
	Observations	302,858	302,858	302,834	290,002
Shampoos	Coefficient	0.0505***	0.0479***	0.0446***	0.044***
	(Std.)	(0.0025)	(0.0025)	(0.0025)	(0.0025)
	Observations	261,723	261,723	261,685	257,832
Snack Crackers	Coefficient	0.0137***	0.0131***	0.012***	0.0121***
	(Std.)	(0.003)	(0.003)	(0.0031)	(0.0032)
	Observations	395,641	395,641	395,549	386,368
Soaps	Coefficient	0.0282***	0.0278***	0.0257***	0.0248***
	(Std.)	(0.0048)	(0.0048)	(0.0048)	(0.0048)
	Observations	150,082	150,082	149,807	147,123
Soft Drinks	Coefficient	0.0261***	0.0257***	0.026***	0.026***
	(Std.)	(0.0014)	(0.0014)	(0.0014)	(0.0014)
	Observations	1,336,429	1,336,428	1,336,424	1,323,703
Toothbrushes	Coefficient	0.035***	0.0324***	0.029***	0.0283***
	(Std.)	(0.0036)	(0.0035)	(0.0035)	(0.0035)
	Observations	125,225	125,225	124,588	122,633
Toothpastes	Coefficient	0.03***	0.0258***	0.0212***	0.0212***
	(Std.)	(0.0031)	(0.0031)	(0.0031)	(0.0031)
	Observations	263,420	263,420	263,259	259,399

Notes: The table reports the results of category-level fixed effect regressions of the probability of a price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50|\overline{\Delta p}_{i,s}|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of a regression that includes the log of the average sales volume, and the average number of products offered in the category by the same producer. In column 2, we add the percentage of the products whose prices changed in the same week, excluding the current observation. In column 3, we add the average size of contemporaneous price changes, excluding the current observation. In column 4, we add the percentage of the products that are produced by the same producer and that changed price in the same week, excluding the current observation. All regressions include fixed effects for months, years, stores, and products. We estimate separate regressions for each product category, clustering the errors by product. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Table 5. Likelihood of price changes

Category		(1)	(2)	(3)
Pooled Data	Coefficient	0.0147***	0.0121***	0.0058***
	(Std.)	(0.0005)	(0.0002)	(0.0001)
	Observations	83,215,123	82,093,485	69,747,351
Analgesics	Coefficient	0.0167***	0.0131***	0.0074***
	(Std.)	(0.0007)	(0.0007)	(0.0004)
	Observations	2,739,160	2,698,523	2,497,692
Bath Soap	Coefficient	0.0183***	0.0122***	0.0061***
	(Std.)	(0.0014)	(0.0011)	(0.0006)
	Observations	357,243	342,106	316,874
Bathroom Tissues	Coefficient	–0.0018	0.0036***	0.0047***
	(Std.)	(0.002)	(0.0013)	(0.0009)
	Observations	958,067	948,228	782,190
Beer	Coefficient	0.0376***	0.0233***	0.0049***
	(Std.)	(0.0017)	(0.001)	(0.0004)
	Observations	1,645,234	1,615,524	1,105,727
Bottled Juice	Coefficient	0.007***	0.0113***	0.0058***
	(Std.)	(0.0007)	(0.0006)	(0.0005)
	Observations	3,770,790	3,734,391	3,065,158
Canned Soup	Coefficient	0.0069***	0.0061***	0.0039***
	(Std.)	(0.0006)	(0.0006)	(0.0004)
	Observations	4,983,364	4,950,656	4,389,589
Canned Tuna	Coefficient	0.0092***	0.0106***	0.0057***
	(Std.)	(0.001)	(0.0008)	(0.0005)
	Observations	2,158,653	2,138,699	1,790,170
Cereals	Coefficient	0.0037***	0.003***	0.0024***
	(Std.)	(0.0004)	(0.0003)	(0.0003)
	Observations	4,335,072	4,298,578	3,996,943
Cheese	Coefficient	0.0085***	0.0104***	0.0064***
	(Std.)	(0.0006)	(0.0006)	(0.0004)
	Observations	5,656,862	5,609,675	4,608,234
Cigarettes	Coefficient	0.0083***	0.0074***	0.007***
	(Std.)	(0.0003)	(0.0003)	(0.0003)
	Observations	1,691,847	1,655,933	1,637,412
Cookies	Coefficient	0.0113***	0.0107***	0.0046***
	(Std.)	(0.0004)	(0.0003)	(0.0002)
	Observations	6,763,887	6,685,702	5,658,488
Crackers	Coefficient	0.0206***	0.0183***	0.0099***
	(Std.)	(0.0013)	(0.0012)	(0.0006)
	Observations	1,924,373	1,903,284	1,524,460
Dish Detergent	Coefficient	0.0107***	0.0108***	0.0065***
	(Std.)	(0.0009)	(0.0007)	(0.0005)
	Observations	1,945,013	1,923,072	1,682,330
Fabric Softener	Coefficient	0.0097***	0.01***	0.0055***
	(Std.)	(0.0008)	(0.0008)	(0.0005)
	Observations	2,070,479	2,045,332	1,808,627
Front-End-Candies	Coefficient	0.0044***	0.0026***	0.0015***
	(Std.)	(0.0004)	(0.0003)	(0.0002)
	Observations	4,216,776	4,182,351	3,875,527
Frozen Dinners	Coefficient	0.0223***	0.0206***	0.0084***
	(Std.)	(0.001)	(0.0014)	(0.0007)
	Observations	1,286,634	1,266,763	1,010,013

Table 5. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.0134***	0.0129***	0.004***
	(Std.)	(0.0006)	(0.0006)	(0.0003)
	Observations	6,004,136	5,936,800	4,942,770
Frozen Juices	Coefficient	0.0079***	0.0098***	0.0048***
	(Std.)	(0.0012)	(0.0008)	(0.0005)
	Observations	1,988,086	1,974,344	1,619,227
Grooming Products	Coefficient	0.0282***	0.0166***	0.0067***
	(Std.)	(0.0009)	(0.0006)	(0.0003)
	Observations	3,226,985	3,142,048	2,747,308
Laundry Detergents	Coefficient	0.0111***	0.0113***	0.0063***
	(Std.)	(0.0008)	(0.0007)	(0.0004)
	Observations	2,915,963	2,870,953	2,516,304
Oatmeal	Coefficient	0.0086***	0.0098***	0.0071***
	(Std.)	(0.0009)	(0.0018)	(0.0012)
	Observations	878,922	871,478	805,015
Paper Towels	Coefficient	0.0037**	0.0022*	0.0025***
	(Std.)	(0.0015)	(0.0012)	(0.0007)
	Observations	796,475	784,801	638,089
Refrigerated Juices	Coefficient	0.0036***	0.006***	0.0056***
	(Std.)	(0.0011)	(0.0009)	(0.0007)
	Observations	1,658,488	1,641,303	1,262,598
Shampoos	Coefficient	0.0255***	0.0138***	0.0049***
	(Std.)	(0.0005)	(0.0005)	(0.0002)
	Observations	3,608,320	3,467,131	3,060,781
Snack Crackers	Coefficient	0.0136***	0.012***	0.0055***
	(Std.)	(0.0009)	(0.0007)	(0.0005)
	Observations	3,015,203	2,984,656	2,406,996
Soaps	Coefficient	0.0123***	0.0113***	0.0072***
	(Std.)	(0.0011)	(0.001)	(0.0007)
	Observations	1,613,707	1,588,614	1,395,413
Soft Drinks	Coefficient	0.0179***	0.0146***	0.0046***
	(Std.)	(0.0008)	(0.0007)	(0.0002)
	Observations	6,997,660	6,893,063	5,182,829
Toothbrushes	Coefficient	0.0239***	0.0161***	0.0075***
	(Std.)	(0.0011)	(0.001)	(0.0006)
	Observations	1,503,671	1,474,631	1,282,647
Toothpastes	Coefficient	0.0213***	0.0156***	0.0058***
	(Std.)	(0.0008)	(0.0008)	(0.0005)
	Observations	2,504,053	2,464,846	2,137,940

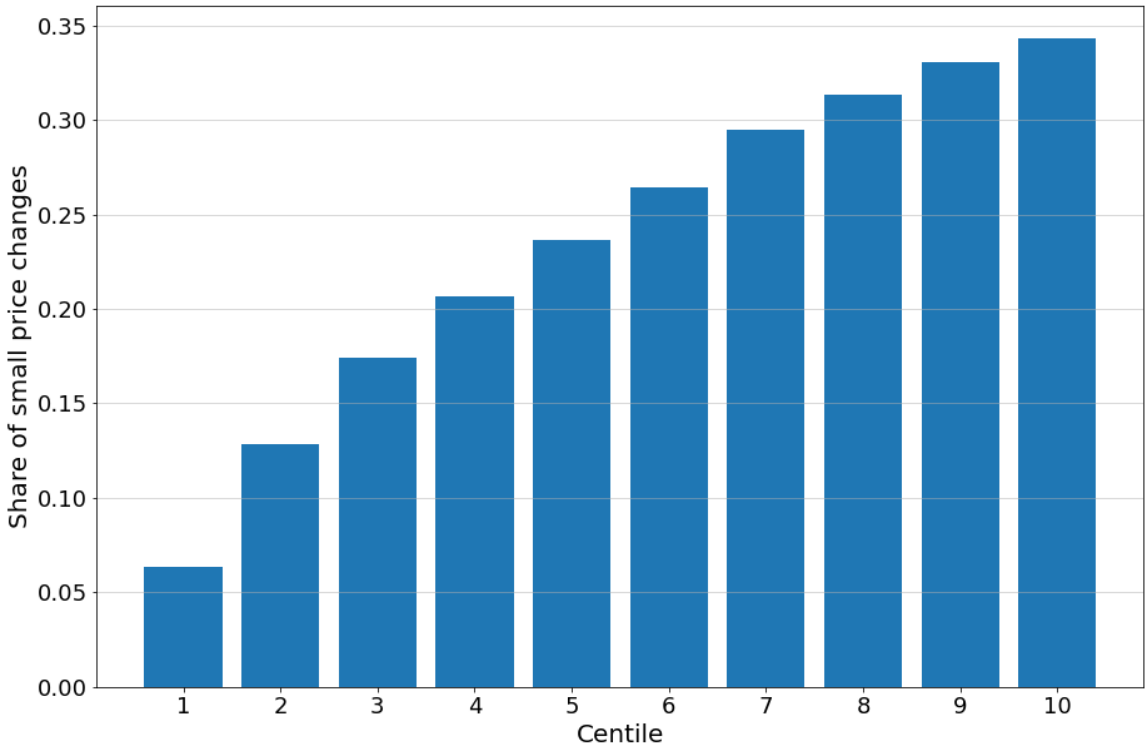
Notes: The table reports the results of category-level fixed effect regressions of the probability of a price change. The dependent variable is "price change," which equals 1 if a price of product *i* in store *s* changed at time *t*. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes only the log of the average sales volume and the fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Table 6. Summary statistics of the distribution of the size of price changes, by sales volumes

	Skewness	Kurtosis	$\lvert\Delta p_{is,t}\rvert < 1\%$	$\lvert\Delta p_{is,t}\rvert < 2\%$	$\lvert\Delta p_{is,t}\rvert < 3\%$	$N(\Delta p_{i,s})$
Transaction prices						
Low	−0.09	2.07	0.5%	2.5%	6.2%	1.4
Medium	−0.09	2.63	0.9%	4.9%	10.7%	4.0
High	−0.05	3.14	1.2%	6.1%	12.6%	5.8
Regular prices						
Low	−0.13	2.59	2.3%	11.2%	19.6%	0.7
Medium	−0.20	3.71	3.7%	19.9%	29.9%	1.4
High	−0.20	4.32	4.5%	23.8%	34.8%	1.7

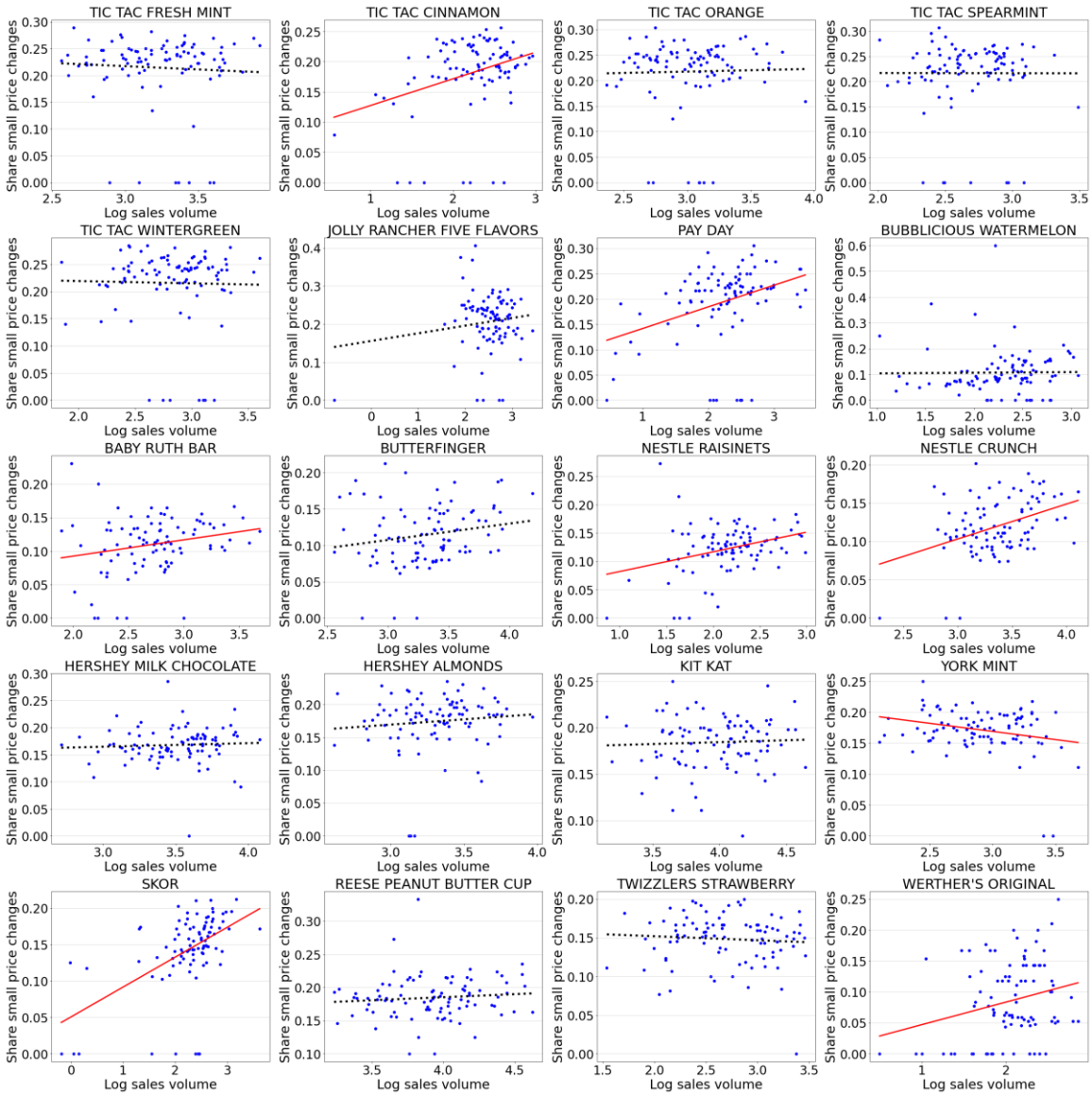
Notes: Low sales volume products are store-products in the low one-third of the distribution of sales volumes (average sales volume < 1.25 units per week). Medium sales volume products are products that have a sales volume in between the low and the high sales volumes. High sales volume products are store-products that have sales in the high one-third of the distribution of sales volumes (average sales volume ≥ 4.82 units per week). The skewness and kurtosis columns give the skewness and the kurtosis of the distribution of the size of price changes. $\lvert\Delta p_{is,t}\rvert < 1\%$, $\lvert\Delta p_{is,t}\rvert < 2\%$, and $\lvert\Delta p_{is,t}\rvert < 3\%$ give the share of the price changes that are smaller than 1%, 2% and 3%, respectively. The skewness and the kurtosis are calculated for the normalized price changes (Alvarez et al., 2016), $z_{i,s,t} = (\Delta p_{is,t} - \overline{\Delta p_{is}})/\sigma_{\Delta p_{is}}$, where $\overline{\Delta p_{is}}$ is the mean of $\Delta p_{is,t}$ and $\sigma_{\Delta p_{is}}$ is the standard deviation of $\Delta p_{is,t}$. $N(\Delta p_{i,s})$ is the average number of price changes per year per product, calculated as the average of $-52/ln(1 - \bar{f}_{i,s})$, where $\bar{f}_{i,s}$ is the frequency of price changes of product i in store s.

Figure 1. Frequency of small price changes by sales volume deciles



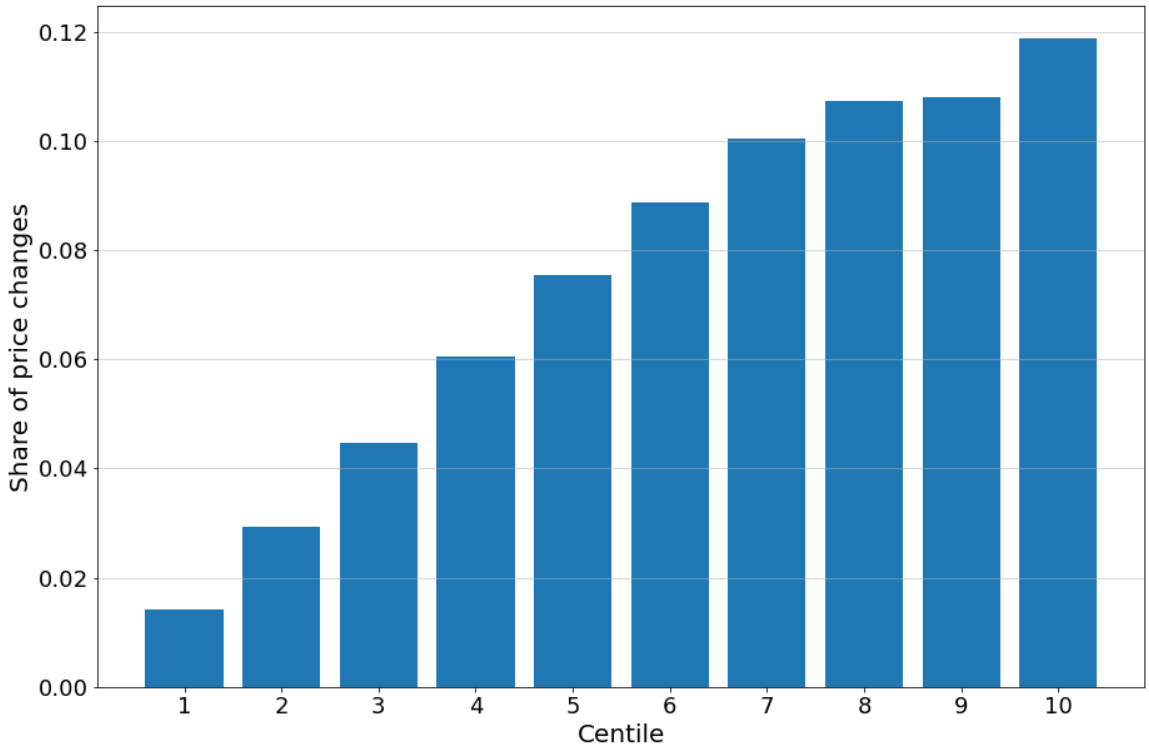
Notes: The figure was obtained by merging all 29 product categories and dividing store-products into centiles according to their average sales volume. The bars give the share of small price changes ($|\Delta p_{i,s,t}| < 0.50|\overline{\Delta p_{i,s}}|$) out of all price changes.

Figure 2. Product-level correlations between sales volume and small price changes in the Front-End Candies Category



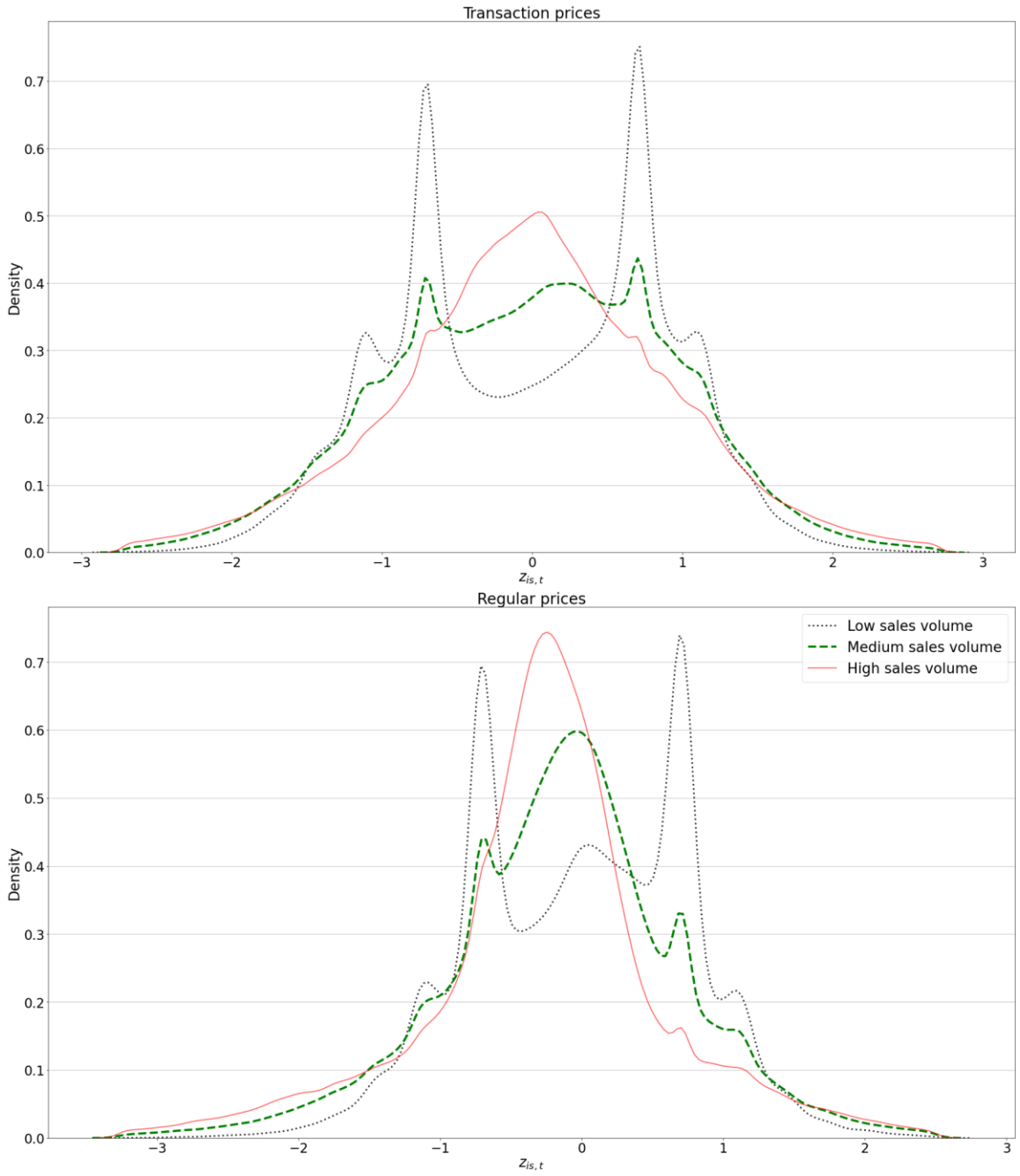
Notes: The figure depicts the correlation between log average sales volume (*x*-axis) and the percentage of small price changes (*y*-axis) for various products in the front-end candies category. Each dot represents the data for the product in a specific store. There are 93 dots in each figure, one for each store. The straight lines in the figures are regression lines. Red solid regression lines indicate that the regression coefficient is significant at the 5% level, which is the case for 7 of the 13 products. The regression lines that are not statistically significant are marked with black dotted lines. The axis scales vary across the panels.

Figure 3. Frequency of price changes by sales volume deciles



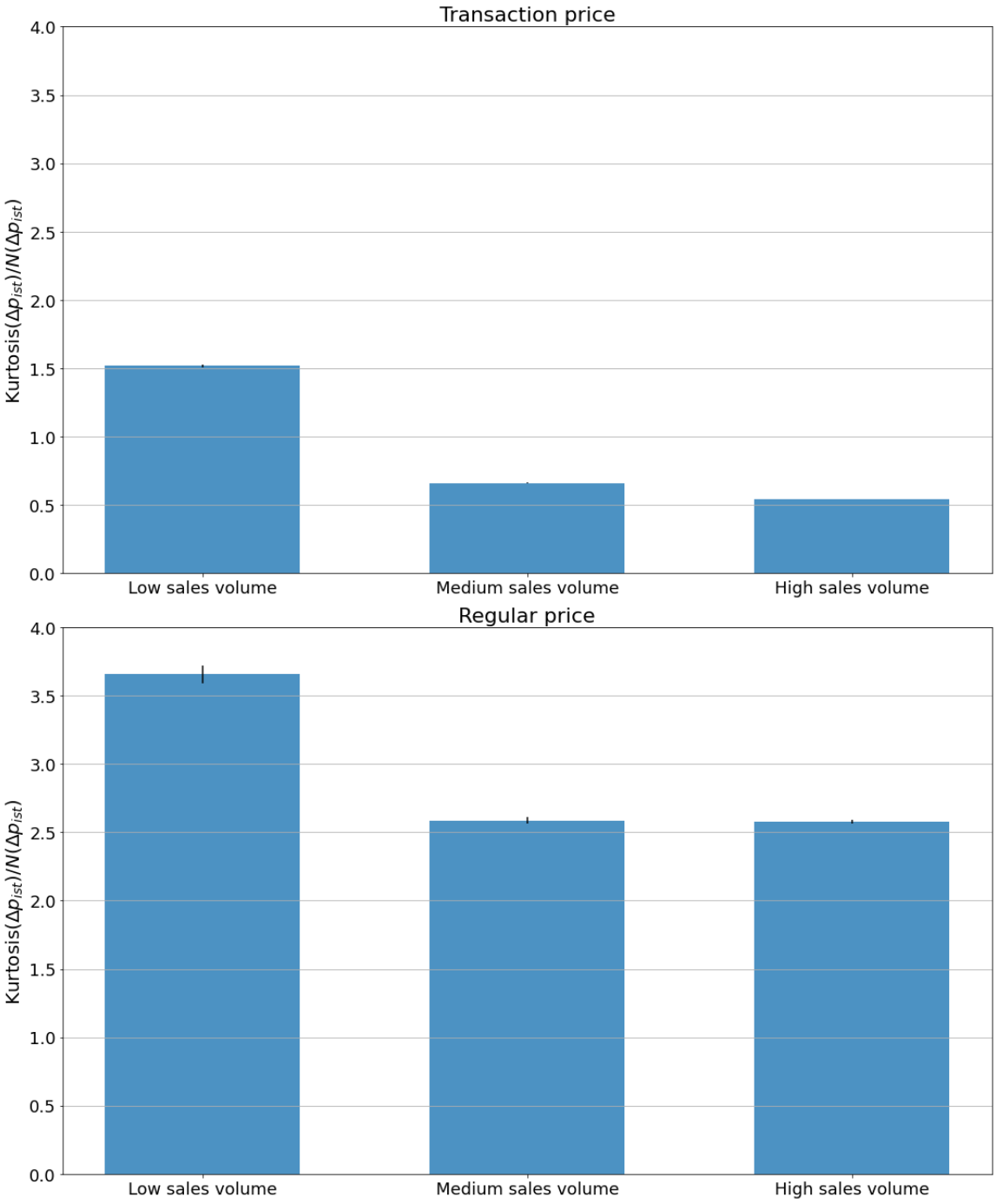
Notes: The figure was obtained by merging all 29 product categories and dividing store-products into centiles according to their average sales volume. The bars give the share of price changes out of all observations.

Figure 4. Distributions of the size of price changes, by sales volumes



Notes: To generate the figure, we pool the observations from all 29 categories and divide the products-stores into three groups according to their sales volumes. Low sales volume products are store-products in the low one-third of the distribution of sales volumes (average sales volume < 1.25 units per week). Medium sales volume products are products that have a sales volume in between the low and the high sales volume. High sales volume products are store-products that have sales in the high one-third of the distribution of sales volumes (average sales volume ≥ 4.82 units per week). The *x*-axis gives the normalized size of log price changes, $z_{is,t} = \frac{\Delta p_{i,s,t} - \overline{\Delta p_{i,s}}}{\sigma_{i,s,t}}$, where $\Delta p_{i,s,t}$ is log price change of product i in store s in week t, $\Delta p_{i,s}$ is the average price change of product i in store s, and $\sigma_{i,s,t}$ is the standard deviation of the price changes of product i in store s.

Figure 5. Estimates of the sufficient statistics



Notes: The figure depicts the ratio of the kurtosis of the distribution of the size of price changes and the average number of price changes for low, middle, and high sales volume products. The black vertical lines represent 95% confidence intervals obtained by bootstrapping 1,000 times.

Online Supplementary Web Appendix

Not for Publication

Small Price Changes, Sales Volume, and Menu Cost

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Appendix A. Alternative definitions of small price changes

In the paper, we define a small price change as a price change smaller than $\kappa\left|\overline{\Delta p}_{i,s}\right|$, where $\overline{\Delta p}_{i,s}$ is the average price change of product i in store s, and κ attains the value 0.5. In this appendix, we repeat our main analysis using 8 alternative definitions of small price changes.

First. we let κ attain the values 0.33, 0.25 and 0.10. Second, we define small price changes as changes of up to, and including 2%, and 5%. Third, we define small price changes as price changes of up to, and including, 5¢, 10¢ and 15¢.

As we do in the paper, we remove observations on price changes smaller than 1¢, and use observations on price changes only if we observe the price in both weeks *t* and *t* + 1 and the post-change price remained unchanged for at least 2 weeks.

Table A1 presents the results of regressions equivalent to the regressions in Table 1 in the paper. The regressions take the following form:

$$small\ price\ change_{i,s,t} = \alpha + \beta\ ln(\ average\ sales\ volume_{i,s}) + \gamma \boldsymbol{X}_{i,s,t} + month_t + year_t + \delta_s + \mu_i + u_{i,s,t} \quad \text{(A1)}$$

where *small price change* is a dummy that equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.33\left|\overline{\Delta p}_{i,s}\right|$, and 0 otherwise. The *average sales volume* is the average sales volume of product *i* in store *s* over the sample period. **X** is a matrix of other control variables. *Month* and *year* are fixed effects for the month and the year of the price change. δ and μ are fixed effects for stores and products, respectively, and *u* is an i.i.d error term. We estimate separate regressions for each product category, clustering the errors by product.

The values in the table are the coefficients of the log of the average sales volume. In column 1, the only control variables are the log of the average sales volume, and the dummies for months, years, stores, and products. The top row gives the values for the pooled regression, using data from all product categories. The other rows give the values for each one of the 29 categories.

We find that 28 of the coefficients of the log of the average sales volume are positive, and 26 of them are statistically significant. Using the pooled data, the coefficient of the log sales volume is 0.018, suggesting that a 1% increase in the sales volume is associated with a 1.8% increase in the likelihood of a small price change.

In column 2, we add controls for the log of the average price, the absolute value of the percentage change in the wholesale price, a control for sale- and bounce-back prices, which we identify using the sales filter algorithm of Fox and Syed (2016), and a dummy for 9-ending prices. 28 of the coefficients are positive, and 23 of them are statistically significant. Using the pooled sample, the coefficient is 0.016 suggesting that a 1% increase in the sales volume is associated with a 1.6% increase in the likelihood of a small price change.

As a further control for the effects of sales on the results, in column 3 we focus on regular prices by excluding all sale- and bounce-back prices. We find that 28 coefficients are positive. 23 of the positive coefficients are statistically significant, and 1 more is statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.035, suggesting that a 1% increase in the sales volume is associated with a 3.5% increase in the likelihood of a small price change.

In Table A2, we present the results of similar regressions, but we define small price changes as price changes smaller than $0.25\left|\overline{\Delta p}_{i,s}\right|$. In column 1, we find that if we look at the pooled data, the coefficient of the sales volumes is 0.015, suggesting that a 1% increase in the sales volume is associated with a 1.5% increase in the likelihood of a small price change. In addition, when we consider individual categories, we find that 28 of the coefficients are positive, and 25 of these coefficients are statistically significant.

In column 2, we add the same controls as in Table A1. We find that 27 coefficients are positive. 19 of the positive coefficients are statistically significant, and 2 more are statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.013, suggesting that a 1% increase in the sales volume is associated with a 1.3% increase in the likelihood of a small price change.

In column 3, we focus on regular prices by removing sales and bounce-back prices. We find that 26 coefficients are positive. 21 of the positive coefficients are statistically significant, and 2 more are statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.028, suggesting that a 1% increase in the sales volume is associated with a 2.8% increase in the likelihood of a small price change.

In Table A3, we define small price changes as price changes smaller than $0.10\left|\overline{\Delta p}_{i,s}\right|$. In column 1, we find that if we look at the pooled data, the coefficient of the sales volumes is 0.006, suggesting that a 1% increase in the sales volume is associated

with a 0.6% increase in the likelihood of a small price change. In addition, when we consider individual categories, we find that 27 of the coefficients are positive, 20 of these coefficients are statistically significant, and 2 more are statistically significant at the 10% level.

In column 2, we add the same controls as in Table A1. We find that 28 coefficients are positive. 17 of the positive coefficients are statistically significant, and 4 more are statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.005, suggesting that a 1% increase in the sales volume is associated with a 0.5% increase in the likelihood of a small price change.

In column 3, we focus on regular prices by removing sales and bounce-back prices. We find that 25 coefficients are positive. 13 of the positive coefficients are statistically significant, and 4 more are statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.011, suggesting that a 1% increase in the sales volume is associated with a 1.1% increase in the likelihood of a small price change.

In Table A4, we report the results when we define small price changes as changes smaller than 2%. In column 1, we find that if we look at the pooled data, the coefficient of the sales volumes is 0.010, suggesting that a 1% increase in the sales volume is associated with a 1.0% increase in the likelihood of a small price change. In addition, when we consider individual categories, we find that all 29 of the coefficients are positive, and 27 of them are statistically significant.

In column 2, we add the same controls as in Table A1. We still find that all 29 coefficients are positive. 26 of the coefficients are statistically significant, and 2 more are statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.008, suggesting that a 1% increase in the sales volume is associated with a 0.8% increase in the likelihood of a small price change.

In column 3, we focus on regular prices by removing sales and bounce-back prices. We find that 28 coefficients are positive. 25 of the positive coefficients are statistically significant, and 1 more is statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.022, suggesting that a 1% increase in the sales volume is associated with a 2.2% increase in the likelihood of a small price change.

In Table A5, we report the results when we define small price changes as changes smaller than 5%. In column 1, we find that if we look at the pooled data, the coefficient of the sales volumes is 0.022, suggesting that a 1% increase in the sales volume is

associated with a 2.2% increase in the likelihood of a small price change. In addition, when we consider individual categories, we find that all 29 of the coefficients are positive, and 27 of them are statistically significant.

In column 2, we add the same controls as in Table A1. We still find that all 29 coefficients are positive and that 26 of them are statistically significant. Using the pooled sample, the coefficient is 0.018, suggesting that a 1% increase in the sales volume is associated with a 1.8% increase in the likelihood of a small price change.

In column 3, we focus on regular prices by removing sales and bounce-back prices. We find that 29 coefficients are positive and 26 of them coefficients are statistically significant. 1 more coefficient is statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.033, suggesting that a 1% increase in the sales volume is associated with a 3.3% increase in the likelihood of a small price change.

In Tables A6–A8, we define small price changes in levels. In Table A6, we define small price changes as price changes smaller than 5¢. In column 1, we find that if we look at the pooled data, the coefficient of the sales volumes is 0.013, suggesting that a 1% increase in the sales volume is associated with a 1.3% increase in the likelihood of a small price change. In addition, when we consider individual categories, we find that all 29 of the coefficients are positive and 28 of them are statistically significant. One more coefficient is statistically significant at the 10% level.

In column 2, we add the same controls as in Table A1. We still find that all 29 coefficients are positive and that 24 of them are statistically significant. One more coefficient is statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.009, suggesting that a 1% increase in the sales volume is associated with a 0.9% increase in the likelihood of a small price change.

In column 3, we focus on regular prices by removing sales and bounce-back prices. We find that 28 of the 29 coefficients are positive. 25 of the positive coefficients are statistically significant. Using the pooled sample, the coefficient is 0.020, suggesting that a 1% increase in the sales volume is associated with a 2.0% increase in the likelihood of a small price change.

In Table A7, we define small price changes as price changes smaller than 10¢. In column 1, we find that if we look at the pooled data, the coefficient of the sales volumes is 0.028, suggesting that a 1% increase in the sales volume is associated with a 2.8% increase in the likelihood of a small price change. In addition, when we consider

individual categories, we find that all 29 of the coefficients are positive and statistically significant.

In column 2, we add the same controls as in Table A1. We still find that all 29 coefficients are positive and that 28 of them are statistically significant. One more coefficient is statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.021, suggesting that a 1% increase in the sales volume is associated with a 2.1% increase in the likelihood of a small price change.

In column 3, we focus on regular prices by removing sales and bounce-back prices. We find that 29 of the 29 coefficients are positive and statistically significant. Using the pooled sample, the coefficient is 0.029, suggesting that a 1% increase in the sales volume is associated with a 2.9% increase in the likelihood of a small price change.

In Table A8, we define small price changes as price changes smaller than 15¢. In column 1, we find that if we look at the pooled data, the coefficient of the sales volumes is 0.024, suggesting that a 1% increase in the sales volume is associated with a 2.4% increase in the likelihood of a small price change. In addition, when we consider individual categories, we find that all 29 of the coefficients are positive and that 28 of them are statistically significant. In column 2, we add the same controls as in Table A1. We still find that all 29 coefficients are positive. 27 of the coefficients are statistically significant. Using the pooled sample, the coefficient is 0.017, suggesting that a 1% increase in the sales volume is associated with a 1.7% increase in the likelihood of a small price change. In column 3, we focus on regular prices by removing sales and bounce-back prices. We find that all 29 coefficients are positive. 26 of the 29 coefficients are statistically significant. One more coefficient is statistically significant at the 1% level. Using the pooled sample, the coefficient is 0.028, suggesting that a 1% increase in the sales volume is associated with a 2.8% increase in the likelihood of a small price change.

Table A1. Category-level regressions of small price changes ($\Delta P \leq 33\%$ of the average price change) and sales volume

Category		(1)	(2)	(3)
Pooled Data	**Coefficient (Std.)**	**0.0181*** (0.0006)**	**0.0159*** (0.0005)**	**0.0346*** (0.0012)**
	Observations	**9,395,668**	**9,395,668**	**2,198,344**
Analgesics	Coefficient (Std.)	0.0408*** (0.004)	0.0312*** (0.0038)	0.0588*** (0.0076)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient (Std.)	0.0463*** (0.0071)	0.0437*** (0.0062)	0.1128*** (0.0168)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient (Std.)	0.0157*** (0.0038)	0.0133*** (0.005)	0.0208** (0.0086)
	Observations	141,801	141,801	39,815
Beer	Coefficient (Std.)	0.0206*** (0.0014)	0.0226*** (0.0014)	0.0878*** (0.0071)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient (Std.)	0.0237*** (0.0025)	0.0198*** (0.0025)	0.0272*** (0.0048)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient (Std.)	-0.0069 (0.0048)	-0.003 (0.0045)	0.0012 (0.0058)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient (Std.)	0.0065* (0.0039)	0.0038 (0.0039)	0.0103 (0.0063)
	Observations	208,198	208,198	60,298
Cereals	Coefficient (Std.)	0.0073** (0.0032)	0.0031 (0.0033)	-0.0011 (0.0052)
	Observations	352,779	352,779	151,201
Cheese	Coefficient (Std.)	0.0169*** (0.0021)	0.0093*** (0.002)	0.0192*** (0.0045)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient (Std.)	0.0433*** (0.0053)	0.044*** (0.0051)	0.0542*** (0.006)
	Observations	35,826	35,826	29,931
Cookies	Coefficient (Std.)	0.0132*** (0.0015)	0.009*** (0.0015)	0.0319*** (0.0034)
	Observations	684,672	684,672	129,854
Crackers	Coefficient (Std.)	0.0127*** (0.0032)	0.0038 (0.0028)	0.0108* (0.0061)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient (Std.)	0.0105*** (0.0025)	0.002 (0.0028)	0.0111** (0.0055)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient (Std.)	0.0219*** (0.0038)	0.0165*** (0.0038)	0.038*** (0.0075)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient (Std.)	0.0204*** (0.0037)	0.0208*** (0.0034)	0.0108*** (0.0038)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient (Std.)	0.0218*** (0.0039)	0.0186*** (0.0042)	0.0746*** (0.0093)
	Observations	199,209	199,209	34,111

Table A1. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.0293***	0.0272***	0.0403***
	(Std.)	(0.0018)	(0.0018)	(0.0035)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient	0.0129***	0.0071**	0.0261***
	(Std.)	(0.0032)	(0.0031)	(0.0064)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient	0.0317***	0.0337***	0.0692***
	(Std.)	(0.002)	(0.0022)	(0.0064)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient	0.0147***	0.0064***	0.0229***
	(Std.)	(0.0027)	(0.0025)	(0.0049)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient	0.013***	0.0009	0.0088
	(Std.)	(0.0047)	(0.0047)	(0.0074)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient	0.0002	0.0042	0.0162
	(Std.)	(0.0056)	(0.0049)	(0.0127)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient	0.0213***	0.0112***	0.0243***
	(Std.)	(0.0029)	(0.003)	(0.006)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient	0.0381***	0.0435***	0.0966***
	(Std.)	(0.0019)	(0.002)	(0.0067)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient	0.0117***	0.0079***	0.0313***
	(Std.)	(0.0023)	(0.0025)	(0.005)
	Observations	395,641	395,641	76,710
Soaps	Coefficient	0.0222***	0.0127***	0.0356***
	(Std.)	(0.0038)	(0.0036)	(0.0076)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient	0.0135***	0.0156***	0.0383***
	(Std.)	(0.0018)	(0.0012)	(0.0036)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient	0.0297***	0.0293***	0.0836***
	(Std.)	(0.0029)	(0.0028)	(0.0085)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient	0.0246***	0.0241***	0.0623***
	(Std.)	(0.0026)	(0.0025)	(0.0066)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.33|\overline{\Delta p}_{i,s}|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes only the log of the average sales volume and the fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product.

* $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Table A2. Category-level regressions of small price changes ($\Delta P \leq 25\%$ of the average price change) and sales volume

Category		(1)	(2)	(3)
Pooled Data	Coefficient	0.0146***	0.0128***	0.0282***
	(Std.)	(0.0005)	(0.0005)	(0.0011)
	Observations	9,395,668	9,395,668	2,198,344
Analgesics	Coefficient	0.0325***	0.0242***	0.0529***
	(Std.)	(0.0035)	(0.0033)	(0.0074)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient	0.028***	0.0262***	0.0937***
	(Std.)	(0.0061)	(0.0054)	(0.0151)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient	0.0042	0.008	0.0077
	(Std.)	(0.0034)	(0.006)	(0.0107)
	Observations	141,801	141,801	39,815
Beer	Coefficient	0.0178***	0.0197***	0.0842***
	(Std.)	(0.0013)	(0.0012)	(0.007)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient	0.0169***	0.0146***	0.0221***
	(Std.)	(0.0022)	(0.0022)	(0.0049)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient	-0.0065	-0.0031	-0.0021
	(Std.)	(0.0043)	(0.0041)	(0.0053)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient	0.0005	-0.0017	0.0001
	(Std.)	(0.0038)	(0.0039)	(0.0069)
	Observations	208,198	208,198	60,298
Cereals	Coefficient	0.0065**	0.0031	-0.0022
	(Std.)	(0.003)	(0.0031)	(0.0051)
	Observations	352,779	352,779	151,201
Cheese	Coefficient	0.0109***	0.0048***	0.0165***
	(Std.)	(0.002)	(0.0019)	(0.0044)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient	0.0268***	0.0267***	0.0342***
	(Std.)	(0.0041)	(0.004)	(0.0045)
	Observations	35,826	35,826	29,931
Cookies	Coefficient	0.0115***	0.0082***	0.0249***
	(Std.)	(0.0013)	(0.0013)	(0.003)
	Observations	684,672	684,672	129,854
Crackers	Coefficient	0.0094***	0.0024	-0.0006***
	(Std.)	(0.0028)	(0.0023)	(0.0059)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient	0.0077***	0.0009	0.0052
	(Std.)	(0.0022)	(0.0024)	(0.0057)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient	0.0139***	0.0097***	0.0246***
	(Std.)	(0.0032)	(0.0031)	(0.0077)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient	0.0139***	0.0164***	0.0087***
	(Std.)	(0.0032)	(0.003)	(0.0033)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient	0.0189***	0.0168***	0.0639***
	(Std.)	(0.0036)	(0.0039)	(0.0101)
	Observations	199,209	199,209	34,111

Table A2. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.0273***	0.0266***	0.0434***
	(Std.)	(0.0016)	(0.0016)	(0.0034)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient	0.011***	0.0064*	0.0219***
	(Std.)	(0.0036)	(0.0034)	(0.0068)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient	0.0184***	0.02***	0.0413***
	(Std.)	(0.0016)	(0.0018)	(0.0057)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient	0.0104***	0.0036***	0.0178***
	(Std.)	(0.0021)	(0.0021)	(0.0046)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient	0.0188***	0.0075	0.0159**
	(Std.)	(0.0046)	(0.0053)	(0.008)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient	0.0051	0.0073	0.0221***
	(Std.)	(0.0049)	(0.0048)	(0.0116)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient	0.0148***	0.006**	0.0148**
	(Std.)	(0.0029)	(0.003)	(0.006)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient	0.0241***	0.028***	0.07***
	(Std.)	(0.0016)	(0.0017)	(0.006)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient	0.0107***	0.0077***	0.0242***
	(Std.)	(0.0017)	(0.0018)	(0.0044)
	Observations	395,641	395,641	76,710
Soaps	Coefficient	0.0166***	0.0091***	0.0297***
	(Std.)	(0.0032)	(0.003)	(0.0078)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient	0.0116***	0.0126***	0.0314***
	(Std.)	(0.0016)	(0.0012)	(0.0031)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient	0.0216***	0.0214***	0.0712***
	(Std.)	(0.0025)	(0.0026)	(0.0076)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient	0.0209***	0.0204***	0.0546***
	(Std.)	(0.0021)	(0.0021)	(0.0061)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.25|\overline{\Delta p}_{i,s}|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes only the log of the average sales volume and the fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Table A3. Category-level regressions of small price changes ($\Delta P \leq 10\%$ of the average price change) and sales volume

Category		(1)	(2)	(3)
Pooled Data	**Coefficient (Std.)**	**0.0057*** (0.0002)**	**0.0051*** (0.0002)**	**0.0115*** (0.0007)**
	Observations	**9,395,668**	**9,395,668**	**2,198,344**
Analgesics	Coefficient (Std.)	0.0113*** (0.0017)	0.0086*** (0.0016)	0.0179*** (0.0045)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient (Std.)	0.0079*** (0.0034)	0.008** (0.0033)	0.0285*** (0.0103)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient (Std.)	0.0013 (0.0024)	0.0093* (0.0047)	0.0108 (0.0071)
	Observations	141,801	141,801	39,815
Beer	Coefficient (Std.)	0.0092*** (0.0009)	0.0105*** (0.0009)	0.0549*** (0.0055)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient (Std.)	0.0016* (0.0009)	0.001 (0.0009)	-0.0003 (0.0027)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient (Std.)	-0.0006 (0.0016)	0.0017 (0.0017)	-0.0002 (0.0037)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient (Std.)	-0.0004 (0.0007)	-0.0006 (0.0008)	-0.0015 (0.0024)
	Observations	208,198	208,198	60,298
Cereals	Coefficient (Std.)	0.0024 (0.0015)	0.0009 (0.0016)	-0.0046 (0.0033)
	Observations	352,779	352,779	151,201
Cheese	Coefficient (Std.)	0.0044*** (0.001)	0.0029*** (0.0009)	0.0068*** (0.0028)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient (Std.)	0.0048*** (0.0015)	0.004*** (0.0014)	0.0052*** (0.0017)
	Observations	35,826	35,826	29,931
Cookies	Coefficient (Std.)	0.0031*** (0.0005)	0.0022*** (0.0005)	0.0059*** (0.0018)
	Observations	684,672	684,672	129,854
Crackers	Coefficient (Std.)	0.0051*** (0.0019)	0.0035*** (0.0017)	0.0068*** (0.0036)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient (Std.)	0.0031*** (0.0008)	0.0013* (0.0008)	0.0033 (0.0025)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient (Std.)	0.002 (0.0013)	0.001 (0.0013)	0.0023 (0.0037)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient (Std.)	0.0041*** (0.0014)	0.0056*** (0.0014)	0.0028** (0.0014)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient (Std.)	0.0026 (0.0019)	0.0023 (0.002)	0.0106 (0.0067)
	Observations	199,209	199,209	34,111

Table A3. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.0122***	0.0136***	0.0333***
	(Std.)	(0.0011)	(0.001)	(0.0029)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient	0.005**	0.0035*	0.0079
	(Std.)	(0.002)	(0.002)	(0.0054)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient	0.0027***	0.003***	0.0087***
	(Std.)	(0.0005)	(0.0005)	(0.0021)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient	0.0025**	0.0003	0.0032
	(Std.)	(0.0013)	(0.0012)	(0.0034)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient	0.0142***	0.0079**	0.008
	(Std.)	(0.0042)	(0.0043)	(0.0071)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient	0.0029	0.0039	0.0094
	(Std.)	(0.0029)	(0.0028)	(0.0064)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient	0.008***	0.0042***	0.0087*
	(Std.)	(0.0019)	(0.0015)	(0.0049)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient	0.0035***	0.0041***	0.0134***
	(Std.)	(0.0005)	(0.0005)	(0.0022)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient	0.0052***	0.0044***	0.0144***
	(Std.)	(0.001)	(0.0009)	(0.0031)
	Observations	395,641	395,641	76,710
Soaps	Coefficient	0.0043***	0.0032***	0.008**
	(Std.)	(0.0013)	(0.0013)	(0.0041)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient	0.0069***	0.0067***	0.0176***
	(Std.)	(0.0006)	(0.0006)	(0.0022)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient	0.0067***	0.0066***	0.0239***
	(Std.)	(0.001)	(0.001)	(0.0041)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient	0.0058***	0.0054***	0.0219***
	(Std.)	(0.001)	(0.001)	(0.0037)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.10\left|\overline{\Delta p}_{i,s}\right|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes only the log of the average sales volume and the fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Table A4. Category-level regressions of small price changes ($\Delta P \leq 2\%$) and sales volume

Category		(1)	(2)	(3)
Pooled Data	**Coefficient (Std.)**	**0.0103*** (0.0004)**	**0.0082*** (0.0003)**	**0.0219*** (0.001)**
	Observations	**9,395,668**	**9,395,668**	**2,198,344**
Analgesics	Coefficient (Std.)	0.02*** (0.0031)	0.0132*** (0.0025)	0.0256*** (0.006)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient (Std.)	0.0115*** (0.0041)	0.0117*** (0.0039)	0.039*** (0.0131)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient (Std.)	0.0227*** (0.0043)	0.017*** (0.0029)	0.0366*** (0.0075)
	Observations	141,801	141,801	39,815
Beer	Coefficient (Std.)	0.0119*** (0.0011)	0.0135*** (0.0011)	0.0712*** (0.0073)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient (Std.)	0.0124*** (0.0025)	0.0062*** (0.002)	0.018*** (0.0056)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient (Std.)	0.0015 (0.0023)	0.0003 (0.002)	-0.0062 (0.0051)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient (Std.)	0.0079*** (0.0029)	0.0049** (0.0024)	0.0075 (0.0059)
	Observations	208,198	208,198	60,298
Cereals	Coefficient (Std.)	0.0126*** (0.0024)	0.0095*** (0.0019)	0.0154*** (0.0043)
	Observations	352,779	352,779	151,201
Cheese	Coefficient (Std.)	0.013*** (0.0022)	0.0052*** (0.0014)	0.0068* (0.0039)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient (Std.)	0.0141*** (0.0024)	0.0141*** (0.0025)	0.0176*** (0.003)
	Observations	35,826	35,826	29,931
Cookies	Coefficient (Std.)	0.0078*** (0.0008)	0.0056*** (0.0007)	0.0214*** (0.0028)
	Observations	684,672	684,672	129,854
Crackers	Coefficient (Std.)	0.0115*** (0.0024)	0.0074*** (0.002)	0.0199*** (0.0058)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient (Std.)	0.0216*** (0.0019)	0.0131*** (0.0014)	0.0319*** (0.0039)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient (Std.)	0.0182*** (0.003)	0.0113*** (0.0022)	0.0224*** (0.0062)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient (Std.)	0.0006*** (0.0003)	0.0007* (0.0004)	0.0027*** (0.0009)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient (Std.)	0.0228*** (0.0024)	0.0179*** (0.0016)	0.0655*** (0.0065)
	Observations	199,209	199,209	34,111

Table A4. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.0293***	0.0272***	0.0403***
	(Std.)	(0.0018)	(0.0018)	(0.0035)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient	0.0129***	0.0071**	0.0261***
	(Std.)	(0.0032)	(0.0031)	(0.0064)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient	0.0317***	0.0337***	0.0692***
	(Std.)	(0.002)	(0.0022)	(0.0064)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient	0.0147***	0.0064***	0.0229***
	(Std.)	(0.0027)	(0.0025)	(0.0049)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient	0.013***	0.0009	0.0088
	(Std.)	(0.0047)	(0.0047)	(0.0074)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient	0.0002	0.0042	0.0162
	(Std.)	(0.0056)	(0.0049)	(0.0127)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient	0.0213***	0.0112***	0.0243***
	(Std.)	(0.0029)	(0.003)	(0.006)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient	0.0381***	0.0435***	0.0966***
	(Std.)	(0.0019)	(0.002)	(0.0067)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient	0.0117***	0.0079***	0.0313***
	(Std.)	(0.0023)	(0.0025)	(0.005)
	Observations	395,641	395,641	76,710
Soaps	Coefficient	0.0222***	0.0127***	0.0356***
	(Std.)	(0.0038)	(0.0036)	(0.0076)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient	0.0135***	0.0156***	0.0383***
	(Std.)	(0.0018)	(0.0012)	(0.0036)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient	0.0297***	0.0293***	0.0836***
	(Std.)	(0.0029)	(0.0028)	(0.0085)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient	0.0246***	0.0241***	0.0623***
	(Std.)	(0.0026)	(0.0025)	(0.0066)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less or equal to 2%, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes only the log of the average sales volume and the fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p <$ 10%, ** $p < 5\%$, *** $p < 1\%$

Table A5. Category-level regressions of small price changes ($\Delta P \leq 2\%$) and sales volume

Category		(1)	(2)	(3)
Pooled Data	**Coefficient (Std.)**	**0.0223*** (0.0007)**	**0.0181*** (0.0007)**	**0.0334*** (0.0011)**
	Observations	**9,395,668**	**9,395,668**	**2,198,344**
Analgesics	Coefficient (Std.)	0.0466*** (0.0047)	0.0364*** (0.004)	0.0472*** (0.0082)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient (Std.)	0.0341*** (0.0103)	0.031*** (0.0095)	0.1069*** (0.0177)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient (Std.)	0.0376*** (0.0074)	0.0243*** (0.006)	0.0344*** (0.0087)
	Observations	141,801	141,801	39,815
Beer	Coefficient (Std.)	0.0239*** (0.0015)	0.0267*** (0.0014)	0.0952*** (0.0066)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient (Std.)	0.0252*** (0.0044)	0.0142*** (0.0041)	0.023*** (0.005)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient (Std.)	0.0052 (0.0075)	0.0006 (0.0071)	0.0068 (0.0069)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient (Std.)	0.0148*** (0.0044)	0.0104*** (0.0042)	0.0215*** (0.0061)
	Observations	208,198	208,198	60,298
Cereals	Coefficient (Std.)	0.025*** (0.0044)	0.0195*** (0.004)	0.0206*** (0.0045)
	Observations	352,779	352,779	151,201
Cheese	Coefficient (Std.)	0.0193*** (0.0028)	0.0105*** (0.0026)	0.0123*** (0.0032)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient (Std.)	0.002 (0.0035)	0.0005 (0.0035)	0.0008 (0.0042)
	Observations	35,826	35,826	29,931
Cookies	Coefficient (Std.)	0.0255*** (0.0018)	0.0216*** (0.0017)	0.0389*** (0.0035)
	Observations	684,672	684,672	129,854
Crackers	Coefficient (Std.)	0.0383*** (0.0032)	0.0308*** (0.0029)	0.0403*** (0.0067)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient (Std.)	0.0342*** (0.0036)	0.0239*** (0.0031)	0.0351*** (0.0046)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient (Std.)	0.0262*** (0.0055)	0.0146*** (0.0051)	0.0304*** (0.0059)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient (Std.)	0.0144*** (0.0026)	0.0147*** (0.0025)	0.0083*** (0.0025)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient (Std.)	0.0402*** (0.0035)	0.0301*** (0.0029)	0.0793*** (0.0069)
	Observations	199,209	199,209	34,111

Table A5. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.0295***	0.0253***	0.042***
	(Std.)	(0.0019)	(0.0016)	(0.0035)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient	0.0255***	0.0192***	0.0307***
	(Std.)	(0.0039)	(0.0033)	(0.0059)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient	0.0262***	0.0284***	0.0479***
	(Std.)	(0.0027)	(0.0029)	(0.0062)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient	0.0409***	0.0264***	0.0371***
	(Std.)	(0.0045)	(0.004)	(0.0054)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient	0.0359***	0.024***	0.0259***
	(Std.)	(0.0092)	(0.0076)	(0.0084)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient	0.0288***	0.0237***	0.0243
	(Std.)	(0.0093)	(0.009)	(0.0138)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient	0.0327***	0.0211***	0.0253***
	(Std.)	(0.0048)	(0.004)	(0.0059)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient	0.0211***	0.0259***	0.0538***
	(Std.)	(0.0018)	(0.0018)	(0.0053)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient	0.0273***	0.0235***	0.043***
	(Std.)	(0.0027)	(0.0025)	(0.005)
	Observations	395,641	395,641	76,710
Soaps	Coefficient	0.0381***	0.0248***	0.0435***
	(Std.)	(0.0055)	(0.005)	(0.0069)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient	0.0163***	0.0152***	0.0344***
	(Std.)	(0.001)	(0.0009)	(0.0032)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient	0.02***	0.0194***	0.0601***
	(Std.)	(0.0033)	(0.0032)	(0.0078)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient	0.0191***	0.0183***	0.056***
	(Std.)	(0.0029)	(0.0024)	(0.0072)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less or equal to 5%, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes only the log of the average sales volume and the fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p <$ 10%, ** $p < 5\%$, *** $p < 1\%$

Table A6. Category-level regressions of small price changes ($\Delta P \leq 5¢$) and sales volume

Category		(1)	(2)	(3)
Pooled Data	**Coefficient (Std.)**	**0.0131*** (0.0006)**	**0.0089*** (0.0005)**	**0.0199*** (0.001)**
	Observations	**9,395,668**	**9,395,668**	**2,198,344**
Analgesics	Coefficient (Std.)	0.0055*** (0.0017)	0.0034*** (0.0015)	0.0068 (0.0042)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient (Std.)	0.014*** (0.0044)	0.0144*** (0.0041)	0.057*** (0.0139)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient (Std.)	0.0437*** (0.0057)	0.0277*** (0.005)	0.0454*** (0.0092)
	Observations	141,801	141,801	39,815
Beer	Coefficient (Std.)	0.0049*** (0.0007)	0.0056*** (0.0007)	0.0231*** (0.0042)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient (Std.)	0.0188*** (0.0046)	0.0048 (0.0037)	0.0246*** (0.0056)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient (Std.)	0.0161*** (0.006)	0.0104* (0.0055)	-0.0001 (0.0061)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient (Std.)	0.0202*** (0.0041)	0.0138*** (0.0039)	0.0159*** (0.0063)
	Observations	208,198	208,198	60,298
Cereals	Coefficient (Std.)	0.008*** (0.0023)	0.0053*** (0.002)	0.0139*** (0.004)
	Observations	352,779	352,779	151,201
Cheese	Coefficient (Std.)	0.0103*** (0.0023)	0.0019 (0.0017)	0.0048 (0.004)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient (Std.)	0.0174*** (0.0034)	0.017*** (0.0034)	0.0203*** (0.0047)
	Observations	35,826	35,826	29,931
Cookies	Coefficient (Std.)	0.0104*** (0.001)	0.0084*** (0.001)	0.0261*** (0.0029)
	Observations	684,672	684,672	129,854
Crackers	Coefficient (Std.)	0.0157*** (0.0025)	0.0106*** (0.0022)	0.0316*** (0.0049)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient (Std.)	0.0211*** (0.0022)	0.0125*** (0.0016)	0.0285*** (0.0038)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient (Std.)	0.0133*** (0.003)	0.0074*** (0.0026)	0.0229*** (0.0053)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient (Std.)	0.03*** (0.0032)	0.0226*** (0.003)	0.012*** (0.0032)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient (Std.)	0.0267*** (0.0031)	0.0214*** (0.0023)	0.0688*** (0.0067)
	Observations	199,209	199,209	34,111

Table A6. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.0148***	0.0131***	0.0304***
	(Std.)	(0.0012)	(0.0011)	(0.0027)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient	0.0193***	0.0142***	0.0266***
	(Std.)	(0.0035)	(0.003)	(0.0063)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient	0.0061***	0.0069***	0.0185***
	(Std.)	(0.001)	(0.001)	(0.0034)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient	0.0055***	0.002	0.0084***
	(Std.)	(0.0018)	(0.0017)	(0.0036)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient	0.0195**	0.0105	0.0212**
	(Std.)	(0.01)	(0.0075)	(0.0106)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient	0.0211***	0.0151***	0.0149
	(Std.)	(0.0075)	(0.0075)	(0.0119)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient	0.0245***	0.0146***	0.0321***
	(Std.)	(0.004)	(0.0039)	(0.0068)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient	0.0038***	0.0047***	0.0143***
	(Std.)	(0.0005)	(0.0005)	(0.0023)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient	0.0143***	0.012***	0.0299***
	(Std.)	(0.0014)	(0.0013)	(0.0044)
	Observations	395,641	395,641	76,710
Soaps	Coefficient	0.022***	0.0116***	0.0434***
	(Std.)	(0.0044)	(0.0038)	(0.0073)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient	0.0154***	0.0103***	0.0262***
	(Std.)	(0.0016)	(0.0007)	(0.0029)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient	0.0069***	0.0066***	0.021***
	(Std.)	(0.0015)	(0.0015)	(0.0045)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient	0.0045***	0.0042***	0.0251***
	(Std.)	(0.0016)	(0.0014)	(0.0043)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less or equal to 5¢, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes only the log of the average sales volume and the fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p <$ 10%, ** $p < 5\%$, *** $p < 1\%$

Table A7. Category-level regressions of small price changes ($\Delta P \leq 10¢$) and sales volume

Category		(1)	(2)	(3)
Pooled Data	**Coefficient (Std.)**	**0.0276*** (0.0008)**	**0.0213*** (0.0008)**	**0.0292*** (0.001)**
	Observations	**9,395,668**	**9,395,668**	**2,198,344**
Analgesics	Coefficient (Std.)	0.0432*** (0.0055)	0.0305*** (0.0049)	0.0413*** (0.0068)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient (Std.)	0.054*** (0.012)	0.0531*** (0.0111)	0.0857*** (0.0211)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient (Std.)	0.0546*** (0.0077)	0.0344*** (0.0071)	0.0186*** (0.007)
	Observations	141,801	141,801	39,815
Beer	Coefficient (Std.)	0.0275*** (0.0022)	0.0298*** (0.0022)	0.0854*** (0.0068)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient (Std.)	0.0331*** (0.0047)	0.0184*** (0.0043)	0.0245*** (0.0047)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient (Std.)	0.0181*** (0.005)	0.0123*** (0.0044)	0.009** (0.0037)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient (Std.)	0.025*** (0.005)	0.0154*** (0.0043)	0.0161*** (0.0048)
	Observations	208,198	208,198	60,298
Cereals	Coefficient (Std.)	0.0287*** (0.004)	0.0231*** (0.0037)	0.0126*** (0.0028)
	Observations	352,779	352,779	151,201
Cheese	Coefficient (Std.)	0.0189*** (0.0033)	0.0092*** (0.0031)	0.0096*** (0.0024)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient (Std.)	0.0114*** (0.0037)	0.0104*** (0.004)	0.0107*** (0.0039)
	Observations	35,826	35,826	29,931
Cookies	Coefficient (Std.)	0.0265*** (0.0018)	0.0216*** (0.0016)	0.0306*** (0.0028)
	Observations	684,672	684,672	129,854
Crackers	Coefficient (Std.)	0.026*** (0.0031)	0.0194*** (0.0028)	0.0203*** (0.0041)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient (Std.)	0.0369*** (0.004)	0.0271*** (0.0032)	0.0223*** (0.0037)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient (Std.)	0.0301*** (0.0067)	0.0186*** (0.0061)	0.0292*** (0.0054)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient (Std.)	0.0257*** (0.0032)	0.0211*** (0.0031)	0.0146*** (0.0031)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient (Std.)	0.0524*** (0.0038)	0.0387*** (0.0036)	0.0633*** (0.0065)
	Observations	199,209	199,209	34,111

Table A7. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.0398***	0.0298***	0.033***
	(Std.)	(0.0024)	(0.002)	(0.0032)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient	0.0292***	0.0188***	0.0221***
	(Std.)	(0.0052)	(0.0048)	(0.0059)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient	0.0427***	0.0456***	0.0501***
	(Std.)	(0.0037)	(0.004)	(0.0059)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient	0.0516***	0.0354***	0.0298***
	(Std.)	(0.0049)	(0.0044)	(0.0042)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient	0.0216***	0.0103*	0.0105**
	(Std.)	(0.0061)	(0.0059)	(0.0049)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient	0.043***	0.0315***	0.0238***
	(Std.)	(0.0096)	(0.0108)	(0.0098)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient	0.0292***	0.015***	0.0177***
	(Std.)	(0.0041)	(0.0035)	(0.0038)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient	0.0345***	0.042***	0.0692***
	(Std.)	(0.003)	(0.003)	(0.0064)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient	0.0148***	0.0112***	0.021***
	(Std.)	(0.0022)	(0.002)	(0.004)
	Observations	395,641	395,641	76,710
Soaps	Coefficient	0.0352***	0.0222***	0.0297***
	(Std.)	(0.0063)	(0.0061)	(0.0055)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient	0.0274***	0.0228***	0.0368***
	(Std.)	(0.0015)	(0.0013)	(0.0031)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient	0.0256***	0.0248***	0.0586***
	(Std.)	(0.0035)	(0.0036)	(0.0088)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient	0.0194***	0.0179***	0.0501***
	(Std.)	(0.0045)	(0.0037)	(0.0059)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less or equal to 10¢, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes only the log of the average sales volume and the fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p <$ 10%, ** $p < 5\%$, *** $p < 1\%$

Table A8. Category-level regressions of small price changes ($\Delta P \leq 15¢$) and sales volume

Category		(1)	(2)	(3)
Pooled Data	Coefficient (Std.)	0.0235*** (0.0007)	0.017*** (0.0007)	0.0279*** (0.001)
	Observations	9,395,668	9,395,668	2,198,344
Analgesics	Coefficient (Std.)	0.0311*** (0.0042)	0.0219*** (0.0036)	0.0353*** (0.0072)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient (Std.)	0.0459*** (0.0134)	0.0447*** (0.0125)	0.0957*** (0.02)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient (Std.)	0.0542*** (0.0083)	0.0265*** (0.0076)	0.0362*** (0.0075)
	Observations	141,801	141,801	39,815
Beer	Coefficient (Std.)	0.0154*** (0.0013)	0.0175*** (0.0012)	0.0741*** (0.0063)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient (Std.)	0.0402*** (0.0051)	0.022*** (0.0038)	0.029*** (0.005)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient (Std.)	0.0167*** (0.004)	0.0083** (0.0034)	0.0037 (0.0027)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient (Std.)	0.0201*** (0.0054)	0.0087** (0.0043)	0.0134*** (0.0054)
	Observations	208,198	208,198	60,298
Cereals	Coefficient (Std.)	0.0267*** (0.0035)	0.0204*** (0.0031)	0.0164*** (0.0042)
	Observations	352,779	352,779	151,201
Cheese	Coefficient (Std.)	0.0187*** (0.0033)	0.0087*** (0.003)	0.0118*** (0.0031)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient (Std.)	0.0051 (0.005)	0.0044 (0.0051)	0.0047 (0.0053)
	Observations	35,826	35,826	29,931
Cookies	Coefficient (Std.)	0.0251*** (0.0017)	0.0205*** (0.0016)	0.0326*** (0.0032)
	Observations	684,672	684,672	129,854
Crackers	Coefficient (Std.)	0.0287*** (0.0031)	0.0219*** (0.0027)	0.0295*** (0.0051)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient (Std.)	0.034*** (0.0038)	0.0232*** (0.0033)	0.0307*** (0.0042)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient (Std.)	0.025*** (0.0061)	0.013** (0.0056)	0.0308*** (0.0059)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient (Std.)	0.0306*** (0.0039)	0.0135*** (0.0028)	0.0059** (0.0027)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient (Std.)	0.0491*** (0.0037)	0.0359*** (0.0033)	0.0797*** (0.0069)
	Observations	199,209	199,209	34,111

Table A8. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.0372***	0.0288***	0.0364***
	(Std.)	(0.002)	(0.0019)	(0.0035)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient	0.0303***	0.02***	0.0145***
	(Std.)	(0.0052)	(0.005)	(0.0058)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient	0.0286***	0.0315***	0.0457***
	(Std.)	(0.0029)	(0.003)	(0.007)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient	0.0332***	0.0209***	0.0264***
	(Std.)	(0.0039)	(0.0035)	(0.0047)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient	0.037***	0.0254***	0.0211*
	(Std.)	(0.0069)	(0.0061)	(0.0126)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient	0.0302***	0.0165	0.0316***
	(Std.)	(0.0116)	(0.0115)	(0.0099)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient	0.0362***	0.0214***	0.0222***
	(Std.)	(0.0046)	(0.0042)	(0.0048)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient	0.029***	0.0357***	0.0647***
	(Std.)	(0.0024)	(0.0024)	(0.0066)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient	0.0169***	0.014***	0.025***
	(Std.)	(0.002)	(0.0019)	(0.0049)
	Observations	395,641	395,641	76,710
Soaps	Coefficient	0.0354***	0.022***	0.0364***
	(Std.)	(0.0054)	(0.0049)	(0.0064)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient	0.0187***	0.0146***	0.0289***
	(Std.)	(0.0016)	(0.0015)	(0.0029)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient	0.0205***	0.0194***	0.0573***
	(Std.)	(0.0032)	(0.0032)	(0.0087)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient	0.0175***	0.0151***	0.0467***
	(Std.)	(0.004)	(0.0033)	(0.0069)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less or equal to 15¢, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes only the log of the average sales volume and the fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p <$ 10%, ** $p < 5\%$, *** $p < 1\%$

Appendix B. Excluding multipacks

In the paper, we use all products. When products are sold in multipacks, such as 6-packs of soft drinks, we count such transactions as a single transaction since the shopper pays only once. However, because such transactions can add noise to the estimation, we replicate the estimation after we remove all the transactions involving multi-packs.

Table B1 presents the results of regressions equivalent to the regressions in Table 1 in the paper. The regressions take the following form:

$$\begin{aligned} small\ \ price\ change_{i,s,t} = \alpha + \beta \ln(average\ sales\ volume_{i,s}) + \gamma \mathbf{X}_{i,s,t} \\ + month_t + year_t + \delta_s + \mu_i + u_{i,s,t} \end{aligned} \quad \text{(B1)}$$

where *small price change* is a dummy that equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.5\left|\overline{\Delta p}_{i,s}\right|$, and 0 otherwise. The *average sales volume* is the average sales volume of product *i* in store *s* over the sample period. **X** is a matrix of other control variables. *Month* and *year* are fixed effects for the month and the year of the price change. δ and μ are fixed effects for stores and products, respectively, and *u* is an i.i.d error term.

We estimate separate regressions for each product category, clustering the errors by product. The values in the table are the coefficients of the log of the average sales volume.

In column 1, the only control variables are the log of the average sales volume, and the dummies for months, years, stores, and products. The top row gives the values for the pooled regression, using data of all product categories. The other rows give the values for the 29 categories. We find that 29 of the coefficients of the log of the average sales volume are positive, and 26 of them are statistically significant. Using the pooled data, the coefficient of the log sales volume is 0.024, suggesting that a 1% increase in the sales volume is associated with a 2.4% increase in the likelihood of a small price change.

In column 2, we add controls for the log of the average price, the absolute value of the percentage change in the wholesale price, a control for sale- and bounce-back prices, which we identify using the sales filter algorithm of Fox and Syed (2016), and a dummy for 9-ending prices. 28 of the coefficients are positive, and 23 of them are statistically significant. Using the pooled sample, the coefficient is 0.02 suggesting that a 1% increase in the sales volume is associated with a 2.0% increase in the likelihood of a small price change.

As a further control for the effects of sales on the results, in column 3 we focus on regular prices by excluding all sale- and bounce-back prices. We find that 29 coefficients are positive. 26 of them are statistically significant. Using the pooled sample, the coefficient is 0.044, suggesting that a 1% increase in the sales volume is associated with a 4.4% increase in the likelihood of a small price change.

Table B1. Category-level regressions of small price changes and sales volume excluding products sold in packages

Category		(1)	(2)	(3)
Pooled Data	**Coefficient (Std.)**	**0.0239*** (0.0006)**	**0.0205*** (0.0006)**	**0.0437*** (0.0012)**
	Observations	**9,139,306**	**9,139,306**	**2,065,974**
Analgesics	Coefficient (Std.)	0.0453*** (0.0051)	0.0343*** (0.0051)	0.064*** (0.0094)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient (Std.)	0.0776*** (0.0102)	0.0724*** (0.0097)	0.1789*** (0.0236)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient (Std.)	0.0102** (0.0046)	0.0028 (0.005)	0.0252*** (0.0073)
	Observations	141,801	141,801	39,815
Beer	Coefficient (Std.)	0.0236*** (0.0017)	0.0266*** (0.0018)	0.0971*** (0.0072)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient (Std.)	0.0228*** (0.003)	0.0182*** (0.0032)	0.0337*** (0.0056)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient (Std.)	0.001 (0.0042)	0.0047 (0.0039)	0.0041 (0.0052)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient (Std.)	0.0116*** (0.0042)	0.0071 (0.0044)	0.0142** (0.0069)
	Observations	208,198	208,198	60,298
Cereals	Coefficient (Std.)	0.0095*** (0.0037)	0.0053 (0.0038)	0.0082** (0.0043)
	Observations	352,779	352,779	151,201
Cheese	Coefficient (Std.)	0.0215*** (0.0025)	0.0126*** (0.0027)	0.0199*** (0.0044)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient (Std.)	0.0901*** (0.0066)	0.0906*** (0.0065)	0.1071*** (0.0077)
	Observations	35,826	35,826	29,931
Cookies	Coefficient (Std.)	0.0222*** (0.0019)	0.0167*** (0.002)	0.0463*** (0.0039)
	Observations	684,672	684,672	129,854
Crackers	Coefficient (Std.)	0.0212*** (0.004)	0.0123*** (0.0038)	0.0313*** (0.0061)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient (Std.)	0.018*** (0.0028)	0.0079*** (0.0029)	0.0257*** (0.0049)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient (Std.)	0.021*** (0.0051)	0.0144*** (0.0052)	0.0447*** (0.0069)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient (Std.)	0.0269*** (0.004)	0.0239*** (0.0038)	0.0164*** (0.0042)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient (Std.)	0.0251*** (0.004)	0.0208*** (0.0044)	0.0626*** (0.009)
	Observations	199,209	199,209	34,111

Table B1. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient (Std.)	0.0337*** (0.002)	0.0294*** (0.002)	0.0383*** (0.0034)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient (Std.)	0.0088** (0.0039)	0.0009*** (0.0039)	0.0215*** (0.0071)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient (Std.)	0.0464*** (0.0025)	0.0488*** (0.003)	0.083*** (0.0067)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient (Std.)	0.0262*** (0.0035)	0.0159*** (0.0032)	0.0399*** (0.0058)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient (Std.)	0.0091 (0.0063)	-0.0035 (0.0066)	0.0059 (0.007)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient (Std.)	0.0151 (0.0096)	0.0202*** (0.0084)	0.0358*** (0.0121)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient (Std.)	0.0208*** (0.0043)	0.0091** (0.004)	0.0238*** (0.0063)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient (Std.)	0.0525*** (0.0024)	0.0593*** (0.0025)	0.1128*** (0.0073)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient (Std.)	0.0127*** (0.0031)	0.0082*** (0.0032)	0.0382*** (0.0054)
	Observations	395,641	395,641	76,710
Soaps	Coefficient (Std.)	0.0279*** (0.0047)	0.016*** (0.0046)	0.0359*** (0.0081)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient (Std.)	0.0221*** (0.0016)	0.0229*** (0.0013)	0.0398*** (0.0035)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient (Std.)	0.0347*** (0.0035)	0.0341*** (0.0034)	0.0862*** (0.0102)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient (Std.)	0.0302*** (0.0031)	0.029*** (0.0031)	0.0804*** (0.0068)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50|\overline{\Delta p}_{i,s}|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes only the log of the average sales volume and the fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. We remove observations on products sold in multipacks. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Appendix C. Robustness of the Product-level regressions of the % of small price changes and sales volume

In the paper, we study the correlation between small price changes and sales volume at the product level using regressions that have only the sales volume as the independent variable. This can raise concerns that the results may be driven by differences between the stores rather than by differences in the sales volume.

To mitigate this concern, we augment the data with socio-demographic information about consumers living in the neighborhood of each store, including their median income, the share of minorities, and the share of unemployed. To control for local competition, we also add a control for the pricing zone of each store, using pricing zone indicators included in Dominick's data.

We estimate for each product in each category an OLS regression with robust standard errors. The dependent variable is the share of small price changes for the product in each store. The independent variable is the average sales volume of the product in each store, the median income, the share of minorities, the share of unemployed, and the stores' pricing zone.

As we do in the paper, we use observations on price changes only if we observe the price in both weeks t and $t + 1$ and the post-change price remained unchanged for at least 2 weeks. The estimation results are summarized in Table C1. Column 1 presents for each product category, the average of the estimated coefficients. Column 2 presents the total number of coefficients. Column 3 presents the percentage of the positive coefficients. Column 4 presents the number of statistically significant coefficients. Column 5 presents the percentage of positive and statistically significant coefficients out of the total number of statistically significant coefficients.

According to the figures in the table, the average coefficients are positive in 26 of the 29 product categories. Further, across all product categories, 75.2% of the coefficients are positive.

Focusing on statistically significant coefficients, we find a far greater number of positive coefficients that are significant than negative coefficients that are significant. Across all product categories, 87.4% of all the statistically significant coefficients are positive. In other words, for the overwhelming majority of the individual products in our sample, we find a positive relationship between sales volume and the share of small price

changes.

As another test, we estimate linear probability model (LPM) regressions with robust standard errors, instead of regressions at the store level. In other words, we estimate:

$$small\ price\ change_{i,s,t} = \alpha + \beta ln\big(average\ sales\ volume_{i,s}\big) + \gamma \mathbf{X}_{i,s,t} + u_{i,s,t} \qquad \text{(E1)}$$

where small price change is a dummy that equals 1 if a price change of product *i* in store *s* in week *t* is smaller than $0.50\left|\overline{\Delta p_{\iota,s}}\right|$, where $\overline{\Delta p_{\iota,s}}$ is the average size of a price change of product i in store s, and 0 otherwise. The average sales volume is the average sales volume of product *i* in store *s* over the sample period.[1] **X** is a matrix of other control variables.

We estimate a separate regression for each product in each category, conditional on it having at least 50 price changes and at least 1 small price change over the sample period. Table C2 reports the estimation results. We find that in 22 of the categories, the average coefficient is positive. Furthermore, summing over all product categories, 64.7% of the coefficients are positive. When we focus on the positive and statistically significant coefficients, we find that 69.3% of the coefficients are positive.

Table C3 reports the estimation results of regressions in which we add the same controls as in Table C1. We find that over all product categories, 62.5% of the coefficients in a category are positive. When we focus on positive and statistically significant coefficients, we find that, on average, 70.6% of the coefficients are positive.

We therefore conclude that changing the estimation method does not change the conclusions we report on in the paper. There is a positive correlation at the product level between the likelihood of a small price change and the sales volume.

[1] In calculating the average sales volume, we need to account for missing observations, because a missing observation in week *t* implies that the product was either out of stock or had 0 sales on that week. Thus, averaging over the available observations can lead to an upward bias for products that are sold in small numbers. Therefore, for each product in each store, we calculate the average by first determining the total number of units sold over all available observations. We then identify the first and last week for which we have observations, and calculate the average for each product-store as $\frac{total\ no.\ of\ units\ sold}{last\ week - first\ week}$. The resulting figure is smaller than we would obtain if we averaged over all available observations (which would not include observations on weeks with 0 sales).

Table C1. Product-level regressions of the % of small price changes and sales volume by categories, with added controls

Product Category	Average coefficient estimate (1)	Number of coefficients (2)	Percentage of positive coefficients (3)	Number of significant coefficients (4)	% of positive and significant coefficients (5)
Pooled	0.022	9515	75.2%	3591	87.4%
Analgesics	0.053	278	91.7%	133	97.7%
Bath Soaps	0.048	40	100.0%	22	100.0%
Bathroom tissues	-0.001	102	47.1%	33	48.5%
Beers	0.022	294	90.8%	155	100.0%
Bottled juices	0.005	369	55.6%	118	59.3%
Canned soups	-0.001	346	45.7%	103	45.6%
Canned tuna	0.015	190	62.1%	64	79.7%
Cereals	-0.001	337	47.5%	99	40.4%
Cheese	0.010	470	58.5%	141	69.5%
Cigarettes	0.085	139	97.8%	113	100.0%
Cookies	0.029	682	75.5%	254	86.2%
Crackers	0.025	212	81.6%	90	92.2%
Dish detergents	0.014	201	70.1%	31	90.3%
Fabric softeners	0.022	225	69.3%	63	82.5%
Front end candies	0.027	268	76.9%	89	95.5%
Frozen dinners	0.030	213	85.9%	85	97.6%
Frozen entrees	0.028	684	86.7%	244	98.0%
Frozen juices	0.006	141	58.2%	40	60.0%
Grooming products	0.036	648	88.9%	312	99.7%
Laundry detergents	0.018	435	68.3%	107	83.2%
Oatmeal	0.007	69	53.6%	20	55.0%
Paper towels	-0.005	87	35.6%	19	42.1%
Refrigerated juices	0.001	174	54.0%	59	49.2%
Shampoos	0.038	857	93.1%	431	100.0%
Snack crackers	0.018	291	66.3%	89	83.1%
Soaps	0.019	221	71.5%	67	76.1%
Soft drinks	0.012	965	80.3%	374	92.0%
Toothbrushes	0.035	232	90.1%	119	100.0%
Toothpastes	0.026	345	79.1%	117	98.3%

Notes: For each product category, column 1 presents the average of the estimated coefficients of the average sales volume. The regression also includes controls for the shoppers' median income, the shares of minorities, the share of unemployed, and competition zones. Column 2 presents the total number of coefficients. Column 3 presents the % of positive coefficients out of all coefficients. Column 4 presents the total number of coefficients that are statistically significant at the 5% level. Column 5 presents the % of coefficients that are positive and statistically significant, at the 5% level. The Pooled column gives the results over the pooled sample. Products are identified by their UPCs.

Table C2. Product-level regressions of the % of small price changes and sales volume by categories, using LPM regressions

Product Category	Average coefficient estimate (1)	Number of coefficients (2)	Percentage of positive coefficients (3)	Number of significant coefficients (4)	% of positive and significant coefficients (5)
Pooled	0.023	1715	64.7%	306	69.3%
Analgesics	0.036	27	70.4%	1	100.0%
Bath Soaps	0.081	1	100.0%	0	-
Bathroom tissues	0.001	22	54.5%	0	-
Beers	0.115	102	82.4%	27	92.6%
Bottled juices	-0.003	95	49.5%	11	9.1%
Canned soups	0.012	92	62.0%	14	35.7%
Canned tuna	-0.009	36	41.7%	8	37.5%
Cereals	0.011	58	53.4%	10	50.0%
Cheese	0.012	150	68.7%	23	78.3%
Cigarettes	-	0	-	0	-
Cookies	0.004	109	59.6%	4	75.0%
Crackers	0.136	50	64.0%	12	33.3%
Dish detergents	0.008	30	70.0%	1	100.0%
Fabric softeners	-0.049	21	47.6%	4	25.0%
Front end candies	0.057	36	80.6%	11	90.9%
Frozen dinners	0.021	31	54.8%	1	0.0%
Frozen entrees	0.046	171	86.0%	46	100.0%
Frozen juices	0.000	65	56.9%	10	70.0%
Grooming products	0.018	29	69.0%	1	100.0%
Laundry detergents	0.023	19	73.7%	2	100.0%
Oatmeal	0.004	14	57.1%	0	-
Paper towels	-0.017	21	38.1%	6	50.0%
Refrigerated juices	-0.001	57	59.6%	20	60.0%
Shampoos	0.057	12	50.0%	0	-
Snack crackers	0.018	75	52.0%	9	22.2%
Soaps	0.002	17	52.9%	1	0.0%
Soft drinks	0.020	300	66.7%	82	73.2%
Toothbrushes	-0.023	24	50.0%	0	-
Toothpastes	-0.024	51	62.7%	2	100.0%

Notes: Results of LPM regressions. For each product category, column 1 presents the average of the estimated coefficients of the average sales volume. Column 2 presents the total number of coefficients. Column 3 presents the % of positive coefficients out of all coefficients. Column 4 presents the total number of coefficients that are statistically significant at the 5% level. Column 5 presents the % of coefficients that are positive and statistically significant, at the 5% level. The Pooled column gives the results over the pooled sample. Products are identified by their UPCs.

Table C3. Product-level regressions of the % of small price changes and sales volume by categories, using LPM regressions with added controls

Product Category	Average coefficient estimate (1)	Number of coefficients (2)	Percentage of positive coefficients (3)	Number of significant coefficients (4)	% of positive and significant coefficients (5)
Pooled	0.017	1647	62.5%	306	70.6%
Analgesics	0.012	20	75.0%	1	100.0%
Bath Soaps	-	0	-	0	-
Bathroom tissues	0.003	22	54.5%	0	-
Beers	0.011	99	74.7%	27	96.3%
Bottled juices	0.002	94	45.7%	11	9.1%
Canned soups	0.019	91	61.5%	14	35.7%
Canned tuna	-0.008	36	50.0%	8	37.5%
Cereals	-0.009	56	42.9%	10	50.0%
Cheese	0.017	147	70.7%	23	78.3%
Cigarettes	-	0	-	0	-
Cookies	0.010	105	52.4%	4	75.0%
Crackers	0.040	48	58.3%	12	33.3%
Dish detergents	0.003	30	56.7%	1	100.0%
Fabric softeners	-0.061	20	20.0%	4	0.0%
Front end candies	0.057	36	80.6%	11	100.0%
Frozen dinners	0.030	28	75.0%	1	100.0%
Frozen entrees	0.022	164	85.4%	46	100.0%
Frozen juices	0.005	65	56.9%	10	70.0%
Grooming products	-0.068	23	60.9%	1	100.0%
Laundry detergents	0.000	17	58.8%	2	100.0%
Oatmeal	-0.015	14	64.3%	0	-
Paper towels	-0.022	21	47.6%	6	50.0%
Refrigerated juices	-0.006	56	64.3%	20	60.0%
Shampoos	0.073	10	80.0%	0	-
Snack crackers	-0.013	71	50.7%	9	33.3%
Soaps	-0.010	16	43.8%	1	0.0%
Soft drinks	0.061	292	63.7%	82	74.4%
Toothbrushes	-0.036	19	57.9%	0	-
Toothpastes	0.001	47	55.3%	2	100.0%

Notes: Results of LPM regressions, with added controls. For each product category, column 1 presents the average of the estimated coefficients of the average sales volume. Column 2 presents the total number of coefficients. Column 3 presents the % of positive coefficients out of all coefficients. Column 4 presents the total number of coefficients that are statistically significant at the 5% level. Column 5 presents the % of coefficients that are positive and statistically significant, at the 5% level. The Pooled column gives the results over the pooled sample. Products are identified by their UPCs.

Appendix D. Controlling for peak days

Bonomo et al. (2022) show that a large share of price changes occur on peak days. We therefore control for the possibility that price change behavior is different on peak weeks relative to other weeks. Following Bonomo et al. (2022), we define peak weeks as the subset of the most active weeks that jointly account for one-half of all price changes in a store over the entire sample period. We then define a dummy for peak weeks that equals 1 if a week is a peak week and 0 otherwise.

Table D1 presents the results of regressions equivalent to the regressions in Table 1 in the paper. The regressions take the following form:

$$small\ price\ change_{i,s,t} = \alpha + \beta\ ln(\ average\ sales\ volume_{i,s}) + \varphi peak_{i,s,t} + \gamma \boldsymbol{X}_{i,s,t} + month_t + year_t + \delta_s + \mu_i + u_{i,s,t} \quad \text{(D1)}$$

where *small price change* is a dummy that equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.5\left|\overline{\Delta p}_{i,s}\right|$, and 0 otherwise. The *average sales volume* is the average sales volume of product *i* in store *s* over the sample period. Peak is a dummy that equals 1 if it is a peak week and 0 otherwise. **X** is a matrix of other control variables. *Month* and *year* are fixed effects for the month and the year of the price change. δ and μ are fixed effects for stores and products, respectively, and *u* is an i.i.d error term. We estimate separate regressions for each product category, clustering the errors by product. Table D1 presents the results of the coefficients of average sales volume. The first row gives the results for the pooled data that includes observations of all the product categories. The other rows give category level results.

In column 1, the only control variables are the log of the average sales volume, and dummies for months, years, stores, and products. We find that 29 of the 29 of the coefficients of the log of the average sales volume are positive, and 26 of them are statistically significant. Using the pooled data, the coefficient of the log sales volume is 0.024, suggesting that a 1% increase in the sales volume is associated with a 2.4% increase in the likelihood of a small price change.

In column 2, we add controls for the log of the average price, the absolute value of the percentage change in the wholesale price, a control for sale- and bounce-back prices, which we identify using the sales filter algorithm of Fox and Syed (2016), and a dummy for 9-ending prices. 28 of the coefficients are positive, and 23 of them are statistically significant. Using the pooled sample, the coefficient is 0.021 suggesting that a 1%

increase in the sales volume is associated with 2.1% increase in the likelihood of a small price change.

As a further control for the effects of sales on the results, in column 3 we focus on regular prices by excluding all sale- and bounce-back prices. We find that all 29 coefficients are positive. 26 of the coefficients are statistically significant, and 1 more is statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.044, suggesting that a 4.4% increase in the sales volume is associated with a 4.4% increase in the likelihood of a small price change.

The results, therefore, suggest that controlling for peak weeks does not affect the correlation between sales volumes and the likelihood of small price changes. To check whether this correlation is different during peak weeks than during other weeks, we add to regression D1 an interaction term between the dummy for peak days and the sales volume. The results are given in Tables D2 and D3. The first column of Table D2 (D3) gives the coefficients of the sales volume (the interaction terms) in a regression with an empty **X** matrix. I.e., where the only control variables are the log of the average sales volume, the dummy for peak weeks, the interaction term between sales volume and peak weeks, and dummies for months, years, stores, and products.

In Table D2, we find that 28 of the coefficients of the sales volumes are positive, and 20 of them are statistically significant. Looking at the coefficient in the pooled regression, the coefficient is 0.025, suggesting that a 1% increase in the sales volume is associated with a 2.5% increase in the likelihood of a small price change.

In column 2, we add controls for the log of the average price, the absolute value of the percentage change in the wholesale price, a control for sale- and bounce-back prices, which we identify using the sales filter algorithm of Fox and Syed (2016), and a dummy for 9-ending prices. 27 of the coefficients are positive, and 21 of them are statistically significant. One more is statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.023 suggesting that a 1% increase in the sales volume is associated with a 2.3% increase in the likelihood of a small price change.

As a further control for the effects of sales on the results, in column 3, we focus on regular prices by excluding all sale- and bounce-back prices. We find that 29 coefficients are positive. 21 of them are statistically significant. Using the pooled sample, the coefficient is 0.046, suggesting that a 1% increase in the sales volume is associated with a 4.6% increase in the likelihood of a small price change.

Focusing on the interaction term, in the first column of Table D3, out of the 29 coefficients, 17 are positive and 12 are negative. Of the positive coefficients, 4 are statistically significant, and 3 more are statistically significant at the 10% level. Of the negative coefficients, 3 are statistically significant. Looking at the coefficient in the pooled regression, the coefficient is -0.002, and it is statistically significant.

In column 2, 13 of the coefficients of the interaction term are positive and 16 are negative. Of the positive coefficients, 6 are statistically significant. Of the negative coefficients, 4 are statistically significant. Looking at the coefficient in the pooled regression, the coefficient is -0.003, and it is statistically significant.

Finally, in column 3, 11 of the coefficients of the interaction term are positive and 18 are negative. Of the positive coefficients, 1 is statistically significant and 1 more is statistically significant at the 10% level. Of the negative coefficients, 6 are statistically significant. Looking at the coefficient in the pooled regression, the coefficient is -0.005, and it is statistically significant.

We conclude that the overall effect of the interaction term is small compared with the main effect. Thus, although the coefficients of the interaction terms tend to be negative, they do not change the overall effect – there is a positive correlation between sales volumes and the likelihood of a small price change.

Table D1. Controlling for peak days: Baseline regressions

Category		(1)	(2)	(3)
Pooled Data	**Coefficient (Std.)**	**0.0236*** (0.0006)**	**0.0214*** (0.0008)**	**0.0441*** (0.0017)**
	Observations	**9,395,668**	**9,395,668**	**2,198,344**
Analgesics	Coefficient (Std.)	0.0414*** (0.0051)	0.0329*** (0.0051)	0.0654*** (0.0096)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient (Std.)	0.0776*** (0.0102)	0.0729*** (0.0096)	0.1768*** (0.0233)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient (Std.)	0.0106** (0.0045)	0.0029 (0.005)	0.0246*** (0.0072)
	Observations	141,801	141,801	39,815
Beer	Coefficient (Std.)	0.0233*** (0.0016)	0.0265*** (0.0018)	0.0962*** (0.0072)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient (Std.)	0.0225*** (0.003)	0.0179*** (0.0032)	0.0335*** (0.0056)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient (Std.)	0.0013 (0.0042)	0.0052 (0.0039)	0.0039 (0.0052)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient (Std.)	0.0109*** (0.0042)	0.0067 (0.0043)	0.0142** (0.0069)
	Observations	208,198	208,198	60,298
Cereals	Coefficient (Std.)	0.0089** (0.0037)	0.0054 (0.0038)	0.0083* (0.0043)
	Observations	352,779	352,779	151,201
Cheese	Coefficient (Std.)	0.0215*** (0.0025)	0.0129*** (0.0027)	0.0208*** (0.0044)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient (Std.)	0.0894*** (0.0066)	0.0899*** (0.0065)	0.1059*** (0.0077)
	Observations	35,826	35,826	29,931
Cookies	Coefficient (Std.)	0.0218*** (0.0019)	0.0168*** (0.002)	0.0461*** (0.0039)
	Observations	684,672	684,672	129,854
Crackers	Coefficient (Std.)	0.0209*** (0.004)	0.0125*** (0.0038)	0.0328*** (0.0061)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient (Std.)	0.0173*** (0.0028)	0.008*** (0.0029)	0.0267*** (0.0049)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient (Std.)	0.0197*** (0.0051)	0.0138*** (0.0052)	0.0445*** (0.0069)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient (Std.)	0.0269*** (0.004)	0.0236*** (0.0037)	0.0163*** (0.0041)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient (Std.)	0.0274*** (0.0039)	0.0236*** (0.0044)	0.0632*** (0.0091)
	Observations	199,209	199,209	34,111

Table D1. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient (Std.)	0.0354*** (0.002)	0.0308*** (0.0021)	0.0387*** (0.0035)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient (Std.)	0.009** (0.0039)	0.0013 (0.0039)	0.0224*** (0.0071)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient (Std.)	0.0453*** (0.0025)	0.0485*** (0.0029)	0.0826*** (0.0066)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient (Std.)	0.0258*** (0.0035)	0.0162*** (0.0032)	0.0404*** (0.0058)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient (Std.)	0.0092 (0.0063)	-0.0032 (0.0067)	0.0061 (0.007)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient (Std.)	0.0151 (0.0096)	0.0202*** (0.0084)	0.0359*** (0.0121)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient (Std.)	0.0207*** (0.0043)	0.009** (0.004)	0.0241*** (0.0063)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient (Std.)	0.0495*** (0.0024)	0.0572*** (0.0025)	0.1081*** (0.0072)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient (Std.)	0.0122*** (0.003)	0.0081*** (0.0032)	0.039*** (0.0054)
	Observations	395,641	395,641	76,710
Soaps	Coefficient (Std.)	0.0276*** (0.0048)	0.016*** (0.0047)	0.0355*** (0.0082)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient (Std.)	0.0222*** (0.0016)	0.023*** (0.0013)	0.0408*** (0.0035)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient (Std.)	0.0334*** (0.0034)	0.0333*** (0.0034)	0.0825*** (0.0103)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient (Std.)	0.027*** (0.0032)	0.029*** (0.0032)	0.0781*** (0.0069)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product i in store s at time t is less than $0.50|\overline{\Delta p}_{i,s}|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variable is the log of the average sales volume of product i in store s over the sample period. Column 1 reports the results of the baseline regression that includes only the log of the average sales volume, a dummy for peak days, and fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Table D2. Controlling for peak days: Coefficients of the sales volume in a regression that also includes interaction terms

Category		(1)	(2)	(3)
Pooled Data	**Coefficient (Std.)**	**0.0248*** (0.0008)**	**0.0227*** (0.001)**	**0.0464*** (0.002)**
	Observations	**9,395,668**	**9,395,668**	**2,198,344**
Analgesics	Coefficient (Std.)	0.0168 (0.0103)	0.0181** (0.0088)	0.0857*** (0.0157)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient (Std.)	0.0686*** (0.0135)	0.0764*** (0.0124)	0.1981*** (0.0294)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient (Std.)	0.0089 (0.0071)	-0.0025 (0.0065)	0.013 (0.0102)
	Observations	141,801	141,801	39,815
Beer	Coefficient (Std.)	0.0238*** (0.0021)	0.0286*** (0.002)	0.1124*** (0.0082)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient (Std.)	0.0197*** (0.0044)	0.0177*** (0.0042)	0.0349*** (0.0088)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient (Std.)	0.0045 (0.0053)	0.0117** (0.0052)	0.006 (0.0067)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient (Std.)	0.0069 (0.0057)	0.0035 (0.0056)	0.0125 (0.0099)
	Observations	208,198	208,198	60,298
Cereals	Coefficient (Std.)	0.0102 (0.0062)	0.0128*** (0.0051)	0.0254*** (0.0071)
	Observations	352,779	352,779	151,201
Cheese	Coefficient (Std.)	0.0245*** (0.0039)	0.0169*** (0.0037)	0.0298*** (0.0059)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient (Std.)	0.0807*** (0.0069)	0.0809*** (0.0068)	0.0984*** (0.0095)
	Observations	35,826	35,826	29,931
Cookies	Coefficient (Std.)	0.0191*** (0.0043)	0.0158*** (0.0041)	0.0611*** (0.006)
	Observations	684,672	684,672	129,854
Crackers	Coefficient (Std.)	0.0156*** (0.0049)	0.0041 (0.005)	0.0373*** (0.0087)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient (Std.)	0.0087 (0.0057)	0.0039 (0.0052)	0.0252*** (0.0081)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient (Std.)	0.0177** (0.0083)	0.0133* (0.0073)	0.0515*** (0.0122)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient (Std.)	0.0177*** (0.0071)	0.0169*** (0.0061)	0.0011 (0.0079)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient (Std.)	0.0383*** (0.0065)	0.0325*** (0.0072)	0.062*** (0.0109)
	Observations	199,209	199,209	34,111

Table D2. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.0578***	0.0529***	0.041***
	(Std.)	(0.0051)	(0.0044)	(0.0054)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient	-0.0007	-0.0107**	0.0164
	(Std.)	(0.0053)	(0.0046)	(0.0117)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient	0.0442***	0.0509***	0.105***
	(Std.)	(0.0044)	(0.004)	(0.0088)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient	0.0358***	0.0231***	0.0414***
	(Std.)	(0.0062)	(0.0058)	(0.0078)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient	0.0043	0.0061	0.0005
	(Std.)	(0.0084)	(0.0077)	(0.0094)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient	0.0168	0.0242***	0.044***
	(Std.)	(0.0114)	(0.0106)	(0.0151)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient	0.0264***	0.0141***	0.0292***
	(Std.)	(0.0055)	(0.0048)	(0.0075)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient	0.038***	0.0476***	0.1034***
	(Std.)	(0.0037)	(0.0035)	(0.0085)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient	0.0142***	0.01***	0.0432***
	(Std.)	(0.0045)	(0.0044)	(0.0082)
	Observations	395,641	395,641	76,710
Soaps	Coefficient	0.0167**	0.0045	0.0292***
	(Std.)	(0.0074)	(0.0066)	(0.0096)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient	0.0259***	0.0266***	0.0509***
	(Std.)	(0.002)	(0.002)	(0.0041)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient	0.0386***	0.0404***	0.0834***
	(Std.)	(0.0063)	(0.0078)	(0.0164)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient	0.0233***	0.0325***	0.0779***
	(Std.)	(0.006)	(0.0059)	(0.0105)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50|\overline{\Delta p}_{i,s}|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The values in the table correspond to the coefficients of the main independent variable, the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes the log of the average sales volume, a dummy for peak days, an interaction term between the sales volumes and the dummy for peak days, and fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p <$ 10%, ** $p < 5\%$, *** $p < 1\%$

Table D3. Controlling for peak days: Coefficients of the interaction term in a regression that also includes the sales volume

Category		(1)	(2)	(3)
Pooled Data	Coefficient	-0.0025**	-0.0027***	-0.0047**
	(Std.)	(0.0011)	(0.001)	(0.0021)
	Observations	9,395,668	9,395,668	2,198,344
Analgesics	Coefficient	0.047***	0.0283**	-0.0341*
	(Std.)	(0.0161)	(0.0126)	(0.0182)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient	0.0174	-0.0067	-0.0395
	(Std.)	(0.0181)	(0.0168)	(0.0281)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient	0.003	0.01	0.0191
	(Std.)	(0.0094)	(0.0086)	(0.0146)
	Observations	141,801	141,801	39,815
Beer	Coefficient	-0.0011	-0.0046*	-0.0289***
	(Std.)	(0.0038)	(0.0027)	(0.0091)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient	0.0058	0.0005	-0.0026
	(Std.)	(0.0075)	(0.0059)	(0.0121)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient	-0.0069	-0.0139**	-0.0037
	(Std.)	(0.008)	(0.008)	(0.0083)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient	0.0081	0.0065	0.0033
	(Std.)	(0.0076)	(0.0066)	(0.0133)
	Observations	208,198	208,198	60,298
Cereals	Coefficient	-0.0027	-0.0158***	-0.0283***
	(Std.)	(0.0098)	(0.0067)	(0.009)
	Observations	352,779	352,779	151,201
Cheese	Coefficient	-0.0061	-0.0082	-0.0175***
	(Std.)	(0.0061)	(0.0053)	(0.0069)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient	0.0187***	0.0193***	0.0149***
	(Std.)	(0.0059)	(0.0058)	(0.0084)
	Observations	35,826	35,826	29,931
Cookies	Coefficient	0.0056	0.0021	-0.0288***
	(Std.)	(0.008)	(0.0074)	(0.0081)
	Observations	684,672	684,672	129,854
Crackers	Coefficient	0.0098*	0.0154***	-0.0074
	(Std.)	(0.0056)	(0.0059)	(0.0107)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient	0.0177	0.0084	0.0027
	(Std.)	(0.0112)	(0.0101)	(0.0122)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient	0.0041	0.0009	-0.0126
	(Std.)	(0.0119)	(0.0094)	(0.0161)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient	0.0192*	0.0139	0.0267***
	(Std.)	(0.0116)	(0.0086)	(0.0111)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient	-0.0219**	-0.0181	0.0025
	(Std.)	(0.0108)	(0.0111)	(0.0096)
	Observations	199,209	199,209	34,111

Table D3. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	-0.0496***	-0.0489***	-0.0055
	(Std.)	(0.0097)	(0.0082)	(0.0089)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient	0.0193**	0.0237***	0.0108
	(Std.)	(0.0069)	(0.0058)	(0.0156)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient	0.002	-0.0046	-0.041***
	(Std.)	(0.0078)	(0.0067)	(0.0133)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient	-0.0211***	-0.0146	-0.002
	(Std.)	(0.0105)	(0.0098)	(0.0095)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient	0.0118	-0.0221***	0.0139
	(Std.)	(0.0117)	(0.0097)	(0.0129)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient	-0.0039	-0.0088	-0.017
	(Std.)	(0.0129)	(0.0123)	(0.0179)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient	-0.0115	-0.0103	-0.0099
	(Std.)	(0.0074)	(0.0067)	(0.01)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient	0.0238***	0.0198***	0.0092
	(Std.)	(0.0055)	(0.0048)	(0.009)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient	-0.004	-0.0037	-0.0078
	(Std.)	(0.007)	(0.0058)	(0.011)
	Observations	395,641	395,641	76,710
Soaps	Coefficient	0.023**	0.0243***	0.012
	(Std.)	(0.0121)	(0.009)	(0.0126)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient	-0.0073***	-0.0072***	-0.0221***
	(Std.)	(0.003)	(0.0028)	(0.0053)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient	-0.0107	-0.0146	-0.002
	(Std.)	(0.0108)	(0.0137)	(0.0212)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient	0.0077	-0.0071	0.0005
	(Std.)	(0.0101)	(0.0093)	(0.0114)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50|\overline{\Delta p}_{i,s}|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The values in the table correspond to the interaction between the main independent variable, the log of the average sales volume of product *i* in store *s* over the sample period, and a dummy for peak days. Column 1 reports the results of the baseline regression that includes the log of the average sales volume, a dummy for peak days, an interaction term between the sales volumes and the dummy for peak days, and fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Appendix E. Product-level regressions of the likelihood of price changes and sales volume: Robustness

In the paper, we present evidence supporting the hypothesis that an increase in the sales volumes is correlated with an increase in the likelihood of a price change. In this section, we show that this correlation is present also in product level regressions.

We estimate for each product in each category an OLS regression with robust standard errors. The dependent variable is the share of price changes out of all observations of a product in each store. The main independent variable is the average sales volume of the product in each store.

As we do in the paper, we use observations on price changes only if we observe the price in both weeks t and $t + 1$ and the post-change price remained unchanged for at least 2 weeks. The estimation results are summarized in Table E1. Column 1 presents for each product category, the average of the estimated coefficients. Column 2 presents the total number of coefficients. Column 3 presents the percentage of the positive coefficients. Column 4 presents the number of statistically significant coefficients. Column 5 presents the percentage of positive and statistically significant coefficients out of the total number of statistically significant coefficients.

According to the figures in the table, the average coefficients are positive in 27 of the 29 product categories. Further, across all product categories, 83.1% of the coefficients are positive.

Focusing on statistically significant coefficients, we find a far greater number of positive coefficients that are significant than negative coefficients that are significant. Across all product categories, 92.8% of all the statistically significant coefficients are positive.

In Table E2, we report the results of similar regressions to which we add information about consumers living in the neighborhood of each store, including their median income, the share of minorities, and the share of unemployed. To control for local competition, we also add a control for the pricing zone of each store, using pricing zone indicators included in Dominick's data.

According to the figures in the table, the average coefficients are positive in 28 of the 29 product categories. Further, across all product categories, 83.2% of the coefficients are positive.

Focusing on statistically significant coefficients, we find a far greater number of positive coefficients that are significant than negative coefficients that are significant. Across all product categories, 92.8% of all the statistically significant coefficients are positive.

The results of the product level regressions, therefore, support the results we report in the paper. There is a positive correlation between the sales volumes and the likelihood of observing a price change.

Table E1. Product-level regressions of the likelihood of a price change and sales volume by categories

Product Category	Average coefficient estimate (1)	Number of coefficients (2)	Percentage of positive coefficients (3)	Number of significant coefficients (4)	% of positive and significant coefficients (5)
Pooled	0.016	12330	83.1%	6769	92.8%
Analgesics	0.016	458	95.2%	278	99.6%
Bath Soaps	0.017	73	98.6%	44	100.0%
Bathroom tissues	-0.001	112	50.9%	42	45.2%
Beers	0.042	392	97.2%	307	100.0%
Bottled juices	0.007	418	61.5%	196	75.5%
Canned soups	0.005	367	61.0%	147	71.4%
Canned tuna	0.010	219	80.4%	142	89.4%
Cereals	0.003	408	60.0%	117	70.1%
Cheese	0.010	529	70.1%	268	79.5%
Cigarettes	0.006	267	94.0%	158	100.0%
Cookies	0.017	873	85.5%	540	95.2%
Crackers	0.022	248	89.5%	177	96.0%
Dish detergents	0.012	244	85.2%	119	90.8%
Fabric softeners	0.011	279	82.4%	118	89.8%
Front end candies	0.006	371	76.0%	157	93.0%
Frozen dinners	0.022	232	95.3%	151	100.0%
Frozen entrees	0.020	750	89.2%	436	97.0%
Frozen juices	0.011	155	82.6%	90	90.0%
Grooming products	0.026	926	93.0%	572	99.3%
Laundry detergents	0.012	513	76.0%	235	89.8%
Oatmeal	0.006	84	71.4%	43	74.4%
Paper towels	0.000	103	44.7%	34	50.0%
Refrigerated juices	0.002	192	57.3%	78	52.6%
Shampoos	0.020	1556	88.6%	780	99.2%
Snack crackers	0.018	352	87.5%	220	95.9%
Soaps	0.016	266	82.0%	146	90.4%
Soft drinks	0.018	1171	83.9%	693	92.6%
Toothbrushes	0.023	325	93.5%	218	98.6%
Toothpastes	0.022	447	92.2%	263	98.9%

Notes: For each product category, column 1 presents the average of the estimated coefficients of the average sales volume. Column 2 presents the total number of coefficients. Column 3 presents the % of positive coefficients out of all coefficients. Column 4 presents the total number of coefficients that are statistically significant at the 5% level. Column 5 presents the % of coefficients that are positive and statistically significant, at the 5% level. The Pooled column gives the results for the pooled sample. Products are identified by their UPCs.

Table E2. Product-level regressions of the likelihood of a price change and sales volume by categories, with added controls

Product Category	Average coefficient estimate (1)	Number of coefficients (2)	Percentage of positive coefficients (3)	Number of significant coefficients (4)	% of positive and significant coefficients (5)
Pooled	0.016	12330	83.2%	6765	92.8%
Analgesics	0.015	458	92.1%	278	99.6%
Bath Soaps	0.017	73	98.6%	44	100.0%
Bathroom tissues	0.000	112	50.0%	42	45.2%
Beers	0.042	392	96.7%	306	100.0%
Bottled juices	0.009	418	65.3%	196	75.5%
Canned soups	0.005	367	62.7%	147	71.4%
Canned tuna	0.011	219	80.8%	142	89.4%
Cereals	0.003	408	59.1%	117	70.9%
Cheese	0.011	529	72.0%	268	79.9%
Cigarettes	0.006	267	94.0%	158	100.0%
Cookies	0.017	873	85.6%	540	95.2%
Crackers	0.022	248	90.3%	177	96.0%
Dish detergents	0.012	244	82.8%	119	90.8%
Fabric softeners	0.011	279	79.9%	118	89.8%
Front end candies	0.007	371	78.2%	157	93.0%
Frozen dinners	0.023	232	93.5%	151	100.0%
Frozen entrees	0.020	750	89.7%	435	97.0%
Frozen juices	0.012	155	83.9%	90	90.0%
Grooming products	0.025	926	91.4%	572	99.3%
Laundry detergents	0.013	513	78.8%	235	89.8%
Oatmeal	0.008	84	72.6%	43	74.4%
Paper towels	0.001	103	47.6%	34	50.0%
Refrigerated juices	0.003	192	57.8%	78	52.6%
Shampoos	0.020	1556	89.1%	779	99.2%
Snack crackers	0.018	352	88.4%	220	95.9%
Soaps	0.016	266	82.3%	146	90.4%
Soft drinks	0.018	1171	83.0%	692	92.8%
Toothbrushes	0.023	325	92.6%	218	98.6%
Toothpastes	0.021	447	92.6%	263	98.9%

Notes: For each product category, column 1 presents the average of the estimated coefficients of the average sales volume. Column 2 presents the total number of coefficients. Column 3 presents the % of positive coefficients out of all coefficients. Column 4 presents the total number of coefficients that are statistically significant at the 5% level. Column 5 presents the % of coefficients that are positive and statistically significant, at the 5% level. The Pooled column gives the results for the pooled sample. Products are identified by their UPCs.

Appendix F. Distributions of the size of price changes, by sales volumes – product categories level

In the paper, we pool the data from all 29 categories, and divide the products-stores into three groups, according to their sales volume. We then depict the kernel density estimators of the distributions of the size of price changes by sales volume groups (Figure 4).

Figure F1 presents similar figures, but we depict separate figures for each of the 29 product categories. We find the same pattern as we found when we used the pooled data. The low sales volume products have a distribution that is bi-modal, with a low share of small price changes. The high sales volume products have a distribution that is smoother, with small price changes being more common than larger price changes. The distributions of the medium sales volume products are in between.

Figure F1. Distributions of the size of price changes, by sales volumes – product categories level

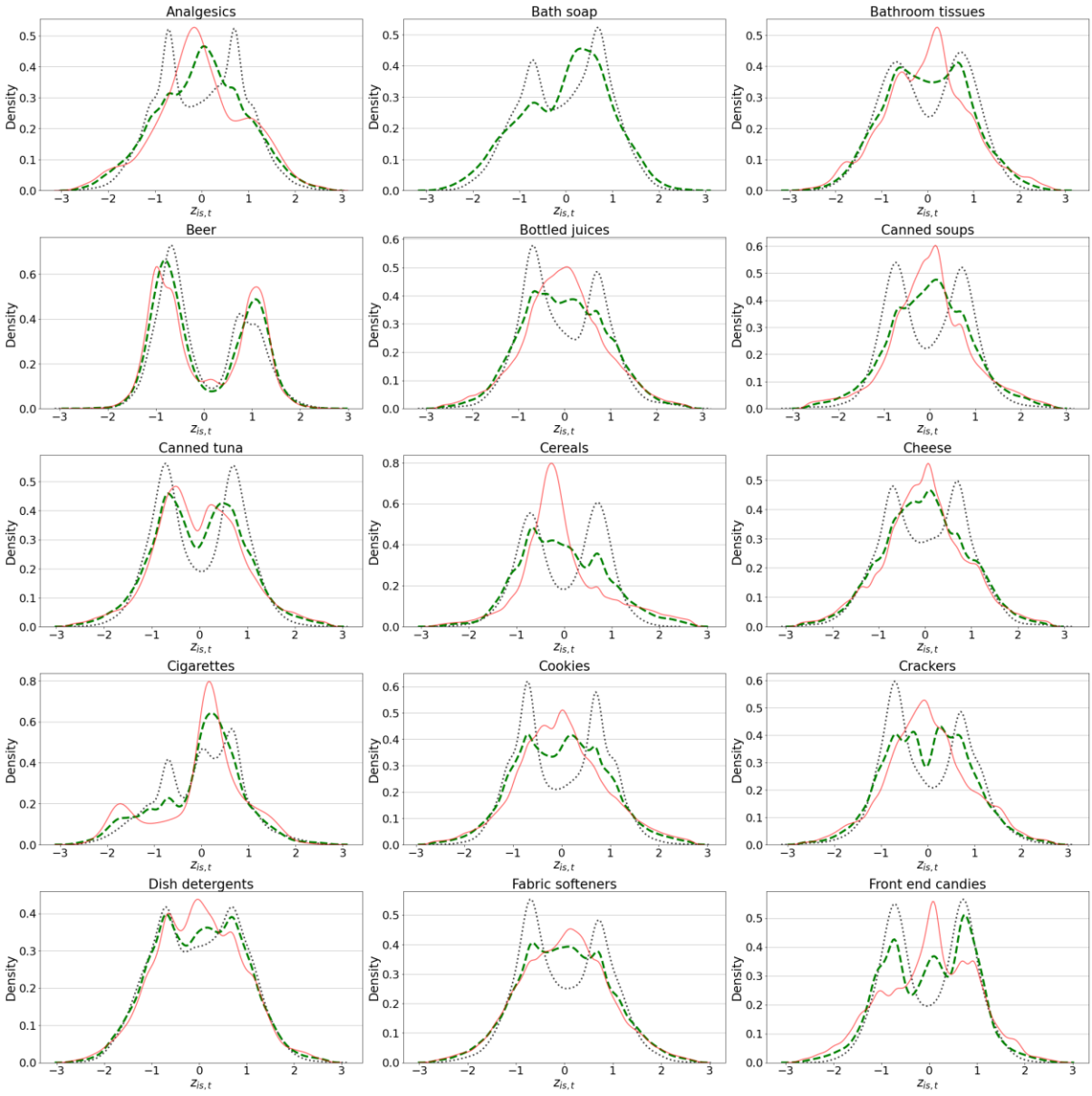
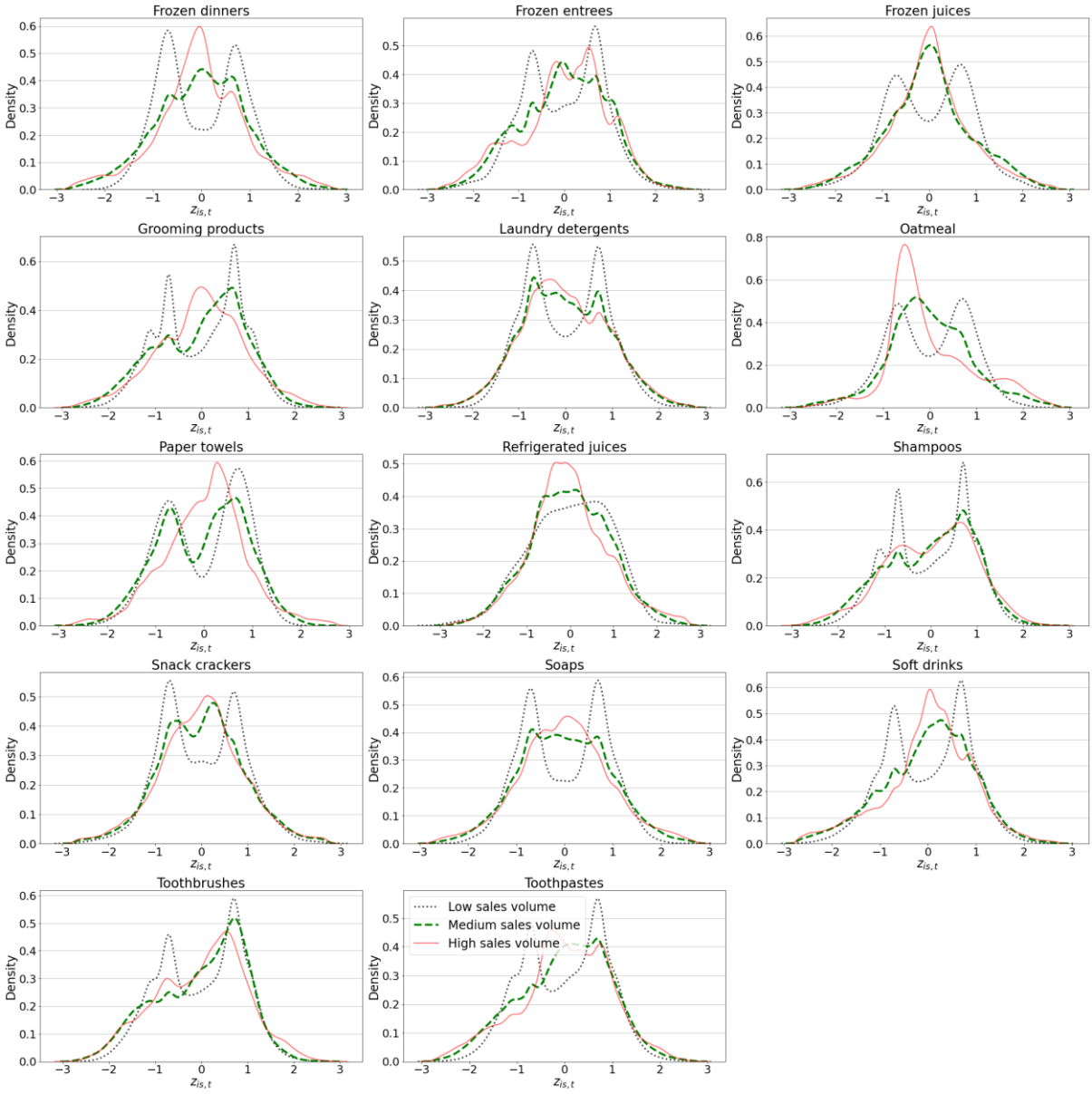


Figure F1 (Cont.)



Appendix G. Controlling for shoppers' socio-demographics and competition

In the paper, we study the correlation between small price changes and sales volume. To control for differences This can raise concerns that the results may be driven by differences between the stores rather than by differences in the sales volume.

To mitigate this concern, we use demographic information about consumers living in the neighborhood of each store. Table G1 presents the results of regressions equivalent to the regressions in Table 1 in the paper. The regressions take the following form:

$$\begin{aligned} small\ price\ change_{i,s,t} = \alpha + \beta \ln(average\ sales\ volume_{i,s}) + \gamma \mathbf{X}_{i,s,t} \\ + month_t + year_t + \delta_s + \mu_i + u_{i,s,t} \end{aligned} \quad \text{(G1)}$$

where *small price change* is a dummy that equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.5\left|\overline{\Delta p}_{i,s}\right|$, and 0 otherwise. The *average sales volume* is the average sales volume of product *i* in store *s* over the sample period. **X** is a matrix of other control variables. *Month* and *year* are fixed effects for the month and the year of the price change. δ and μ are fixed effects for stores and products, respectively, and *u* is an i.i.d error term. We estimate separate regressions for each product category, clustering the errors by product.

In column 1, the **X** matrix contains the following independent variables: the shoppers' median income, the share of minorities in the neighborhood in which the store is located, and the share of unemployed. To control for local competition, we also add a control for the pricing zone of each store, using pricing zone indicators included in Dominick's data.

The values in the table are the values of the coefficients of the average sales volume. We find that 28 of the coefficients are positive, and 24 of them are statistically significant.

In column 2, we add controls for the log of the average price, the absolute value of the percentage change in the wholesale price, a control for sale- and bounce-back prices, which we identify using the sales filter algorithm of Fox and Syed (2016), and a dummy for 9-ending prices. 26 of the coefficients of the average sales volume are positive. 21 of the 26 coefficients are statistically significant, and 2 more are statistically significant at the 10% level.

In column 3, we focus on regular prices by excluding all sale- and bounce-back prices. We find that 29 coefficients are positive. 25 of them are statistically significant and one more is statistically significant at the 10% level. Using the pooled sample, the

coefficient is 0.042, suggesting that a 1% increase in the sales volume is associated with a 4.2% increase in the likelihood of a small price change.

Table G1. Category-level regressions of small price changes of the average price change and sales volume, controlling for demographics and competition

Category		(1)	(2)	(3)
Pooled Data	Coefficient	0.0223***	0.0199***	0.0419***
	(Std.)	(0.0009)	(0.0008)	(0.0017)
	Observations	9,054,523	9,054,523	2,124,122
Analgesics	Coefficient	0.0449***	0.0332***	0.0622***
	(Std.)	(0.005)	(0.0049)	(0.0096)
	Observations	138,598	138,598	43,217
Bath Soap	Coefficient	0.0744***	0.0678***	0.18***
	(Std.)	(0.0108)	(0.0103)	(0.0258)
	Observations	14,067	14,067	2,896
Bathroom Tissues	Coefficient	0.0035	-0.0058	0.0213***
	(Std.)	(0.0052)	(0.0052)	(0.0078)
	Observations	137,694	137,694	38,629
Beer	Coefficient	0.0241***	0.0267***	0.0969***
	(Std.)	(0.0017)	(0.0019)	(0.0071)
	Observations	273,324	273,324	25,791
Bottled Juice	Coefficient	0.0226***	0.0162***	0.032***
	(Std.)	(0.003)	(0.0032)	(0.0055)
	Observations	473,277	473,277	122,205
Canned Soup	Coefficient	-0.0007	0.0016	0.0003
	(Std.)	(0.0043)	(0.004)	(0.0051)
	Observations	461,662	461,662	153,726
Canned Tuna	Coefficient	0.0099**	0.0054	0.0124*
	(Std.)	(0.0042)	(0.0043)	(0.0069)
	Observations	202,461	202,461	58,318
Cereals	Coefficient	0.01***	0.0044	0.0062
	(Std.)	(0.0037)	(0.0038)	(0.0044)
	Observations	342,347	342,347	147,131
Cheese	Coefficient	0.021***	0.0114***	0.0175***
	(Std.)	(0.0026)	(0.0027)	(0.0044)
	Observations	748,900	748,900	196,877
Cigarettes	Coefficient	0.0878***	0.0878***	0.1046***
	(Std.)	(0.007)	(0.0068)	(0.0078)
	Observations	34,574	34,574	28,969
Cookies	Coefficient	0.021***	0.0145***	0.0418***
	(Std.)	(0.0019)	(0.002)	(0.0039)
	Observations	662,436	662,436	125,556
Crackers	Coefficient	0.0191***	0.0095***	0.028***
	(Std.)	(0.0039)	(0.0035)	(0.0056)
	Observations	234,111	234,111	46,892
Dish Detergent	Coefficient	0.0173***	0.0072**	0.0213***
	(Std.)	(0.0029)	(0.0029)	(0.0044)
	Observations	180,705	180,705	48,838
Fabric Softener	Coefficient	0.0204***	0.0135***	0.0396***
	(Std.)	(0.0049)	(0.0049)	(0.0068)
	Observations	173,428	173,428	52,369
Front-End-Candies	Coefficient	0.0257***	0.0216***	0.0152***
	(Std.)	(0.004)	(0.0037)	(0.004)
	Observations	257,998	257,998	102,121
Frozen Dinners	Coefficient	0.0225***	0.0189***	0.0631***
	(Std.)	(0.0041)	(0.0043)	(0.0085)
	Observations	189,986	189,986	32,708

Table G1. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.0333***	0.0288***	0.0396***
	(Std.)	(0.002)	(0.0022)	(0.0035)
	Observations	817,469	817,469	191,522
Frozen Juices	Coefficient	0.0058	-0.0024	0.0178***
	(Std.)	(0.0038)	(0.0038)	(0.0063)
	Observations	291,239	291,239	78,405
Grooming Products	Coefficient	0.0469***	0.0482***	0.0785***
	(Std.)	(0.0027)	(0.0031)	(0.0069)
	Observations	251,017	251,017	48,072
Laundry Detergents	Coefficient	0.0257***	0.0148***	0.0376***
	(Std.)	(0.0036)	(0.0032)	(0.0059)
	Observations	263,975	263,975	82,061
Oatmeal	Coefficient	0.0065	-0.0056	0.0054
	(Std.)	(0.0063)	(0.0069)	(0.0073)
	Observations	75,356	75,356	33,303
Paper Towels	Coefficient	0.015	0.0215**	0.0366***
	(Std.)	(0.0097)	(0.0085)	(0.0124)
	Observations	108,558	108,558	23,956
Refrigerated Juices	Coefficient	0.0201***	0.0079*	0.0197***
	(Std.)	(0.0045)	(0.0041)	(0.0068)
	Observations	293,827	293,827	65,512
Shampoos	Coefficient	0.0516***	0.0585***	0.1086***
	(Std.)	(0.0025)	(0.0026)	(0.0076)
	Observations	242,990	242,990	38,240
Snack Crackers	Coefficient	0.0119***	0.006*	0.0343***
	(Std.)	(0.0031)	(0.0033)	(0.0055)
	Observations	383,346	383,346	74,244
Soaps	Coefficient	0.0272***	0.0152***	0.0351***
	(Std.)	(0.005)	(0.0048)	(0.0084)
	Observations	143,599	143,599	42,702
Soft Drinks	Coefficient	0.0204***	0.0215***	0.0383***
	(Std.)	(0.0017)	(0.0014)	(0.0035)
	Observations	1,286,038	1,286,038	141,579
Toothbrushes	Coefficient	0.034***	0.0343***	0.0845***
	(Std.)	(0.0035)	(0.0035)	(0.0102)
	Observations	119,223	119,223	23,993
Toothpastes	Coefficient	0.0285***	0.0271***	0.0777***
	(Std.)	(0.0032)	(0.0033)	(0.0068)
	Observations	252,318	252,318	54,290

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50\left|\overline{\Delta p}_{i,s}\right|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes the log of the average sales volume, the shoppers' median income, the share of minorities in the neighborhood in which the store is located, the share of unemployed, and the stores' pricing zones. The regression also includes the fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. All regressions also include controls for the shoppers' median income, the share of minorities, the share of unemployed, and a control for competition zones. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Appendix H. Sales volume, markup, and small price changes

Our results suggest that small price changes should be relatively common for products with high sales volumes. Yet, in the marketplace there are products with high sales volumes that rarely have small price changes. One example is the iPhone.

A possible explanation is that the likelihood of small price changes is negatively correlated with markups. It is possible that sellers that have high markups are less likely to make small price changes, because the effect of a small price change on the profits of a firm with high markup could be small in percentage terms.

To check this, we take advantage of the fact that Dominick's data contain a proxy for the products' markup (Barsky et al., 2003), and thus estimate a regression that is similar to regression (1) in the paper:

$$small\ price\ change_{i,s,t} = \alpha + \beta_1 ln\big(average\ sales\ volume_{i,s}\big) + \beta_2\big(average\ markup_{i,s}\big) + \gamma \boldsymbol{X}_{i,s,t} + month_t + year_t + \delta_s + \mu_i + u_{i,s,t} \quad \text{(H1)}$$

where *small price change* is a dummy that equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.5\left|\overline{\Delta p}_{i,s}\right|$, and 0 otherwise. As we do in the paper, we use observations on price changes only if we observe the price in both weeks *t* and *t* + 1 and the post-change price remained unchanged for at least 2 weeks. The *average sales volume* is the average sales volume of product *i* in store *s* over the sample period. The *average markup* is the average markup of product *i* in store *s* over the sample period. *Month* and *year* are fixed effects for the month and the year of the price change. δ and μ are fixed effects for stores and products, respectively, and *u* is an i.i.d error term.

The results are summarized in Table H1. Column 1 reports the results when the $\boldsymbol{X}$ matrix is empty. I.e., where the only control variables are the log of the average sales volume, and dummies for months, years, stores, and products.

We find that 28 of the coefficients of the log of the average sales volume are positive, and 24 of them are statistically significant. Using the pooled data, the coefficient of the log sales volume is 0.023, suggesting that a 1% increase in the sales volume is associated with a 2.3% increase in the likelihood of a small price change.

In column 2, we add controls for the log of the average price, the absolute value of the percentage change in the wholesale price, a control for sale- and bounce-back prices, which we identify using the sales filter algorithm of Fox and Syed (2016), and a dummy

for 9-ending prices. 26 of the coefficients are positive, and 21 of them are statistically significant. 2 more coefficients are statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.021, suggesting that a 1% increase in the sales volume is associated with a 2.1% increase in the likelihood of a small price change.

As a further control for the effects of sales on the results, in column 3 we focus on regular prices by excluding all sale- and bounce-back prices. We find that 28 of the 29 coefficients are positive. 25 of them are statistically significant and 1 more is statistically significant at the 10% level. Using the pooled sample, the coefficient is 0.043, suggesting that a 1% increase in the sales volume is associated with a 4.3% increase in the likelihood of a small price change.

The results, therefore, suggest that adding the markups to the regression does not affect our main finding. There is a positive correlation between sales volumes and small price changes.

Table H1. Category-level regressions of small price changes and sales volume, controlling for markup

Category		(1)	(2)	(3)
Pooled Data	Coefficient	0.0233***	0.0213***	0.0431***
	(Std.)	(0.0009)	(0.0008)	(0.0016)
	Observations	9,395,668	9,395,668	2,198,344
Analgesics	Coefficient	0.043***	0.0323***	0.0619***
	(Std.)	(0.005)	(0.0049)	(0.0096)
	Observations	138,598	138,598	43,217
Bath Soap	Coefficient	0.0723***	0.0671***	0.1799***
	(Std.)	(0.0112)	(0.0106)	(0.0259)
	Observations	14,067	14,067	2,896
Bathroom Tissues	Coefficient	0.003	-0.0064	0.0214***
	(Std.)	(0.0052)	(0.0053)	(0.0078)
	Observations	137,694	137,694	38,629
Beer	Coefficient	0.0226***	0.0264***	0.0897***
	(Std.)	(0.0016)	(0.0019)	(0.0068)
	Observations	273,324	273,324	25,791
Bottled Juice	Coefficient	0.0229***	0.0162***	0.032***
	(Std.)	(0.0031)	(0.0032)	(0.0055)
	Observations	473,277	473,277	122,205
Canned Soup	Coefficient	-0.0006	0.0015	-0.0003
	(Std.)	(0.0043)	(0.004)	(0.0051)
	Observations	461,662	461,662	153,726
Canned Tuna	Coefficient	0.0099**	0.0055	0.0123*
	(Std.)	(0.0042)	(0.0043)	(0.0069)
	Observations	202,461	202,461	58,318
Cereals	Coefficient	0.0092**	0.0038	0.0063
	(Std.)	(0.0037)	(0.0038)	(0.0045)
	Observations	342,347	342,347	147,131
Cheese	Coefficient	0.0203***	0.0109***	0.0177***
	(Std.)	(0.0026)	(0.0027)	(0.0044)
	Observations	748,900	748,900	196,877
Cigarettes	Coefficient	0.087***	0.0865***	0.1024***
	(Std.)	(0.007)	(0.0068)	(0.0079)
	Observations	34,574	34,574	28,969
Cookies	Coefficient	0.021***	0.0146***	0.0417***
	(Std.)	(0.0019)	(0.002)	(0.0038)
	Observations	662,436	662,436	125,556
Crackers	Coefficient	0.019***	0.0092***	0.028***
	(Std.)	(0.0039)	(0.0036)	(0.0056)
	Observations	234,111	234,111	46,892
Dish Detergent	Coefficient	0.0174***	0.0074**	0.0214***
	(Std.)	(0.0029)	(0.0029)	(0.0044)
	Observations	180,705	180,705	48,838
Fabric Softener	Coefficient	0.0204***	0.0134***	0.0388***
	(Std.)	(0.0049)	(0.005)	(0.0068)
	Observations	173,428	173,428	52,369
Front-End-Candies	Coefficient	0.0262***	0.0219***	0.0149***
	(Std.)	(0.004)	(0.0037)	(0.004)
	Observations	257,998	257,998	102,121
Frozen Dinners	Coefficient	0.0229***	0.0193***	0.0631***
	(Std.)	(0.0041)	(0.0042)	(0.0085)
	Observations	189,986	189,986	32,708

Table H1. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.0322***	0.029***	0.0394***
	(Std.)	(0.002)	(0.0022)	(0.0035)
	Observations	817,469	817,469	191,522
Frozen Juices	Coefficient	0.0053	-0.002	0.0164**
	(Std.)	(0.0039)	(0.0038)	(0.0063)
	Observations	291,239	291,239	78,405
Grooming Products	Coefficient	0.0435***	0.0469***	0.077***
	(Std.)	(0.0026)	(0.0031)	(0.0068)
	Observations	251,017	251,017	48,072
Laundry Detergents	Coefficient	0.0258***	0.0145***	0.0375***
	(Std.)	(0.0036)	(0.0033)	(0.0059)
	Observations	263,975	263,975	82,061
Oatmeal	Coefficient	0.0053	-0.0064	0.0056
	(Std.)	(0.0064)	(0.007)	(0.0073)
	Observations	75,356	75,356	33,303
Paper Towels	Coefficient	0.0143	0.021**	0.0366***
	(Std.)	(0.0097)	(0.0084)	(0.0124)
	Observations	108,558	108,558	23,956
Refrigerated Juices	Coefficient	0.0203***	0.0079*	0.0196***
	(Std.)	(0.0045)	(0.0041)	(0.0067)
	Observations	293,827	293,827	65,512
Shampoos	Coefficient	0.048***	0.0568***	0.1047***
	(Std.)	(0.0024)	(0.0026)	(0.0075)
	Observations	242,990	242,990	38,240
Snack Crackers	Coefficient	0.012***	0.006*	0.0334***
	(Std.)	(0.0031)	(0.0033)	(0.0055)
	Observations	383,346	383,346	74,244
Soaps	Coefficient	0.0272***	0.0152***	0.0352***
	(Std.)	(0.005)	(0.0048)	(0.0084)
	Observations	143,599	143,599	42,702
Soft Drinks	Coefficient	0.0206***	0.0219***	0.0385***
	(Std.)	(0.0017)	(0.0014)	(0.0035)
	Observations	1,286,038	1,286,038	141,579
Toothbrushes	Coefficient	0.0317***	0.0328***	0.0844***
	(Std.)	(0.0035)	(0.0035)	(0.0101)
	Observations	119,223	119,223	23,993
Toothpastes	Coefficient	0.0279***	0.027***	0.0778***
	(Std.)	(0.0032)	(0.0033)	(0.0068)
	Observations	252,318	252,318	54,290

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50\left|\overline{\Delta p}_{i,s}\right|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period. Column 1 reports the results of the baseline regression that includes the log of the average sales volume, the average markup, and fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. All regressions also include a control for markup. We estimate separate regressions for each product category, clustering the errors by product. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Appendix I. Using a rolling 52-week window to calculate the average sales volume

In the paper, we calculate the average sales volume for each product in each store over the entire period. This has the advantage of using a long-term "expected" sales volume for each product in each store. However, it implicitly assumes that the retailer can forecast future sales.

An alternative is to assume that the retailer makes decisions based on a recent past. To control for this possibility, we calculate the average sales volume for each product in each store based on data from the previous 52 weeks.

We then use the results to re-estimate regressions similar to the ones that we report in Table 3 in the paper. The regressions take the following form:

$$\begin{aligned} small\ \ price\ change_{i,s,t} = \alpha + \beta \ln(average\ sales\ volume_{i,s}) + \gamma \mathbf{X}_{i,s,t} \\ + month_t + year_t + \delta_s + \mu_i + u_{i,s,t} \end{aligned} \quad \text{(D1)}$$

where *small price change* is a dummy that equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.5\left|\overline{\Delta p}_{i,s}\right|$, and 0 otherwise. The *average sales volume* is the average sales volume of product *i* in store *s* over the 52 weeks preceding week *t*. **X** is a matrix of other control variables. *Month* and *year* are fixed effects for the month and the year of the price change. δ and μ are fixed effects for stores and products, respectively, and *u* is an i.i.d error term. We estimate separate regressions for each product category, clustering the errors by product.

The results are summarized in Table I1. The values in the table are the coefficients of the log of the average sales volume. In column 1, the only control variables are the log of the average sales volume, and the dummies for months, years, stores, and products. The estimation is much less precise than when we use the full period, because there is more noise when we use a short time period. Nevertheless, we find that 20 of the 29 coefficients of the log of the average sales volume are positive. Focusing on the pooled sample, we find that the coefficient is 0.002.

In column 2, we add controls for the log of the average price, the absolute value of the percentage change in the wholesale price, a control for sale- and bounce-back prices, which we identify using the sales filter algorithm of Fox and Syed (2016), and a dummy for 9-ending prices. We find that 20 of the 29 coefficients are positive. Focusing on the pooled sample, we find that the coefficient is 0.001.

As a further control for the effects of sales on the results, in column 3 we focus on

regular prices by excluding all sale- and bounce-back prices. When we focus on regular prices, the results are stronger. We find that 27 of the 29 coefficients are positive and 16 of them are statistically significant. 4 more coefficients are statistically significant at the 10% level. The coefficient of the pooled sample is 0.030, suggesting that a 1% increase in the sales volume is associated with a 3.0% increase in the likelihood of a small price change.

Thus, relying on the sales volume of the more recent period, does not change our main results. The correlation between small price changes and sales volume holds in a large majority of the product categories.

Table I1. Category-level regressions of small price changes and sales volume, defining the average sales volume using a 52-week rolling moving average

Category		(1)	(2)	(3)
Pooled Data	Coefficient	0.0017	0.0014	0.0302***
	(Std.)	(0.0016)	(0.0015)	(0.0022)
	Observations	8,374,997	8,374,997	1,870,983
Analgesics	Coefficient	0.0262**	0.0196*	-0.0073
	(Std.)	(0.0123)	(0.0103)	(0.0141)
	Observations	116,559	116,559	37,882
Bath Soap	Coefficient	0.0223**	0.0202*	0.0692***
	(Std.)	(0.011)	(0.0106)	(0.0199)
	Observations	10,897	10,897	1,881
Bathroom Tissues	Coefficient	0.0078	0.0062	0.029*
	(Std.)	(0.0139)	(0.012)	(0.0152)
	Observations	119,268	119,268	31,450
Beer	Coefficient	0.0117***	0.0095***	0.044***
	(Std.)	(0.0026)	(0.0024)	(0.008)
	Observations	210,202	210,202	18,091
Bottled Juice	Coefficient	0.0153	0.0099	0.0096
	(Std.)	(0.0095)	(0.0072)	(0.0088)
	Observations	421,240	421,240	107,057
Canned Soup	Coefficient	0.0307***	0.014*	0.0087
	(Std.)	(0.0083)	(0.0072)	(0.0114)
	Observations	392,931	392,931	128,120
Canned Tuna	Coefficient	-0.0184	-0.0144	0.0128
	(Std.)	(0.0115)	(0.0104)	(0.0094)
	Observations	173,941	173,941	51,348
Cereals	Coefficient	-0.01	-0.0018	-0.0097
	(Std.)	(0.0082)	(0.0061)	(0.0076)
	Observations	302,450	302,450	126,410
Cheese	Coefficient	0.0046	0.0021	0.0017
	(Std.)	(0.0074)	(0.0062)	(0.0075)
	Observations	636,817	636,817	162,722
Cigarettes	Coefficient	0.0163**	0.016**	0.0236***
	(Std.)	(0.0066)	(0.0066)	(0.0086)
	Observations	29,398	29,398	25,293
Cookies	Coefficient	0.0084	0.0013	0.0132*
	(Std.)	(0.006)	(0.0053)	(0.0071)
	Observations	568,872	568,872	101,214
Crackers	Coefficient	0.0208**	0.0051	0.0253***
	(Std.)	(0.0083)	(0.0082)	(0.0086)
	Observations	203,571	203,571	39,796
Dish Detergent	Coefficient	-0.0108	-0.0162**	0.008
	(Std.)	(0.0086)	(0.0073)	(0.0114)
	Observations	158,237	158,237	43,212
Fabric Softener	Coefficient	0.0021	0.0034	0.0378***
	(Std.)	(0.0124)	(0.0098)	(0.0145)
	Observations	153,228	153,228	46,236
Front-End-Candies	Coefficient	0.0277***	0.0074	0.0117
	(Std.)	(0.0103)	(0.0077)	(0.0082)
	Observations	221,564	221,564	76,556
Frozen Dinners	Coefficient	0.0329***	0.0375***	0.0436***
	(Std.)	(0.0079)	(0.0073)	(0.0159)
	Observations	144,888	144,888	19,220

Table I1. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	-0.0167**	-0.0099*	0.0375***
	(Std.)	(0.0069)	(0.006)	(0.0063)
	Observations	722,444	722,444	157,067
Frozen Juices	Coefficient	-0.001	-0.008	0.0265***
	(Std.)	(0.0087)	(0.007)	(0.0098)
	Observations	255,233	255,233	68,603
Grooming Products	Coefficient	0.0144***	0.0178***	0.0261***
	(Std.)	(0.0043)	(0.0043)	(0.0067)
	Observations	211,219	211,219	36,624
Laundry Detergents	Coefficient	-0.0341***	-0.0163**	0.0175
	(Std.)	(0.0097)	(0.0082)	(0.0125)
	Observations	234,479	234,479	68,640
Oatmeal	Coefficient	-0.0042	0.0017	0.0293*
	(Std.)	(0.015)	(0.0119)	(0.0149)
	Observations	61,064	61,064	24,713
Paper Towels	Coefficient	0.0157	0.0161	0.0612***
	(Std.)	(0.0153)	(0.0155)	(0.0198)
	Observations	89,640	89,640	20,371
Refrigerated Juices	Coefficient	-0.0044	-0.0059	0.0348***
	(Std.)	(0.0113)	(0.0099)	(0.01)
	Observations	258,227	258,227	56,758
Shampoos	Coefficient	0.0099*	0.023***	0.0786***
	(Std.)	(0.0052)	(0.0058)	(0.0088)
	Observations	178,952	178,952	21,945
Snack Crackers	Coefficient	0.0283***	0.0202***	0.0199*
	(Std.)	(0.0069)	(0.0064)	(0.0115)
	Observations	330,558	330,558	60,800
Soaps	Coefficient	-0.0134	-0.0112	0.0342**
	(Std.)	(0.0124)	(0.0096)	(0.0154)
	Observations	113,015	113,015	32,942
Soft Drinks	Coefficient	-0.0107***	-0.0099***	0.0277***
	(Std.)	(0.0037)	(0.0037)	(0.0054)
	Observations	1,155,062	1,155,062	112,914
Toothbrushes	Coefficient	0.0049	0.0105*	0.0259**
	(Std.)	(0.0058)	(0.0061)	(0.0105)
	Observations	100,594	100,594	19,150
Toothpastes	Coefficient	-0.0001	0.0094	0.0395***
	(Std.)	(0.0079)	(0.0063)	(0.0088)
	Observations	222,995	222,995	47,528

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50|\overline{\Delta p}_{i,s}|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variable is the log of the average sales volume of product *i* in store *s* over the sample period, defined using a 52 rolling window. Column 1 reports the results of the baseline regression that includes only the log of the average sales volume and the fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p <$ 10%, ** $p < 5\%$, *** $p < 1\%$

Appendix J. Sales volumes and price increases vs. price decreases

The results we report in the paper do not distinguish between price increases and price decreases. It is possible, however, that retailers treat price increases and decreases differently. We therefore estimate regressions similar to the ones that their results are reported in Table 1 in the paper:

$$\begin{aligned} small\ price\ change_{i,s,t} \\ &= \alpha + \beta_1\, ln(\,average\ sales\ volume_{i,s}) \\ &+ \beta_2 decrease \times ln(\,average\ sales\ volume_{i,s}) + \beta_3 decrease + \\ &\gamma \boldsymbol{X}_{i,s,t} + month_t + year_t + \delta_s + \mu_i + u_{i,s,t} \end{aligned} \qquad \text{(J1)}$$

In this regression, *small price change* is a dummy that equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50\left|\overline{\Delta p}_{i,s}\right|$, and 0 otherwise. The *average sales volume* is the average sales volume of product *i* in store *s* over the sample period. The variable $decrease$ is a dummy variable that equals 1 if the price has decreased and 0 otherwise. **X** is a matrix of other control variables. *Month* and *year* are fixed effects for the month and the year of the price change. δ and μ are fixed effects for stores and products, respectively, and *u* is an i.i.d error term..

Table J1 reports the coefficients of the average sales volume. Table J2 reports the coefficients of the interaction term. In column 1, the only control variables are the log of the average sales volume, a dummy for price decreases, the interaction between sales volumes and the dummy for price decreases, and the dummies for months, years, stores, and products. We find that the main effect of the sales volume is positive in 27 of the 29 categories. 22 of these coefficients are statistically significant. Out of the 29 coefficients of the interaction terms, 17 are positive and 12 are negative. 11 of the positive coefficients and 6 of the negative coefficients are statistically significant.

It is therefore not clear if the correlation between sales volumes and the likelihood of a small price change is larger or smaller among price increases or decreases.

Column 2 reports the results of regressions where we add the following control variables to the **X** matrix: The log of the average price, the absolute value of the percentage change in the wholesale price, a control for sale- and bounce-back prices, which we identify using the sales filter algorithm of Fox and Syed (2016), and a dummy for 9-ending prices. The results remain similar to those we find in Column 1. We find that 25 of the coefficients of the main effect are positive. 19 of the positive coefficients are

statistically significant and 2 more are statistically significant at the 10% level. Among the coefficients of the interaction term, 14 are positive and 15 are negative. 10 of the positive coefficients are statistically significant, and 6 of the negative coefficients are statistically significant.

In column 3, we report the results of a regression that focuses on regular prices. We keep all the control variables as in column 2, and exclude observations on sale- and bounce-back prices. We find that 29 of the 29 coefficients of the main effects are positive and 27 of them are statistically significant. Among the coefficients of the interaction terms 5 are positive and 24 are negative. Out of the positive (negative) coefficients, 1 (15) are statistically significant.

Thus, it seems that if we look at all price changes, the correlation between sales volumes and small price changes is quite symmetric. If we focus on the regular prices, then the correlation seems to be somewhat stronger among price increases than among price decreases.

Table J1. Category-level regressions of small price changes and sales volume, controlling price increases vs. decreases, coefficients of the average sales volume

Category		(1)	(2)	(3)
Pooled Data	Coefficient	0.0207***	0.0207***	0.0499***
	(Std.)	(0.0012)	(0.001)	(0.002)
	Observations	9,395,668	9,395,668	2,198,344
Analgesics	Coefficient	0.04***	0.038***	0.0806***
	(Std.)	(0.0068)	(0.0062)	(0.0106)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient	0.0747***	0.0815***	0.1859***
	(Std.)	(0.0111)	(0.0109)	(0.0268)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient	0.0261***	0.0063	0.0466***
	(Std.)	(0.0066)	(0.0068)	(0.0094)
	Observations	141,801	141,801	39,815
Beer	Coefficient	0.0321***	0.0367***	0.1037***
	(Std.)	(0.0034)	(0.0029)	(0.0091)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient	0.0203***	0.0161***	0.0393***
	(Std.)	(0.0048)	(0.0047)	(0.0081)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient	0.0213***	0.0154**	0.0253***
	(Std.)	(0.0081)	(0.0065)	(0.0064)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient	0.0014	-0.0059	0.0157*
	(Std.)	(0.0053)	(0.0051)	(0.0088)
	Observations	208,198	208,198	60,298
Cereals	Coefficient	0.0181***	0.0145***	0.0205***
	(Std.)	(0.0044)	(0.0041)	(0.0054)
	Observations	352,779	352,779	151,201
Cheese	Coefficient	0.0243***	0.0177***	0.0298***
	(Std.)	(0.0035)	(0.0032)	(0.0053)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient	0.1019***	0.1026***	0.1183***
	(Std.)	(0.008)	(0.008)	(0.0098)
	Observations	35,826	35,826	29,931
Cookies	Coefficient	0.0115***	0.012***	0.0537***
	(Std.)	(0.0033)	(0.0029)	(0.0048)
	Observations	684,672	684,672	129,854
Crackers	Coefficient	0.0091**	0.0024	0.041***
	(Std.)	(0.0051)	(0.0051)	(0.0081)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient	0.0072**	-0.0007	0.0279***
	(Std.)	(0.0042)	(0.0041)	(0.0075)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient	0.0297***	0.0169***	0.0495***
	(Std.)	(0.0072)	(0.0062)	(0.0094)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient	0.0199***	0.0169***	0.011**
	(Std.)	(0.0053)	(0.0045)	(0.0051)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient	0.0036	0.0026	0.0846***
	(Std.)	(0.0049)	(0.0049)	(0.0109)
	Observations	199,209	199,209	34,111

Table J1. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.0409***	0.039***	0.0446***
	(Std.)	(0.0028)	(0.0025)	(0.0044)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient	-0.0021	-0.0052	0.0204***
	(Std.)	(0.0045)	(0.0046)	(0.0079)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient	0.0372***	0.046***	0.0762***
	(Std.)	(0.0031)	(0.0036)	(0.0089)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient	0.0231***	0.0182***	0.0394***
	(Std.)	(0.0055)	(0.0048)	(0.0087)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient	-0.0087	-0.0041	0.0122
	(Std.)	(0.0097)	(0.0069)	(0.0074)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient	0.0183*	0.0179**	0.0549***
	(Std.)	(0.0099)	(0.0091)	(0.0158)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient	0.0234***	0.0117**	0.0279***
	(Std.)	(0.006)	(0.0049)	(0.0082)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient	0.0526***	0.0623***	0.1245***
	(Std.)	(0.0029)	(0.003)	(0.0082)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient	0.0096**	0.0036	0.0482***
	(Std.)	(0.004)	(0.0041)	(0.0071)
	Observations	395,641	395,641	76,710
Soaps	Coefficient	0.0248***	0.011***	0.0349***
	(Std.)	(0.0057)	(0.0056)	(0.0099)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient	0.0149***	0.0158***	0.0523***
	(Std.)	(0.0025)	(0.002)	(0.0046)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient	0.0401***	0.0431***	0.1021***
	(Std.)	(0.0046)	(0.0045)	(0.0118)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient	0.0265***	0.0304***	0.0807***
	(Std.)	(0.0037)	(0.0037)	(0.0073)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50\left|\overline{\Delta p}_{i,s}\right|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variables are the log of the average sales volume of product *i* in store *s* over the sample period, a dummy for price decreases, and an interaction between the sales volumes and price decreases. The values in the table are the coefficients of the average sales volume. The coefficients of the interaction term are reported in Table J2. Column 1 reports the results of the baseline regression that includes the log of the average sales volume, the average markup, and fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Table J2. Category-level regressions of small price changes and sales volume, controlling for price increases vs. decreases, coefficients of the interaction term

Category		(1)	(2)	(3)
Pooled Data	Coefficient	0.0105***	0.0044***	-0.02***
	(Std.)	(0.002)	(0.0018)	(0.003)
	Observations	9,395,668	9,395,668	2,198,344
Analgesics	Coefficient	0.013***	-0.0073***	-0.0702***
	(Std.)	(0.0129)	(0.0099)	(0.0203)
	Observations	144,201	144,201	44,797
Bath Soap	Coefficient	0.0074***	-0.0263***	-0.0512***
	(Std.)	(0.015)	(0.0165)	(0.0637)
	Observations	15,222	15,222	3,196
Bathroom Tissues	Coefficient	-0.0437***	-0.009***	-0.0532***
	(Std.)	(0.0154)	(0.0119)	(0.0155)
	Observations	141,801	141,801	39,815
Beer	Coefficient	-0.0144***	-0.0165***	-0.0131***
	(Std.)	(0.0042)	(0.0032)	(0.0131)
	Observations	290,313	290,313	27,166
Bottled Juice	Coefficient	0.0098***	0.0097***	-0.0149***
	(Std.)	(0.0088)	(0.0085)	(0.0174)
	Observations	489,123	489,123	127,133
Canned Soup	Coefficient	-0.0584***	-0.0286***	-0.0724***
	(Std.)	(0.0186)	(0.014)	(0.0112)
	Observations	474,214	474,214	157,882
Canned Tuna	Coefficient	0.0227***	0.0283***	-0.0027***
	(Std.)	(0.0059)	(0.0053)	(0.0124)
	Observations	208,198	208,198	60,298
Cereals	Coefficient	-0.0299***	-0.0328***	-0.0464***
	(Std.)	(0.0098)	(0.0087)	(0.0112)
	Observations	352,779	352,779	151,201
Cheese	Coefficient	-0.0051***	-0.011***	-0.0294***
	(Std.)	(0.0068)	(0.0047)	(0.0096)
	Observations	773,222	773,222	204,902
Cigarettes	Coefficient	-0.045***	-0.046***	-0.0534***
	(Std.)	(0.0124)	(0.0127)	(0.0178)
	Observations	35,826	35,826	29,931
Cookies	Coefficient	0.0323***	0.017***	-0.0346***
	(Std.)	(0.0075)	(0.0063)	(0.011)
	Observations	684,672	684,672	129,854
Crackers	Coefficient	0.0324***	0.027***	-0.0312***
	(Std.)	(0.0077)	(0.0089)	(0.0156)
	Observations	243,435	243,435	49,040
Dish Detergent	Coefficient	0.0333***	0.0267***	-0.0068***
	(Std.)	(0.0081)	(0.0081)	(0.0133)
	Observations	186,800	186,800	50,640
Fabric Softener	Coefficient	-0.0179***	-0.0028***	-0.0128***
	(Std.)	(0.0108)	(0.0085)	(0.0167)
	Observations	178,936	178,936	54,280
Front-End-Candies	Coefficient	0.0182***	0.0181***	0.0146***
	(Std.)	(0.0086)	(0.0064)	(0.0086)
	Observations	264,936	264,936	103,367
Frozen Dinners	Coefficient	0.0792***	0.0645***	-0.0489***
	(Std.)	(0.0082)	(0.0066)	(0.01)
	Observations	199,209	199,209	34,111

Table J2. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	-0.0199***	-0.0252***	-0.0158***
	(Std.)	(0.006)	(0.0046)	(0.0069)
	Observations	845,711	845,711	195,823
Frozen Juices	Coefficient	0.035***	0.0221***	0.0027***
	(Std.)	(0.0099)	(0.0093)	(0.0114)
	Observations	300,483	300,483	80,926
Grooming Products	Coefficient	0.0268***	0.0111***	0.0233***
	(Std.)	(0.0061)	(0.0058)	(0.0207)
	Observations	269,278	269,278	51,539
Laundry Detergents	Coefficient	0.0113***	-0.0026***	0.0011***
	(Std.)	(0.0103)	(0.009)	(0.0154)
	Observations	272,143	272,143	84,651
Oatmeal	Coefficient	0.0545***	0.0035***	-0.0196***
	(Std.)	(0.0209)	(0.0104)	(0.0112)
	Observations	78,407	78,407	34,570
Paper Towels	Coefficient	-0.0078***	0.006***	-0.0409***
	(Std.)	(0.0113)	(0.0108)	(0.0198)
	Observations	111,381	111,381	24,711
Refrigerated Juices	Coefficient	-0.0059***	-0.006***	-0.012***
	(Std.)	(0.0116)	(0.0086)	(0.0144)
	Observations	302,858	302,858	68,444
Shampoos	Coefficient	-0.0009***	-0.0083***	-0.051***
	(Std.)	(0.0053)	(0.0048)	(0.0139)
	Observations	261,723	261,723	40,970
Snack Crackers	Coefficient	0.0114***	0.0149***	-0.0408***
	(Std.)	(0.007)	(0.0067)	(0.0147)
	Observations	395,641	395,641	76,710
Soaps	Coefficient	0.0118***	0.0164***	0.0023***
	(Std.)	(0.0089)	(0.0073)	(0.02)
	Observations	150,082	150,082	44,723
Soft Drinks	Coefficient	0.0304***	0.029***	-0.0329***
	(Std.)	(0.0059)	(0.0054)	(0.0066)
	Observations	1,336,429	1,336,429	146,635
Toothbrushes	Coefficient	-0.0169***	-0.0253***	-0.0562***
	(Std.)	(0.0091)	(0.0088)	(0.0203)
	Observations	125,225	125,225	24,869
Toothpastes	Coefficient	0.0163***	-0.0005***	-0.001***
	(Std.)	(0.0075)	(0.0069)	(0.0122)
	Observations	263,420	263,420	56,160

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50\left|\overline{\Delta p}_{i,s}\right|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variables are the log of the average sales volume of product *i* in store *s* over the sample period, a dummy for price decreases, and an interaction between the sales volumes and price decreases. The values in the table are the coefficients of the interaction term. The coefficients of average sales volume are reported in Table J1. Column 1 reports the results of the baseline regression that includes the log of the average sales volume, a dummy for price decreases, the interaction between sales volumes and the dummy for price decreases,, and fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Appendix K. Sales volumes, small price changes, and holidays

Levy et al. (2010) argue that menu costs are higher during the holiday season than at other times. As they note, store traffic is higher during holidays than in other times and, consequently, tasks such as restocking shelves, running cash registers, cleaning and bagging, etc., become more urgent. Therefore, the opportunity cost of price adjustment increases during holiday periods.

If the menu costs are higher, then we should observe fewer price changes. It is unclear, however, how it would affect the correlation between sales volumes and the likelihood of small price changes. To explore this, we focus on the holiday period, which, following Warner and Barsky (1995) and Levy et al. (2010), we define as the period starting the week before Thanksgiving through the week of Christmas, a total of six weeks.

To test this, we estimate a series of regressions equivalent to the regressions in Table 1 in the paper. The regressions take the following form:

$$\begin{aligned} small\ price\ change_{i,s,t} \\ &= \alpha + \beta_1\, ln(\, average\ sales\ volume_{i,s}) \\ &+ \beta_2 holiday \times ln(\, average\ sales\ volume_{i,s}) + \beta_3 holiday + \\ &\gamma \boldsymbol{X}_{i,s,t} + month_t + year_t + \delta_s + \mu_i + u_{i,s,t} \end{aligned}$$

where *small price change* is a dummy that equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50\left|\overline{\Delta p}_{i,s}\right|$, and 0 otherwise. The *average sales volume* is the average sales volume of product *i* in store *s* over the sample period. **X** is a matrix of other control variables. The variable $holiday$ is a dummy that equals 1 if the week is a holiday, as defined above, and 0 otherwise. *Month* and *year* are fixed effects for the month and the year of the price change. δ and μ are fixed effects for stores and products, respectively, and *u* is an i.i.d error term. We estimate separate regressions for each product category, clustering the errors by product.

Table K1 reports the coefficients of the log of the average sales volume. Table K2 reports the coefficients of the interaction term.

In column 1, the only control variables are the log of the average sales volume, a dummy holidays, the interaction between sales volumes and the dummy for holidays, and the dummies for months, years, stores, and products. We find that 28 of the coefficients of the main effects are positive, and 22 of them are statistically significant. Out of the

coefficients of the interaction terms, 20 are positive. 5 (2) of the positive (negative) coefficients are statistically significant.

In column 2, we add the following control variables to the **X** matrix: The log of the average price, the absolute value of the percentage change in the wholesale price, a control for sale- and bounce-back prices, which we identify using the sales filter algorithm of Fox and Syed (2016), and a dummy for 9-ending prices. The results remain similar to those we find in Column 1. We find that 26 of the coefficients of the main effect are positive. 20 of the positive coefficients are statistically significant and 2 more are statistically significant at the 10% level. Among the interaction term coefficients, 17 are positive and 12 are negative. 5 of the positive coefficients are statistically significant, and 2 of the negative coefficients are statistically significant.

In column 3, we report the results of a regression that focuses on regular prices. We keep all the control variables as in column 2 and remove observations on sale- and bounce-back prices. We find that 29 of the 29 coefficients of the main effects are positive and 27 of them are statistically significant. Among the coefficients of the interaction terms 12 are positive and 17 are negative. Of the positive (negative) coefficients, 4 (5) are statistically significant.

Thus, it seems that the correlation between the sales volumes and the likelihood of a small price change is not much different on holidays than in other times.

Table K1. Category-level regressions of small price changes and sales volume, controlling for holidays, coefficients of the average sales volume

Category		(1)	(2)	(3)
Pooled Data	Coefficient	0.0225***	0.0203***	0.0442***
	(Std.)	(0.0009)	(0.0008)	(0.0017)
	Observations	9,395,668	9,395,668	2,198,344
Analgesics	Coefficient	0.0445***	0.0354***	0.0595***
	(Std.)	(0.0054)	(0.005)	(0.01)
	Observations	138,598	138,598	43,217
Bath Soap	Coefficient	0.0671***	0.0617***	0.1765***
	(Std.)	(0.0119)	(0.0114)	(0.0252)
	Observations	14,067	14,067	2,896
Bathroom Tissues	Coefficient	0.0046	-0.005	0.0274***
	(Std.)	(0.0056)	(0.0056)	(0.0085)
	Observations	137,694	137,694	38,629
Beer	Coefficient	0.0238***	0.0262***	0.0982***
	(Std.)	(0.0019)	(0.002)	(0.0071)
	Observations	273,324	273,324	25,791
Bottled Juice	Coefficient	0.0195***	0.0141***	0.033***
	(Std.)	(0.0035)	(0.0035)	(0.0061)
	Observations	473,277	473,277	122,205
Canned Soup	Coefficient	-0.0014	0.0018	0.0009
	(Std.)	(0.0047)	(0.0042)	(0.0059)
	Observations	461,662	461,662	153,726
Canned Tuna	Coefficient	0.0087*	0.0048	0.0163**
	(Std.)	(0.0047)	(0.0046)	(0.0073)
	Observations	202,461	202,461	58,318
Cereals	Coefficient	0.0116***	0.0073*	0.0107**
	(Std.)	(0.0042)	(0.004)	(0.005)
	Observations	342,347	342,347	147,131
Cheese	Coefficient	0.0214***	0.0119***	0.0186***
	(Std.)	(0.003)	(0.003)	(0.0046)
	Observations	748,900	748,900	196,877
Cigarettes	Coefficient	0.092***	0.0921***	0.11***
	(Std.)	(0.007)	(0.0068)	(0.0078)
	Observations	34,574	34,574	28,969
Cookies	Coefficient	0.0185***	0.0125***	0.0396***
	(Std.)	(0.0024)	(0.0023)	(0.0043)
	Observations	662,436	662,436	125,556
Crackers	Coefficient	0.0165***	0.0086**	0.0296***
	(Std.)	(0.0043)	(0.0039)	(0.0062)
	Observations	234,111	234,111	46,892
Dish Detergent	Coefficient	0.0142***	0.0068*	0.0204***
	(Std.)	(0.0036)	(0.0036)	(0.0049)
	Observations	180,705	180,705	48,838
Fabric Softener	Coefficient	0.0179***	0.0113**	0.032***
	(Std.)	(0.0053)	(0.0052)	(0.0065)
	Observations	173,428	173,428	52,369
Front-End-Candies	Coefficient	0.0215***	0.0176***	0.0195***
	(Std.)	(0.0045)	(0.0042)	(0.0042)
	Observations	257,998	257,998	102,121
Frozen Dinners	Coefficient	0.0297***	0.0251***	0.0631***
	(Std.)	(0.0045)	(0.0046)	(0.0088)
	Observations	189,986	189,986	32,708

Table K1. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	0.035***	0.0295***	0.0446***
	(Std.)	(0.0023)	(0.0024)	(0.0038)
	Observations	817,469	817,469	191,522
Frozen Juices	Coefficient	0.0034	-0.0032	0.0242***
	(Std.)	(0.004)	(0.0039)	(0.0074)
	Observations	291,239	291,239	78,405
Grooming Products	Coefficient	0.0432***	0.0452***	0.0746***
	(Std.)	(0.0028)	(0.0033)	(0.0083)
	Observations	251,017	251,017	48,072
Laundry Detergents	Coefficient	0.0209***	0.0119***	0.0378***
	(Std.)	(0.0042)	(0.0037)	(0.0065)
	Observations	263,975	263,975	82,061
Oatmeal	Coefficient	0.0091	-0.0044	0.0078
	(Std.)	(0.0066)	(0.0073)	(0.0075)
	Observations	75,356	75,356	33,303
Paper Towels	Coefficient	0.0117	0.0191**	0.0312***
	(Std.)	(0.0093)	(0.008)	(0.0123)
	Observations	108,558	108,558	23,956
Refrigerated Juices	Coefficient	0.0193***	0.0068	0.0215***
	(Std.)	(0.0048)	(0.0043)	(0.0076)
	Observations	293,827	293,827	65,512
Shampoos	Coefficient	0.0536***	0.0604***	0.1043***
	(Std.)	(0.0029)	(0.003)	(0.0077)
	Observations	242,990	242,990	38,240
Snack Crackers	Coefficient	0.0063*	0.0019	0.0312***
	(Std.)	(0.0034)	(0.0036)	(0.006)
	Observations	383,346	383,346	74,244
Soaps	Coefficient	0.0299***	0.0159***	0.0254***
	(Std.)	(0.0052)	(0.005)	(0.0092)
	Observations	143,599	143,599	42,702
Soft Drinks	Coefficient	0.0196***	0.0209***	0.0388***
	(Std.)	(0.0016)	(0.0014)	(0.0035)
	Observations	1,286,038	1,286,038	141,579
Toothbrushes	Coefficient	0.0318***	0.0349***	0.0917***
	(Std.)	(0.0041)	(0.0044)	(0.0099)
	Observations	119,223	119,223	23,993
Toothpastes	Coefficient	0.0255***	0.0259***	0.0777***
	(Std.)	(0.0037)	(0.0035)	(0.0073)
	Observations	252,318	252,318	54,290

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50|\overline{\Delta p}_{i,s}|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variables are the log of the average sales volume of product *i* in store *s* over the sample period, a dummy for holidays, and an interaction between the sales volumes and holidays. The values in the table are the coefficients of the average sales volume. The coefficients of the interaction term are reported in Table J2. Column 1 reports the results of the baseline regression that includes the log of the average sales volume, the average markup, and fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Table K2. Category-level regressions of small price changes and sales volume, controlling for holidays, coefficients of the interaction term

Category		(1)	(2)	(3)
Pooled Data	Coefficient	0.0095***	0.0095***	-0.0042
	(Std.)	(0.0029)	(0.0026)	(0.0045)
	Observations	9,395,668	9,395,668	2,198,344
Analgesics	Coefficient	0.0044	-0.0201	0.0226
	(Std.)	(0.02)	(0.0151)	(0.0364)
	Observations	138,598	138,598	43,217
Bath Soap	Coefficient	0.0793**	0.0662**	0.0548
	(Std.)	(0.0397)	(0.0328)	(0.0749)
	Observations	14,067	14,067	2,896
Bathroom Tissues	Coefficient	-0.0101	-0.0067	-0.0628**
	(Std.)	(0.0182)	(0.0172)	(0.0282)
	Observations	137,694	137,694	38,629
Beer	Coefficient	0.0026	0.0053	-0.0153
	(Std.)	(0.005)	(0.004)	(0.0129)
	Observations	273,324	273,324	25,791
Bottled Juice	Coefficient	0.0278*	0.0184	-0.0017
	(Std.)	(0.015)	(0.0122)	(0.0138)
	Observations	473,277	473,277	122,205
Canned Soup	Coefficient	0.0057	-0.0005	-0.0037
	(Std.)	(0.0192)	(0.0158)	(0.0293)
	Observations	461,662	461,662	153,726
Canned Tuna	Coefficient	0.0089	0.0039	-0.0325
	(Std.)	(0.0099)	(0.0094)	(0.0201)
	Observations	202,461	202,461	58,318
Cereals	Coefficient	-0.0135	-0.0248*	-0.032**
	(Std.)	(0.0151)	(0.0136)	(0.0157)
	Observations	342,347	342,347	147,131
Cheese	Coefficient	-0.0043	-0.0051	-0.012
	(Std.)	(0.013)	(0.0106)	(0.0121)
	Observations	748,900	748,900	196,877
Cigarettes	Coefficient	-0.0312***	-0.0326***	-0.0372***
	(Std.)	(0.0036)	(0.0036)	(0.0051)
	Observations	34,574	34,574	28,969
Cookies	Coefficient	0.0359**	0.0281**	0.0176
	(Std.)	(0.0183)	(0.014)	(0.0163)
	Observations	662,436	662,436	125,556
Crackers	Coefficient	0.0272*	0.009	-0.022
	(Std.)	(0.0161)	(0.0118)	(0.0228)
	Observations	234,111	234,111	46,892
Dish Detergent	Coefficient	0.0227	0.0027	0.0079
	(Std.)	(0.0145)	(0.0142)	(0.0204)
	Observations	180,705	180,705	48,838
Fabric Softener	Coefficient	0.0271	0.023	0.0755***
	(Std.)	(0.0242)	(0.0213)	(0.0338)
	Observations	173,428	173,428	52,369
Front-End-Candies	Coefficient	0.0456***	0.0437**	-0.0442***
	(Std.)	(0.0184)	(0.0179)	(0.0137)
	Observations	257,998	257,998	102,121
Frozen Dinners	Coefficient	-0.0783***	-0.0668***	0.0014
	(Std.)	(0.0199)	(0.0179)	(0.0205)
	Observations	189,986	189,986	32,708

Table K2. (Cont.)

Category		(1)	(2)	(3)
Frozen Entrees	Coefficient	-0.0238	-0.0093	-0.052***
	(Std.)	(0.0157)	(0.0138)	(0.017)
	Observations	817,469	817,469	191,522
Frozen Juices	Coefficient	0.0201	0.0066	-0.0465*
	(Std.)	(0.0135)	(0.012)	(0.0281)
	Observations	291,239	291,239	78,405
Grooming Products	Coefficient	0.0464***	0.0372***	0.047
	(Std.)	(0.0162)	(0.0148)	(0.0447)
	Observations	251,017	251,017	48,072
Laundry Detergents	Coefficient	0.0407***	0.0239*	-0.0018
	(Std.)	(0.0148)	(0.0129)	(0.0184)
	Observations	263,975	263,975	82,061
Oatmeal	Coefficient	-0.0255	-0.012	-0.0215
	(Std.)	(0.0215)	(0.0284)	(0.0171)
	Observations	75,356	75,356	33,303
Paper Towels	Coefficient	0.0322	0.0233	0.0611***
	(Std.)	(0.0225)	(0.0193)	(0.0194)
	Observations	108,558	108,558	23,956
Refrigerated Juices	Coefficient	0.0062	0.0097	-0.0144
	(Std.)	(0.0136)	(0.0095)	(0.0198)
	Observations	293,827	293,827	65,512
Shampoos	Coefficient	-0.0205	-0.0196	0.0585***
	(Std.)	(0.0152)	(0.0141)	(0.0239)
	Observations	242,990	242,990	38,240
Snack Crackers	Coefficient	0.0482***	0.0347***	0.0261
	(Std.)	(0.0121)	(0.0127)	(0.0242)
	Observations	383,346	383,346	74,244
Soaps	Coefficient	-0.0399*	-0.0103	0.1629***
	(Std.)	(0.0219)	(0.0181)	(0.0459)
	Observations	143,599	143,599	42,702
Soft Drinks	Coefficient	0.0079	0.0061	-0.0073
	(Std.)	(0.0083)	(0.008)	(0.012)
	Observations	1,286,038	1,286,038	141,579
Toothbrushes	Coefficient	0.0198	-0.0058	-0.0586***
	(Std.)	(0.019)	(0.025)	(0.0325)
	Observations	119,223	119,223	23,993
Toothpastes	Coefficient	0.027	0.0118	0.0005
	(Std.)	(0.0178)	(0.0117)	(0.0208)
	Observations	252,318	252,318	54,290

Notes: The table reports the results of category-level fixed effect regressions of the probability of a small price change. The dependent variable is "small price change," which equals 1 if a price change of product *i* in store *s* at time *t* is less than $0.50\left|\overline{\Delta p}_{i,s}\right|$ where $\overline{\Delta p}_{i,s}$ is the average size of a price change of product i in store s, and 0 otherwise. The main independent variables are the log of the average sales volume of product *i* in store *s* over the sample period, a dummy for holidays, and an interaction between the sales volumes and holidays. The values in the table are the coefficients of the interaction terms. The coefficients of the average sales volume are reported in Table J2. Column 1 reports the results of the baseline regression that includes the log of the average sales volume, the average markup, and fixed effects for months, years, stores, and products. In column 2, we add the following controls: the log of the average price, the absolute value of the percentage change in the wholesale price, a dummy for 9-ending prices, and a control for sale- and bounce-back prices, which we identify using a sales filter algorithm. In column 4, we focus on regular prices by excluding the sale- and bounce-back prices. We estimate separate regressions for each product category, clustering the errors by product. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$

Appendix L. The correlation between sales volumes and the likelihood of small price changes in Barro's (1972) menu cost model

To motivate the empirical analysis of the relationship between sales volumes and the prevalence of small price changes, we extend Barro's (1972) model. Although the model is highly stylistic, it is useful because one criticism of the canonical menu cost model is that it fails to predict small price changes. We show that conditional on sales volume, even this highly stylistic model can predict small price changes.

Following Barro (1972), consider a profit-maximizing monopolist producing a homogenous good. The linear demand and the quadratic cost functions are given by $Y = \alpha - \beta P + u$ and $C(Y) = a + bY + cY^2$, respectively, where u is a symmetric demand disturbance/shifter, $C'(Y) > 0$, and $a, b, c, \alpha, \beta > 0$. The producer's maximization problem is thus given by:

$$\begin{cases} \max\left[PY - \left(a + bY + cY^2 \right) \right] \\ \text{s.t. } Y = \alpha - \beta P + u \end{cases} \tag{1}$$

Setting $MR = MC$, and solving for P and Y, we obtain

$$P^* = \left[\frac{\alpha + \beta\left(2c\alpha + b\right)}{2\beta\left(1 + c\beta\right)} \right] + \left[\frac{1 + 2c\beta}{2\beta\left(1 + c\beta\right)} \right] u \tag{2}$$

and

$$Y^* = \left[\frac{\alpha - \beta b}{2\left(1 + c\beta\right)} \right] + \left[\frac{1}{2\left(1 + c\beta\right)} \right] u \tag{3}$$

The second-order condition for a maximum is given by $1 + c\beta > 0$.

In the absence of a disturbance, i.e. if $u = 0$, the profit-maximizing output is given by

$$Y^*\big|_{u=0} = \frac{\alpha - \beta b}{2\left(1 + c\beta\right)} \tag{4}$$

where $\alpha - \beta b > 0$, which is required for the output to be positive in the disturbance-free equilibrium. We can think of $Y^*\big|_{u=0}$ as the expected output.

Following Barro (1972, p. 19), suppose that the value of the disturbance changes from 0 to u. Assuming that the firm continuously adjusts its price and output to the change in u, the resulting change in the firm's profit, as Barro shows, is given by

$$\begin{aligned}\Delta\pi_{(0,u)} &= \int_0^u \left(\frac{d\pi}{du}\right)du \\ &= \int_0^u \left[P - C'(Y)\right]du \\ &= \left[\frac{\alpha-\beta b}{2\beta\left(1+c\beta\right)}\right]u + \left[\frac{1}{4\beta\left(1+c\beta\right)}\right]u^2\end{aligned} \tag{5}$$

Next, assume that the firm's price is sticky, stuck at $\hat{P}$, which denotes the optimal price in the disturbance-free equilibrium, such that $d\hat{P}/du = 0$. Then, (2) implies that

$$\hat{P} = \frac{\alpha + \beta\left(2c\alpha + b\right)}{2\beta\left(1+c\beta\right)} \tag{6}$$

We follow Barro (1972, p. 20) to assume that the disturbance is not "too small" or "too large", i.e., $u_{\min} \le u \le u_{\max}$. This is necessary to avoid the situations of no production, which will be the case if $u < u_{\min}$, or a shortage, which will be the case if $u > u_{\max}$. Then,

$$\begin{aligned}\Delta\hat{\pi}_{(0,u)} &= \int_0^u \left(\frac{d\hat{\pi}}{du}\right)du \\ &= \int_0^u \left[\hat{P} - C'(\hat{Y})\right]du \\ &= \left[\frac{\alpha-\beta b}{2\beta\left(1+c\beta\right)}\right]u - cu^2\end{aligned} \tag{7}$$

The expression in (7) is the change in the profit when the disturbance value changes from 0 to *u*, but the firm does not adjust its price, i.e. when the price is stuck at $\hat{P}$.

The firm's profit gain, if it adjusts its price to the demand shock, is therefore given by

$$\Delta\pi_{(0,u)} - \Delta\hat{\pi}_{(0,u)} = \theta u^2 \tag{8}$$

where

$$\theta = \frac{\left(1+2c\beta\right)^2}{4\beta\left(1+c\beta\right)} > 0 \tag{9}$$

The expression in (8) can be interpreted as the loss the firm incurs for not adjusting its price in response to the demand shock. As Barro (1972, p. 20) notes, the symmetry of this loss means that what matters is the size of the demand shock, not its sign. It follows that the optimal price adjustment rule (*S*, *s*), is symmetric. Also, for a given disturbance *u*, the loss from not adjusting the price decreases with the price sensitivity of demand β, and

increases with the slope of the marginal cost curve $C''(Y) = 2c$.

Barro's (1972) main conclusion is that if *u* follows a symmetric random walk, then the optimal (*S*, *s*) band is symmetric, given by $\left(\hat{h}, -\hat{h}\right)$, where

$$\hat{h} = \sqrt{\sigma}\left(\frac{6\gamma}{\theta}\right)^{0.25} \tag{10}$$

where γ is a fixed, lump-sum menu cost, σ^2 is the variance of the Bernoulli process driving the symmetric random walk, and θ is given by (9).[2]

According to (10), the higher the menu cost, the wider the band of inaction. On the other hand, a high θ implies a narrow band of inaction. That is because according to (8)–(9), a high θ means a greater profit loss from not adjusting the price.

In models with CES demand, the optimal value of the barrier $\hat{h}$ is independent of the output produced, because of the constant price elasticity assumption. Here, however, the demand is assumed linear and thus its price elasticity is not constant. We can therefore take advantage of this property by extending the model to derive the relationship between the optimal barrier, i.e., the optimal (*S*, *s*) band, and the output. Rewrite (9) as

$$\begin{aligned}\theta &= \frac{\left(1+2c\beta\right)^2}{4\beta\left(1+c\beta\right)} \\ &= \left[\frac{\alpha-\beta b}{2\left(1+c\beta\right)}\right]\left[\frac{\left(1+2c\beta\right)^2}{2\beta\left(\alpha-\beta b\right)}\right]\end{aligned} \tag{11}$$

By (4), the term in the first brackets is the optimal level of output in the disturbance-free equilibrium $Y^*|_{u=0}$. Therefore, (11) can be written as a function of $Y^*|_{u=0}$,

$$\theta\left(Y^*|_{u=0}\right) = \left(Y^*|_{u=0}\right)\left[\frac{\left(1+2c\beta\right)^2}{2\beta\left(\alpha-\beta b\right)}\right] \tag{12}$$

which shows that $\theta = \theta\left(Y^*|_{u=0}\right)$, i.e., θ is a function of $Y^*|_{u=0}$.

To show the effect of changes in output $Y^*|_{u=0}$ on the frequency of small price changes, consider a change in β which by (4) affects the output $Y^*|_{u=0}$ because of its effect on the demand, while in parallel it also affects θ by (11). Note that from the first

[2] The expression for the barrier $\hat{h}$ as given above, is identical to the expression for the barrier that Dixit (1991, p. 144) derives and reports in his equation (11).

part of (11), it follows that

$$\begin{aligned}\frac{\partial\theta}{\partial\beta} &= \frac{\partial}{\partial\beta}\left[\frac{(1+2c\beta)^2}{4\beta(1+c\beta)}\right] \\ &= -\frac{1+2c\beta}{4\beta^2(1+c\beta)^2} \\ &< 0\end{aligned} \tag{13}$$

while from (10) it follows that

$$\begin{aligned}\frac{\partial\hat{h}}{\partial\theta} &= \frac{\partial}{\partial\theta}\left[\sqrt{\sigma}\left(\frac{6\gamma}{\theta}\right)^{\frac{1}{4}}\right] \\ &= -\frac{\sqrt{\sigma}(6\gamma)^{\frac{1}{4}}}{4\theta^{\frac{5}{4}}} \\ &< 0\end{aligned} \tag{14}$$

Now consider a situation where there is an increase in demand because of a decrease in β, which leads to higher $Y^*|_{u=0}$ because, using (4), we have

$$\begin{aligned}\frac{\partial\left(Y^*|_{u=0}\right)}{\partial\beta} &= \frac{\partial}{\partial\beta}\left[\frac{\alpha-\beta b}{2(1+c\beta)}\right] \\ &= -\frac{(\alpha c+b)}{2(c\beta+1)^2} \\ &< 0\end{aligned} \tag{15}$$

Then, the decrease in β which by (15) increases $Y^*|_{u=0}$, increases θ by (13), which by (14) decreases $\hat{h}$, making the (s, S) band narrower.

Another way to see this, is to find directly the sign of the partial derivative of $\hat{h}$ with respect to β, by first substituting (9) in (10). Then we obtain the partial derivative

$$\frac{\partial\hat{h}}{\partial\beta} = \frac{\partial}{\partial\beta}\left[\sqrt{\sigma}\left(\frac{6\gamma}{\theta}\right)^{\frac{1}{4}}\right]$$

$$= \frac{\partial}{\partial \beta}\left[\sqrt{\sigma}\left\{\frac{6\gamma}{\left[\frac{\left(1+2c\beta\right)^2}{4\beta\left(1+c\beta\right)}\right]}\right\}^{\frac{1}{4}}\right]$$

$$= \frac{\sqrt[4]{\frac{3}{2}}\left(\frac{c\gamma\beta}{\left(1+2c\beta\right)^2} - \frac{4c\gamma\beta\left(1+c\beta\right)}{\left(1+2c\beta\right)^3} + \frac{\gamma\left(1+c\beta\right)}{\left(1+2c\beta\right)^2}\right)\sqrt{\sigma}}{2\left[\frac{\gamma\beta\left(1+c\beta\right)}{\left(1+2c\beta\right)^2}\right]^{\frac{3}{4}}} \tag{16}$$

$$= \frac{\sqrt[4]{\frac{3}{2}}\,\gamma\sqrt{\sigma}}{2\left(1+2c\beta\right)^3\left[\frac{\gamma\beta\left(1+c\beta\right)}{\left(1+2c\beta\right)^2}\right]^{\frac{3}{4}}}$$

$$> 0$$

The expressions in (13)–(15), or alternatively (15)–(16), constitute our main analytical result. Consider, for example, a situation where there is an increase in demand because of a decrease in β. Then, according to (15), output will increase. But according to (16), the decrease in β will reduce $\hat{h}$, leading to a narrower optimal (*S*, *s*) band. In other words, there is an inverse relationship between the level of output (as determined by the demand) and the width of the (*S*, *s*) band. If the output of the monopolist is high (low), then the (*S*, *s*) band will be narrower (wider), which means that we will see more (less) frequent smaller price changes. Trivially, this will be true for small menu costs. However, our result is independent of the size of the menu cost. That is, the model predicts that we will likely see small price changes even if the menu cost is large.

Another implication of the reduction in the width of the (*S*, *s*) band is that as the sales volume increases, the frequency of price changes, irrespective of their size, should also increase.

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