If You Think 9-Ending Prices Are Low, Think Again

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ABSTRACT 9-ending prices, which comprise between 40%–95% of retail prices, are popular because shoppers perceive them as being low. We study whether this belief is justified using scanner price-data with over 98-million observations from a large US grocery-chain. We find that 9-ending prices are higher than non 9-ending prices, by as much as 18%. Two factors explain why shoppers believe, mistakenly, that 9-ending prices are low. First, we find that *among sale-prices*, 9-ending prices are indeed lower than non 9-ending prices, giving 9-ending prices an aura of being low. Second, at first, 9-ending prices were indeed lower than other prices. Shoppers, therefore, learned to associate 9-endings with low prices. Over time, however, 9-ending prices rose substantially, which shoppers failed to notice, because the continuous use of 9-ending prices for promoting deep price cuts draws shoppers' attention to them, and helps to maintain-and-preserve the image of 9-ending prices as bargain prices.

JEL Codes: M30, M31, L11, L16, L81, D12, D22, D40, D90, D91, E31

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9-ending prices comprise as much as 30%–95% of retail prices, far higher than 10% predicted by the uniform distribution. The effect of 9-ending prices on consumer demand and on sales volume is also well-documented and widely recognized. Studies conclude that shoppers perceive 9-ending prices as lower than comparable non 9-ending prices.

Are 9-ending prices really lower than non 9-ending prices? This is a fundamental question in behavioral pricing, in light of the overwhelming popularity of 9-ending prices in many retail— both traditional and internet—settings, and the widespread belief that they are lower than comparable non 9-ending prices (Schindler, Parsa, and Naipaul 2011).

Surprisingly, empirical studies that directly address this question are rare. Schindler (2001) is a rare exception. In a dataset that he collected over a two-month period in 1997 at a US metropolitan area on 10 retail prices for 120 different goods, he finds, counter to the common belief, that the average 99-ending price of an item is 24.1% higher than the lowest price of the item in the comparison set which the 10 price observations comprise.

We revisit the question, but unlike Schindler (2001), who focuses on 99-ending prices, we study 9-ending prices, noting that 99-ending prices are a subset of 9-ending prices. We use a large retail scanner price data from a major Midwestern US supermarket chain.

The data have several advantages. First, its size, over 98-million weekly price observations over eight years. Second, it includes the prices of 18,036 products. Third, the prices are actual transaction prices, as recorded by scanners at the cash registers. Fourth, the dataset is weekly, which corresponds to the retail practice of weekly pricing cycle.

There are important differences between the dataset Schindler uses and the dataset we employ. His data are *cross-section*, and include the prices of 120 goods from 65 different retailers at a point in time, in one geographical location. We use a *panel data* that span an eight-year period, which contain the prices of thousands of goods in 29 product categories, from a major US retailer. The size of the datasets also differs dramatically: Schindler's

data contain 1,200 observations, while our data contain over 98-million observations.

Still, some tests we run are similar to his, allowing us to compare our findings to his, and confirm them. Given our data size, however, we go beyond Schindler's tests as follows. First, we conduct category-level analysis, for each of the 29 product categories. Second, the panel structure enables us to compare prices across stores, within stores, and over time. To exploit these possibilities, we estimate regression equations with fixed effects that control for stores, product sub-categories, products, and weeks. This allows us to measure the gap between 9-ending and non 9-ending prices, while controlling for the variability across stores, for sub-category level inflation, and for products within stores. The differences we report, are thus the residual price differences that remain within stores between similar goods on the same week, and for each product in each store *over time*. In contrast, Schindler (2001), compares 99-ending and non 99-ending prices *across stores*.

OVERVIEW

We report the following findings. First, at the category level, 9-ending prices are on average higher than non 9-ending prices. Second, at the product level, in most cases, 9-ending prices are on average higher than prices with other endings. Third, we find that sale prices are more likely to be non-9 ending than the corresponding regular prices. Fourth, *among sale prices*, 9-ending prices are on average lower than comparable non 9-ending prices. Fifth, over time, the overall frequency of 9-ending prices increased, as did the share of 9-ending prices among regular prices, but the share of 9-ending prices among sale prices decreased. We find that in parallel, over time, 9-ending *regular* prices became higher than non 9-ending *regular* prices, while 9-ending *sale* prices became lower than non 9-ending *sale* prices. These findings are robust to nine different tests of robustness.

The first three findings suggest that although consumers may think 9-ending prices are

low, the data indicate otherwise. The fourth finding offers a possible explanation for why 9-ending prices are perceived as low: retailer's practice of using 9-ending prices to emphasize large price cuts during sales, may be guiding the shoppers towards associating 9-ending prices with low prices. The fifth finding points towards a possible mechanism that may have led the consumers to learn to associate 9-endings with low prices.

We proceed as follows. We start with a brief review of the relevant literature on 9-ending prices. Next, we describe the retail scanner price data that we use, discuss corresponding descriptive statistics, and present the frequency distribution of the last digit in the prices. Next, we present and discuss the main econometric tests and report empirical findings, and briefly summarize the results of nine robustness tests that we run. We conclude the article by offering some caveats in light of the limitations of the data, and by discussing some possible avenues for future research in the context of behavioral pricing.

LITERATURE REVIEW

The overrepresentation of 9-ending prices is well-documented using many types of data, for various goods, across different types of retailers, and across many countries. For example, Twedt (1965) finds that 64% of meat product prices in 70 cities are 9-ending. For advertised products, the average share of 9-ending prices is 57%. Friedman (1967) finds that 33.8% of the food prices are 9-ending. Kreul (1982) finds that the prices of 58% of the menu items at restaurants priced below $7, are 9-ending. Huston and Kamdar (1996) find that 45.6% of prices of clothing are 9-ending. Schindler and Kirby (1997) report that 30.7% of consumer goods prices are 9-ending. Stiving and Winer (1997) find that 50.5% and 36.1% of tuna and yogurt prices in their data, respectively, are 9-ending. Lee, Kauffman, and Bergen (2009) find that 38.7% of the prices in their internet data are 9-ending. Shlain (2018) studies data with 375 million observations and finds that 61% of

the prices end with 9. In the data of DellaVigna and Gentzkow's (2019), 78% of the prices are 9-ending. Anderson, Jaimovich, and Simester (2015) report an even larger figure: 95% of their prices are 9-ending. Freling et al. (2010) offers a meta-study.

Recent findings that 9-ending prices are significantly more rigid than other prices, got the attention of macroeconomists, as well as of monetary economists, because of the importance of the price rigidity for monetary non-neutrality. Examples include, Blinder (1991), Kashyap (1995), Blinder et al. (1998), Eichenbaum, Jaimovich, and Rebelo (2011), Guimaraes and Sheedy (2011), Klenow and Malin (2011), Midrigan (2011), Levy et al. (2011, 2019), Snir, Levy, and Chen (2017), and Knotek (2008, 2011, 2016).

Empirical evidence suggests that shoppers perceive 9-ending price as low. Two leading explanations for these perceptions are level-effect and image-effect. According to the level-effect, shoppers round-down prices, or process price information left-to-right, ignoring the right-most digits (Basu 1997; Schindler and Kirby 1997; Stiving and Winer 1997; Thomas and Morwitz 2005; Ruffle and Shtudiner 2006). According to the image-effect, 9-endings are a signal for low prices (Anderson and Simester 2003a; Stiving 2000).

For example, Schindler (1984) suggests 9-endings indicate that the price has not been raised. Quigley and Notarantonio (2015) and Schindler and Kibarian (1996) find that 99-endings indicate sale prices, and that in shoppers' mind, 99-ending prices are the lowest prices found. Bizer and Schindler (2005) find that shoppers are less attentive to the two rightmost digits. Shlain (2018) documents about 25% left-digit bias among shoppers.

Consistent with these findings, studies show 9-ending prices lead to higher demand and consequently to higher sales volume. For example, Blattberg and Wisniewski (1987) find that 9-ending pricing increases sales by 10%. Schindler and Warren (1988) find consumers prefer 9-ending prices to 0-ending prices. Schindler and Kibarian (1996), Holdershaw, Gendall, and Garland (1997), Anderson and Simester (2003a), and Gendall,

Holdershaw, and Garland (1997), also find that the use of 9-endings increases demand.

SCANNER PRICE DATA

Our retail scanner price data come from a large Midwestern retail supermarket chain Dominick's Finer Food. During the period sampled that the data cover, 1989–1997, Dominick's was the second largest retailer in the Chicago metropolitan area, with 20%–25% of the market share (Srinivasan et al. 2004; Pofahl, Capps, and Love 2006).

The price data, from the chain's 93 stores, contain 98,914,300 weekly price observations for 18,036 products in 29 categories, from September 14, 1989 to May 14, 1997. These are the actual transaction prices that consumers paid each week, as recorded by the scanners at the checkout cash-register, and reflect retailer discounts. The price data comprise about 30% of the chain's revenue (Chevalier, Kashyap, and Rossi 2003).

The database is broad, covering food (perishables and non-perishables) and non-food products. The sample period covers 400 weeks, but the length of individual time series varies depending on when the data collection for the specific category began and ended.

Although the prices are set on a chain-wide basis, there is price variation across the stores depending on the local competitive environment (Barsky et al. 2003). 95 percent of Dominick's stores follow a Hi-Lo ("Promo") format (Hoch et al. 1995; Ellickson and Misra 2008). Dominick's groups its stores into 16 zones, maintaining uniform regular prices within each zone, but the same promoted prices chain-wide (Dominick's Data Manual 2018, p. 19). See the Web Appendix A1 for store locations and pricing zones.

The number of Dominick's pricing zones increased over time, starting with 3–4 zones in 1989–1990, and reaching 16 price zones in 1992 and beyond (Besanko, Dubé, and Gupta 2005). It appears, however, that the chain does not always respect the price zone boundaries in its pricing decisions (Chintagunta, Dubé, and Singh 2003). Its main pricing

zones are *Cub-Fighter*, *Low*, *Medium*, and *High* (Dominick's Data Manual 2018, 19). Thus, for example, if a particular store is located near a Cub Food store, then the store may be designated a "Cub-fighter" and consequently it might pursue a more aggressive pricing policy in comparison to other stores that the chain operates (Barsky et al. 2003).[1]

DESCRIPTIVE STATISTICS AND THE DISTRIBUTION OF THE LAST DIGIT

Of the 29 product categories, the smallest category, Bath Soaps, has 418,097 weekly price observations, and the largest, Soft Drinks, 10,741,742 observations. In terms of the number of products, the Oatmeal category is the smallest, with only 96 products, while the Shampoos category is the largest, with 2,930 products. The average price in the data is $2.59. See Web Appendix A2 for more detailed descriptive statistics by product category.

Figure 1, shows the frequency distribution of the last digit in the price data. The figure indicates that 9-ending prices are the most common with 63.9%, followed by 5-ending and 0-ending prices, with 11.4% and 4.7% respectively. Prices that end with other digits are scarcer, and comprise only between 1.9% and 4.1% of the total number of observations in the data. Further, as demonstrated by the frequency distributions included in Web Appendix E, 9-ending prices are the most frequent also in 28 of the 29 product categories in the data.

RESULTS OF THE ECONOMETRIC ANALYSES

Before presenting the findings, consider a sample price series' plot. Figure 2 depicts 379 weekly price observations of Nabisco Wheat Thins Low Salt, 10oz. The volatility that the series exhibit, is consistent with Dominick's Hi-Lo pricing format. Focusing on the

[1] For more details about Dominick's data, see Barsky et al. (2003), Chen et al. (2008), Chevalier et al. (2003), Mehrhoff (2018), and Levy et al. (2010). The entire dataset (which includes additional variables in addition to the retail price) and the Dominick's Data User Manual which accompanies it, can be downloaded from the web site of the Booth School of Business at the University of Chicago: https://www.chicagobooth.edu/research/kilts/datasets/dominicks.

behavior of the price endings, we find that the price is 9-ending for 219 weeks (57.78%), and non 9-ending for 160 weeks (42.22%). The average 9-ending price, $2.26, exceeds the average non 9-ending price, $1.98. The difference is statistically significant at the 1% level ($p < .01$) using Wilcoxon rank-sum test, with the statistic value of $z = 11.18$.

The price series plot emphasizes four attributes that we find in our data. First, 9-ending prices are more common than non 9-ending prices. Second, 9-ending prices are more common among regular prices than among sale prices. Third, non 9-ending prices are more common among sale prices than among regular prices. Fourth, on average, 9-ending prices are higher than non 9-ending prices. These observations are typical for a large proportion of the products that are included in our dataset. See Web Appendix F for the plots of the time series of the retail prices of all the products in the Snack Crackers' category that have at least 208 weeks (the equivalent of four years) of data.

Average 9-Ending and Non 9-Ending Prices

We start with Table 1, by comparing the average 9-ending and non-9 ending prices by product categories. In 22 of the 29 categories, the 9-ending prices exceed the non 9-ending prices by 18%, on average. In what follows, we try to assess the robustness of this fact.

9-Ending versus Non 9-Ending Prices for Individual Products at the Store-Level

The stores with higher than average prices could also have higher than average shares of 9-ending prices. In that case, even if 9-ending prices are the lowest in each store, across all stores they might still be higher than non-9 ending prices. Also, if 9-ending prices are more prevalent in sub-categories with relatively high prices, then even if 9-ending prices are the lowest in each sub-category, we might still find the opposite at the category level. To test this, we calculate for each product at each store, the percentage difference between the average 9-ending and non 9-ending price. Figure 3 shows their frequency distribution

for the entire dataset, excluding the outliers (defined as differences in excess of 100% in absolute value). In Web Appendix H, we show the distribution with all the observations.

The average of the distribution is $M = 5.97$ ($SD = 18.68$), confirming that 9-ending prices exceed non 9-ending prices on average. The median is 4.74 suggesting that the higher average 9-ending prices are not caused by outliers. The skewness is 0.43, meaning the distribution is skewed to the right. Kurtosis 23.7 exceeds 3, implying that the tail of the distribution is thicker than the Normal Distribution. Skewness and kurtosis tests reject the null of normality at the 1% level ($p < .01$). This confirms that 9-ending prices exceed non 9-ending prices at the level of individual products across the stores of the chain. In Web Appendix G, we report 29 category-level frequency distributions, with similar findings.

The Role of Upward Trend in the Prevalence of 9-Ending Prices

If 9-ending prices became more prevalent over time, then they might on average be high overall, even if they are lower than non 9-ending prices in any given year. The share of 9-ending prices (see Table 2, Panel A) increased from 51.9% in 1989 to 73.0% in 1997. Since inflation in this period was positive, this increase can explain why 9-ending prices are higher than non 9-ending prices. We test this by estimating log-linear OLS regressions with fixed effects, with $ln(price)$ as the dependent variable, and 9-ending price dummy, which equals 1 if the price is 9-ending and 0 otherwise, as the key independent variable. The dummy's coefficient, therefore, gives the expected percentage difference between 9-ending and non 9-ending prices. We report the estimation results in Table 3.

When we control for subcategories at the store level and for the overall price trend (column 1), 9-ending prices exceed non 9-ending prices in 22 categories. In column (2), the 9-ending price dummy captures the gap within a store, on a given week, between prices of goods in the same subcategory. Here we find that 9-ending prices are higher than

non 9-ending prices in 23 categories. Considering individual goods' prices, at individual stores over time, and comparing them when they are 9-ending and when they are non 9-ending (column 3), we find that in 25 categories, 9-ending prices are higher than non 9-ending prices. Thus, 9-ending prices are higher than non 9-ending prices in a large majority of categories. This is true whether we compare the prices of products within the same sub-categories controlling for stores, across products in the same week at the store, and at the level of individual products in individual stores over time.

Regular Prices versus Sale Prices

Since consumers might be perceiving 9-ending prices as low because they associate 9-endings with sale prices (Schindler and Kibarian 2001), we compare the share of 9-ending prices among regular and sale prices. To identify sale-prices, we use a sales filter, which classifies a price as a sale price if it decreased, stayed low for 4-weeks or less, and then increased to the pre-sale level or above it (Dutta, Bergen, and Levy 2002; Levy, Dutta, and Bergen 2002; Nakamura and Steinsson 2008 and 2011; Tsiros and Hardesty 2010; Chahrour 2011; Knotek 2016). We report the results in Table 4. We find that in 28 categories, 9-ending prices are more common among regular-prices than sale-prices. Thus, consumers' tendency to associate 9-endings with low prices can't be explained by 9-ending prices being sale prices, as the shoppers are more likely to encounter 9-ending prices when they buy the goods at a regular price than at a sale price.

Another possibility is that if 9-ending prices are lower on average than non-9 ending prices *among sale prices*, consumers could associate 9-endings with price cuts (Schindler 2001, 2003, 2006). To test this, we run the above regressions separately for regular and sale prices. See Table 5. Among regular prices, which in our data comprise 88.68% of all prices, 9-ending prices exceed non 9-ending prices in most categories, regardless of the

specification we use. Among sale prices, when we compare the prices of individual goods when they are 9-ending and when they are non 9-ending (column 6) that is true for only 12 categories. This suggests that Dominick's may be reinforcing the low price image of 9-ending prices by setting prices at 9-endings in case of particularly deep price cuts.

Dynamics of 9-Ending and Non 9-Ending Prices: Regular Prices versus Sale Prices

According to Table 2, panel A, during 1989–1997, the share of 9-ending prices among regular prices *increased* from 51.06% to 75.14%, while among sale prices it *decreased* from 61.49% to 47.58%. Thus, in the earlier period of the sample, 9-ending prices had stronger association with sales. During that period, the percentage difference between 9-ending and non 9-ending prices increased from 3.02% to 24.95% among regular prices, and from −1.55% to 31.40% among sale prices (panel B).

Next, we estimate a set of log-linear OLS regressions with fixed effects, one regression for each year, with the logarithm of prices as the dependent variable. A positive (negative) coefficient of the 9-ending dummy indicates that 9-ending prices are expected to be higher (lower) than non 9-ending prices. See Table 6 for the estimation results.

In the regressions, we control for products in stores and for weeks. The coefficient estimates of the 9-ending dummy thus captures the average difference between 9-ending and non 9-ending prices, at the level of an individual product, offered at a specific store. We find that at the product-store level during 1989–1992, 9-ending regular prices were lower than non 9-ending regular prices. Thus, in that period, 9-ending prices were indeed associated with lower regular and overall prices. During that period, however, 9-ending sale prices were sometimes higher and sometimes lower than non 9-ending sale prices.

Following 1993, we see a reversal: 9-ending regular prices become higher than non 9-ending regular prices, making 9-ending prices higher overall than non 9-ending prices. 9-

ending sale prices, however, become lower (and in 1997, not higher) than non 9-ending sale prices. Thus, until 1993, a consumer who bought a given product at a given store got a better deal if s/he bought the good at a 9-ending price. After 1993 however, among regular prices, which compose the vast majority of prices, the consumer got a better deal if s/he bought the good when its price was not 9-ending.

Thus, we find that 9-ending prices were lower in the early part of the sample until 1993, but rose significantly since then. The findings point toward a possible mechanism that lead consumers to associate 9-endings with low prices. Dominick's uses 9-ending prices to promote sales and to draw consumers' attention to particularly large price cuts, which seem to condition the shoppers to associate 9-endings with low prices. Therefore, if consumers paid more attention to sale prices, then they would have a reason to believe that 9-ending prices are lower than non 9-ending prices even after 1993.

Robustness Tests

To assess the robustness of our findings, we run nine sensitivity tests, which we discuss in the Web Appendix. Below we briefly summarize the findings of these tests. See the corresponding sections of the Appendix for details of these tests and their results.

Comparison of 9-Ending and 0-Ending Prices. We compare 9- and 0-ending prices because low-price image of 9-ending prices could stem from consumers' tendency to judge 9-ending prices relative to nearby 0-ending prices. We find that 9-ending prices exceed 0-ending prices in 21 of the 29 categories.

The Role of 9-Endings as the Highest Possible Ending. 9-ending prices could be higher than other prices for a technical reason: a 9-ending price exceeds any price with the same left-most-digits but that ends with any digit between 0 and 8. We find that in 21

categories, the average 9-ending prices are still higher than the average non 9-ending princes, even after accounting for the rightmost digit effect.

Regressions of Prices without Log-Transformation. We run the regression analyses presented in Table 3 using the prices without a log-transformation. In great majority of the product categories, the expected 9-ending prices are still higher than the expected non 9-ending prices, regardless of the additional controls we include.

The Role of Outlier Observations. We checked whether outlier values drive our results, by excluding observations that are more than two *SD* away from the category average. We find that the expected 9-ending prices are still higher than non 9-ending prices, in most categories. This finding, therefore, is not driven by the outlier observations.

Using Dominick's Sale Dummy to Identify Sale Prices. We rerun the regular and sale price analyses by identifying the sale prices using Dominick's sale dummy (Peltzman 2000; Ray et al. 2019), instead of using a sale filter. The results we obtain are qualitatively unchanged. For regular prices, the expected 9-ending prices are usually higher than non 9-ending prices, while the expected 9-ending sale prices are lower than the expected non 9-ending sale prices. Thus, it does not matter what method we use to identify the sale prices.

Dynamics of 9-Ending and Non 9-Ending Prices Using Dominick's Sale Dummy. We repeated the analyses of Dominick's price-ending dynamics, but this time using Dominick's sale dummy to identify sale prices. The results of the analysis are qualitatively identical to what we report above, and thus our conclusions remain unchanged.

Dynamics of 9-Ending and Non 9-Ending Prices at a Weekly Frequency. We repeated

the dynamic analyses at a weekly frequency. If Dominick's sets high 9-ending regular prices and low 9-ending sale prices, then we could expect a negative correlation between 9-ending regular and sale prices: when 9-ending regular prices are high relative to non 9-ending regular prices, we would expect 9-ending sale prices to be low relative to non 9-ending sale prices. We estimated cross-correlations between the two series using weekly data, which allow non-contemporaneous correlations as well. We repeated these analyses twice, once using the sale filter and once using Dominick's sale dummy. The results are not in line with the hypothesized pricing patterns, suggesting that these processes are more long term in the sense that they take longer than just few weeks to develop.

Clustering the Regression Standard Errors at the Level of Price Zones. We repeated the analyses by clustering the regression standard errors at the level of price zones rather than at the level of stores. The findings are similar to what we report in the article.

Regressions of the Percentage Difference Between 9-Ending and Non 9-Ending Prices. We repeated the analyses reported in Table 6, using controls for stores, for categories, and for subcategories, rather than for individual products at individual stores. The estimation results we obtain are consistent with the findings we have reported above.

CONCLUSION, CAVEATS, AND FUTURE EXTENSIONS

Counter to common beliefs, we find that 9-ending prices tend to be higher than non 9-ending prices by as much as 18% on average. It appears that Dominick's maintained the belief that 9-ending prices are lower by using 9-endings for particularly low prices.

Data Limitations and Caveats

Dominick's dataset is large, with 98+ million observations for thousands of goods, and it

has been used widely. Nevertheless, it has limitations. First, it comes from a single retailer, based in the Chicago metro area, making this a case study and raising questions about generalizability of our findings to other retailers, markets, and geographical areas. Second, Dominick's, as a mid-size Hi-Lo retailer, may not be a good representative of the current retail landscape, which has a continuum of pricing formats (Bolton and Shankar 2003). Third, Dominick's dataset is dated, raising questions about generalizability of our findings to recent periods. Fourth, the explanation we are offering for the consumers' mistaken beliefs is based on "circumstantial evidence." The pricing pattern we find in the data, can indeed produce in shoppers' minds an association between 9-endings and low prices. This explanation, however, requires more direct evidence and a stronger support.

Technological Innovations

Current technological innovations in retail pricing technologies, including digital signage, smart carts, price comparison apps, etc., offer consumers extraordinary amount of information with a click of a button, which can alter the way retailers price. For example, with these technologies, shoppers might discover that 9-ending prices are not lower than prices that end with other digits. This can have important implications for retail pricing, promotional practices, etc. This is relevant, for example, in personalized pricing where sellers' access to big data can alter the way price endings are used to target individual shoppers (Dubé and Misra 2017; Bruno, Cebollada, and Chintagunta 2018).

Other Price Endings

The popularity of 9-ending prices is not universal. For example, they are rare in Poland, and Hungary (Konieczny and Rumler 2007; Konieczny and Skrzypacz 2017). Moreover, there are other common endings. For example, 0-ending prices are common because they may signal quality (Stiving and Winer 1997; Stiving 2000; Schindler et al. 2011), because

of their cognitive convenience (Wadhwa and Zhang 2015; Snir, Chen, and Levy 2018), and because they reduce the amount of the change used in transactions (Knotek 2008, 2011).

For example, Coca-Cola price was fixed for 70+ years at 5¢, because raising it by less than 100% would require the use of multiple coins, making it less convenient for shoppers (Levy and Young 2004, 2019; Young and Levy 2014). Doubling it to 10¢ would preserve the single-coin price, but it was viewed too risky. Moreover, some numbers' symbolic significance leads to their overuse (Schindler 1991). For example, prices that end with 8 are common in Hong Kong, Japan and China because 8 is considered a lucky number, and because its resemblance to a mountain, 八, signifies prosperity. More work is needed to better understand the cognitive and cultural determinants of such pricing practices.

Public Policy Aspects

9-ending prices are debated in countries where low denomination coins are not used because transactions with small changes require rounding, if 9-ending prices are used. For example, In Israel, after 1-agora and 5-agora coins were abolished, the law required the final bills be rounded to the nearest 10-agora. However, Israeli retailers kept using 9-ending prices extensively, irritating consumers who claimed that the practice is unethical given the absence of the 1-agora coin. In response, in January 2014, the Ministry of the Economy banned the use of 9-ending prices (Ater and Gerlitz 2017; Snir et al. 2017).

A related question concerns the use of 9-endings for sale prices, to draw the shoppers' attention to price cuts, while simultaneously setting most 9-ending prices higher than non 9-ending prices. Recent studies document similar behavior. For example, Levy et al. (2019) find that in the same Dominick's dataset, new prices are 9-ending more often after price increases than after price decreases. Chakraborty et al. (2015) find that at UK supermarkets many individual prices fell but the overall basket prices rose, concluding that small price

cuts were used to disguise increases in the basket price. Anderson et al. (2017) report that in their data temporary price cuts were offered along with regular price increases simultaneously, concluding that the retailer was trying to mask the regular price increases.

These findings are in line with what Akerlof and Shiller's (2015, pp. vii, 1) call a *phishing equilibrium*, stating "…if we have some weakness…in the phishing equilibrium someone will take advantage of it." 9-ending prices might be a phishing-equilibrium where consumers use 9-endings as signal for low prices, and retailers respond by setting 9-ending prices higher than non 9-ending prices. Retailers gain because this enables them to conceal price increases while buyers gain by saving the costs of the time as well as the costs of the cognitive efforts that are needed—what Shugan (1980) and Kashyap (1995) call "thinking costs"— for noticing, processing, and assessing these price changes.

Future Research

Future research, should explore further the issues raised here. In particular, given the importance of 9-ending prices, it is essential to study them using variety of datasets, across different markets and geographical areas, and in more recent time periods. In particular, there is a need for more studies that compare 9-ending and non 9-ending prices. Besides the work of Schindler (2001) and this article, no study assesses directly the validity of the widespread belief that 9-ending prices are lower than comparable non 9-ending prices.

More studies are needed also to assess the effect of 9-ending prices on consumer demand and on the sales volume, a question we did not address in this article. For example, how much of the effects of 9-ending prices on consumer demand are context-dependent, as reported by Macé (2012)? How much these effects vary across markets? While several studies confirm the positive effect of 9-ending prices have on consumer demand and on sales, there are exceptions. For example, in field experiments, rounding up 9-ending prices

to 0-endings, led to greater profits (Diller and Brielmaier 1995; Bray and Harris 2006).

Our attempt to shed light on the process that leads the shoppers to associate 9-endings with low prices, is suggestive. It is likely that such processes develop slowly over long periods of time, and thus 8-years of data cannot be too informative on the mechanisms that govern them. Future research should therefore explore processes through which shoppers learn from salient cues which shape their long-term beliefs, to better understand the mechanisms that govern such learning processes (Anderson and Simester 2003b, 2009).

REFERENCES

Akerlof, George, and Robert Shiller (2015), *Phishing for Phools* (Princeton University Press, Princeton, NJ).

Anderson, Eric, Nir Jaimovich, and Duncan Simester (2015), "Price Stickiness: Empirical Evidence of the Menu Cost Channel," ***Review of Economics and Statistics***, 97 (4), 813–826.

Anderson, Eric, Benjamin Malin, Emi Nakamura, Duncan Simester, and Jón Steinsson (2017), "Informational Rigidities and the Stickiness of Temporary Sales," ***Journal of Monetary Economics***, 90 (October), 64–83.

Anderson, Eric, and Duncan Simester (2003a), "Effects of $9 Price-Endings on Sales: Evidence from Field Experiments," ***Quantitative Marketing and Economics***, 1 (1), 93–110.

Anderson, Eric, and Duncan Simester (2003b), "Mind Your Pricing Cues," ***Harvard Business Review***, 81 (9), 97–103.

Anderson, Eric and Duncan Simester (2009), "Price Cues and Customer Price Knowledge," in *Handbook of Pricing Research in Marketing*, ed. Vithala R. Rao, Northampton, MA: Edward Elgar Publishing, 150–166.

Ater, Itai, and Omri Gerlitz (2017), "Round Prices and Price Rigidity: Evidence from Outlawing Odd Prices" ***Journal of Economic Behavior & Organization***, 144 (December), 188–203.

Barsky, Robert, Mark Bergen, Shantanu Dutta, and Daniel Levy (2003), "What Can the Price Gap between Branded and Private Label Products Tell Us about Markups? in *Scanner Data and Price Indexes*, ed. Robert Feenstra and Matthew Shapiro, Chicago, IL: NBER and the University of Chicago Press, 165–225.

Basu, Kaushik (1997), "Why Are So Many Goods Priced to End in Nine? And Why this Practice Hurts the Producers?" ***Economics Letters***, 54 (1), 41–44.

Besanko, David, Jean-Pierre Dubé, and Sachin Gupta (2005), "Own-Brand and Cross-Brand Retail Pass-Through," ***Marketing Science***, 24 (1), 123–137.

Bizer, George, and Robert Schindler (2005), "Direct Evidence of Ending Digit Drop-Off in Price Information Processing," ***Psychology and Marketing***, 22 (10), 771–783.

Blattberg, Robert, and Kenneth Wisniewski (1987), "How Retail Promotions Work: Empirical Results," Working Paper No. 42, Graduate School of Business, University of Chicago.

Blinder, Alan (1991), "Why Are Prices Sticky? Preliminary Results from an Interview Study," ***American Economic Review***, 81 (2), 89–96.

Blinder, Alan S., Elie R.D. Canetti, David E. Lebow, and Jeremy B. Rudd (1998), *Asking about Prices: A New Approach to Understanding Price Stickiness*, New York, NY: Russell Sage Foundation.

Bolton, Ruth, and Venkatesh Shankar (2003), "An Empirically Derived Taxonomy of Retailer Pricing and Promotion Strategies," ***Journal of Retailing***, 79 (4), 213–224.

Bray, Jeffery P., and Christine Harris (2006), "The Effect of 9-Ending Prices on Retail Sales: A Quantitative UK Based field Study," ***Journal of Marketing Management***, 22 (5-6), 601–617.

Bruno, Hernán A., Javier Cebollada, and Pradeep K. Chintagunta (2018), "Targeting Mr. or Mrs. Smith: Modeling and Leveraging Intra-household Heterogeneity in Brand Choice Behavior," ***Marketing Science***, 37 (4), 631–648.

Chahrour, Ryan (2011), "Sales and Price Spikes in Retail Price Data," ***Economics Letters***, 110 (2), 143–146.

Chakraborty, Ratula, Paul Dobson, Jonathan Seaton, and Michael Waterson (2015),

"Pricing in Inflationary Times: the Penny Drops," ***Journal of Monetary Economics***, 76 (November), 71–86.
Chen, Haipeng (Allan), Daniel Levy, Sourav Ray, and Mark Bergen (2008), "Asymmetric Price Adjustment in the Small," ***Journal of Monetary Economics***, 55 (4), 728–737.
Chevalier, Judith, Anil Kashyap, and Peter Rossi (2003), "Why Don't Prices Rise during Periods of Peak Demand? Evidence from Scanner Data," ***American Economic Review***, 93 (1), 15–37.
Chintagunta, Pradeep K., Jean-Pierre Dubé, and Vishal Singh (2003), "Balancing Profitability and Customer Welfare in a Supermarket Chain," ***Quantitative Marketing and Economics***, 1 (1), 111–147.
DellaVigna, Stefano, and Matthew Gentzkow (2019), "Uniform Pricing in US Retail Chains," ***Quarterly Journal of Economics*** (forthcoming).
Diller, Hermann, and Andreas Brielmaier (1995), "The Impact of Rounding-Up Odd Prices: Results of a Field Experiment in German Drugstores," ***Pricing Strategy & Practice***, 3 (4), 4–13.
Dominick's Data Manual (2018), Kilts Center for Marketing, Booth School of Business, University of Chicago, https://www.chicagobooth.edu/-/media/enterprise/centers/kilts/datasets/dominicks-dataset/dominicks-manual-and-codebook_kiltscenter.aspx.
Dubé, Jean-Pierre, and Sanjog Misra (2017), "Scalable Price Targeting," NBER Working Paper No. 23775.
Dutta, Shantanu, Mark Bergen, and Daniel Levy (2002), "Price Flexibility in Channels of Distribution: Evidence from Scanner Data," ***Journal of Economic Dynamics and Control***, 26 (11), 1845–1900.
Eichenbaum, Martin, Nir Jaimovich, and Sergio Rebelo (2011), "Reference Prices, Costs, and Nominal Rigidities," ***American Economic Review***, 101 (1), 234–262.
Ellickson, Paul, and Sanjog Misra (2008), "Supermarket Pricing Strategies," ***Marketing Science***, 27 (5), 811–828.
Freling, Traci, Leslie Vincent, Robert Schindler, David Hardesty, and Jason Rowe (2010), "A Meta-Analytic Review of Just-Below Pricing Effects," in ***Advances in Consumer Research***, Volume 37, ed. Margaret C. Campbell, Jeff Inman, and Rik Pieters, Duluth, MN: Association for Consumer Research, 618–620.
Friedman, Lawrence (1967), **"**Psychological Pricing in the Food Industry," in *Prices: Issues in Theory, Practice, and Public Policy*, ed. Almarin Phillips, and Oliver E. Williamson, Philadelphia, PA: University of Pennsylvania Press, 187–201.
Gendall, Philip, Judith Holdershaw, and Ron Garland (1997), "The Effect of Odd Pricing on Demand," ***European Journal of Marketing***, 31 (11-12), 799–813.
Guimaraes, Bernardo, and Kevin Sheedy (2011), "Sales and Monetary Policy" ***American Economic Review***, 101 (2), 844–876.
Hoch, Stephen J., Byung-Do Kim, Alan L. Montgomery, and Peter E. Rossi (1995), "Determinants of Store-Level Price Elasticity," ***Journal of Marketing Research***, 32 (1), 17–29.
Holdershaw, Judith, Philip Gendall, and Ron Garland (1997), "The Widespread Use of Odd Pricing in the Retail Sector," ***Marketing Bulletin***, 8 (1), 53–58.
Huston, John, and Nipoli Kamdar (1996), "$9.99: Can 'Just-Below' Pricing Be Reconciled with Rationality?" ***Eastern Economic Journal***, 22 (2), 137–145.
Kashyap, Anil (1995), "Sticky Prices: New Evidence from Retail Catalogs," ***Quarterly Journal of Economics***, 110 (1), 245–274.
Klenow, Peter, and Benjamin Malin (2011), "Microeconomic Evidence on Price Setting," in *Handbook of Monetary Economics, Volume 3A*, ed. Benjamin Friedman and Michael

Woodford, New York, NY: North Holland, 231–284.
Knotek, Edward S., II (2008), "Convenient Prices, Currency, and Nominal Rigidity: Theory with Evidence from Newspaper Prices" ***Journal of Monetary Economics***, 55 (7), 1303–1316.
Knotek, Edward S., II (2011), "Convenient Prices and Price Rigidity: Cross–Sectional Evidence," ***Review of Economics and Statistics***, 93 (3), 1076‑1086.
Knotek, Edward S., II (2016), "The Roles of Menu Costs and Nine Endings in Price Rigidity," manuscript, presented at the 2016 Annual Conference of the Society for Economic Dynamics, Paper ID No. 1563.
Konieczny, Jerzy, and Fabio Rumler (2007), "Regular Adjustment: Theory and Evidence," Kiel Working Paper No. 1352, Kiel Institute for the World Economy, Kiel, Germany.
Konieczny, Jerzy, and Andrzej Skrzypacz (2017), "Search, Costly Price Adjustment and the Frequency of Price Changes: Theory and Evidence," mimeo, Department of Economics, Wilfrid Laurier University.
Kreul, Lee (1982), "Magic Numbers: Psychological Aspects of Menu Pricing," ***Cornell Hotel and Restaurant Administration Quarterly***, 22 (August), 70–76.
Lee, Dongwon, Robert J. Kauffman, and Mark E. Bergen (2009), "Image Effects and Rational Inattention in Internet-Based Selling," ***International Journal of Electronic Commerce***, 13 (4), 127–165.
Levy, Daniel, Shantanu Dutta, and Mark Bergen (2002), "Heterogeneity in Price Rigidity: Evidence from Primary Micro-Level Data," ***Journal of Money, Credit and Banking***, 34 (1), 197–220.
Levy, Daniel, Dongwon Lee, Haipeng (Allan) Chen, Robert Kauffman, and Mark Bergen (2011), "Price Points and Price Rigidity," ***Review of Economics and Statistics***, 93 (4), 1417–1431.
Levy, Daniel, Georg Müller, Haipeng (Allan) Chen, Mark Bergen, and Shantanu Dutta (2010), "Holiday Price Rigidity and Cost of Price Adjustment," ***Economica***, 77 (January), 172–198.
Levy, Daniel, Avichai Snir, Alex Gotler, and Haipeng (Allan) Chen (2019), "Not All Price Endings Are Created Equal: Price Points and Asymmetric Price Rigidity," ***Journal of Monetary Economics*** (forthcoming).
Levy, Daniel, and Andrew Young (2004), "The Real Thing: Nominal Price Rigidity of the Nickel Coke, 1886–1959," ***Journal of Money, Credit and Banking***, 36 (4), 765–799.
Levy, Daniel, and Andrew Young (2014), "Explicit Evidence of an Implicit Contract," ***Journal of Law, Economics, & Organization***, 30 (4), 804–832.
Macé, Sandrine (2012), "The Impact and Determinants of Nine-Ending Pricing in Grocery Retailing," ***Journal of Retailing***, 88 (1), 115–130.
Mehrhoff, Jens (2018), "Promoting the Use of a Publically Available Scanner Data set in Price Index Research and for Capacity Building," manuscript, Eurostat, European Commission, Luxembourg.
Midrigan, Virgiliu (2011), "Menu Costs, Multiproduct Firms, and Aggregate Fluctuations," ***Econometrica***, 79 (4), 1139–1180.
Nakamura, Emi, and Jón Steinsson (2008), "Five Facts about Prices: a Reevaluation of Menu Cost Models," ***Quarterly Journal of Economics***, 123 (4), 1415–1464.
Nakamura, Emi, and Jón Steinsson (2011), "Price Setting in Forward-Looking Customer Markets," ***Journal of Monetary Economics***, 58 (3), 220−233.
Peltzman, Sam (2000), "Prices Rise Faster than They Fall," ***Journal of Political Economy***, 108 (3), 466–502.
Pofahl, Geoffrey, Oral Capps Jr., and H. Alan Love (2006), "Retail Zone Pricing and

Simulated Price Effects of Upstream Mergers," ***International Journal of Economics and Business***, 13 (2), 195–215.

Quigley, Charles J., and Elaine M. Notarantonio (2015), "An Exploratory Investigation of Perceptions of Odd and Even Pricing," in *Proceedings of the 1992 Academy of Marketing Science (AMS) Annual Conference*, *Developments in Marketing Science: Proceedings of the Academy of Marketing Science*, ed. Crittenden, Victoria L., Springer, Cham, 306–309.

Ray, Sourav, Avichai Snir, and Daniel Levy (2019), "Retail Pricing Strategy, Sales, and Price Rigidity," manuscript, Department of Economics, Bar-Ilan University.

Ruffle, Bradley, and Ze'ev Shtudiner (2006), "99: Are Retailers Best Responding to Rational Consumers? Experimental Evidence," ***Managerial and Decision Economics***, 27 (6), 459–75.

Schindler, Robert M. (1984), "Consumer Recognition of Increases in Odd and Even Prices," in ***Advances in Consumer Research***, Vol. 11, ed. Thomas Kinnear, Ann Arbor, MI: Association of Consumer Research, 459–462.

Schindler, Robert M. (1991), "Symbolic Meanings of a Price Ending," in ***Advances in Consumer Research***, Vol. 18, ed. Rebecca H. Holman and Michael Solomon, Provo, UT: Association for Consumer Research, 794–801.

Schindler, Robert M. (2001), "Relative Price Level of 99-Ending Prices: Image versus Reality," ***Marketing Letters***, 12 (3), 239–247.

Schindler, Robert M. (2003), "The 99 Price Ending As a Signal of a Low-Price Appeal," in ***Advances in Consumer Research*****,** Volume 30, ed. Punam Anand Keller and Dennis W. Rook, Valdosta, GA: Association for Consumer Research, 270.

Schindler, Robert M. (2006), "The 99 Price-Ending as a Signal of a Low-Price Appeal," ***Journal of Retailing***, 82 (1), 71–77.

Schindler, Robert M., and Thomas Kibarian (1996), "Increased Consumer Sales Response through Use of 99-Ending Prices," ***Journal of Retailing***, 72 (2), 187–199.

Schindler, Robert M., and Thomas Kibarian (2001), "Image Communicated by the Use of 99 Endings in Advertised Prices," ***Journal of Advertising***, 30 (4), 95–99.

Schindler, Robert M. and Patrick N. Kirby (1997), "Patterns of Rightmost Digits Used in Advertised Prices: Implications for Nine-Ending Effects," ***Journal of Consumer Research***, 24 (2), 192–201.

Schindler, Robert M., H.G. Parsa, and Sandra Naipaul (2011), "Hospitality Managers' Price-Ending Beliefs: a Survey and Applications, ***Cornell Hospitality Quarterly***, 52 (4), 421–428.

Schindler, Robert M. and Lori S. Warren (1988), "Effect of Odd Pricing on Choice of Items from a Menu," in ***Advances in Consumer Research***, Vol. 15, ed. Michael Houston, Ann Arbor, MI: Association of Consumer Research, 348–353.

Shlain, Avner S. (2018), "More than a Penny's Worth: Left-Digit Bias and Firm Pricing," manuscript, Department of Economics, University of California, Berkeley.

Shugan, Steven M. (1980), "The Cost of Thinking," ***Journal of Consumer Research***, 7 (2), 99–111.

Snir, Avichai, Haipeng (Allan) Chen, and Daniel Levy (2018), "Zero-Ending Prices, Cognition, and Price Rigidity: Evidence from a Natural Experiment," manuscript, Department of Economics, Bar-Ilan University.

Snir, Avichai, Daniel Levy, and Haipeng (Allan) Chen (2017), "End of 9-Endings, Price Recall, and Price Perceptions," ***Economics Letters***, 155 (June), 157–163.

Srinivasan, Shuba, Koen Pauwels, Dominique Hanssens, and Marnik Dekimpe (2004), "Do Promotions Benefit Manufacturers, Retailers, or Both?" ***Management Science***, 50 (5), 617–629.

Stiving, Mark (2000), "Price-Endings When Prices Signal Quality," ***Management Science***, 46 (12), 1617–1629.
Stiving, Mark, and Russell Winer (1997), "An Empirical Analysis of Price Endings Using Scanner Data," ***Journal of Consumer Research***, 24 (1), 57–67.
Thomas, Manoj, and Vicki Morwitz (2005), "Penny Wise and Pound Foolish: the Left-Digit Effect in Price Cognition," ***Journal of Consumer Research***, 32 (June), 54–64.
Tsiros, Michael, and David Hardesty (2010), "Ending a Price Promotion: Retracting It in One Step or Phasing It Out Gradually," ***Journal of Marketing***, 74 (1), 49–64.
Twedt, Dik Warren (1965), "Does the '9 Fixation' in Retail Pricing Really Promote Sales?" ***Journal of Marketing***, 29 (4), 54–55.
Wadhwa, Monica, and Kuangjie Zhang (2015), "This Number Just Feels Right: The Impact of Roundness of Price Numbers on Product Evaluation," ***Journal of Consumer Research***, 41 (February), 1172–1185.
Young, Andrew, and Daniel Levy (2019), "Promise, Trust, and Betrayal: Costs of Breaching an Implicit Contract," manuscript, Department of Economics, Bar-Ilan University.

Table 1. Average 9-Ending and Non 9-Ending Prices, and the Percentage Difference between Them, Dominick's, September 14, 1989–May 8, 1997

Category	(1) 9-Ending	(2) Non 9-Ending	(3) Percentage Difference
Analgesics	5.33	4.31	21.24
Bath Soaps	3.15	3.24	−2.82
Beer	5.68	5.83	−2.61
Bottled Juices	2.27	2.22	2.23
Cereal	3.08	3.14	−1.93
Cheese	2.53	2.42	4.45
Cigarettes	11.93	6.85	55.48
Cookies	2.06	2.21	−7.03
Crackers	2.08	1.90	9.05
Canned Soups	1.21	1.09	10.44
Dish Detergents	2.36	2.30	2.58
Front-End-Candies	0.74	0.53	33.38
Frozen Dinners	2.33	2.42	−3.79
Frozen Entrees	2.34	2.32	0.86
Frozen Juices	1.32	1.44	−8.70
Fabric Softeners	2.88	2.74	4.98
Grooming products	3.02	2.42	22.15
Laundry Detergents	5.76	5.11	11.97
Oatmeal	2.65	2.66	−0.38
Paper Towels	1.69	1.30	26.24
Refrigerated Juices	2.28	2.19	5.51
Soft Drinks	2.53	1.44	56.36
Shampoos	3.00	2.44	20.66
Snack Crackers	2.20	2.12	3.25
Soaps	2.74	2.12	25.65
Toothbrushes	2.21	2.09	5.58
Tuna	1.99	1.63	19.96
Toothpastes	2.53	2.26	11.29
Toilet papers	2.51	1.64	42.56
Average of the Positive Percentage Differences			17.99

Note.—In columns (1) and (2), we report the average 9-ending and non 9-ending prices, respectively, in each one of Dominick's 29 product categories, calculated over all stores and weeks. In column (3), we report the percentage difference between the average 9-ending and non 9-ending prices computed as a log-difference. There are 22 product categories with positive values in column (3). All the differences are statistically significant based on the Mann-Whitney test with $p < .01$.

Table 2. The Share of 9-Ending Prices, Average 9-Ending and Non 9-Ending Prices, and the Percentage Difference between Them, Regular and Sale Prices, Dominick's, Dominick's, 1989–1997

Year	(A) Share of 9-Ending Prices in Percent, among -			(B) Average Prices and Percentage Difference					
				Regular Prices			Sale Prices		
	All Prices	Regular Prices	Sale Prices	9-Ending	Non 9-Ending	Percentage Difference	9-Ending	Non 9-Ending	Percentage Difference
1989	51.9	51.06	61.49	2.35	2.28	3.02	1.92	1.95	−1.55
1990	54.7	53.76	63.12	2.42	2.35	2.94	1.93	1.83	5.32
1991	55.8	55.37	59.07	2.73	2.29	17.57	2.15	1.87	13.95
1992	63.9	65.13	53.57	2.82	2.16	26.66	2.40	1.85	26.03
1993	63.8	65.23	52.10	2.70	2.43	10.54	2.39	1.83	26.70
1994	67.2	70.45	45.98	2.79	2.38	15.89	2.52	1.84	31.45
1995	66.7	70.96	40.74	2.89	2.26	24.59	2.62	1.84	35.34
1996	68.9	72.94	39.33	3.03	2.41	22.89	2.38	1.97	18.91
1997	73.0	75.14	47.58	3.17	2.47	24.95	2.82	2.06	31.40

Table 3. Regression Analyses of the Percentage Difference between 9-Ending and Non 9-Ending Prices, Dominick's, September 14, 1989–May 8, 1997

	(1)	(2)	(3)	*N*
Analgesics	0.13 (0.005)***	0.13 (0.005)***	0.15 (0.001)***	3,040,172
Bath Soaps	0.02 (0.010)**	0.03 (0.010)***	0.12 (0.001)***	418,097
Beer	0.03 (0.009)***	0.03 (0.009)***	−0.02 (0.001)***	1,966,148
Bottled Juices	0.03 (0.003)***	0.03 (0.003)***	0.02 (0.000)***	4,325,024
Cereal	−0.02 (0.001)***	−0.02 (0.001)***	0.01 (0.000)***	4,707,776
Cheese	0.11 (0.002)***	0.08 (0.001)***	0.15 (0.000)***	6,752,326
Cigarettes	0.59 (0.059)***	0.02 (0.005)***	0.27 (0.001)***	1,801,444
Cookies	−0.09 (0.003)***	0.00 (0.002)	−0.03 (0.000)***	7,568,352
Crackers	0.06 (0.001)***	0.07 (0.001)***	0.03 (0.000)***	2,228,268
Canned Soups	0.09 (0.005)***	0.09 (0.005)***	0.06 (0.000)***	5,504,492
Dish Detergents	0.03 (0.006)***	0.03 (0.004)***	0.02 (0.000)***	2,164,793
Front-End-Candies	0.39 (0.002)***	0.38 (0.002)***	0.24 (0.003)***	4,437,054
Frozen Dinners	−0.01 (0.007)*	−0.01 (0.007)	0.04 (0.000)***	1,654,053
Frozen Entrees	0.06 (0.005)***	0.05 (0.005)***	0.01 (0.000)***	7,172,075
Frozen Juices	−0.07 (0.003)***	−0.08 (0.003)***	−0.06 (0.000)***	2,368,157
Fabric Softeners	−0.03 (0.003)***	−0.03 (0.003)***	0.02 (0.001)***	2,278,995
Grooming products	0.21 (0.002)***	0.16 (0.002)***	0.17 (0.000)***	4,065,689
Laundry Detergents	0.10 (0.003)***	0.13 (0.002)***	0.12 (0.001)***	3,277,444
Oatmeal	−0.02 (0.006)***	−0.01 (0.006)*	0.01 (0.004)***	981,037
Paper Towels	0.14 (0.010)***	0.14 (0.010)***	0.05 (0.001)***	940,757
Refrigerated Juices	0.06 (0.004)***	0.06 (0.004)***	0.06 (0.001)***	2,166,755
Soft Drinks	0.69 (0.010)***	0.30 (0.005)***	0.30 (0.000)***	10,741,742
Shampoos	0.16 (0.012)***	0.12 (0.009)***	0.12 (0.000)***	4,666,565
Snack Crackers	0.03 (0.004)***	0.03 (0.004)***	0.05 (0.000)***	3,487,564
Soaps	0.15 (0.003)***	0.15 (0.003)***	0.11 (0.006)***	1,835,196
Toothbrushes	−0.03 (0.005)***	−0.01 (0.005)***	0.02 (0.000)***	1,772,158
Tuna	0.19 (0.003)***	0.19 (0.003)***	0.10 (0.001)***	2,382,983
Toothpastes	0.01 (0.004)	0.01 (0.004)***	−0.01 (0.003)***	2,981,532
Toilet papers	0.41 (0.007)***	0.41 (0.007)***	0.11 (0.001)***	1,149,972
Dummies for weeks	√		√	
Dummies for product-store			√	
Dummies for sub-categories-store	√			
Dummies for sub-categories-store-weeks		√		

Note.—In the table, we report the coefficient estimates of a 9-ending dummy in log-linear OLS regressions with fixed effects, where the dependent variable is the log of the prices. The 9-ending dummy equals 1 if the price ends with 9, and 0 if the price ends with any other digit. In column (1), the regression includes controls for weeks and for subcategories-store. In column (2), the regression includes controls for subcategories-stores-weeks. In column (3), the regression includes dummies for weeks and for product-store. *N* denotes the number of observations. In parentheses, we report robust standard errors, clustered at the store level. * $p < .10$ ** $p < .05$, *** $p < .01$.

Table 4. The Percentage of 9-Ending Prices, by Product Categories, among Sale Prices and among Regular Prices, and the Difference between Them, Dominick's, September 14, 1989–May 8, 1997

Category	(1) Sale Prices	(2) Regular Prices	(3) Difference
Analgesics	67.3	86.8	−19.5
Bath Soaps	60.5	89.2	−28.7
Beer	90.8	96.6	−5.8
Bottled Juices	43.3	51.8	−8.5
Cereal	38.7	39.7	−1.0
Cheese	41.0	65.2	−24.2
Cigarettes	4.3	16.5	−12.2
Cookies	42.6	77.8	−35.2
Crackers	34.3	68.3	−34.0
Canned Soups	26.5	31.4	−4.9
Dish Detergents	59.0	68.1	−9.1
Front-End-Candies	20.5	40.1	−19.6
Frozen Dinners	27.2	62.4	−35.2
Frozen Entrees	29.3	64.2	−34.9
Frozen Juices	48.1	46.1	2.0
Fabric Softeners	56.9	59.6	−2.7
Grooming products	56.5	88.8	−32.3
Laundry Detergents	64.8	77.5	−12.7
Oatmeal	36.8	53.7	−16.9
Paper Towels	48.3	50.3	−2.0
Refrigerated Juices	53.5	57.7	−4.2
Soft Drinks	64.8	87.4	−22.6
Shampoos	73.1	92.6	−19.5
Snack Crackers	41.1	77.6	−36.5
Soaps	43.7	64.7	−21.0
Toothbrushes	69.6	78.1	−8.5
Tuna	32.2	50.6	−18.4
Toothpastes	62.8	63.9	−1.1
Toilet papers	52.7	53.5	−0.8
Average of the Negative Differences			−16.9

Note.—We identify sale prices using "Filter A" of Nakamura and Steinsson (2008). In column (1), we report the percentage of 9-ending prices among sale prices. In column (2), we report the percentage of 9-ending prices among regular prices. In column (3), we report the difference between the percentage of 9-ending prices in sale prices and in regular prices. All the differences are statistically significant based on the z-scores proportions test, with $p < .01$.

Table 5. Regression Analysis of the Percentage Difference between 9-Ending and Non 9-Ending Prices, Regular and Sale Prices, Dominick's, September 14, 1989–May 8, 1997

Category	Regular Prices				Sale Prices			
	(1)	(2)	(3)	*N*	(4)	(5)	(6)	*N*
Analgesics	0.13*** (0.005)	0.13*** (0.005)	0.15*** (0.000)	2,924,303	0.00 (0.003)	0.01* (0.003)	−0.01*** (0.002)	115,869
Bath Soaps	−0.01 (0.011)	−0.01 (0.010)	0.11*** (0.001)	405,439	0.02*** (0.008)	0.03*** (0.007)	−0.04*** (0.003)	12,658
Beer	0.02 (0.010)	0.02** (0.010)	−0.04*** (0.001)	1,660,236	0.11*** (0.010)	0.09*** (0.010)	−0.03*** (0.002)	305,912
Bottled Juices	0.02*** (0.004)	0.02*** (0.003)	0.02*** (0.000)	3,753,608	0.06*** (0.003)	0.05*** (0.003)	−0.00** (0.001)	571,416
Cereal	−0.02*** (0.001)	−0.02*** (0.001)	0.01*** (0.000)	4,379,009	−0.01*** (0.003)	−0.02*** (0.003)	−0.03*** (0.001)	328,767
Cheese	0.12*** (0.002)	0.08*** (0.002)	0.16*** (0.000)	5,684,114	−0.01*** (0.001)	−0.01*** (0.001)	0.03*** (0.001)	1,068,212
Cigarettes	0.59*** (0.058)	0.02*** (0.005)	0.27*** (0.001)	1,793,459	0.01 (0.201)	−0.05*** (0.017)	0.21*** (0.019)	7,985
Cookies	−0.13*** (0.003)	−0.03*** (0.003)	−0.04*** (0.000)	6,725,729	−0.06*** (0.001)	−0.03*** (0.001)	−0.03*** (0.001)	842,623
Crackers	0.07*** (0.002)	0.07*** (0.001)	0.02*** (0.000)	1,943,794	−0.08*** (0.002)	−0.07*** (0.001)	−0.06*** (0.001)	284,474
Canned Soups	0.09*** (0.005)	0.08*** (0.005)	0.06*** (0.000)	5,018,750	0.12*** (0.002)	0.11*** (0.002)	0.01*** (0.001)	485,742
Dish Detergents	0.03*** (0.007)	0.04*** (0.004)	0.02*** (0.000)	1,973,399	−0.04*** (0.003)	0.05*** (0.002)	−0.04*** (0.001)	191,394
Front-End-Candies	0.39*** (0.002)	0.38*** (0.002)	0.24*** (0.000)	4,189,543	0.18*** (0.003)	0.20*** (0.004)	0.06*** (0.001)	247,511
Frozen Dinners	−0.06*** (0.006)	−0.07*** (0.007)	−0.01 (0.000)	1,391,236	0.07*** (0.005)	0.04*** (0.006)	0.01*** (0.001)	262,817
Frozen Entrees	0.01*** (0.005)	0.00 (0.005)	−0.05*** (0.000)	6,289,007	0.00** (0.000)	−0.01* (0.004)	0.00* (0.001)	883,068
Frozen Juices	−0.07*** (0.003)	−0.08*** (0.003)	−0.06*** (0.000)	2,016,638	−0.07*** (0.002)	−0.09*** (0.002)	−0.02*** (0.001)	351,519
Fabric Softeners	−0.04*** (0.003)	−0.05*** (0.003)	0.01*** (0.001)	2,101,762	0.10*** (0.003)	0.15*** (0.003)	0.01 (0.002)	177,233
Grooming products	0.20*** (0.003)	0.14*** (0.002)	0.16*** (0.000)	3,806,684	0.18*** (0.004)	0.08*** (0.002)	0.07*** (0.001)	259,005
Laundry Detergents	0.08*** (0.003)	0.12*** (0.002)	0.12*** (0.001)	3,002,713	0.18*** (0.005)	0.17*** (0.005)	0.07*** (0.001)	274,731
Oatmeal	−0.03*** (0.005)	−0.03*** (0.005)	−0.01*** (0.000)	898,099	−0.05*** (0.004)	0.00 (0.004)	−0.03*** (0.002)	82,938
Paper Towels	0.15*** (0.010)	0.15*** (0.010)	0.07*** (0.001)	807,388	0.03*** (0.005)	0.01** (0.005)	0.01*** (0.002)	133,369
Refrigerated Juices	0.07*** (0.005)	0.08*** (0.005)	0.07*** (0.001)	1,702,858	0.01*** (0.002)	0.01*** (0.002)	0.01*** (0.001)	463,897
Soft Drinks	0.76*** (0.011)	0.34*** (0.007)	0.30*** (0.001)	8,516,259	0.56*** (0.007)	0.14*** (0.003)	0.20*** (0.001)	2,225,483
Shampoos	0.15*** (0.013)	0.11*** (0.010)	0.10*** (0.000)	4,416,767	−0.08*** (0.005)	−0.05*** (0.003)	−0.00 (0.001)	249,798
Snack Crackers	0.01** (0.006)	0.02*** (0.006)	0.03*** (0.000)	3,019,467	−0.03*** (0.001)	−0.03*** (0.001)	−0.04*** (0.001)	468,097
Soaps	0.16*** (0.004)	0.15*** (0.004)	0.12*** (0.001)	1,662,739	0.07*** (0.003)	0.07*** (0.003)	0.01*** (0.001)	172,457
Toothbrushes	−0.04*** (0.004)	−0.02*** (0.005)	0.02*** (0.000)	1,662,831	0.01** (0.005)	0.00 (0.005)	−0.07*** (0.001)	109,327

Tuna	0.20*** (0.003)	0.20*** (0.003)	0.10*** (0.001)	2,183,367	−0.03 (0.003)	−0.05 (0.003)	−0.01*** (0.002)	199,616
Toothpastes	−0.00 (0.004)	0.00 (0.004)	−0.02*** (0.000)	2,709,365	0.01*** (0.002)	0.03*** (0.002)	−0.03*** (0.001)	272,167
Toilet papers	0.43*** (0.008)	0.43*** (0.008)	0.13*** (0.001)	983,422	0.20*** (0.005)	0.23*** (0.005)	−0.03*** (0.002)	166,550
Dummies for weeks	√		√		√		√	
Dummies for product-store			√				√	
Dummies for sub-categories-store	√				√			
Dummies for sub-categories-store-weeks		√				√		

Note.—In the table, we report the coefficient estimates of a 9-ending dummy in a number of log-linear OLS regressions with fixed effects, where the dependent variable is the log of the prices. In columns (1)–(3), we report the results when we estimate the regression using data on regular prices only. In columns (4)–(6), we report the results when we estimate the regression using data on sale prices only. We identify sale prices using a sales filter that identifies a sale if the price decreases and then increases back to the previous level or above. In columns (1) and (4), the regression includes controls for weeks and for subcategories-store. In columns (2) and (5), the regression includes controls for subcategories-stores-weeks. In columns (3) and (6), the regression includes dummies for weeks and for product-store. *N* denotes the number of observations. In the parentheses we report robust standard errors, clustered at the store level. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table 6. Annual Regressions of the Percentage Difference between 9-Ending and Non 9-Ending Prices, Dominick's, September 14, 1989–May 8, 1997

	All Observations		Regular Prices		Sale Prices	
Year	9-Ending	*N*	9-Ending	*N*	9-Ending	*N*
1989	−0.03***	2,570,474	−0.03***	2,362,875	0.03***	207,599
	(0.005)		(0.005)		(0.011)	
1990	−0.05***	9,228,965	−0.04***	8,366,677	−0.02***	862,288
	(0.005)		(0.005)		(0.004)	
1991	−0.04***	10,650,384	−0.04***	9,552,147	0.02	1.098.237
	(0.003)		(0.003)		(0.013)	
1992	−0.00	13,731,259	−0.02***	12,343,849	0.02***	1,387,410
	(0.003)		(0.003)		(0.009)	
1993	0.02***	14,023,602	0.01***	12,549,782	0.00	1,473,820
	(0.002)		(0.002)		(0.004)	
1994	0.06***	13,645,820	0.04***	11,905,363	−0.03***	1,740,457
	(0.002)		(0.002)		(0.002)	
1995	0.07***	13,424,315	0.05***	11,544,459	−0.04***	1,879,856
	(0.002)		(0.002)		(0.002)	
1996	0.10***	14,238,652	0.07***	12,524,236	−0.02***	1,714,416
	(0.002)		(0.002)		(0.003)	
1997	0.09***	5,156,434	0.06***	4,769,776	0.00	386,658
	(0.003)		(0.003)		(0.003)	

Note.—The table reports the coefficient estimates of a 9-ending dummy in fixed effect log-linear OLS regressions, where the dependent variable is the log of the prices. The regressions are estimated for each year over all stores and products. 9-ending dummy equals 1 if the price ends with 9, 0 otherwise. The regressions include controls for product-store and for weeks. *N* denotes the number of observations. We identify sale prices using a sale filter that identifies a sale if the price decreases and then increases back to the previous level or above. *** $p < .01$.

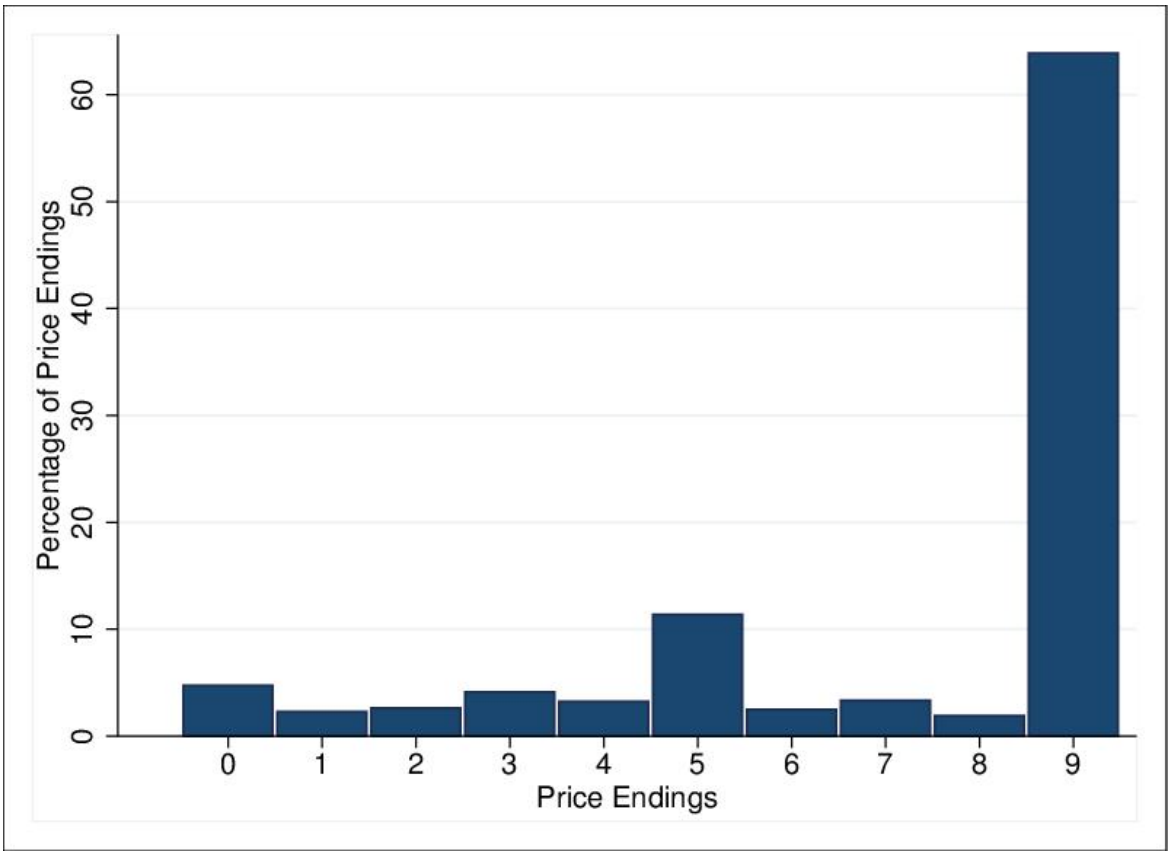

Figure 1. Frequency Distribution of the Last Digit of the Retail Prices at Dominick's, September 14, 1989–May 8, 1997

Note.—The figure was generated using all 98,914,300 weekly retail price observations of Dominick's, at 93 stores for 400 weeks, from September 14, 1989 to May 8, 1997. In Web Appendix E, we present the histogram plots of the frequency distribution of the last digit by product categories.

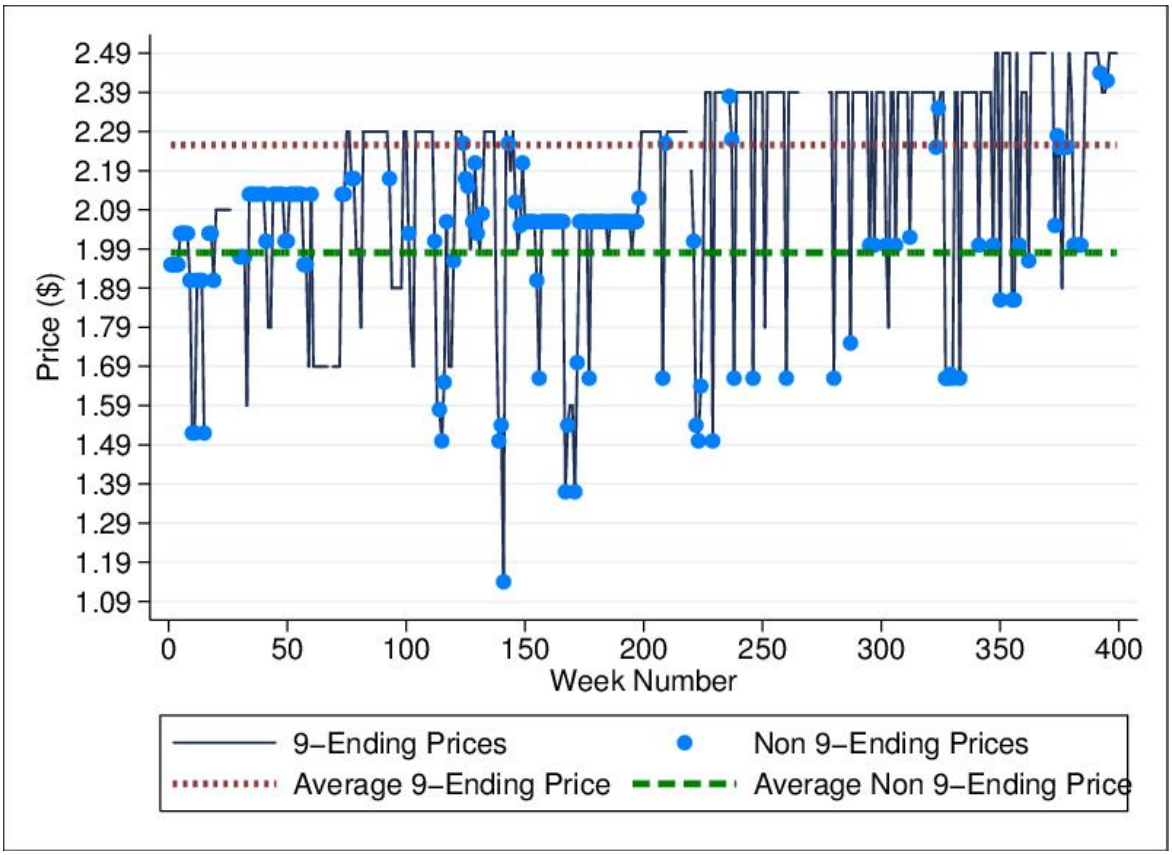

Figure 2. Retail Price of Nabisco Wheat Thins Low Salt, 10oz (Snack Crackers' Category, SKU: 1275660, Store No. 122) – Dominick's, September 14, 1989–May 7, 1997

Note.—The observations where a blue dot appears to coincide with a 9-ending price point/line, are the cases where the 9-ending price is right below the 0-ending price that follows immediately. For example, $1.49 and $1.50. In Web Appendix F, we present the time series plots for all the products in the Snack Crackers category.

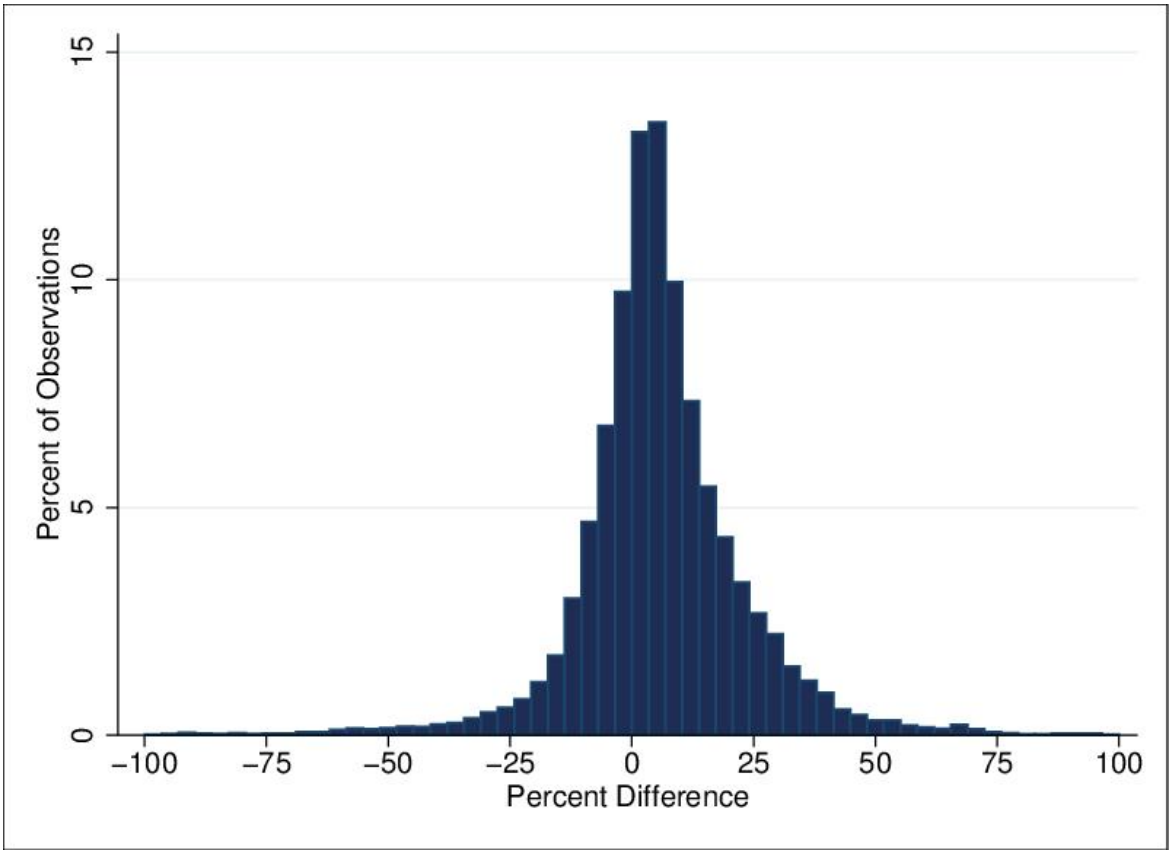

Figure 3. Frequency Distribution of the Percentage Differences between the Average 9-Ending and Non 9-Ending Prices, Dominick's, September 14, 1989–May 8, 1997

Note.—The figure was produced using all 98,914,300 weekly retail price observations of Dominick's from 93 stores over 400 weeks, except the outliers. We define an outlier as a price difference of greater than 100% in absolute value. There were 1,654 such outliers, comprising about 0.2% of the total number of observations. Figure 1 in Web Appendix H Presents the plot with all the data points (including the outliers).

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WEB APPENDIX

"If You Think 9-Ending Prices Are Low, Think Again"

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October 17, 2019

Table of Contents

APPENDIX A. DOMINICK'S STORE LOCATIONS, DOMINICK'S PRICE ZONES, AND DESCRIPTIVE STATISTICS

In this appendix we offer details about the geographical location of Dominick's stores, in the Chicago Metro area. In addition, we offer information about Dominick's price zones, and to which price zone each of the stores belong. Finally, we present descriptive statistics of the Dominick's retail price data.

A.1. Dominick's Store Locations in the Chicago Metropolitan Area, and Dominick's Price Zones

According to Hoch et al (1995) and Ellickson and Misra (2008), 95 percent of Dominick's stores follow a Hi-Lo ("Promo") pricing format. Dominick's groups its stores into 16 pricing zones, maintaining uniform regular prices within each pricing zone, but the same promoted prices chain-wide (Dominick's Data Manual 2018, p. 19). Figure A1 shows the location of the stores on the Chicago area map, and indicates the price zone number to which each store belongs. See Section 3 in the paper for more details.

A.2. Descriptive Statistics of Dominick's Retail Price Data by Product Categories

Table 1 offers descriptive statistics about the retail price data, by product categories. The table lists 29 product categories, which include a total of 18,036 individual products, and 98,914,300 weekly price observations.

Among the 29 product categories, the smallest category in terms of the total number of observations we have, Bath Soaps, has 418,097 weekly price observations, and the largest, Soft Drinks, has 10,741,742 weekly price observations.

In terms of the number of products, the Oatmeal category is the smallest, containing 96 different products, and Shampoos category is the largest, containing 2,930 different products. The average price in the data is $2.59.

Figure A1. Dominick's Store Locations in Chicago Metropolitan Area and their Price Zone Category

Source: Chintagunta, et al (2003, Figure 1, p. 128)

Table A1. Descriptive Statistics of Dominick's Retail Scanner Price Data, by Product Categories, September 14, 1989–May 8, 1997

Category	Number of Observations	Proportion of the Total	Number of Products	Mean Price ($)	Std. Dev.	Min. Price ($)	Max. Price ($)
Analgesics	3,040,172	3.07%	638	5.18	2.36	0.02	23.69
Bath Soaps	418,097	0.42%	579	3.16	1.60	0.01	28.00
Beer	1,966,148	1.99%	787	5.69	2.70	0.01	29.64
Bottled Juices	4,325,024	4.37%	506	2.24	0.97	0.19	9.41
Cereal	4,707,776	4.76%	489	3.12	0.76	0.05	26.02
Cheese	6,752,326	6.83%	657	2.42	1.12	0.05	84.72
Cigarettes	1,801,444	1.82%	793	7.69	7.90	0.01	25.65
Cookies	7,568,428	7.65%	1,124	2.10	0.63	0.02	10.99
Crackers	2,228,269	2.25%	330	2.01	0.57	0.01	7.29
Canned Soups	5,504,492	5.56%	445	1.13	0.49	0.19	8.00
Dish Detergents	2,164,793	2.19%	287	2.34	0.90	0.25	15.89
Front-End-Candies	4,437,054	4.49%	503	0.61	0.24	0.01	6.99
Frozen Dinners	1,654,053	1.67%	266	2.37	0.89	0.12	72.47
Frozen Entrees	7,172,075	7.25%	898	2.33	1.06	0.10	15.99
Frozen Juices	2,368,157	2.39%	175	1.39	0.45	0.10	6.57
Fabric Softeners	2,278,995	2.30%	318	2.82	1.45	0.01	9.99
Grooming products	4,065,689	4.11%	1,380	2.94	1.37	0.01	41.70
Laundry Detergents	3,277,444	3.31%	581	5.61	3.22	0.04	24.49
Oatmeal	981,037	0.99%	96	2.65	0.66	0.25	5.00
Paper Towels	940,757	0.95%	163	1.50	1.41	0.23	13.99
Refrigerated Juices	2,166,755	2.19%	225	2.24	0.91	0.10	7.05
Soft Drinks	10,741,742	10.86%	1,608	2.34	1.89	0.01	55.55
Shampoos	4,676,790	4.73%	2,930	2.95	1.86	0.02	54.99
Snack Crackers	3,487,564	3.53%	420	2.18	0.57	0.02	8.00
Soaps	1,835,196	1.86%	334	2.51	1.48	0.01	10.99
Toothbrushes	1,839,536	1.86%	491	2.18	0.85	0.20	27.52

Tuna	2,382,983	2.41%	278	1.80	1.07	0.11	12.89
Toothpastes	2,981,532	3.01%	608	2.43	0.89	0.10	19.95
Toilet papers	1,149,972	1.16%	127	2.10	1.68	0.19	11.99
Total	**98,914,300**	**100.00%**	**18,036**	**2.59**			

Notes

The price data are weekly. The figures in the table are based on all price observations of Dominick's, in all its 93 stores, for 400 weeks, from September 14, 1989 to May 8, 1997. We exclude 40 observations with prices higher than $100.

APPENDIX B. ADDITIONAL TESTS

To assess the robustness of our findings, we run several sensitivity tests which we present below as follows. In section B.1, we compare 9-ending prices to 0-ending prices. In section B.2, we explore the effect of 9 as the highest possible right-most digit. In section B.3, we assess the effect of the log-transformation of prices by redoing the analyses using the level of prices. In section B.4, we rerun the analyses by excluding outlier observations. Finally, in section B.5, we compare again regular and sale prices, but this time using Dominick's sale dummy instead of a sale filter.

B.1. Comparison of 9-Ending and 0-Ending Prices

It is often argued that consumers interpret 9-ending prices as if they come with a small gain relative to the nearby round price (Schindler and Kirby, 1997). In addition, it has been suggested that 9-endings signal low prices, whereas 0-endings signal quality (Schindler and Kirby 1997, Stiving and Winer 1997, Stiving 2000, Schindler and Kibarian 2001, Schindler 2006). It is therefore possible that the low-price image that 9-ending prices have, stems from consumers' practice of interpreting 9-ending prices relative to, or in comparison to, the nearby 0-ending prices, and judging them accordingly. Schindler (2001) examines this hypothesis by comparing 99-ending prices to 00-ending prices.

We explore this hypothesis with our data by repeating the analyses that we report in Tables 1 and 3 in the paper. This time, however, we compare 9-ending prices to 0-ending prices only, excluding from our analyses all other non 9-ending prices. In Table B1, which is equivalent to Table 1, we report for each product category, the average of 9-ending prices in column (1), the average of 0-ending prices in column (2), and the percentage differences between the two, computed as a log-difference, in column (3).

According to the figures in the table, the average 9-ending prices are higher than the average 0-ending prices in 20 of the 29 product categories. The average percentage difference computed across these 20 product categories is 10.84%. In some product categories, the size of this difference is particularly large, including Cigarettes (32.54%), Grooming Products (20.26%), Soft Drinks (21.84%), and Toilet Papers (30.63%).

Thus, even when we restrict the sample of non 9-ending prices to 0-ending prices only, we find that although 0-endings might be perceived as a signal of quality, in most product categories 0-ending prices are still lower than 9-ending prices, on average.

As a formal test, in Table B2, we report the estimation results of a series of regressions of the differences between 9-ending and 0-ending prices by product categories. These OLS regressions are similar to the ones that we report in Table 3. This time, however, the data include only 9-ending and 0-ending prices.

The estimation results of this regression further strengthen the results we reported in Table 5. In the regression in column (1), which includes dummies for weeks and for subcategories-store, we find that in only five product categories (Bath Soaps, Cookies, Frozen Dinners, Frozen Entrees, and Frozen Juices), the coefficient of 9-ending price dummy is negative and statistically significant. In 21 of the 29 product categories, the coefficient is positive and statistically significant. Thus, the expected 9-ending prices are significantly higher than the expected 0-ending prices in 21 product categories. In three product categories (Crackers, Canned Soup, and Paper Towels), the differences are not statistically significant.

In column (2), where we add fixed effects for subcategory-store-weeks, we find that the coefficient estimate of the 9-ending price dummy is again negative and statistically significant in only five product categories (Bath Soaps, Cookies, Frozen Dinners, Frozen Entrees, and Frozen Juices). The coefficient estimate of the 9-ending price dummy is positive and statistically significant in 20 product categories. Thus, in this specification, we find that the expected 9-ending prices are higher than the expected 0-ending prices in 20 of the 29 product categories. In four product categories (Crackers, Canned Soup, Fabric Softeners, and Paper Towels), the differences are not statistically significant.

In column (3), where we add fixed effects for weeks and for products within stores, we find that the coefficient of the 9-ending price dummy is positive and statistically significant in 21 of the 29 product categories. In other words, we find that even when we restrict the sample to 9-ending and 0-ending prices, in 21 of the 29 product categories, a consumer who buys the same good at the same store, is expected to get a better deal if the price s/he pays ends with a 0 than with a 9. This finding is consistent with Schindler

(2001), who finds that in his data, 99-ending price were not, on average, lower than 00-ending prices.

B.2. Could It Be the Rightmost Digit Effect?

A possible explanation for the finding that 9-ending prices are higher than the prices that end with other digits, is that the difference might be due to 9 being the largest digit. Thus, it is possible that 9-ending prices are higher, on average, than other prices for a technical reason: A price that ends with 9 is greater than any price with the same left most digits but that ends with any digit between 0 and 8. That is, 9.99 is higher than all the prices in the range 9.90–9.98.

To test this possibility, we first truncate all price endings so that the right most digits are now all set equal to 0. To keep track of the original prices, we use an indicator variable which identifies the prices that were 9-ending prior to the truncation. In column (1) of Table B3, we report the average 9-ending prices after-truncation, in column (2) we report the average non 9-ending prices after-truncation, and in column (3) we report the percentage difference between them, computed as a log-difference.

We find that the truncation decreases, as expected, the differences between the average 9-ending and non 9-ending prices. Yet in 21 product categories, the average 9-ending prices are still higher than the average non 9-ending princes. Even after the truncation, the average percentage difference computed across the 21 product categories in which the average 9-ending prices exceed the corresponding average non 9-ending prices is 17.31%.

In Table B4, we report the estimation results of a series of regressions of the differences between 9-ending and non 9-ending prices by product categories, when we use the truncated data. These are OLS regressions with the same fixed effects as the ones we report in Table 3.

In the regression in column (1), which includes dummies for weeks and for subcategories-store, we find that the coefficient of the 9-ending price dummy is negative

and statistically significant in only 8 product categories (Cereal, Cookies, Frozen Dinners, Frozen Juices, Fabric Softeners, Oatmeal, Toothbrushes and Toothpastes). In 16 of the 29 product categories, the coefficient of the 9-ending price dummy is positive and statistically significant. In five categories, the differences are not statistically significant (Bath Soaps, Beer, Bottled Juices, Dish Detergents, and Snack Crackers).

In the regression in column (2), which includes fixed effects for subcategory-store-weeks, we find that the coefficient estimate of the 9-ending price dummy is negative and statistically significant in 8 product categories (Cereal, Cookies, Frozen Dinners, Frozen Juices, Fabric Softeners, Oatmeal, Toothbrushes and Toothpastes). The coefficient estimate of the 9-ending price dummy is positive and statistically significant in 17 product categories. In four categories, the differences are not statistically significant (Bath Soaps, Bottled Juices, cigarettes, Snack Crackers).

In the regression in column (3), which includes fixed effects for weeks and for products within stores, we find that the coefficient of the 9-ending price dummy is positive and statistically significant in 17 of the 29 product categories. In other words, we find that even after we truncate all prices to have a 0-ending, we find that in 17 of the 29 product categories, a consumer who buys the same good at the same store, is expected to get a better deal if the price s/he pays does not end with a 9.

B.3. Average 9-Ending and Non 9-Ending Prices in Levels

In the regression analyses conducted in the paper, we use the log of the prices as the dependent variable. To check that our results do not depend on this transformation, we re-estimate the same OLS regressions with the same fixed effects that we reported in Table 3, but this time we use the level of the prices rather than their logs. The coefficient estimates we report here, should therefore be interpreted as the expected differences in dollars rather than in percentages. The estimation results are reported in Table B5.

In the regression in column (1), which includes dummies for weeks and for subcategories-store, we find that in 21 out of the 29 product categories, the expected 9-ending prices are higher than the expected non 9-ending prices. The differences are

statistically significant ($p < 0.01$) in 20 of the cases.

In the regression in column (2), which includes subcategories-store-week dummies, we find that the expected 9-ending prices are higher than the corresponding expected non 9-ending prices in 19 of the 29 product categories. In four more product categories (Beer, Cigarettes, Frozen Entrees, Toothbrushes), the differences are not statistically significant. Thus, in 23 of 29 product categories, the expected 9-ending prices are either higher or no different than the expected non 9-ending prices.

In the regression in column (3), which includes fixed effects for weeks and for products at the store-level, we find that in 24 out of the 29 product categories, the expected 9-ending prices are higher than corresponding non 9-ending prices. In only 5 product categories (Beer, Cookies, Frozen Entrees, Frozen Juices, Toothpastes), the expected 9-ending prices are lower than the expected non 9-ending prices.

Thus, using the level of the prices instead of their logs, does not change the main conclusion we reported above: in great majority of the product categories, the expected 9-ending prices are higher than the expected non 9-ending prices, regardless of the additional controls that we include in the regressions.

B.4. Analysis of the Data with Outliers Excluded

One possible explanation for our results is that they are driven by outliers. To explore this possibility, in each category we exclude from the sample the observations that are more than 2-standard-deviations away from the category mean. Using the restricted sample, we rerun the analyses we reported in Tables 1 and 3.

In columns (1) and (2) of Table B6, we report the average 9-ending and non 9-ending prices in the restricted sample. In column (3), we report the percentage difference between them, computed as a log-difference. Inspecting the figures in the table, we find that the exclusion of the outlier observations does not change the main finding we reported for the entire sample: in 22 product categories, 9-ending prices are on average higher than non 9-ending princes. The average percentage difference computed across

these 22 product categories is 16%.

In Table B7, we report the estimation results of a series of regressions of the differences between 9-ending and non 9-ending prices by product categories, when the outlier observations are excluded. These are OLS regressions, similar to the regressions we reported in Table 3.

In the regression in column (1), which includes dummies for weeks and for subcategories-store, we find that the coefficient of the 9-ending dummy is negative and statistically significant in 8 product categories (Cereal, Cookies, Frozen Juices, Fabric Softeners, Oatmeal, Snack Crackers, Toothbrushes and Toothpastes). In 19 of the 29 product categories, the coefficient of the 9-ending price dummy is positive and statistically significant. In two categories, the estimated coefficients are not statistically significant (Dish Detergents and Frozen Dinners).

In the regression in column (2), which includes fixed effects for subcategory-store-weeks, we find that the coefficient estimate of the 9-ending price dummy is negative and statistically significant in five product categories (Cereal, Frozen Juices, Fabric Softeners, Toothbrushes and Toothpastes). The coefficient estimate of the 9-ending price dummy is positive and statistically significant in 20 product categories. In four product categories, the estimated coefficients are not statistically significant (Cookies, Frozen Dinners, Oatmeal and Snack Crackers).

In the regression in column (3), which includes fixed effects for weeks and for products within stores, we find that the coefficient of the 9-ending price dummy is negative and statistically significant in 6 product categories (Beer, Cheese, Frozen Juices, Fabric Softeners, Paper Towels, Toothpastes). The coefficient is positive and statistically significant in the remaining 23 of the 29 product categories.

Thus, in comparison to the results we reported for the full sample, when outliers are excluded, we still find that in a large majority of the product categories, the expected 9-ending prices are on average higher than non 9-ending prices.

B.5. Regular and Sale Prices Using Dominick's Sale Dummy

In the paper, we identify sales by using a sale filter (Nakamura and Steinsson 2008, 2011). Sale filters are not foolproof, however. Their disadvantage is that they can occasionally lead to false positives, that is, they can wrongly identify a regular price as a sale price (Nakamura and Steinsson 2008, Ray et al 2019). This issue is less relevant in the case of Dominick's however, because Ray et al (2019) find that sale filters tend to correctly identify most of the sales in case of Hi-Lo pricing format, which is the format Dominick's follows. Another weakness of sale filters is that they cannot identify the sale price if the sale occurs in the proximity of the end points of the time series. The sale filters are nevertheless used extensively, because in many scanner datasets, sale indicator variables are not available. For an example and discussion, see Nakamura and Steinsson (2008).

As a robustness check, we rerun the regular and sale price analyses as discussed and presented in Tables 4 and 5 in section 5.4. The difference is that this time we identify sale prices by using the Dominick's sale dummy ("sale flag"), which is included in the Dominick's dataset. This sale indicator variable, however, has an important disadvantage because according to Dominick's Data Manual (2018, p. 10), the sale dummy was not set by Dominick's on a regular basis, and consequently there are instances were a good was offered at a sale price, but the Dominick's sale dummy indicates no sale price. Thus, Dominick's sale dummy is not accurate. According to Peltzman (2000), this is a major drawback. Nevertheless, we use the sale dummy as a robustness check for the results presented in the paper. We identify a sale if the Dominick's sale indicator is marked as "S" (sale) or "B" (bonus sale).

The figures reported in column (1) of Table B8 show the percentage of sale prices that are 9-ending. Column (2) reports the percentage of regular prices (the prices that are not flagged by the sale dummy) that are 9-ending. Column (3) reports the difference between the shares of 9-ending prices among sale and regular prices.

We find that in 25 out of the 29 product categories (the categories of Cereals, Cigarettes, Frozen Juices, and Toothpastes being the exception), the values in column (3) are negative, with an average of −18.5%. In other words, in these categories, 9-ending

prices are more common among regular prices than among sale prices. Furthermore, in the Cigarettes category, there are only 21 observations that Dominick's sale dummy marks as sale prices, and thus the results in that category are based on a very small sample of sale prices. Therefore, consumers' tendency to associate 9-endings with low prices cannot be explained by 9-ending prices being sale prices. That is because the shoppers are more likely to encounter 9-ending prices when they buy the goods at a regular price than at a sale price.

There is another possibility, however. Even if 9-endings are not more common among sale prices than among regular prices, the belief of the consumers that 9-ending prices are low, could perhaps still be rationalized. If 9-ending prices are lower on average than non-9 ending prices *among sale prices*, then it is possible that consumers associate 9-endings with price cuts. Indeed, Schindler (2001) offers this as a possible explanation for his finding that 99-ending prices are not as low as is commonly believed.

To explore this possibility, we run the same OLS regressions with the same fixed effects, as the ones we presented in Table 5. The only exception is that we now estimate separate regressions for regular prices and for sale prices. We report the estimation results in Table B9. The figures that we report in the table are the coefficient estimates of the 9-ending price dummy, which equals 1 if the price ends with 9, and 0 if the price ends with any other digit.

In columns (1)–(3) of the table, we report the estimation results for regular prices, and in columns (4)–(6) for sale prices. In columns (1) and (4), we report the estimation results of regressions where we include controls for weeks and for subcategories-store. In columns (2) and (5), we report the estimation results of regressions that include controls for subcategories- store-weeks. In columns (3) and (6), we report the estimation results of the regressions that include controls for weeks and for products-store.

For regular prices, the estimation results in column (1) suggest that the expected 9-ending prices are lower than the expected non 9-ending prices (that is, the estimated coefficient is negative and statistically significant) in 10 product categories. In one category (Toothpastes), however, the difference is only marginally significant. In column (2), the coefficient of the 9-ending dummy in the regression for the Toothpastes' category

is not significant and, consequently, the expected 9-ending prices are lower than the expected non 9-ending prices in 9 product categories.

In column (3), where we use dummies for products-store, we find that the expected 9-ending prices are lower than the expected non 9-ending prices in only four product categories. Thus, when we focus on regular prices, and include dummies for products in specific stores, we find that in 24 out of 29 product categories, the expected 9-ending prices are higher than the expected non 9-ending prices, and in one category, there are no statistically significant differences between 9-ending and non 9-ending prices.

For sale prices, we cannot estimate the regressions for the Cigarettes' category because the Dominick's sale dummy identifies only 21 prices as sale prices and all of them are 9-ending. For the remaining 28 categories, we find in column (4) that the expected 9-ending prices are lower than the expected non 9-ending prices in 13 product categories, higher in 14 product categories, and there is no statistically significant difference in one product category. According to the figures in column (5), the expected 9-ending prices are lower than the expected non 9-ending prices in 10 product categories, higher in 12 categories, and there are no statistically significant differences in six product categories.

In column (6), where we use dummies for products-store, we find that the expected 9-ending prices are lower than the expected non 9-ending prices in 17 categories, higher in 9 product categories, and there are no statistically significant differences in two categories.

Thus, to summarize the results on regular and sale prices, we find that for regular prices, which in our data are the bulk of the prices (82.2%), 9-endings are not indicative of a better deal than non 9-ending prices. For sale prices, the results are more mixed. At least according to column (6), which focuses on the difference between 9- and non 9-ending prices of products within stores, in 19 out of 28 product categories, the expected 9-ending prices are either lower or not higher than the expected non 9-ending prices.

This suggests that although 9-ending prices are in general higher, not lower, than non 9-ending prices, it might be that Dominick's helps to maintain the image of 9-ending

prices as low prices by setting sale prices at 9-endings in the case of price cuts. Such behavior by the retailer can perhaps explain how consumers learn to associate 9-endings with low prices.

Table B1. Average 9-Ending and 0-Ending Prices, and Percentage Difference between Them, Dominick's, September 14, 1989–May 8, 1997

Category	(1) 9-Ending	(2) 0-Ending	(3) % Difference
Analgesics	***5.33***	***4.21***	***10.24%***
Bath Soaps	3.15	4.54	−15.92%
Beers	***5.68***	***4.67***	***8.52%***
Bottled Juices	***2.27***	***2.21***	***1.12%***
Cereals	***3.08***	***2.85***	***3.37%***
Cheese	***2.53***	***2.11***	***7.88%***
Cigarettes	***11.93***	***5.64***	***32.54%***
Cookies	2.06	2.36	−5.99%
Crackers	2.08	2.14	−1.24%
Canned Soups	1.21	1.36	−5.15%
Dish Detergents	***2.36***	***2.30***	***1.14%***
Front End Candies	***0.74***	***0.55***	***13.00%***
Frozen Dinners	2.33	3.07	−11.98%
Frozen Entrees	2.34	3.47	−17.10%
Frozen Juices	1.32	1.82	−13.83%
Fabric Softeners	***2.88***	***2.58***	***4.77%***
Grooming products	***3.02***	***1.89***	***20.26%***
Laundry Detergents	***5.76***	***5.33***	***3.39%***
Oatmeal	***2.65***	***2.36***	***5.00%***
Paper Towels	1.69	1.71	−0.40%
Refrigerated Juices	***2.281***	***2.280***	***0.02%***
Soft Drinks	***2.53***	***1.53***	***21.84%***
Shampoos	***3.00***	***2.19***	***13.67%***
Snack Crackers	2.20	2.20	0.00%
Soaps	***2.74***	***2.18***	***9.97%***
Toothbrushes	***2.21***	***1.85***	***7.72%***

Tuna	***1.99***	***1.48***	***12.93%***
Toothpastes	***2.53***	***2.07***	***8.78%***
Toilet papers	***2.51***	***1.24***	***30.63%***
Average of the Positive % Differences			**10.84%**

Notes

In columns (1) and (2), we report the average 9-ending and 0-ending prices, respectively, in each one of the 29 Dominick's product categories, calculated over all stores and weeks. In column (3), we report the percentage difference between the average 9-ending and the average 0-ending prices computed as a log-difference. The 20 product categories with positive values in column (3) are indicated in italic boldface. All the differences are statistically significant based on the Mann-Whitney test with $p < 0.01$.

Table B2. Regression Analyses of the Percentage Difference between 9-Ending and 0-Ending Prices, Dominick's, September 14, 1989–May 8, 1997

	(1)	(2)	(3)	*N*
Analgesics	0.18 (0.009)***	0.18 (0.009)***	0.15 (0.003)***	2,627,640
Bath Soaps	−0.16 (0.035)***	−0.14 (0.035)***	0.31 (0.002)***	382,106
Beers	0.33 (0.018)***	0.31 (0.018)***	0.22 (0.003)***	1,889,570
Bottled Juices	0.08 (0.011)***	0.08 (0.011)***	0.02 (0.001)***	2,400,064
Cereals	0.05 (0.002)***	0.05 (0.003)***	0.05 (0.001)***	2,061,159
Cheese	0.23 (0.003)***	0.18 (0.002)***	0.17 (0.001)***	4,426,654
Cigarettes	1.10 (0.080)***	0.03 (0.035)***	0.55 (0.003)***	452,873
Cookies	−0.10 (0.013)***	−0.05 (0.012)***	−0.04 (0.001)***	5,758,138
Crackers	0.01 (0.005)	0.01 (0.006)	−0.00 (0.001)**	1,491,464
Canned Soups	−0.00 (0.015)	−0.02 (0.015)	−0.03 (0.001)***	1,858,854
Dish Detergents	0.07 (0.006)***	0.05 (0.006)***	0.09 (0.002)***	1,483,456
Front End Candies	0.35 (0.003)***	0.34 (0.003)***	0.22 (0.001)***	2,800,489
Frozen Dinners	−0.25 (0.08)***	−0.29 (0.09)***	−0.06 (0.001)***	1,157,152
Frozen Entrees	−0.27 (0.012)***	−0.29 (0.012)***	−0.28 (0.000)***	4,962,968
Frozen Juices	−0.23 (0.010)***	−0.24 (0.011)***	−0.17 (0.001)***	1,253,120
Fabric Softeners	0.02 (0.006)***	0.01 (0.006)	0.02 (0.001)***	1,418,673
Grooming products	0.44 (0.002)***	0.34 (0.001)***	0.31 (0.001)***	3,665,407
Laundry Detergents	0.09 (0.012)***	0.09 (0.010)***	0.11 (0.000)***	2,545,027
Oatmeal	0.11 (0.007)***	0.10 (0.007)***	0.07 (0.001)***	534,846
Paper Towels	0.01 (0.015)	−0.02 (0.016)	−0.03 (0.003)***	496,075
Refrigerated Juices	0.02 (0.006)***	0.02 (0.006)***	0.06 (0.001)***	1,301,869
Soft Drinks	0.48 (0.013)***	0.11 (0.013)***	0.09 (0.001)***	9,342,891
Shampoos	0.26 (0.007)***	0.21 (0.005)***	0.28 (0.001)***	4,383,314
Snack Crackers	0.08 (0.010)***	0.09 (0.010)***	0.06 (0.001)***	2,635,531
Soaps	0.14 (0.007)***	0.14 (0.006)***	0.17 (0.002)***	1,188,833
Toothbrushes	0.15 (0.006)***	0.16 (0.006)***	0.18 (0.001)***	1,392,950

Tuna	0.27 (0.004)***	0.27 (0.005)***	−0.01 (0.001)***	1,250,726
Toothpastes	0.19 (0.006)***	0.19 (0.006)***	0.15 (0.001)***	1,973,223
Toilet papers	0.66 (0.018)***	0.65 (0.019)***	0.14 (0.002)***	662,257
Dummies for weeks	√		√	
Dummies for product-store			√	
Dummies for sub-categories-store	√			
Dummies for sub-categories-store-weeks		√		

Notes

In the table, we report the coefficient estimates of a 9-ending dummy in OLS regressions with fixed effects, where the dependent variable is the log of the prices. The sample includes only 9-ending and 0-ending prices. The 9-ending dummy equals 1 if the price ends with 9, and 0 if the price ends with 0. In column (1), the regression includes controls for weeks and for subcategories-store. In column (2), the regression includes controls for subcategories-stores-weeks. In column (3), the regression includes dummies for weeks and for product-store. In parentheses, we report robust standard errors, clustered at the store level. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$.

Table B3. Average Truncated 9-Ending and non 9-Ending Prices, and the Percentage Differences between Them, Dominick's, September 14, 1989–May 8, 1997

Category	(1) 9-Ending	(2) Non 9-Ending	(3) % Difference
Analgesics	***5.24***	***4.26***	***20.71%***
Bath Soaps	3.06	3.21	−4.79%
Beers	5.59	5.79	−3.52%
Bottled Juices	***2.18***	***2.17***	***0.46%***
Cereals	2.99	3.10	−3.61%
Cheese	***2.50***	***2.23***	***11.43%***
Cigarettes	***11.84***	***6.81***	***55.31%***
Cookies	1.97	2.18	−10.13%
Crackers	***1.99***	***1.86***	***6.76%***
Canned Soups	***1.12***	***1.05***	***6.45%***
Dish Detergents	***2.27***	***2.26***	***0.44%***
Front End Candies	***0.65***	***0.50***	***26.24%***
Frozen Dinners	2.24	2.38	−6.06%
Frozen Entrees	2.25	2.28	−1.32%
Frozen Juices	1.23	1.40	−12.95%
Fabric Softeners	***2.79***	***2.69***	***3.65%***
Grooming products	***2.93***	***2.38***	***20.79%***
Laundry Detergents	***5.67***	***5.06***	***11.38%***
Oatmeal	2.56	2.61	−1.93%
Paper Towels	***1.60***	***1.26***	***23.89%***
Refrigerated Juices	***2.19***	***2.14***	***2.31%***
Soft Drinks	***2.44***	***1.40***	***55.55%***
Shampoos	***2.91***	***2.41***	***18.85%***
Snack Crackers	***2.11***	***2.09***	***0.95%***
Soaps	***2.65***	***2.07***	***24.70%***

Toothbrushes	***2.12***	***2.04***	***3.85%***
Tuna	***1.90***	***1.58***	***18.44%***
Toothpastes	***2.44***	***2.21***	***9.90%***
Toilet papers	***2.42***	***1.60***	***41.38%***
Average of the Positive % Differences			**17.31**

Notes

Columns (1) and (2) report the average truncated 9-ending and non 9-ending prices, respectively, in each of the 29 Dominick's product categories, calculated over all stores and weeks. Column (3) reports the percentage difference between them computed as a log-difference. The 21 product categories with positive values in column (3) are indicated in italic boldface. All the differences are statistically significant based on the Mann-Whitney test, with $p < 0.01$.

Table B4. Regression Analyses of the Percentage Difference between Truncated 9-Ending and Non 9-Ending Prices, Dominick's, September 14, 1989–May 8, 1997

	(1)	(2)	(3)	*N*
Analgesics	0.12 (0.005)***	0.12 (0.005)***	0.14 (0.001)***	3,040,159
Bath Soaps	−0.00 (0.010)	0.00 (0.009)	0.09 (0.001)***	418,096
Beers	0.02 (0.010)	0.02 (0.009)**	−0.03 (0.001)***	1,966,147
Bottled Juices	0.00 (0.003)	0.00 (0.003)	−0.00 (0.000)***	4,325,024
Cereals	−0.04 (0.001)***	−0.04 (0.001)***	−0.01 (0.000)***	4,707,772
Cheese	0.08 (0.002)***	0.06 (0.002)***	0.12 (0.003)***	6,752,325
Cigarettes	0.58 (0.059)***	0.00 (0.006)	0.26 (0.001)***	1,801,443
Cookies	−0.12 (0.003)***	−0.03 (0.002)***	−0.03 (0.000)***	7,568,350
Crackers	0.04 (0.001)***	0.05 (0.001)***	0.01 (0.000)***	2,228,268
Canned Soups	0.05 (0.006)***	0.04 (0.006)***	0.01 (0.000)***	5,504,492
Dish Detergents	0.01 (0.007)	0.01 (0.004)**	−0.01 (0.000)***	2,164,793
Front End Candies	0.33 (0.002)***	0.31 (0.003)***	0.16 (0.000)***	4,436,801
Frozen Dinners	−0.04 (0.007)***	−0.04 (0.007)***	0.02 (0.000)***	1,654,053
Frozen Entrees	0.03 (0.005)***	0.03 (0.005)***	−0.02 (0.000)***	7,172,075
Frozen Juices	−0.12 (0.003)***	−0.12 (0.003)***	−0.10 (0.000)***	351,519
Fabric Softeners	−0.05 (0.003)***	−0.06 (0.003)***	−0.01 (0.000)***	2,278,536
Grooming products	0.19 (0.002)***	0.14 (0.002)***	0.15 (0.000)***	4,065,687
Laundry Detergents	0.08 (0.003)***	0.12 (0.002)***	0.11 (0.001)***	3,277,442
Oatmeal	−0.04 (0.006)***	−0.03 (0.006)***	−0.01 (0.000)***	981,037
Paper Towels	0.10 (0.001)***	0.09 (0.001)***	−0.00 (0.001)**	940,757
Refrigerated Juices	0.04 (0.004)***	0.04 (0.004)***	0.04 (0.001)***	2,166,755
Soft Drinks	0.69 (0.010)***	0.27 (0.005)***	0.27 (0.000)***	10,741,681
Shampoos	0.14 (0.012)***	0.09 (0.009)***	0.09 (0.000)***	4,666,564
Snack Crackers	0.00 (0.005)	0.01 (0.004)	0.02 (0.000)***	3,487,548
Soaps	0.13 (0.004)***	0.12 (0.004)***	0.09 (0.001)***	1,835,196
Toothbrushes	−0.06 (0.005)***	−0.04 (0.005)***	−0.01 (0.000)***	1,772,158
Tuna	0.16 (0.003)***	0.16 (0.003)***	0.07 (0.001)***	2,382,983

Toothpastes	−0.02 (0.004)***	−0.01 (0.004)***	−0.03 (0.000)***	2,981,532
Toilet papers	0.39 (0.008)***	0.39 (0.008)***	0.07 (0.001)***	1,149,972
Dummies for weeks	√		√	
Dummies for product-store			√	
Dummies for sub-categories-store	√			
Dummies for sub-categories-store-weeks		√		

Notes

The table reports the coefficients of a 9-ending dummy in OLS regressions with fixed effects, where the dependent variable is the log of the prices. The sample includes truncated 9-ending and non 9-ending prices. In column (1), the regression includes controls for weeks and for subcategories-store. In column (2), the regression includes controls for subcategories-stores-weeks. In column (3), the regression includes dummies for weeks and for product-store. Robust standard errors, clustered at the store level are reported in parentheses. *** $p < 1\%$. ** $p < 5\%$

Table B5. Regression Analyses of the Level Difference between 9-Ending and Non 9-Ending Prices, Dominick's, September 14, 1989–May 8, 1997

	(1)	(2)	(3)	*N*
Analgesics	0.64 (0.025)***	0.65 (0.026)***	0.72 (0.004)***	3,040,172
Bath Soaps	−0.19 (0.49)***	−0.16 (0.47)***	0.33 (0.004)***	418,097
Beers	−0.07 (0.040)*	0.00 (0.039)	−0.22 (0.006)***	1,966,148
Bottled Juices	0.06 (0.007)***	0.06 (0.007)***	0.04 (0.001)***	4,325,024
Cereals	−0.06 (0.003)***	−0.06 (0.003)***	0.03 (0.001)***	4,707,776
Cheese	0.25 (0.004)***	0.21 (0.003)***	0.33 (0.001)***	6,752,326
Cigarettes	4.83 (0.472)***	−0.02 (0.036)	2.16 (0.010)***	1,801,444
Cookies	−0.20 (0.037)***	−0.02 (0.005)***	−0.00 (0.000)***	7,568,352
Crackers	0.13 (0.003)***	0.14 (0.002)***	0.04 (0.001)***	2,228,268
Canned Soups	0.10 (0.006)***	0.10 (0.006)***	0.06 (0.000)***	5,504,492
Dish Detergents	0.09 (0.014)***	0.10 (0.010)***	0.05 (0.001)***	2,164,793
Front End Candies	0.23 (0.002)***	0.22 (0.002)***	0.13 (0.000)***	4,437,054
Frozen Dinners	−0.06 (0.017)***	−0.06 (0.017)***	0.04 (0.001)***	1,654,053
Frozen Entrees	0.02 (0.015)	0.01 (0.016)	−0.08 (0.001)***	7,172,075
Frozen Juices	−0.12 (0.004)***	−0.12 (0.004)***	−0.10 (0.001)***	2,368,157
Fabric Softeners	0.07 (0.008)***	0.06 (0.007)***	0.16 (0.002)***	2,278,995
Grooming products	0.58 (0.008)***	0.38 (0.006)***	0.42 (0.001)***	4,065,689
Laundry Detergents	0.62 (0.015)***	0.86 (0.011)***	0.77 (0.004)***	3,277,444
Oatmeal	−0.04 (0.014)***	−0.03 (0.001)*	0.02 (0.001)***	981,037
Paper Towels	0.43 (0.021)***	0.42 (0.021)***	0.28 (0.003)***	940,757
Refrigerated Juices	0.11 (0.008)***	0.11 (0.008)***	0.12 (0.001)***	2,166,755
Soft Drinks	1.08 (0.13)***	0.35 (0.007)***	0.41 (0.001)***	10,741,742
Shampoos	0.52 (0.032)***	0.37 (0.024)***	0.30 (0.001)***	4,666,565
Snack Crackers	0.03 (0.008)***	0.04 (0.008)***	0.09 (0.001)***	3,487,564
Soaps	0.49 (0.012)***	0.49 (0.012)***	0.43 (0.002)***	1,835,196
Toothbrushes	−0.03 (0.008)***	−0.01 (0.008)	0.05 (0.001)***	1,772,158
Tuna	0.47 (0.005)***	0.37 (0.005)***	0.21 (0.001)***	2,382,983

Toothpastes	0.05 (0.009)***	0.06 (0.008)***	−0.03 (0.001)***	2,981,532
Toilet papers	0.75 (0.004)***	0.75 (0.004)***	0.26 (0.002)***	1,149,972
Dummies for weeks	√		√	
Dummies for product-store			√	
Dummies for sub-categories-store	√			
Dummies for sub-categories-store-weeks		√		

Notes

In the table, we report the coefficient estimates of a 9-ending dummy in OLS regressions with fixed effects, where the dependent variables are the prices. The 9-ending dummy equals 1 if the price ends with 9, and 0 if the price ends with any other digit. In column (1), the regression includes controls for weeks and for subcategories-store. In column (2), the regression includes controls for subcategories-stores-weeks. In column (3), the regression includes dummies for weeks and for product-store. In parentheses, we report robust standard errors, clustered at the store level. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$.

Table B6. Average 9-Ending and Non 9-Ending Prices, and Percentage Difference between Them, Outliers Excluded, Dominick's, September 14, 1989–May 8, 1997

Category	(1) 9-Ending	(2) Non 9-Ending	(3) % Difference
Analgesics	***4.95***	***4.16***	***7.55%***
Bath Soaps	***2.88***	***2.60***	***4.40%***
Beers	***1.58***	***1.54***	***1.14%***
Bottled Juices	***2.13***	***2.12***	***0.20%***
Cereals	3.08	3.17	−1.20%
Cheese	***2.34***	***2.16***	***3.52%***
Cigarettes	***11.92***	***6.80***	***24.39%***
Cookies	0.67	0.74	−4.10%
Crackers	***2.05***	***1.87***	***3.91%***
Canned Soups	***1.16***	***1.05***	***4.37%***
Dish Detergents	0.74	0.75	−0.58%
Front End Candies	***0.74***	***0.51***	***16.18%***
Frozen Dinners	2.29	2.31	−0.46%
Frozen Entrees	***2.25***	***2.03***	***4.56%***
Frozen Juices	1.31	1.39	−2.48%
Fabric Softeners	2.58	2.63	−0.75%
Grooming products	***2.78***	***2.31***	***8.07%***
Laundry Detergents	***4.72***	***5.14***	***3.70%***
Oatmeal	2.68	2.69	−0.09%
Paper Towels	***1.28***	***1.22***	***1.93%***
Refrigerated Juices	***0.72***	***0.64***	***5.41%***
Soft Drinks	***2.16***	***1.30***	***22.13%***
Shampoos	***2.75***	***2.39***	***6.15%***
Snack Crackers	***2.20***	***2.14***	***1.15%***
Soaps	***2.33***	***2.07***	***5.05%***

Toothbrushes	***2.13***	***2.01***	***2.54%***
Tuna	***1.80***	***1.52***	***7.34%***
Toothpastes	***0.84***	***0.79***	***2.80%***
Toilet papers	***2.10***	***1.55***	***13.21%***
Average of the Positive % Differences			**15.96%**

Notes

In columns (1) and (2), we report the average 9-ending and non 9-ending prices, respectively, in each one of Dominick's 29 product categories, calculated over all stores and weeks. In column (3), we report the percentage difference between them computed as a log-difference. For each product category, we exclude from the sample the observations that are more than two standard deviations away from the category mean. The 22 product categories with positive values in column (3) are indicated in italic boldface. All the differences are statistically significant based on the Mann-Whitney test with $p < 0.01$.

Table B7. Regression Analysis of the Percentage Difference between the 9-Ending and Non 9-Ending Prices, Outliers Excluded, Dominick's, September 14, 1989–May 8, 1997

	(1)	(2)	(3)	*N*
Analgesics	0.11 (0.004)***	0.11 (0.004)***	0.12 (0.001)***	2,893,605
Bath Soaps	0.10 (0.005)***	0.10 (0.004)***	0.11 (0.001)***	392,621
Beers	0.06 (0.001)***	0.06 (0.001)***	−0.02 (0.001)***	1,858,635
Bottled Juices	0.02 (0.002)***	0.01 (0.002)***	0.01 (0.000)***	4,166,948
Cereals	−0.03 (0.001)***	−0.03 (0.001)***	0.01 (0.000)***	4,478,505
Cheese	0.08 (0.002)***	0.06 (0.001)***	−0.03 (0.001)***	6,487,618
Cigarettes	0.60 (0.006)***	0.02 (0.005)***	0.28 (0.001)***	1,796,262
Cookies	−0.10 (0.002)***	0.00 (0.001)	0.01 (0.000)***	7,308,003
Crackers	0.07 (0.001)***	0.07 (0.001)***	0.03 (0.000)***	2,151,818
Canned Soups	0.09 (0.005)***	0.09 (0.005)***	0.06 (0.000)***	5,345,950
Dish Detergents	0.00 (0.007)	0.01 (0.005)**	0.00 (0.000)***	2,087,095
Front End Candies	0.40 (0.002)***	0.39 (0.002)***	0.24 (0.000)***	4,397,689
Frozen Dinners	−0.00 (0.007)	0.00 (0.006)	0.07 (0.000)***	1,617,178
Frozen Entrees	0.11 (0.003)***	0.12 (0.003)***	0.08 (0.000)***	6,832,117
Frozen Juices	−0.06 (0.002)***	−0.07 (0.002)***	−0.05 (0.000)***	2,319,924
Fabric Softeners	−0.07 (0.003)***	−0.07 (0.004)***	−0.01 (0.000)***	2,161,634
Grooming products	0.19 (0.003)***	0.15 (0.003)***	0.16 (0.000)***	3,872,011
Laundry Detergents	0.07 (0.003)***	0.09 (0.002)***	0.08 (0.001)***	3,087,133
Oatmeal	−0.01 (0.006)*	−0.01 (0.006)	0.01 (0.000)***	926,918
Paper Towels	0.04 (0.007)***	0.04 (0.008)***	−0.06 (0.001)***	903,436
Refrigerated Juices	0.10 (0.003)***	0.10 (0.003)***	0.09 (0.001)***	2,064,972
Soft Drinks	0.63 (0.009)***	0.31 (0.005)***	0.28 (0.000)***	1,0091,205
Shampoos	0.12 (0.010)***	0.11 (0.008)***	0.11 (0.000)***	4,462,260
Snack Crackers	−0.00 (0.002)**	0.00 (0.002)	0.05 (0.000)***	3,361,275
Soaps	0.08 (0.003)***	0.07 (0.002)***	0.04 (0.000)***	1,722,143
Toothbrushes	−0.05 (0.005)***	−0.04 (0.005)***	0.02 (0.000)***	1,713,069

Tuna	0.16 (0.002)***	0.16 (0.002)***	0.09 (0.000)***	2,285,445
Toothpastes	−0.02 (0.002)***	−0.02 (0.002)***	−0.02 (0.000)***	2,878,058
Toilet papers	0.36 (0.007)***	0.35 (0.007)***	0.08 (0.001)***	1,091,805
Dummies for weeks	√		√	
Dummies for product-store			√	
Dummies for sub-categories-store	√			
Dummies for sub-categories-store-weeks		√		

Notes

The table reports the coefficients of a 9-ending dummy in OLS regressions with fixed effects, where the dependent variable is the log of the prices. For each product category, we exclude from the sample the observations that are more than two standard deviations away from the category mean. In column (1), the regression includes controls for weeks and for subcategories-store. In column (2), the regression includes controls for subcategories-stores-weeks. In column (3), the regression includes dummies for weeks and for product-store. The estimated coefficients in the Oatmeal category in columns (1) and (2) look equal because of the rounding. Without rounding, only one of them is statistically significant. Robust standard errors, clustered at the store level are reported in parentheses. *** $p < 1\%$. ** $p < 5\%$

Table B8. The Share of 9-Ending Prices by Product Categories,
Using Dominick's Sale Dummy, September 14, 1989–May 8, 1997

Category	(1) Sale Prices	(2) Regular Prices	(3) Difference
Analgesics	69.2%	87.6%	−18.4%
Bath Soaps	61.8%	91.6%	−29.8%
Beers	95.6%	95.8%	-0.2%
Bottled Juices	42.3%	52.7%	−10.4%
Cereals	41.1%	39.6%	1.6%
Cheese	46.5%	64.6%	−18.1%
Cigarettes	100.0%	16.5%	83.6%
Cookies	45.2%	79.8%	−34.6%
Crackers	35.5%	72.3%	−36.8%
Canned Soups	26.3%	31.7%	−5.4%
Dish Detergents	57.7%	68.8%	−11.1%
Front End Candies	21.8%	40.7%	−18.9%
Frozen Dinners	28.9%	65.7%	−6.8%
Frozen Entrees	25.6%	67.8%	−42.2%
Frozen Juices	48.8%	45.8%	3.0%
Fabric Softeners	54.4%	60.3%	−5.9%
Grooming products	60.0%	92.2%	−32.2%
Laundry Detergents	64.2%	78.6%	−14.4%
Oatmeal	37.1%	53.9%	−16.8%
Paper Towels	45.0%	51.4%	−6.4%
Refrigerated Juices	55.9%	57.1%	−1.2%
Soft Drinks	69.3%	88.6%	−19.3%
Shampoos	79.3%	94.2%	−14.9%
Snack Crackers	43.1%	81.3%	−38.2%
Soaps	44.2%	66.2%	−22.0%
Toothbrushes	70.0%	79.2%	−9.2%
Tuna	33.7%	52.4%	−18.7%

Toothpastes	65.4%	63.5%	1.9%
Toilet papers	52.0%	53.7%	−1.7%
Average of the Negative Differences			**−18.5%**

Notes

We use Dominick's sale dummy indicator to identify sale prices. In column (1), we report the percentage of 9-ending prices among sale prices. In column (2), we report the percentage of 9-ending prices among regular prices. In column (3), we report the difference between the percentage of 9-ending prices among sale prices and among regular prices. All differences are statistically significant with $p < 0.01$, based on the z-scores proportions test.

Table B9. Regression Analysis of the Percentage Difference between 9-Ending and Non 9-Ending Prices, Regular Prices vs Sale Prices, Using Dominick's Sale Dummy, September 14, 1989–May 8, 1997

	Regular Prices				**Sale Prices**			
	(1)	**(2)**	**(3)**	***N***	**(4)**	**(5)**	**(6)**	***N***
Analgesics	0.14*** (0.005)	0.14*** (0.006)	0.16*** (0.001)	2,782,538	−0.01*** (0.002)	−0.00 (0.002)	−0.00** (0.002)	257,634
Bath Soaps	−0.09*** (0.015)	−0.09*** (0.014)	0.06*** (0.001)	372,448	0.07*** (0.009)	0.06*** (0.007)	0.00 (0.002)	45,649
Beers	−0.13*** (0.006)	−0.11*** (0.006)	−0.008*** (0.001)	1,421,725	0.36*** (0.017)	0.34*** (0.017)	0.13*** (0.002)	544,423
Bottled Juices	0.04*** (0.003)	0.03*** (0.003)	0.03*** (0.00)	3,482,485	−0.02*** (0.002)	−0.03*** (0.003)	−0.03*** (0.001)	842,539
Cereals	−0.02*** (0.001)	−0.02*** (0.001)	0.01*** (0.000)	4,365,153	0.02*** (0.002)	0.00 (0.002)	−0.02*** (0.001)	342,623
Cheese	0.12*** (0.003)	0.09*** (0.002)	0.18*** (0.000)	5,559,438	−0.02*** (0.002)	−0.00 (0.002)	−0.00*** (0.001)	1,192,888
Cigarettes	0.59*** (0.058)	0.02*** (0.005)	0.27*** (0.01)	1,801,423	NA	NA	NA	21
Cookies	−0.14*** (0.003)	−0.03*** (0.006)	−0.04*** (0.000)	6,289,751	−0.09*** (0.003)	−0.06*** (0.002)	−0.07*** (0.000)	1,278,677
Crackers	0.08*** (0.001)	0.09*** (0.001)	0.02*** (0.000)	1,726,858	−0.06*** (0.002)	−0.07*** (0.001)	−0.05*** (0.001)	501,410
Canned Soups	0.10*** (0.006)	0.09*** (0.006)	0.07*** (0.000)	4,806,570	0.03*** (0.003)	0.05*** (0.003)	−0.01*** (0.000)	697,922
Dish Detergents	0.04*** (0.008)	0.05*** (0.004)	0.03*** (0.000)	1,871,492	−0.07*** (0.002)	−0.07*** (0.002)	−0.06*** (0.001)	293,301
Front End Candies	0.40*** (0.002)	0.39*** (0.003)	0.24*** (0.000)	4,025,320	0.07*** (0.004)	0.04*** (0.004)	−0.01 (0.002)	411,734
Frozen Dinners	−0.07*** (0.007)	−0.07*** (0.007)	0.01*** (0.003)	1,254,403	−0.01 (0.009)	−0.03*** (0.009)	−0.07*** (0.001)	399,650
Frozen Entrees	0.09*** (0.003)	0.08*** (0.002)	0.02*** (0.000)	5,830,824	−0.19*** (0.006)	−0.23*** (0.007)	−0.20*** (0.001)	1,341,251
Frozen Juices	−0.05*** (0.002)	−0.06*** (0.003)	−0.04*** (0.000)	1,915,472	−0.19*** (0.006)	−0.19*** (0.007)	−0.12*** (0.001)	452,685
Fabric Softeners	−0.05*** (0.003)	−0.06*** (0.003)	0.01*** (0.001)	1,947,002	0.10*** (0.004)	0.13*** (0.002)	0.00** (0.001)	331,993

Grooming products	0.07*** (0.003)	0.04*** (0.004)	0.08*** (0.001)	3,379,005	0.21*** (0.003)	0.12*** (0.002)	0.11*** (0.001)	686,684
Laundry Detergents	0.07*** (0.003)	0.11*** (0.003)	0.12*** (0.001)	2,783,222	0.20*** (0.003)	0.19*** (0.003)	0.07*** (0.001)	494,222
Oatmeal	−0.03*** (0.005)	−0.03*** (0.006)	0.00*** (0.000)	884,061	−0.03*** (0.004)	0.01 (0.004)	−0.03*** (0.001)	96,976
Paper Towels	0.15*** (0.011)	0.15*** (0.011)	0.06*** (0.001)	740,148	0.05*** (0.006)	0.04*** (0.006)	0.02*** (0.002)	200,609
Refrigerated Juices	0.09*** (0.005)	0.09*** (0.005)	0.08*** (0.001)	1,649,385	−0.01*** (0.002)	−0.02*** (0.002)	−0.00** (0.000)	517,370
Soft Drinks	0.84*** (0.011)	0.43*** (0.005)	0.42*** (0.001)	7,458,955	0.60*** (0.009)	0.11*** (0.004)	0.13*** (0.001)	3,282,787
Shampoos	0.13*** (0.017)	0.09*** (0.013)	0.05*** (0.000)	3,817,736	−0.03*** (0.004)	−0.05*** (0.003)	0.02*** (0.001)	848,829
Snack Crackers	0.01 (0.007)	0.01 (0.006)	0.04*** (0.000)	2,704,331	−0.04*** (0.003)	−0.04*** (0.003)	−0.06*** (0.000)	783,233
Soaps	0.16*** (0.005)	0.15*** (0.004)	0.12*** (0.001)	1,544,719	0.11*** (0.002)	0.12*** (0.002)	0.03*** (0.001)	290477
Toothbrushes	−0.05*** (0.005)	−0.03*** (0.005)	0.00 (0.001)	1,472,393	−0.03 (0.004)	−0.02 (0.003)	−0.04*** (0.001)	299765
Tuna	0.21*** (0.003)	0.22*** (0.003)	0.11*** (0.001)	1,950,555	−0.01*** (0.004)	−0.01 (0.004)	−0.01*** (0.002)	432,428
Toothpastes	−0.01* (0.005)	−0.00 (0.004)	−0.02*** (0.000)	2,534,793	0.02*** (0.002)	0.04*** (0.002)	−0.02*** (0.001)	446,739
Toilet papers	0.45*** (0.008)	0.45*** (0.009)	0.14*** (0.001)	920,896	0.20*** (0.007)	0.20*** (0.006)	0.01*** (0.002)	229,076
Dummies for weeks	√		√		√		√	
Dummies for product-store			√				√	
Dummies for sub-categories-store	√				√			
Dummies for sub-categories-store-weeks		√				√		

Notes

In the table, we report the coefficient estimates of a 9-ending dummy in OLS regressions with fixed effects, where the dependent variable is the log of the prices. In columns (1)–(3), we report the results when we estimate the regression using

data on regular prices only. In columns (4)–(6), we report the results when we estimate the regression using data on sale prices only. We use Dominick's sale dummy indicator to identify sale prices. In columns (1) and (4), the regression includes controls for weeks and for subcategories-store. In columns (2) and (5), the regression includes controls for subcategories-stores-weeks. In columns (3) and (6), the regression includes dummies for weeks and for product-store. We could not estimate a regression for sale prices in the Cigarettes' category because there are only 21 observations on sale prices in that category and all of them end with 9. In parentheses we report robust standard errors, clustered at the store level. * $p <$ 10%, ** $p <$ 5%, *** $p <$ 1%.

APPENDIX C. ANNUAL DYNAMICS OF 9-ENDING AND NON 9-ENDING PRICES: REGULAR PRICES VS SALE PRICES USING DOMINICK'S SALE DUMMY

In the paper, we show that there were significant changes in the shares of 9-ending prices over time among regular and sale prices. In addition, we show that the difference between the average 9- and non 9-ending prices among regular and sale prices have changed significantly over time. In this section, we replicate these calculations, this time using the Dominick's sale Dummy instead of the sale filter we use in the paper.

Table C1 gives the shares of 9-ending prices among regular and sale prices. It can be observed that among regular prices, the share of 9-ending prices increases over time: The share of 9-ending prices among regular prices was 51.66% in 1989 and 75.07% in 1997, an increase of 45%. Among sale prices, the share of 9-ending prices was relatively constant and even decreasing: it was 53.48% in 1989 and 45.00% in 1996, before recovering to 62.19% in 1997.

The changes in the shares of 9-ending prices among regular and sale prices result in 9-ending being more common among sale prices than regular prices in 1989 (53.48% vs. 51.66%). From 1990 onwards, they became more popular among regular than among sale prices.

In Table C2, we present for each year, the average price over all products, stores and weeks. In Panel A, we report the average 9- and non 9-ending prices for all the observations, and in Panels B and C for regular and sale prices, respectively. The figures indicate that the difference between 9- and non 9-ending prices has been increasing over time. When we look at all observations, the percentage difference increases from 1.75 percent in 1989, to 27.09 percent in 1997. For regular prices, we find that the difference increases from 1.28 percent in 1989, to 22.31 percent in 1997, while for sale prices its increases from 10.21 percent in 1989, to 45.33 percent in 1997

These figures are averages, however, and thus they could be affected by the heterogeneity across products. To control for that, we estimate two sets of log-linear OLS regressions, one regression equation for each year. The dependent variable in all

regressions is the log of the prices. The main independent variable in all the regressions is a 9-ending dummy. Its coefficient should capture the expected percentage difference between 9- and non 9-ending prices. A positive (negative) 9-ending dummy coefficient indicates that the expected 9-ending prices are higher (lower) than the expected non 9-ending prices. To control for heterogeneity, the first set of regressions also includes fixed effects for stores, product categories, product sub-categories, and weeks. The top panel of Table C3 reports the results.

We find that throughout the time period, the coefficients of the 9-ending dummy in the regular prices' regression are positive and significant. It therefore seems that when we control for heterogeneity by comparing products within subcategories, the expected 9-ending regular prices were always larger than the expected non 9-ending regular prices.

For sale prices, however, we find that until 1993, the coefficient of the 9-ending dummy is negative. Thus, until 1993, the expected 9-ending sale price was lower than the expected non 9-ending sale price. I.e., when we define sales by the Dominick's sale dummy, we find that in the early part of the data the expected 9-ending prices were lower than the corresponding non 9-ending prices. This has changed, however, in the later period.

The bottom panel summarizes the results of a stricter test: In the bottom panel we summarize the results of annual regressions that include, in addition to the 9-ending dummy, controls for products in stores and for weeks. Thus, the coefficient estimates of the 9-ending dummy should capture the average difference between 9-eding and non 9-ending prices at the level of an individual product, offered at a specific store. In other words, the coefficient estimate will indicate whether a consumer that has bought a product in a specific store, in a given year, got a better deal at a 9-ending or a non 9-ending price.

The results are stronger than the ones we find in Panel A: When we look at the product-store level, we find that during 1989–1990, 9-ending regular prices were usually lower than non 9-ending regular prices. Thus, in that period, 9-ending prices were indeed associated with lower regular and overall prices. In addition, during the same period, the expected 9-ending sale prices were also lower than non 9-ending sale prices.

From 1993 onwards the expected 9-ending regular price was higher than the expected non 9-ending regular prices, resulting in 9-ending prices being higher, overall, than non 9-ending prices. The expected 9-ending sale prices, however, remained lower than the expected non 9-ending sale prices until 1996. Thus, until 1991 a consumer that has bought a product in a specific store, was better off, in expected terms, if s/he bought the good when its price was 9-ending. Following that time, if s/he bought the good at a regular price, s/he was better off if s/he bought the good when its price was not 9-ending. If the consumer, however, bought the good at a sale price, then s/he made a better deal if s/he bought the product at a 9-ending price rather than a non 9-ending price.

Table C1. The Share of 9-Ending Prices in Regular and Sale Prices, Using Dominick's Sale Dummy, Dominick's, September 14, 1989–May 8, 1997

Year	All Observations	Regular Price	Sale Price
1989	51.91%	51.66%	53.48%
1990	54.66%	55.05%	52.49%
1991	55.76%	56.77%	50.58%
1992	63.93%	65.86%	54.77%
1993	63.82%	65.60%	55.89%
1994	67.23%	70.12%	55.12%
1995	66.67%	71.09%	48.01%
1996	68.85%	74.22%	45.00%
1997	73.05%	75.07%	62.19%

Table C2. Annual Average 9-Ending and Non 9-Ending Prices, and Percentage Difference between Them, Regular and Sale Prices, Using Dominick's Sale Dummy, Dominick's, September 14, 1989–May 8, 1997

Year	(1) All observations			(2) Regular Price			(3) Sale Price		
	9-Ending	Non 9-Ending	% Difference	9-Ending	Non 9-Ending	% Difference	9-Ending	Non 9-Ending	% Difference
1989	2.30	2.26	1.75%	2.35	2.32	1.28%	2.06	1.86	10.21%
1990	2.36	2.31	2.14%	2.42	2.34	3.36%	2.01	2.18	−8.12%
1991	2.67	2.46	8.19%	2.74	2.18	22.86%	2.27	2.55	−11.63%
1992	2.78	2.12	27.10%	2.83	2.10	29.83%	2.51	2.16	15.02%
1993	2.67	2.34	13.19%	2.69	2.45	9.35%	2.57	1.96	27.10%
1994	2.77	2.26	20.35%	2.78	2.41	14.28%	2.69	1.86	36.90%
1995	2.86	2.16	28.07%	2.86	2.30	21.79%	2.86	1.81	45.75%
1996	2.98	2.30	25.90%	3.02	2.46	20.51%	2.76	1.98	33.21%
1997	3.16	2.41	27.09%	3.15	2.52	22.31%	3.21	2.04	45.33%

Notes

In the three panels we report for each year the average 9-ending and non 9-ending prices, respectively, for all observations, regular prices and sale prices, calculated over all stores and all weeks. In the difference column of each panel we report the percentage difference between the average 9-ending and non 9-ending prices computed as a log-difference. We use Dominick's sale dummy indicator to identify sales.

Table C3. Annual Regressions of the Percentage Difference between 9-Ending and Non 9-Ending Prices, Using Dominick's Sale Dummy, Dominick's, September 14, 1989–May 8, 1997

Panel A						
Year	All Observations		Regular Prices		Sale Prices	
	9-Ending	*N*	9-Ending	*N*	9-Ending	*N*
1989	0.10*** (0.003)	2,570,474	0.12*** (0.004)	2,216,482	0.01*** (0.002)	353,992
1990	0.04*** (0.002)	9,228,965	0.08*** (0.002)	7,826,038	−0.13*** (0.001)	1,402,927
1991	0.03*** (0.003)	10,650,384	0.07*** (0.002)	8,938,168	−0.12*** (0.005)	1,712,216
1992	0.07*** (0.005)	13,731,259	0.09*** (0.003)	11,377,868	−0.04*** (0.010)	2,353,391
1993	0.07*** (0.002)	14,023,602	0.07*** (0.002)	11,486,371	0.05*** (0.003)	2,537,231
1994	0.11*** (0.001)	13,645,820	0.10*** (0.001)	10,972,699	0.05*** (0.001)	2,673,121
1995	0.14*** (0.001)	13,424,315	0.12*** (0.002)	10,854,559	0.05*** (0.001)	2,569,756
1996	0.15*** (0.001)	14,238,652	0.13*** (0.001)	11,625,293	0.03*** (0.002)	2,613,359
1997	0.14*** (0.001)	5,156,434	0.13*** (0.001)	4,3461,99	0.13*** (0.002)	810,235
Panel B						
Year	All Observations		Regular Prices		Sale Prices	
	9-Ending	*N*	9-Ending	*N*	9-Ending	*N*
1989	−0.03*** (0.005)	2,570,474	−0.01*** (0.004)	2,216,482	−0.04 (0.012)	353,992
1990	−0.04*** (0.005)	9,228,965	−0.02*** (0.003)	7,826,038	−0.13*** (0.009)	1,402,927
1991	−0.04*** (0.004)	10,650,384	0.00 (0.003)	8,938,168	−0.17*** (0.008)	1,712,216
1992	−0.00 (0.003)	13,731,259	0.01*** (0.003)	11,377,868	−0.08*** (0.004)	2,353,391
1993	0.02*** (0.002)	14,023,602	0.02*** (0.002)	11,486,371	−0.03*** (0.004)	2,537,231
1994	0.06*** (0.002)	13,645,820	0.04*** (0.002)	10,972,699	−0.01*** (0.002)	2,673,121
1995	0.07*** (0.002)	13,424,315	0.05*** (0.002)	10,854,559	−0.03*** (0.002)	2,569,756
1996	0.10*** (0.002)	14,238,652	0.04*** (0.002)	11,625,293	−0.00 (0.003)	2,613,359
1997	0.09 (0.003)	5,156,434	0.04*** (0.003)	4,346,199	0.07 (0.003)	810,235

Notes

In the table, we report the coefficient estimates of a 9-ending dummy in OLS regressions with fixed effects, where the dependent variable is the log of the prices. The regressions were estimated for each year separately over all stores and all products. The 9-ending dummy equals 1 if the price ends with 9, and 0 if the price ends with any other digit. Panel A gives the results where the regression includes controls for product category, product-subcategory and weeks. Panel B gives the results where the regressions include controls for product-store. The All Observations Panel gives the results of a regression that was estimated using all the observations. The Regular Prices Panel gives the results of a regression that was estimated

using only observations on regular prices. The Sale Prices Panel gives the results of a regression that was estimated using only observations on sale prices. We use the Dominick's sale dummy indicator to identify sale prices. The regressions also include fixed effects for stores, categories, sub−categories and weeks. ***− $p < 0.01$.

APPENDIX D. WEEKLY DYNAMICS OF 9-ENDING AND NON 9-ENDING PRICES: REGULAR PRICES VS SALE PRICES

D.1. Using a Sale Filter

The results presented in the paper suggest that Dominick's may be using low 9-ending sale prices to support consumers' belief that 9-ending prices are lower than non 9-ending prices, although on average they are higher. It might therefore be that low 9-ending sale prices are correlated with high regular 9-ending prices. In other words, it is possible that to draw the consumers' attention away from high 9-ending prices, Dominick's contemporaneously sets low 9-ending sale prices.

If this is the case, then we would expect a negative correlation between 9-ending regular and sale prices: When 9-ending regular prices are high relative to non 9-ending regular prices, we would expect 9-ending sale prices to be low relative to non 9-ending prices.

In the paper we look at these correlations at the annual frequency. Here, we reassess this possibility at the weekly frequency. We thus calculated for each product category the difference between the average 9- and non 9-ending regular prices on a weekly basis. Similarly, we calculated for each product category the difference between the average 9- and non 9-ending sale prices on a weekly basis. We used the same sale filter as in the paper to identify sale prices. We use the results to draw product category level plots of the weekly time series of the percentage difference between the average 9- and non 9-ending prices. The dark line in Figure D1 depicts the average difference between 9- and non 9-ending regular prices over the 400-week sample period. The lighter (blue) dashed line depicts the average difference between 9- and non 9-ending sale prices. Table D1 summarizes the key observations that we draw from the data depicted in the time series plots.

First, it can be observed that the average difference between the average 9- and non 9-ending sale prices is significantly more volatile over time than the difference between 9- and non 9-ending regular prices. For regular prices, the average of the standard deviations of the difference is 20.65%, compared to 34.78% for sale prices. The large variance

suggests that consumers would find it difficult to discern whether or not the 9-ending sale prices are a better deal than a non 9-ending sale prices.

Second, consistent with the findings reported in the paper, the difference between the average 9- and non 9-ending prices is more pronounced for regular than for sale prices. For regular prices the average 9-ending prices are higher than the average non 9-ending prices 63.57% of the time (weeks). For sale prices, they are higher 53.47% of the time (weeks). Thus, whereas 9-ending regular prices are higher than non 9-ending prices most of the time, among sale prices the ratio is closer to 50:50. Another way to see the same phenomenon is to note that for regular prices, in 17 product categories the average 9-ending prices are higher than the average non-9 ending prices 60% of the time (weeks). In 8 of these product categories, the average 9-ending prices are higher than non 9-ending prices more than 80% of the time (weeks).

Among sale prices, in only 6 product categories the average 9-ending prices is higher than the average non 9-endign more than 60% of the time (weeks). And, in only one product category the average 9-ending prices is higher than the average non 9-ending prices more than 80% of the time (weeks).

As for the correlation between regular and sale 9-ending prices, the final column of Table D1 gives, for each product category, the value of the contemporaneous cross-correlation between the difference of 9- and non 9-ending regular and sale prices. Figure D2 complements this information by depicting the cross-correlogram plots for 16 leads and 16 lags for each product category.

The figures in the table indicate that in only 10 of the 27 product categories, the cross-correlations are statistically significant. All the significant cross-correlations are positive. It therefore seems that in the majority of product categories, the correlation between sale and regular 9-ending prices is either weak or positive. Looking at Figure D2, we can see that this is also the case if we study more leads and lags. The weak correlations do not agree with the hypothesis that Dominick's uses low 9-ending sale prices to draw attention away from relatively high 9-ending regular prices. This suggests that Dominick's builds the image of low 9-ending prices over time, perhaps over years, rather than using low 9-ending prices in a given week to draw attention away from high 9-ending regular prices.

D.2. Using Dominick's Sale Dummy

As a robustness check of the results we report in section D.1, we replicate the weekly time series analyses using the Dominick's sale dummy, instead of the sale filter, to identify sales.

We therefore calculated for each product category the difference between the average 9- and non 9-ending regular prices on a weekly basis again, this time using the sale dummy to identify sales. Similarly, we calculated for each product category the difference between the average 9- and non 9-ending sale prices on a weekly basis. We use the results to draw product category level plots of the weekly time series of the percentage difference between the average 9- and non 9-ending prices. The dark line in Figure D3 depicts the average difference between 9- and non 9-ending regular prices over the 400-week sample period. The lighter (blue) dashed line depicts the average difference between 9- and non 9-ending sale prices. Table D2 summarizes the key observations we draw from the data depicted in the Figure.

First, it can be observed, again, that the average difference between the average 9- and non 9-ending sale prices is significantly more volatile over time than the difference between 9- and non 9-ending regular prices. For regular prices, the average of the standard deviations of the difference is 20.48%, compared to 34.50% for sale prices. The large variance suggests that consumers would find it difficult to determine whether or not the 9-ending sale prices are a better deal than a non 9-ending sale prices.

Second, consistent with the findings reported in the paper, compared to sale prices, average regular 9-ending prices are much more likely to be higher than average regular non 9-ending prices. For regular prices, the average 9-ending prices are higher than the average non 9-ending prices 62.53% of the time (weeks). For sale prices, they are higher 50.80% of the time (weeks). Thus, whereas among regular prices, 9-ending prices are higher than non 9-ending prices in the majority of the weeks, among sale prices, the ratio is close to 50:50. Another way to see the same phenomenon is to note that for regular prices, in 17 product categories the average 9-ending prices are higher than the average non-9 ending prices more than 60% of the time (weeks). In 9 of these product categories,

the average 9-ending prices are higher than the average non 9-ending prices more than 80% of the time (weeks).

Among sale prices, in only 7 product categories the average 9-ending prices is higher than the average non 9-endign more than 60% of the time (weeks). And, in only one product category the average 9-ending prices is higher than non 9-ending prices more than 80% of the time (weeks).

Thus, the dynamic behavior of the difference over time, corroborates the findings from more aggregated data analyses presented in the paper. 9-ending prices are much more likely to be higher than non 9-ending prices among regular prices than among sale prices.

As for the correlation between regular and sale 9-ending prices, the final column of Table D2 gives, for each product category, the value of the contemporaneous cross-correlation of the difference between 9- and non 9-ending regular and sale prices. Figure D4 complements this information by depicting the cross-correlogram with 16 leads and 16 lags.

The figures in the table show that in only 15 of the 27 product categories, the cross-correlations are statistically significant. Only 4 of these cross-correlations are negative. It therefore seems that in the majority of product categories, the correlation between sale and regular 9-ending prices is either weak or positive. Looking at Figure D4, we can see that this is also the case if we consider more leads and lags. Thus the conclusion that follows from the analyses of weekly time series data, is not in line with the hypothesis that Dominick's uses low 9-ending sale prices to draw attention away from relatively high 9-ending regular prices. This suggests that Dominick's builds the image of low 9-ending prices over time, at a lower frequency, rather than use low 9-ending prices in a given week to draw attention from high 9-ending regular prices.

Table D1. The Percentage Difference between 9 and non-9 Ending Prices, Regular and Sale Prices, Using a Sale Filter

	Regular Prices				Sale Prices				
	Average Diff.	**S.D. Diff.**	**% Greater than 0**	**% Smaller than 0**	**Average Diff.**	**S.D. Diff.**	**% Greater than 0**	**% Smaller than 0**	**Correlation**
Analgesics	17.09%	19.33%	80.77%	19.23%	-1.16%	30.53%	50.99%	49.01%	0.25**
Bath Soaps	-10.88%	27.95%	36.60%	63.40%	0.21%	28.53%	44.30%	55.70%	0.30***
Beer	7.73%	42.20%	48.33%	51.67%	11.02%	37.36%	56.12%	43.88%	0.64***
Bottled Juices	2.04%	8.00%	61.22%	38.78%	6.96%	29.86%	59.38%	40.63%	0.04
Cereal	-2.26%	3.49%	24.59%	75.41%	0.45%	23.13%	48.42%	51.58%	0.24**
Cheese	12.09%	8.95%	92.09%	7.91%	-0.95%	20.84%	47.26%	52.74%	0.21**
Cigarettes	78.13%	104.24%	68.84%	31.16%					
Cookies	-9.43%	16.25%	27.06%	72.94%	-3.90%	22.46%	42.26%	57.74%	0.14**
Crackers	7.27%	9.61%	79.74%	20.26%	-7.38%	24.81%	43.70%	56.30%	0.11
Canned Soups	9.08%	11.11%	79.37%	20.63%	11.76%	30.71%	63.37%	36.63%	0.07
Dish Detergents	1.33%	18.63%	47.70%	52.30%	-6.53%	33.38%	44.13%	55.87%	0.10
Front End Candies	39.67%	10.49%	100%	0%	11.68%	24.25%	67.23%	32.77%	-0.06
Frozen Dinners	-5.97%	18.09%	39.61%	60.39%	2.36%	33.76%	49.37%	50.63%	0.10
Frozen Entrees	2.29%	21.37%	69.95%	30.05%	5.46%	37.67%	56.91%	43.09%	-0.03
Frozen Juices	-6.28%	9.18%	19.70%	80.30%	-6.06%	24.34%	34.84%	65.16%	0.07
Fabric Softeners	-3.64%	9.72%	37.12%	62.88%	10.15%	38.49%	56.50%	43.50%	-0.02
Grooming products	17.93%	18.62%	85.61%	14.39%	11.74%	31.31%	65.28%	34.72%	0.43***
Laundry Detergents	10.67%	17.70%	74.75%	25.25%	16.13%	33.38%	66.49%	33.51%	0.08
Oatmeal	-2.90%	8.37%	33.44%	66.56%	-5.84%	28.54%	50.23%	49.79%	0.08
Paper Towels	14.80%	17.46%	81.44%	18.56%	8.34%	59.32%	51.71%	48.29%	0.08
Refrigerated Juices	8.34%	12.07%	76.01%	23.99%	0.27%	26.37%	49.48%	50.52%	0.01
Soft Drinks	77.61%	30.70%	99.74%	0.26%	60.85%	62.11%	87.12%	12.88%	-0.10
Shampoos	12.65%	25.65%	69.30%	30.70%	-7.74%	34.53%	41.26%	58.74%	0.29***
Snack Crackers	10.06%	30.69%	42.71%	57.29%	-3.56%	19.95%	43.16%	56.84%	0.02
Soaps	16.17%	14.43%	83.34%	16.36%	9.25%	31.24%	58.94%	41.06%	0.01
Toothbrushes	1.69%	23.96%	42.53%	57.47%	-3.40%	42.73%	43.61%	56.39%	0.41***
Tuna	19.89%	11.46%	95.99%	4.01%	0.56%	42.26%	51.63%	48.37%	0.10
Toothpastes	7.60%	21.27%	55.03%	44.97%	-0.08%	27.94%	46.58%	53.42%	0.19**
Toilet papers	40.08%	27.72%	90.89%	9.11%	16.99%	55.58%	62.54%	37.46%	0.02
Average	**12.86%**	**20.65%**	**63.57%**	**36.42%**	**5.50%**	**34.78%**	**53.47%**	**46.53%**	**0.14**

Notes

In the table, we summarize the results on the average differences between 9- and non 9-ending prices at a weekly frequency. The Regular prices panel summarizes the results for the differences between 9- and non 9-ending regular prices. The average column gives the average of the average percentage weekly differences between regular 9- and non 9-ending prices. The S.D. column gives the standard deviation of the average percentage weekly differences between regular 9- and non 9-ending prices. The % greater than zero column gives the percentage out of all weeks in which the average regular 9-ending prices were above the average non 9-ending regular prices. The % smaller than zero column gives the percentage out of all weeks in which the average regular 9-ending prices were below the average non 9-ending regular prices. The Sale prices panel summarizes the results for the differences between 9- and non 9-ending Sale prices. The average column gives the average of the average percentage weekly differences between Sale 9- and non 9-ending prices. The S.D. column gives the standard deviation of the average percentage weekly differences between sale 9- and non 9-ending prices. The % greater than zero column gives the percentage out of all weeks in which the average sale 9-ending prices were above the average non 9-ending sale prices. The % smaller than zero column gives

the percentage out of all weeks in which the average sale 9-ending prices were below the average non 9-ending sale prices. We use a sale filter to identify sale prices. The correlation column gives the value of the period zero cross-correlation between the average regular and sale prices percentage differences between 9- and non 9-ending prices. ** $p < 5\%$, *** $p < 1\%$.

Table D2. The Percentage Difference between 9 and non-9 Ending Prices, Regular and Sale Price, Using Dominick's Sale Dummy, Dominick's, September 14, 1989–May 8, 1997

	Regular Prices				Sale Prices				
	Average Diff.	**S.D. Diff.**	**% Greater than 0**	**% Smaller than 0**	**Average Diff.**	**S.D. Diff.**	**% Greater than 0**	**% Smaller than 0**	**Correlation**
Analgesics	19.43%	19.15%	83.42%	16.58%	−2.08%	30.05%	45.40%	54.60%	0.11
Bath Soaps	−21.05%	28.39%	22.64%	77.36%	7.31%	42.88%	57.30%	42.70%	0.07
Beer	−4.81%	28.32%	36.45%	63.55%	20.85%	49.64%	62.02%	37.98%	0.46***
Bottled Juices	3.48%	8.38%	66.84%	33.16%	−0.92%	23.21%	47.96%	52.04%	0.01
Cereal	−2.35%	3.24%	23.22%	76.78%	1.07%	24.78%	50.55%	49.45%	0.09
Cheese	12.25%	9.66%	87.76%	12.24%	−2.31%	24.09%	47.45%	52.55%	−0.02
Cigarettes	77.92%	104.42%	68.84%	31.16%					
Cookies	−8.96%	17.09%	27.84%	72.16%	−8.18%	21.06%	37.79%	65.21%	0.23**
Crackers	7.26%	11.22%	76.32%	23.68%	−6.63%	22.05%	40.92%	59.08%	0.13**
Canned Soups	10.20%	11.43%	80.42%	19.58%	3.78%	26.65%	55.08%	44.92%	0.04
Dish Detergents	1.69%	18.61%	47.96%	52.04%	−7.85%	29.81%	39.52%	60.48%	0.14**
Front End Candies	41.16%	9.69%	100%	0%	7.50%	36.48%	57.72%	42.28%	−0.21**
Frozen Dinners	−5.94%	16.12%	37.25%	62.75%	−1.79%	34.74%	51.50%	48.50%	−0.01
Frozen Entrees	9.26%	13.03%	85.35%	14.65%	−14.98%	50.17%	36.20%	63.80%	0.34***
Frozen Juices	−4.11%	8.14%	28.28%	71.72%	−20.82%	33.32%	24.53%	75.47%	0.16**
Fabric Softeners	−4.84%	9.98%	33.84%	66.16%	11.79%	38.23%	62.14%	37.86%	−0.15**
Grooming products	8.84%	18.52%	71.22%	28.78%	14.12%	29.14%	68.30%	31.70%	0.06
Laundry Detergents	9.57%	16.41%	74.75%	25.25%	19.05%	33.15%	76.28%	23.72%	0.23**
Oatmeal	−3.03%	9.19%	32.79%	67.21%	−3.27%	26.09%	47.51%	52.49%	−0.05
Paper Towels	14.83%	16.11%	82.47%	17.53%	5.67%	54.43%	50.68%	49.32%	0.17**
Refrigerated Juices	10.03%	12.45%	79.04%	20.96%	−2.56%	25.57%	44.42%	55.58%	0.05

Soft Drinks	87.78%	34.17%	99.49%	0.51%	54.63%	54.29%	86.12%	13.88%	−0.16**
Shampoos	13.26%	27.91%	64.65%	35.35%	−5.35%	37.92%	45.75%	54.25%	0.22**
Snack Crackers	14.35%	38.71%	43.75%	56.25%	−3.44%	21.63%	39.27%	60.73%	0.08
Soaps	16.25%	16.65%	74.91%	25.09%	9.83%	26.78%	63.50%	36.50%	−0.17**
Toothbrushes	0.84%	21.33%	39.02%	60.98%	−9.30%	44.13%	34.94%	65.06%	0.29***
Tuna	21.19%	11.47%	96.26%	3.74%	−1.37%	36.22%	46.05%	53.95%	0.12
Toothpastes	10.05%	25.18%	56.28%	43.72%	−0.01%	28.16%	45.11%	54.89%	0.17**
Toilet papers	49.94%	28.81%	92.45%	7.55%	14.10%	51.55%	61.26%	38.74%	0.06
Average	**13.26%**	**20.48%**	**62.53%**	**37.47%**	**2.82%**	**34.15%**	**50.80%**	**49.20%**	**0.08**

Notes

In the table, we summarize the results on the average differences between 9- and non 9-ending prices at a weekly frequency. The Regular prices panel summarizes the results for the differences between 9- and non 9-ending regular prices. The average column gives the average of the average percentage weekly differences between regular 9- and non 9-ending prices. The S.D. column gives the standard deviation of the average percentage weekly differences between regular 9- and non 9-ending prices. The % greater than zero column gives the percentage out of all weeks in which the average regular 9-ending prices were above the average non 9-ending regular prices. The % smaller than zero column gives the percentage out of all weeks in which the average regular 9-ending prices were below the average non 9-ending regular prices.

The Sale prices panel summarizes the results for the differences between 9- and non 9-ending Sale prices. The average column gives the average of the average percentage weekly differences between Sale 9- and non 9-ending prices. The S.D. column gives the standard deviation of the average percentage weekly differences between sale 9- and non 9-ending prices. The % greater than zero column gives the percentage out of all weeks in which the average sale 9-ending prices were above the average non 9-ending sale prices. The % smaller than zero column gives the percentage out of all weeks in which the average sale 9-ending prices were below the average non 9-ending sale prices. We use Dominick's sale dummy indicator to identify sales.

The correlation column gives the value of the contemporary cross-correlation between the average regular and sale prices percentage differences between 9- and non 9-ending prices. ** $p < 5\%$, *** $p < 1\%$.

Figure D1. The Percentage Differences between the Average 9-Ending and Non 9-Ending Prices, Regular and Sale Prices, on a Weekly Basis, by Product Categories at the Product-Store Level, Using a Sale Filter, Dominick's, September 14, 1989–May 8, 1997

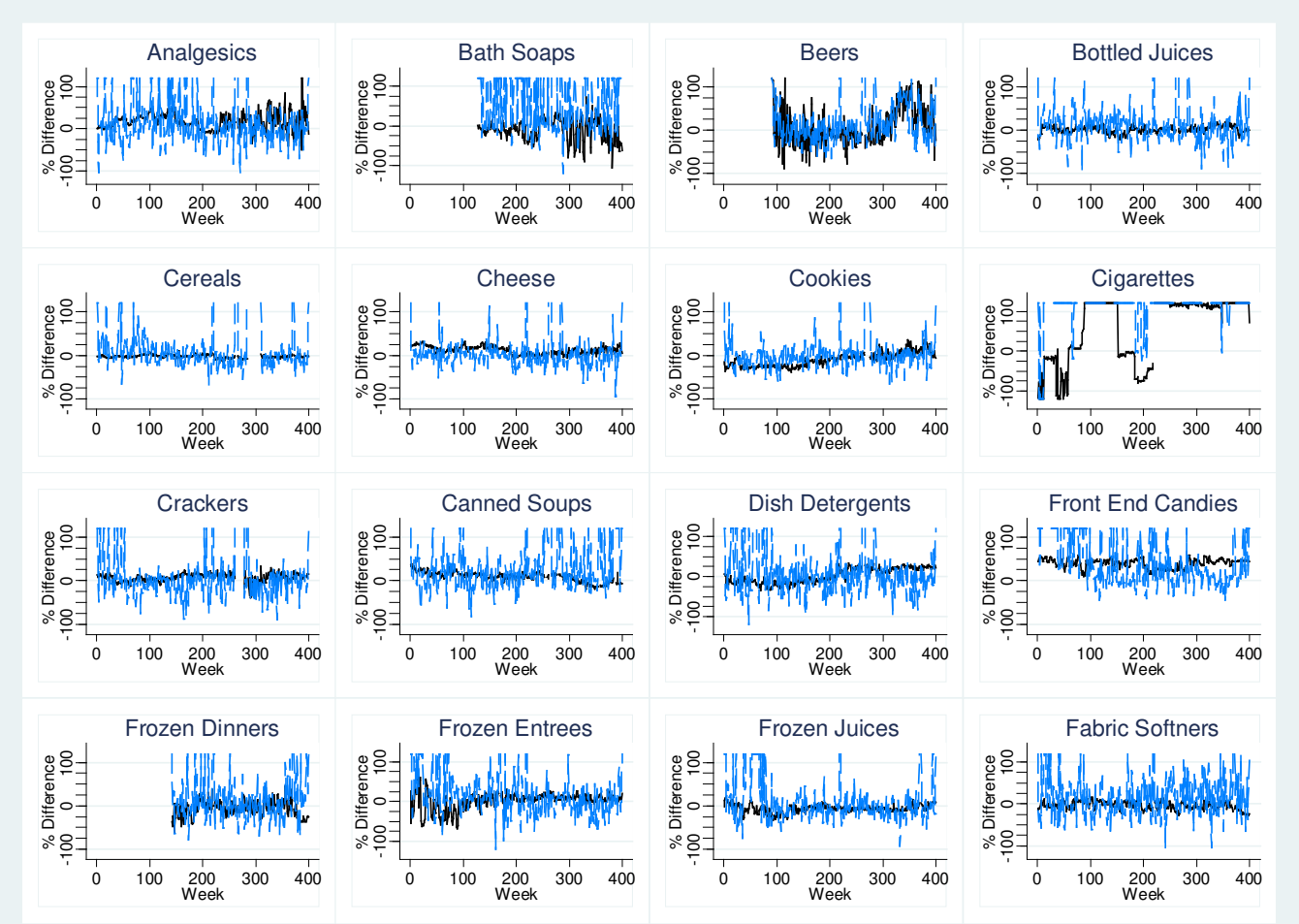


Figure D1. The Percentage Differences between the Average 9-Ending and Non 9-Ending Prices, Regular and Sale Prices, on a Weekly Basis, by Product Categories at the Product-Store Level, Using a Sale Filter, Dominick's, September 14, 1989–May 8, 1997 (Cont.)

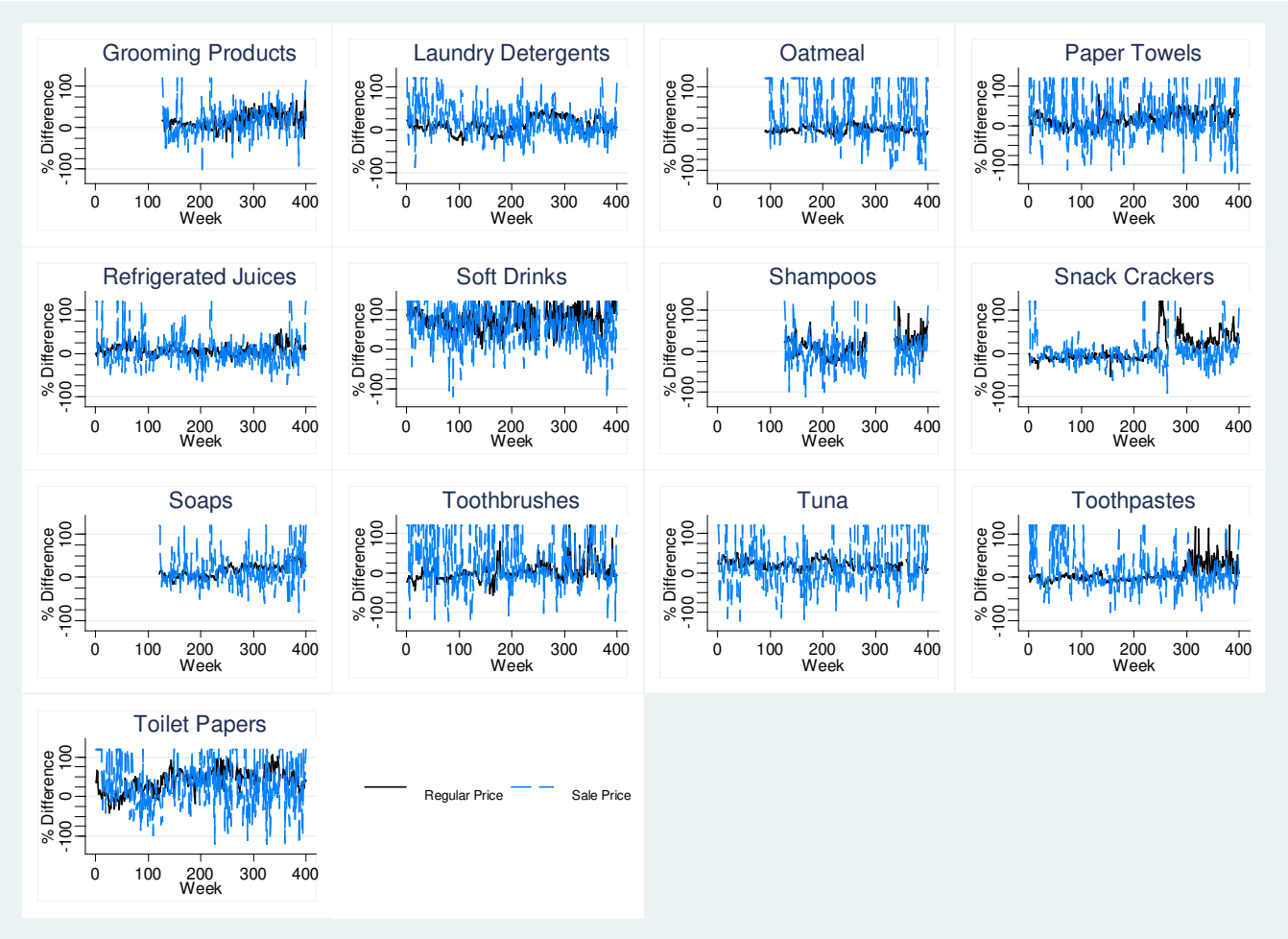


Figure D2. Cross-Correlograms of the Percentage Differences between Average 9-Ending and Non 9-Ending Prices, Regular and Sale Prices, on a Weekly Basis, by Product Categories at the Product-Store Level, Using a Sale Filter, Dominick's, September 14, 1989–May 8, 1997

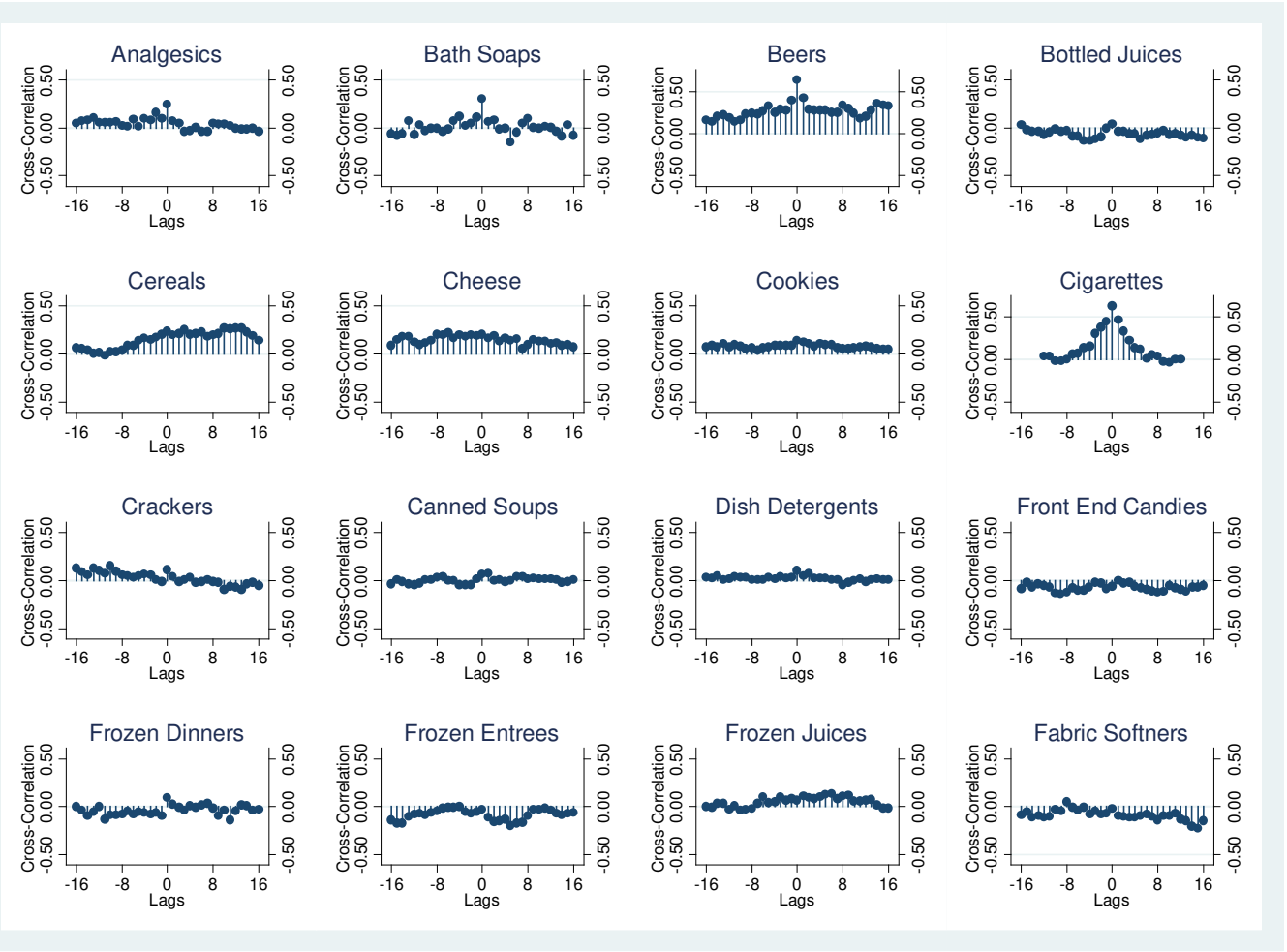


Figure D2. Cross-Correlograms of the Percentage Differences between Average 9-Ending and Non 9-Ending Prices, Regular and Sale Prices, on a Weekly Basis, by Product Categories at the Product-Store Level, Using a Sale Filter, Dominick's, September 14, 1989–May 8, 1997 (Cont.)

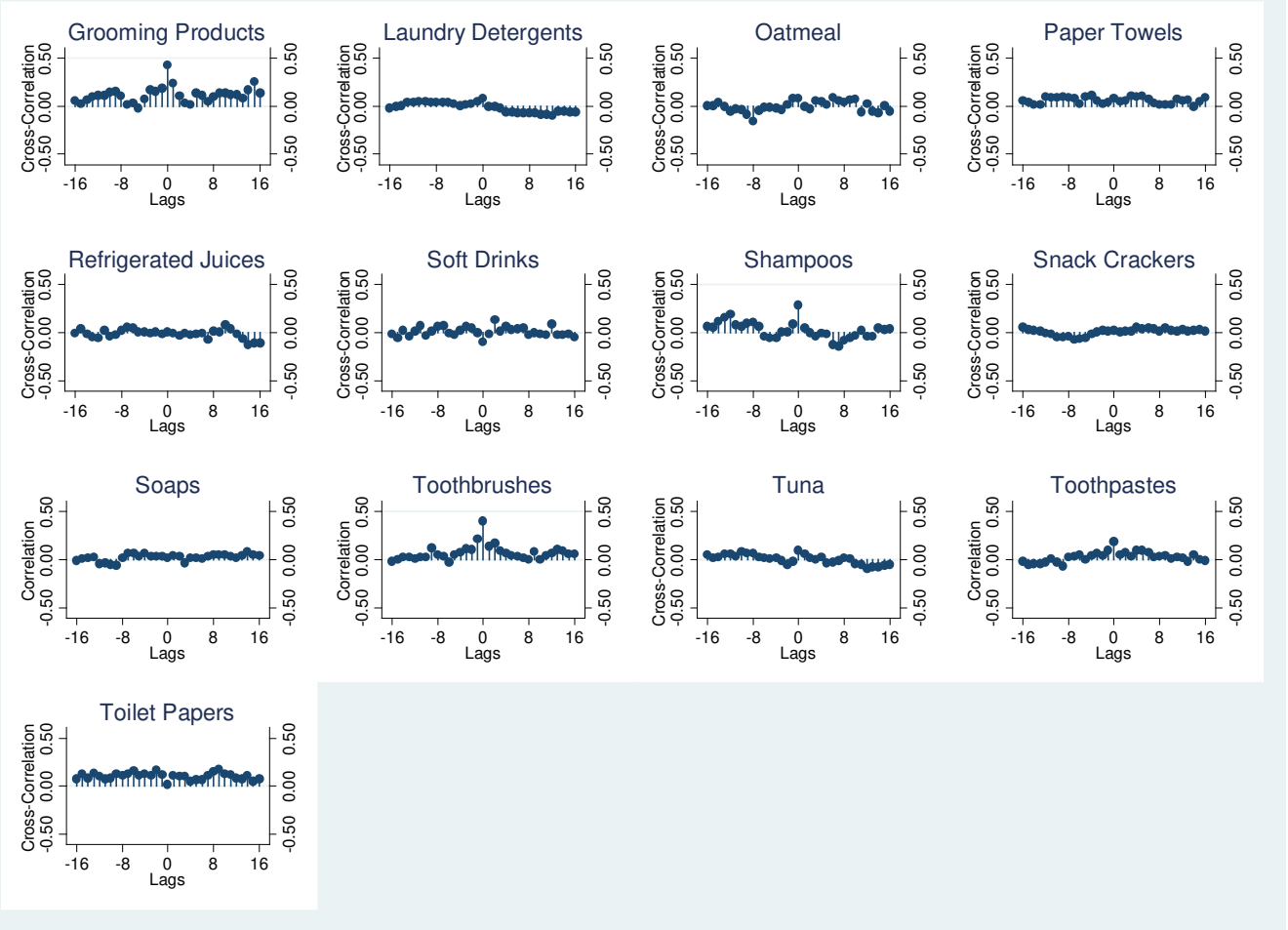


Figure D3. The Percentage Differences between the Average 9-Ending and Non 9-Ending Prices, Regular and Sale Prices, on a Weekly Basis, by Product Categories at the Product-Store Level, Using Dominick's Sale Dummy, Dominick's, September 14, 1989–May 8, 1997

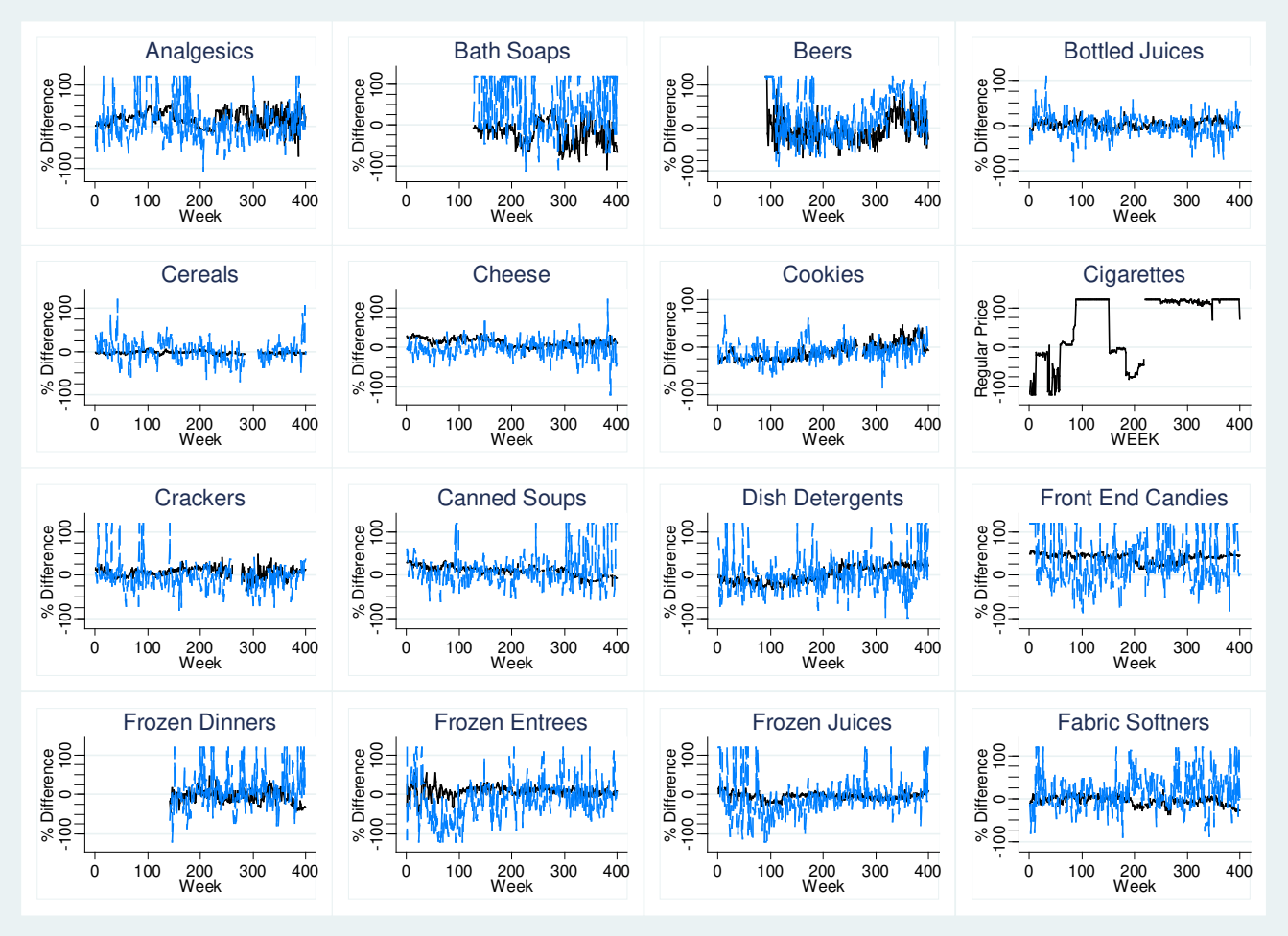


Figure D3. The Percentage Differences between the Average 9-Ending and Non 9-Ending Prices, Regular and Sale Prices, on a Weekly Basis, by Product Categories at the Product-Store Level, Using Dominick's Sale Dummy, Dominick's, September 14, 1989–May 8, 1997 (Cont.)

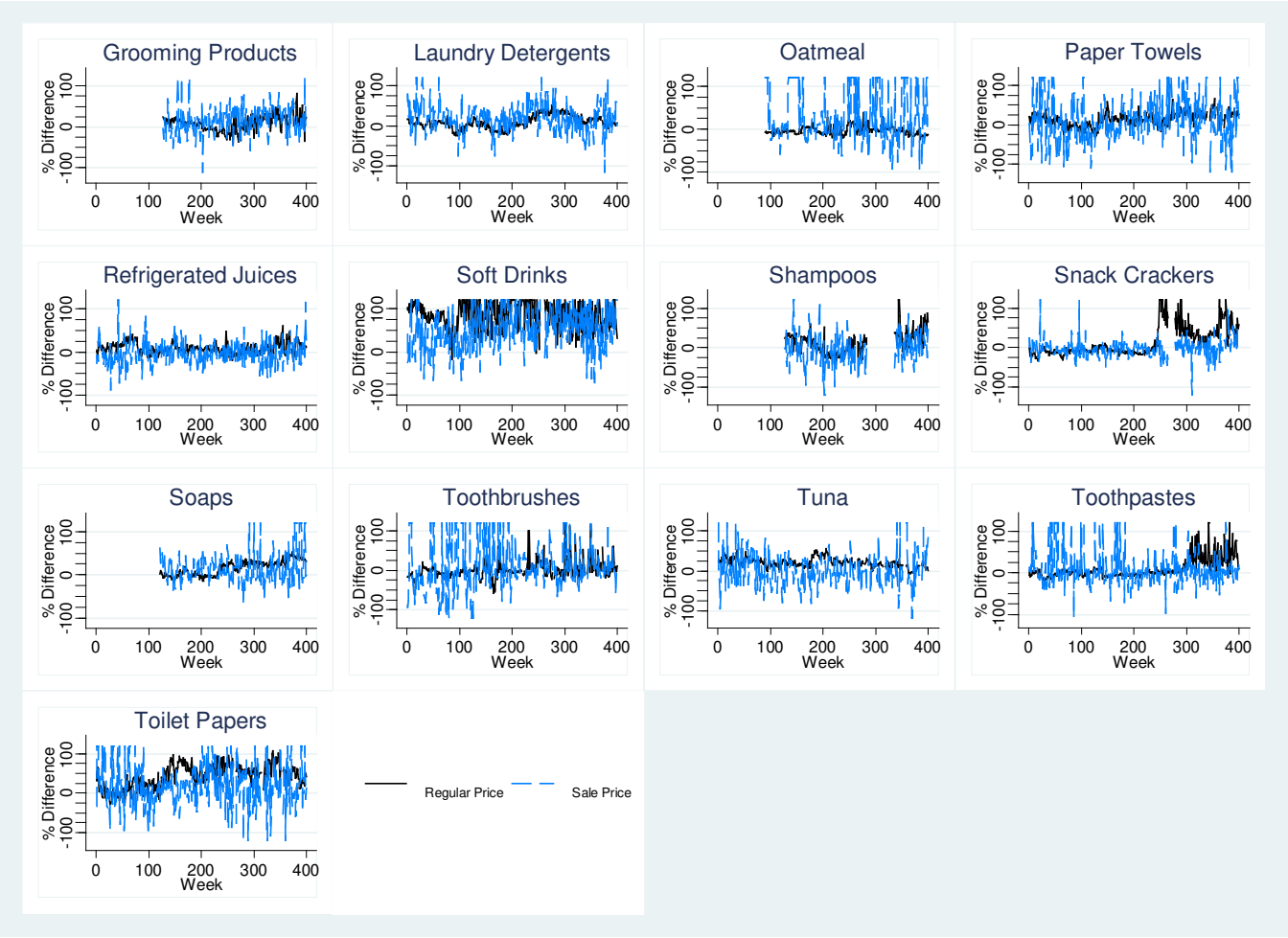


Figure D4. Cross-Correlograms of the Percentage Differences between Average 9-Ending and Non 9-Ending Prices, Regular and Sale Prices, on a Weekly Basis, by Product Categories at the Product-Store Level, Using Dominick's Sale Dummy, Dominick's, September 14, 1989–May 8, 1997

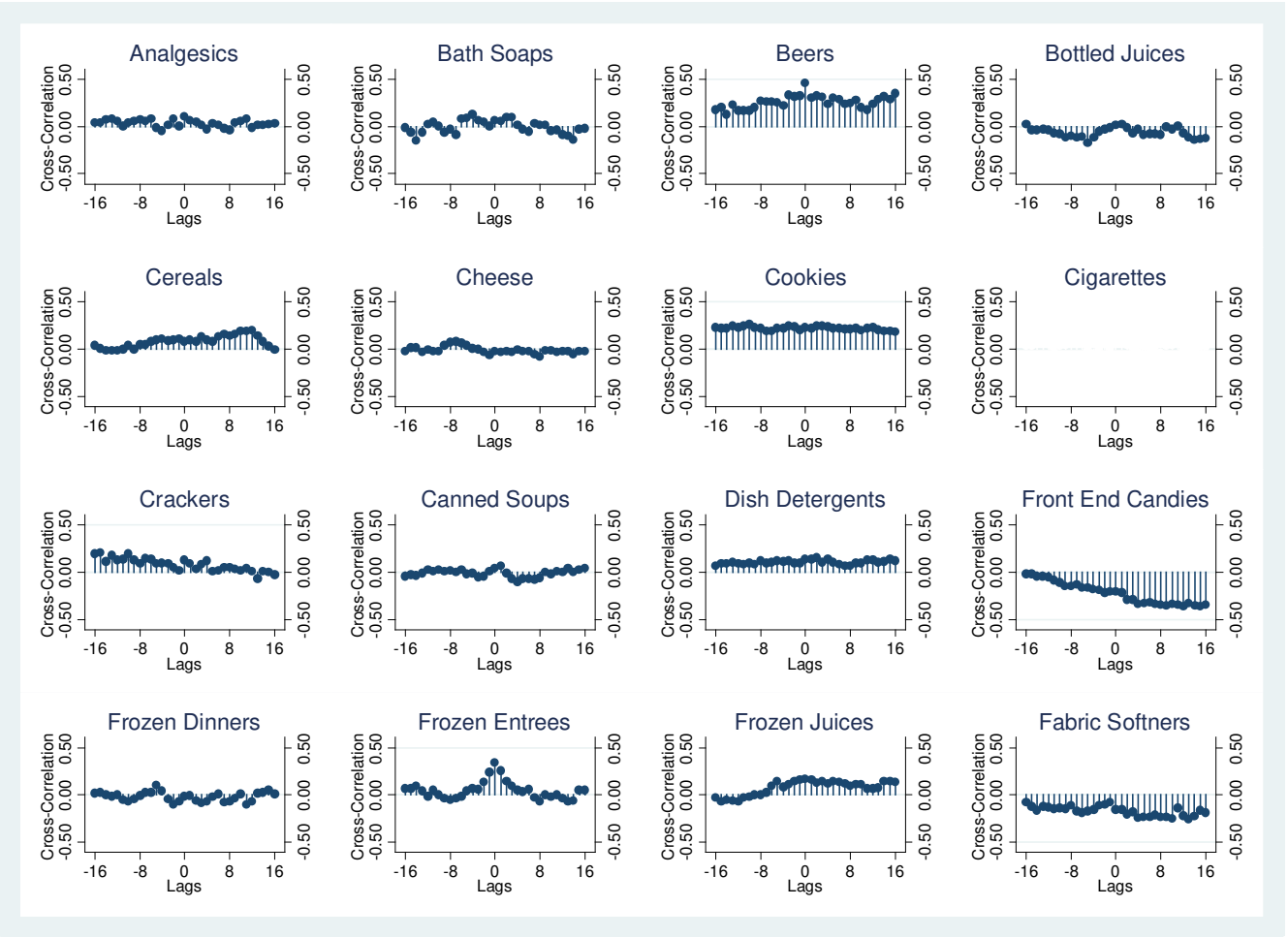
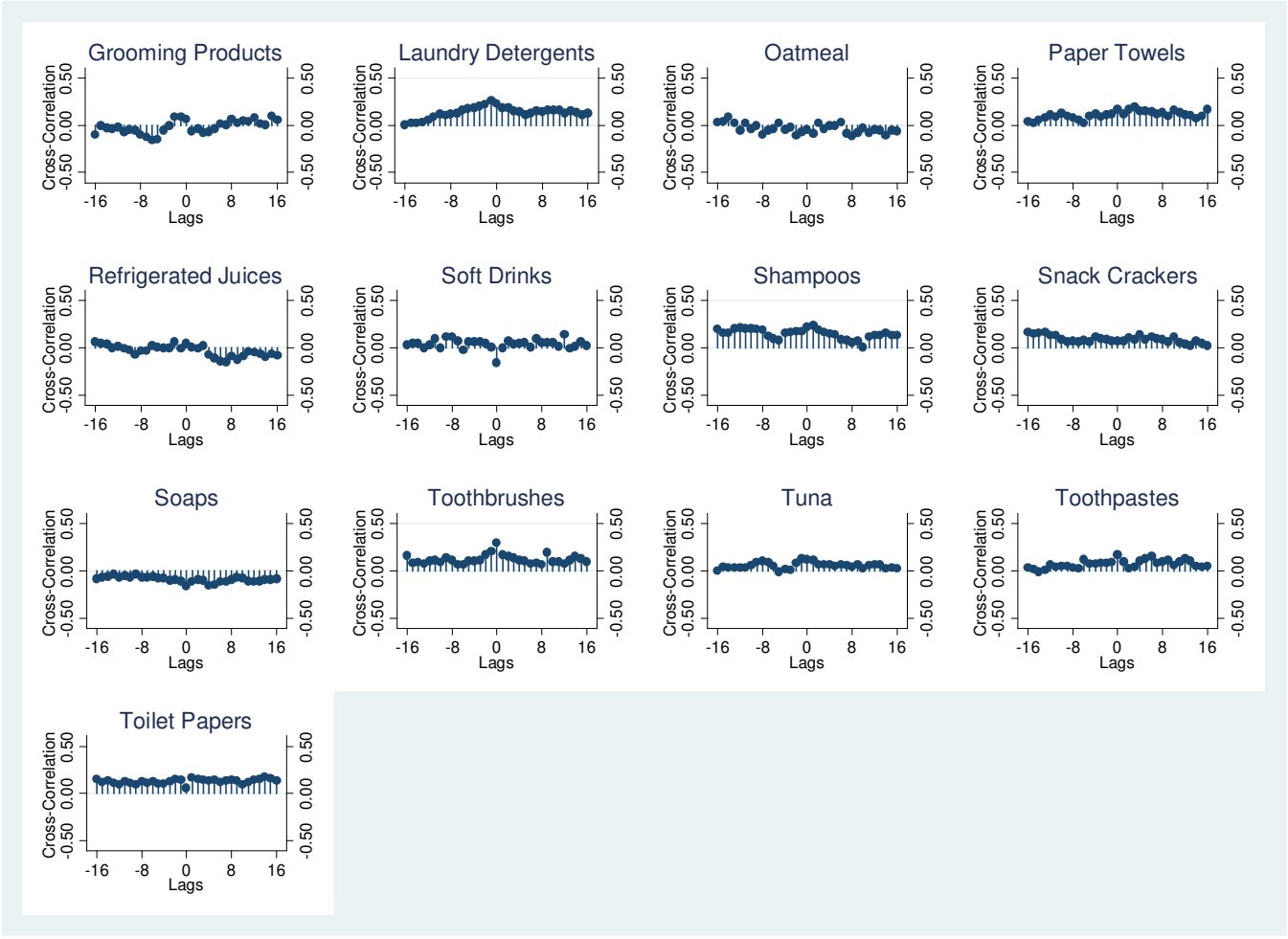


Figure D4. Cross-Correlograms of the Percentage Differences between Average 9-Ending and Non 9-Ending Prices, Regular and Sale Prices, on a Weekly Basis, by Product Categories at the Product-Store Level, Using Dominick's Sale Dummy, Dominick's, September 14, 1989–May 8, 1997 (Cont.)



APPENDIX E. FREQUENCY DISTRIBUTION OF THE LAST DIGIT OF THE RETAIL PRICES AT DOMINICK'S BY PRODUCT CATEGORY

The frequency distribution of the last digit by product category is shown in Figure E1. According to the plots in the figure, 9 is the most frequent price ending in 28 out of the 29 categories, with the exception of the category of Cigarettes, which according to Besley and Rosen (1999) and Chen et al (2008), is subject to numerous regulatory restrictions.

In some product categories, 9-endingss are particularly dominant, comprising over 80% of the prices. These include Analgesics (86.0%), Bath Soap (88.3%), Beer (95.7%), Grooming Products (86.8%), Shampoos (91.5%) and Soft Drinks (82.7%).

Thus, the results we are reporting for the aggregated data in Figure 1 in the paper, hold for individual product categories as well.

Figure E1. Frequency Distribution of the Last Digit of the Retail Prices at Dominick's, by Product Category, September 14, 1989–May 8, 1997

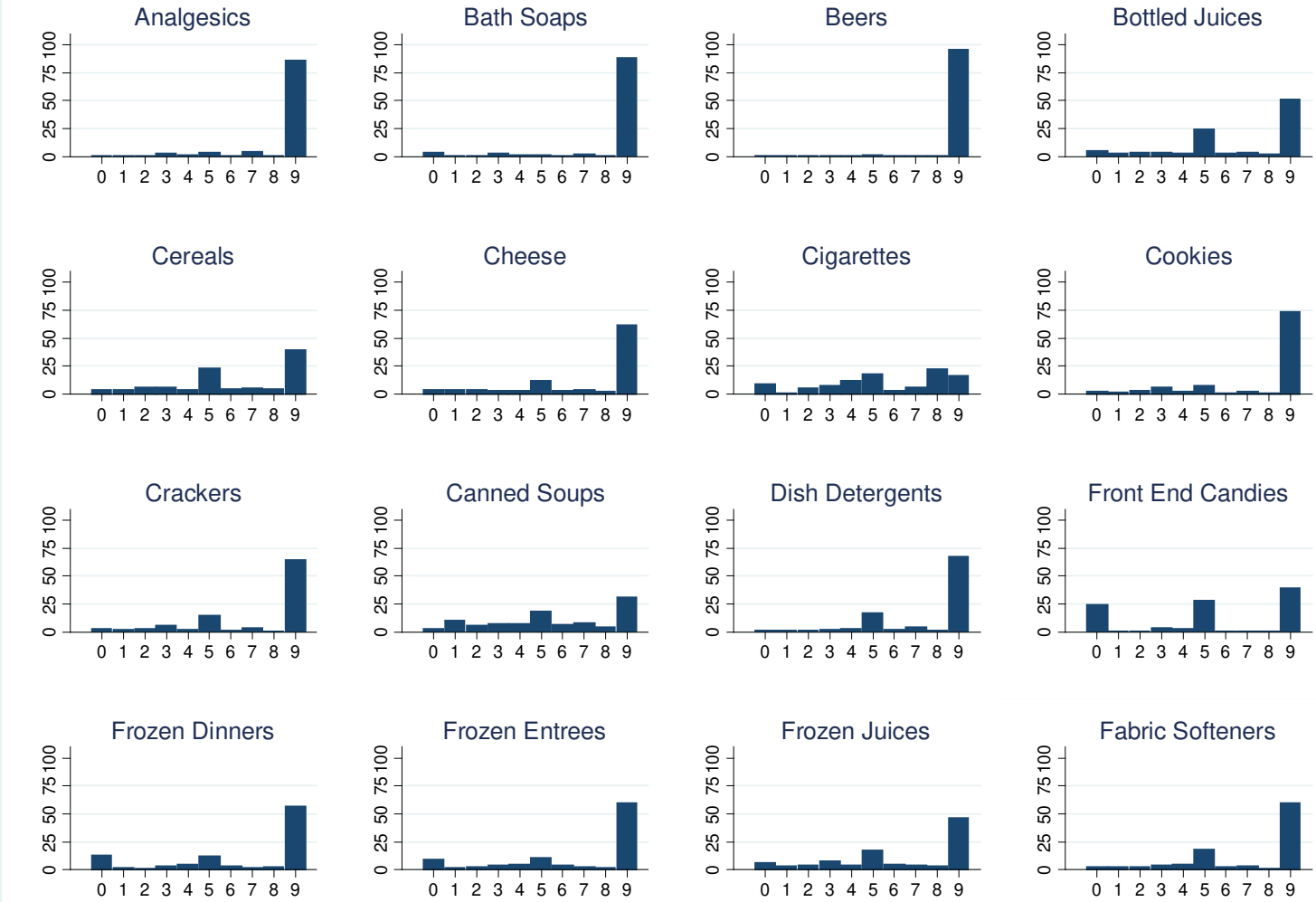
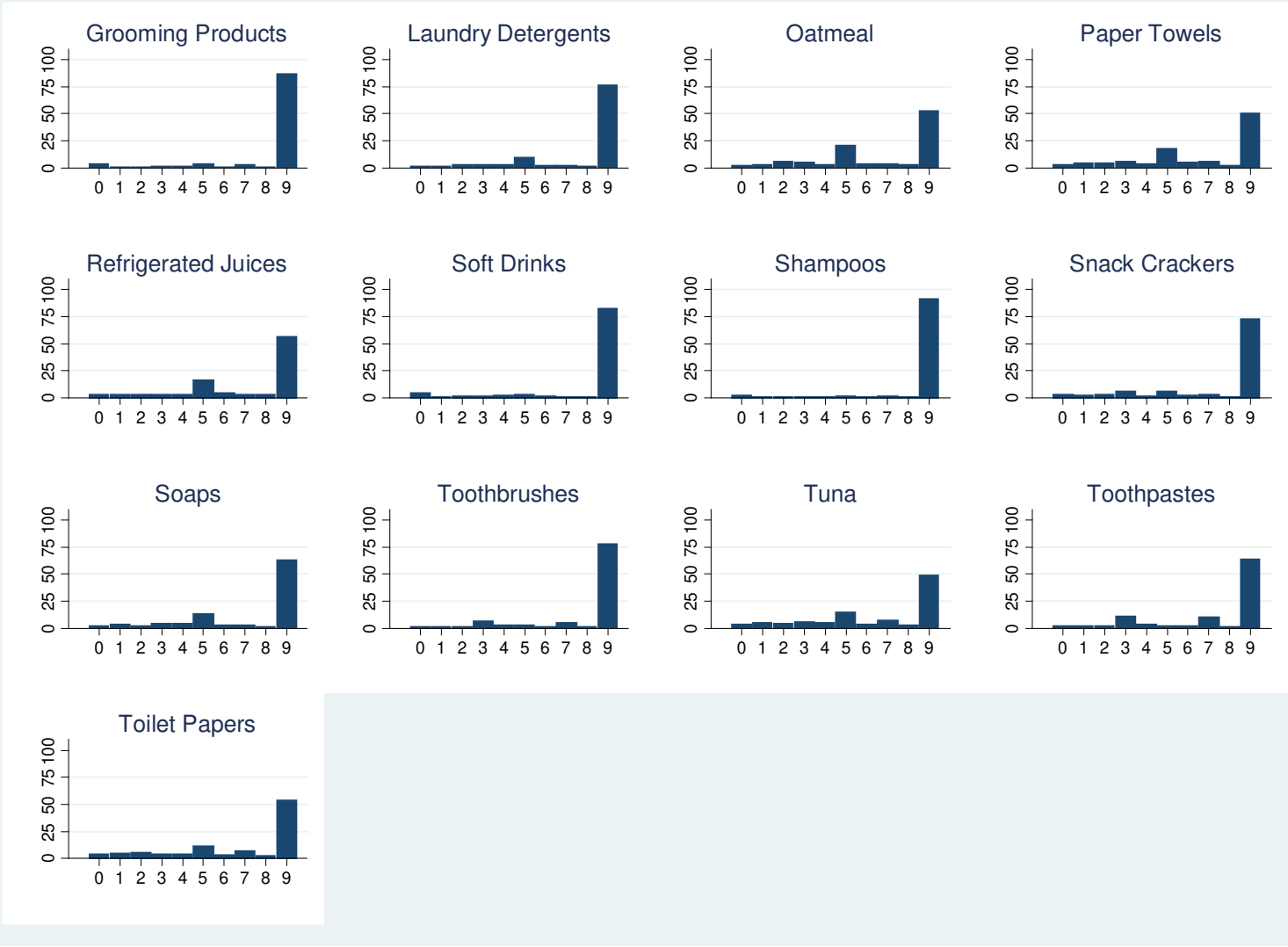


Figure E1. Frequency Distribution of the Last Digit of the Retail Prices at Dominick's, by Product Categories, September 14, 1989–May 8, 1997 (Cont.)



APPENDIX F. RETAIL PRICES OF THE PRODUCTS IN THE SNACK CRACKERS CATEGORY AT DOMINICK'S

In the paper, in Figure 2 in section 5 of the paper, we provide as an example of our main findings, a price series of a sample product, Nabisco Wheat Thins Low Salt, 10oz, from the Snack Crackers' category. We use the figure to illustrate that (a) 9-ending prices are more common than non 9-ending prices, (b) that 9-ending prices are more common among regular prices than among sale prices, (c) that non 9-ending prices are more common among sale prices than among regular prices, and (d) that on average, 9-ending prices are higher than non 9-ending prices.

To show that these attributes are typical for a large proportion of the products in our sample, and that they are not limited to the particular product we show in Figure 2 in the paper, in Figure F1 we show the retail prices of the products in the entire Snack Crackers category during September 14, 1989–May 7, 1997, at Dominick's Store 122, located in 2575 W. Golf Rd., Hoffman Estates, IL.[1] The figure gives the prices of the 84 products for which we have at least 208 weeks of data (the equivalent of 4 years), including the prices of the product depicted in Figure 2 in the paper, Nabisco Wheat Thins Low Salt, 10oz.

Looking at the figures, we see that 9-ending prices are indeed more common than non 9-ending prices for almost all products. Out of the 84 products, there are only three products for which non 9-ending products are more common than 9-ending prices. These are Nabisco Ritz Crackers (52.79% of the prices are non 9-ending), Ry Krisp Seasoned (51.75% of the prices are non 9-ending), and Ry Krisp Natural (53.55% of the prices are non 9-ending).

9-ending prices are also more common among regular prices than among sale prices. There are only three products for which 9-ending prices comprise less than 50% of the regular prices. These are Nabisco Ritz Crackers (52.46% of the regular prices are non 9-

[1] According to Midrigan (2011), Dominick's store number 122 has the highest number of price observations.

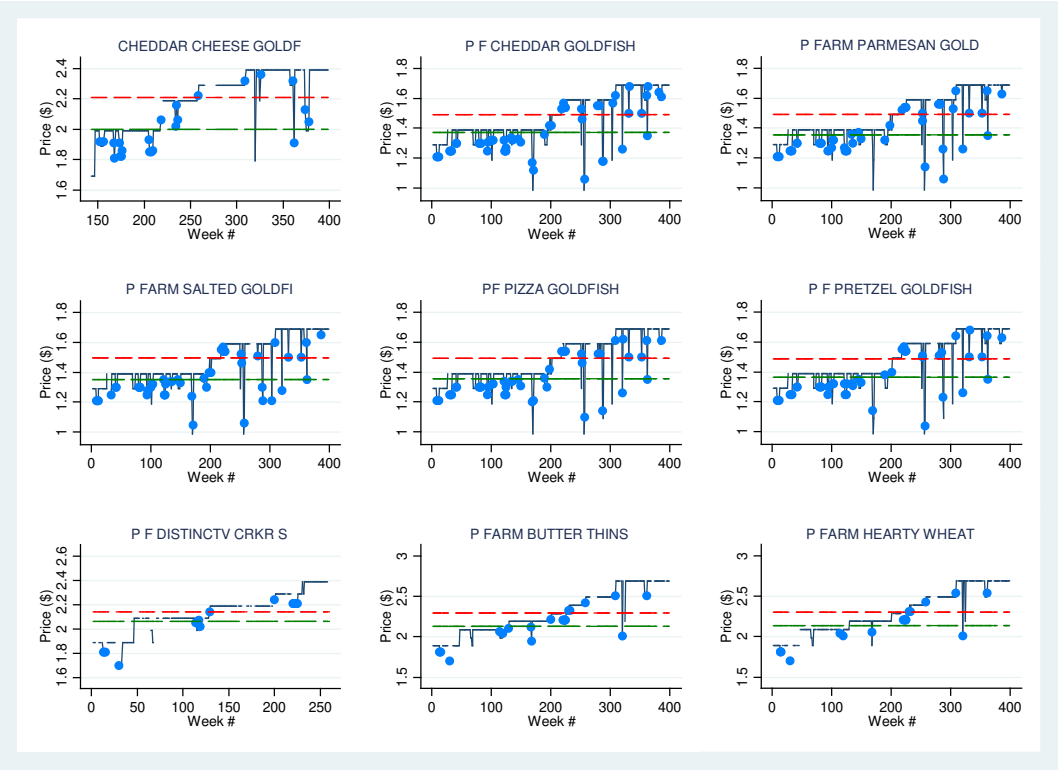
ending) Ry Krisp Seasoned (53.35% of the regular prices are non 9-ending), and Ry Krisp Natural (55.02% of the regular prices are non 9-ending).

Among sale prices, however, 9-ending prices comprise more than 50% of the prices for only 11 products. Thus, for the majority of the products shown in the figure, 9-ending prices comprise most of the regular prices, but only a minority of the sale prices. The opposite is true for non 9-ending prices: for the majority of the products shown, non 9-ending prices comprise minority of the regular prices but the majority of the sale prices.

Finally, out of the 84 products, for 82 products 9-ending prices are higher, on average, than non 9-ending prices. The only exceptions are Sunshine Cheez It and Nabisco Cheese Nips.

We therefore conclude that the example we use in the paper is not unique, and that it is representative of a large number of products sold at Dominick's.

Figure F1. Retail Price of the Products in the Snack Crackers Category – Dominick's, September 14, 1989–May 7, 1997
Store No. 122, 2575 W. Golf Rd., Hoffman Estates, IL



Notes

Only products with at least 208 weeks of data (equivalent to 4 years) are included in the figure. The continuous dark line represents 9-ending prices. The blue dots represent non 9-ending prices. The red dashed line represents the average 9-ending price computed over all weeks of data. The long-dashed green line represents the average non 9-ending price, also computed over all weeks of data. We use a sales filter to identify sale prices.

Figure F1. Retail Price of the Products in the Snack Crackers Category – Dominick's, September 14, 1989–May 7, 1997, Store No. 122, 2575 W. Golf Rd., Hoffman Estates, IL (cont.)

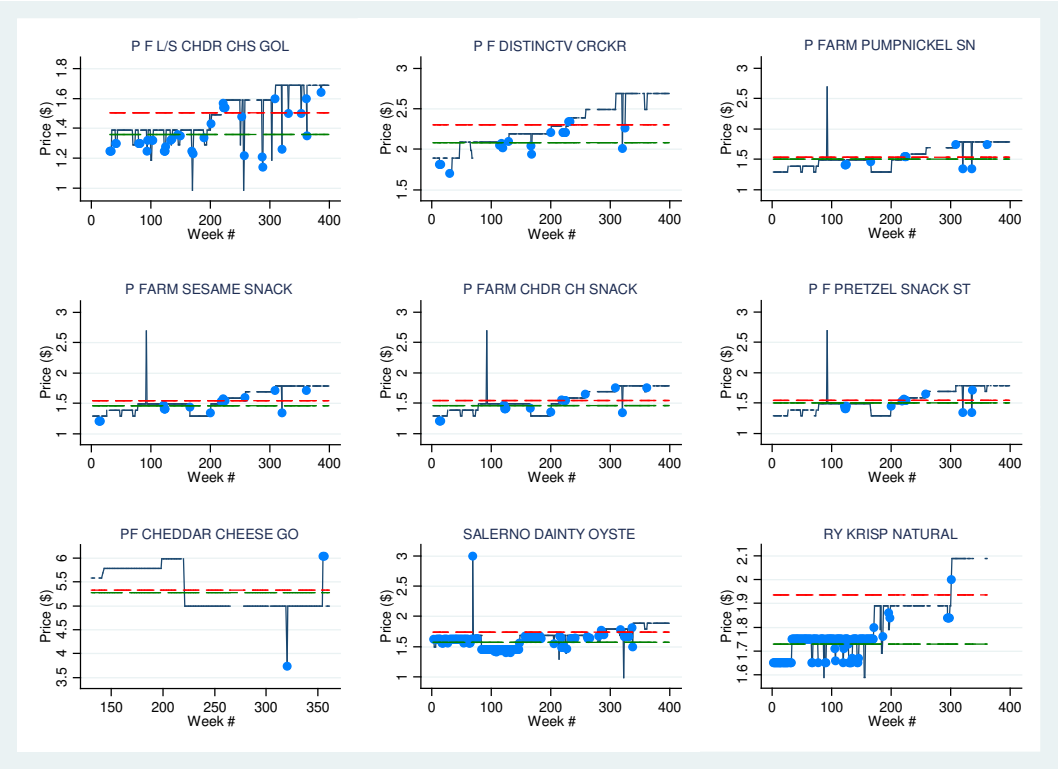


Figure F1. Retail Price of the Products in the Snack Crackers Category – Dominick's, September 14, 1989–May 7, 1997, Store No. 122, 2575 W. Golf Rd., Hoffman Estates, IL (cont.)

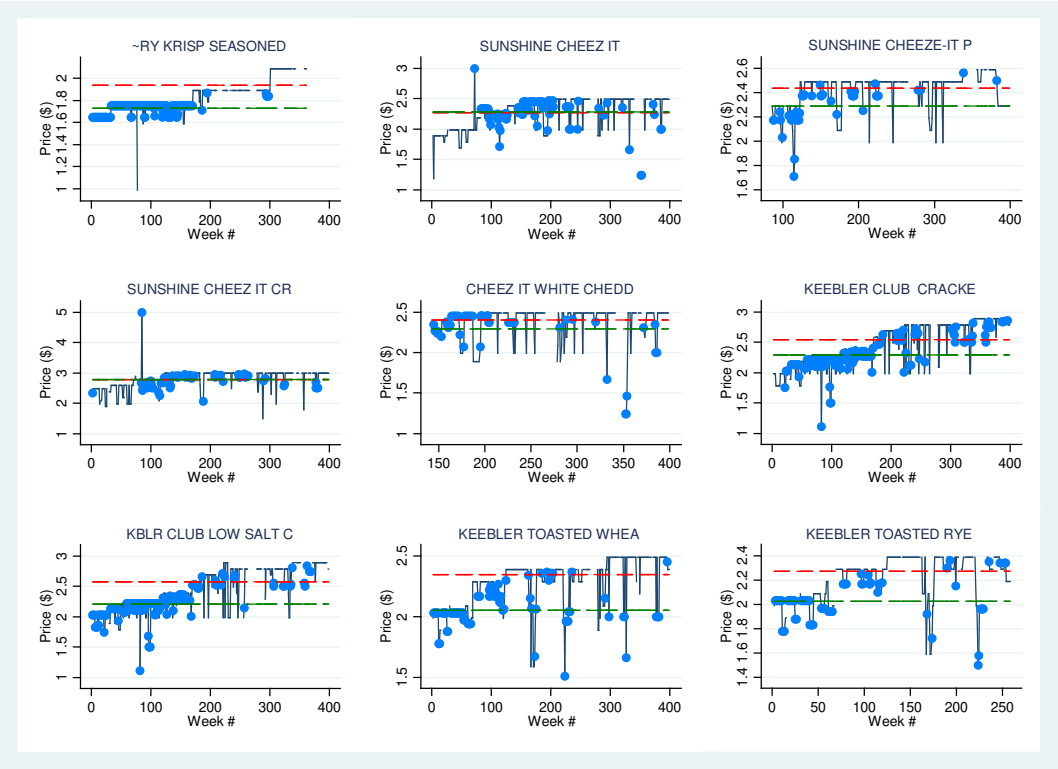


Figure F1. Retail Price of the Products in the Snack Crackers Category –
Dominick's, September 14, 1989–May 7, 1997,
Store No. 122, 2575 W. Golf Rd., Hoffman Estates, IL (cont.)

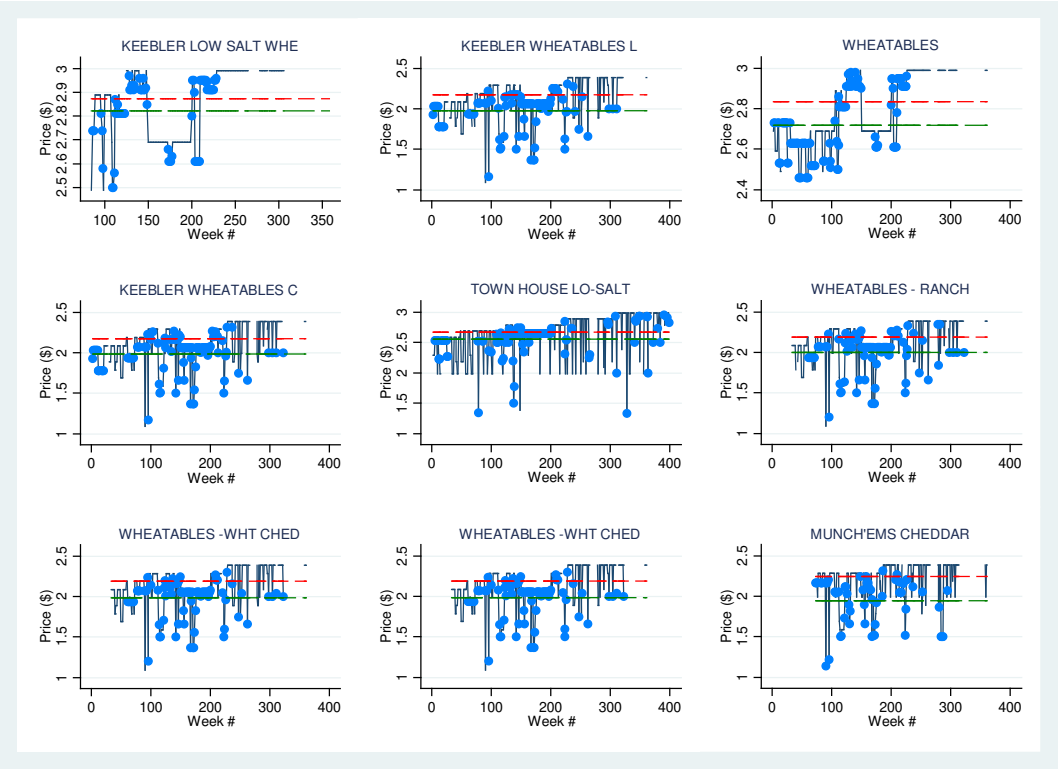


Figure F1. Retail Price of the Products in the Snack Crackers Category – Dominick's, September 14, 1989–May 7, 1997, Store No. 122, 2575 W. Golf Rd., Hoffman Estates, IL (cont.)

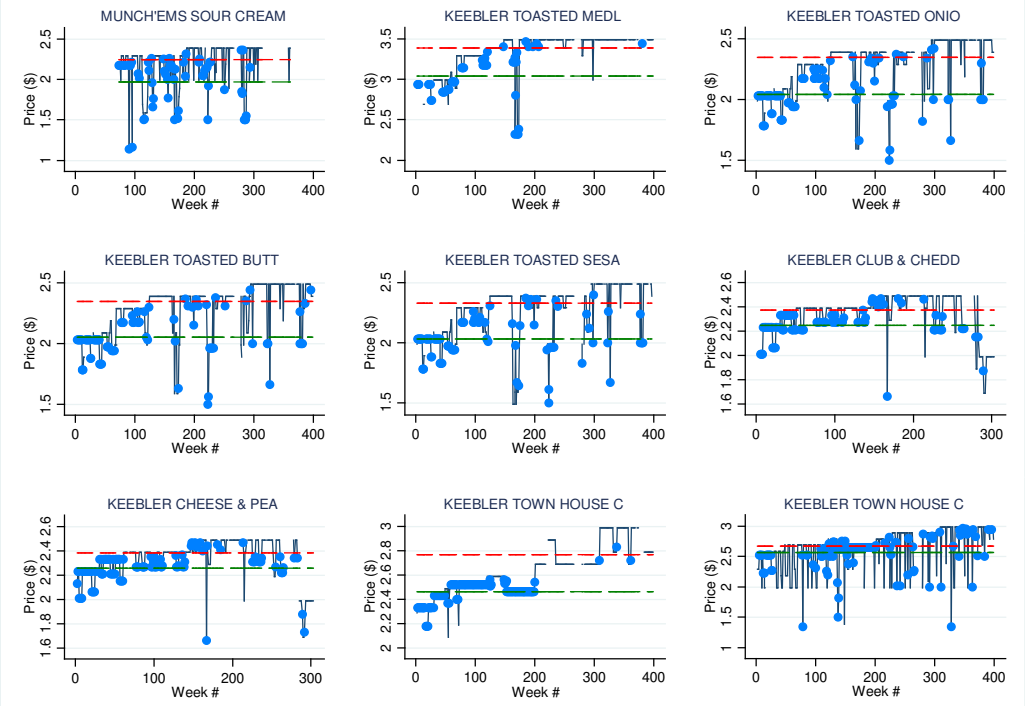


Figure F1. Retail Price of the Products in the Snack Crackers Category –
Dominick's, September 14, 1989–May 7, 1997,
Store No. 122, 2575 W. Golf Rd., Hoffman Estates, IL (cont.)

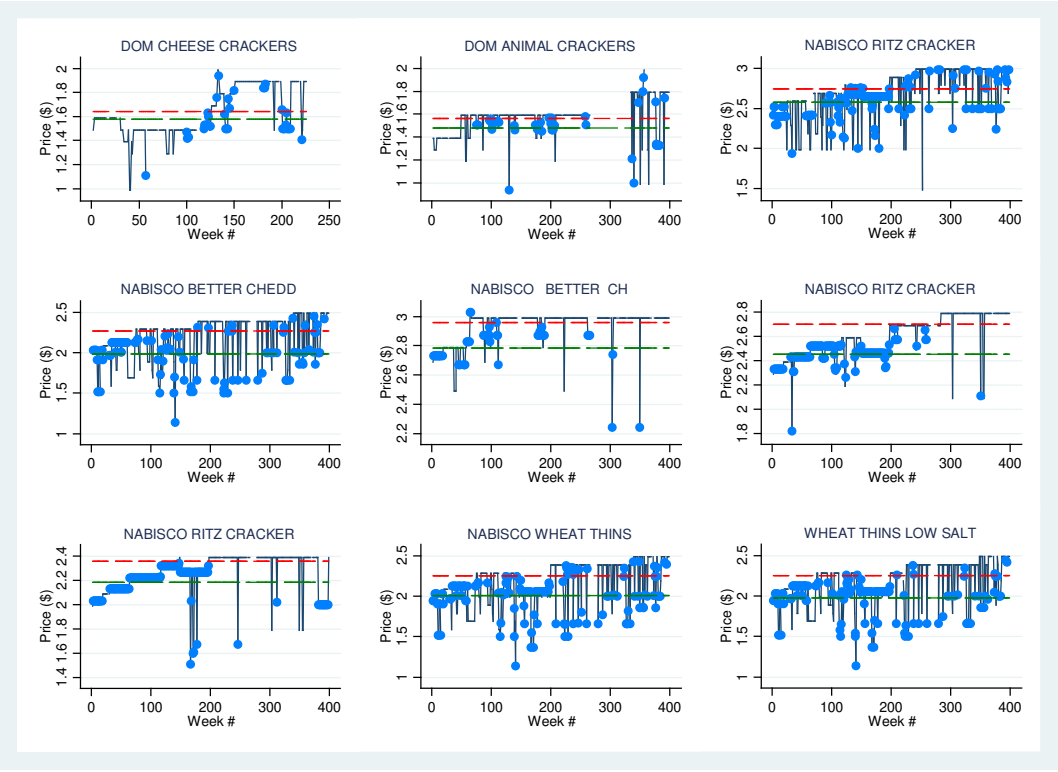


Figure F1. Retail Price of the Products in the Snack Crackers Category – Dominick's, September 14, 1989–May 7, 1997, Store No. 122, 2575 W. Golf Rd., Hoffman Estates, IL (cont.)

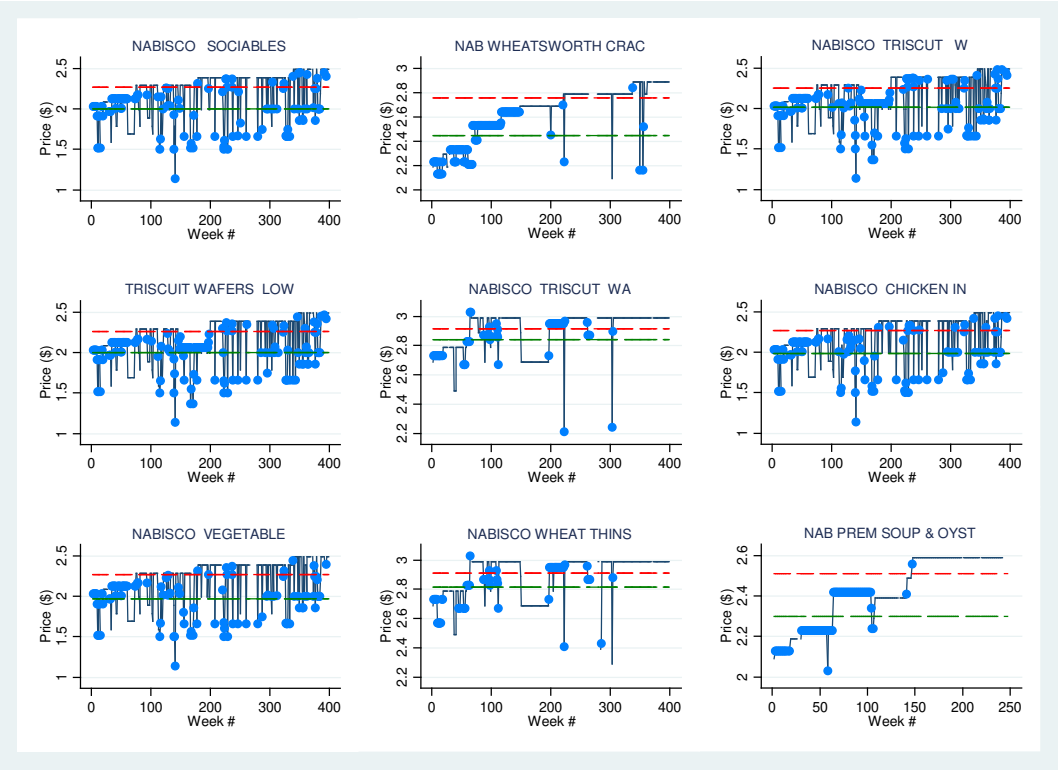


Figure F1. Retail Price of the Products in the Snack Crackers Category – Dominick's, September 14, 1989–May 7, 1997, Store No. 122, 2575 W. Golf Rd., Hoffman Estates, IL (cont.)

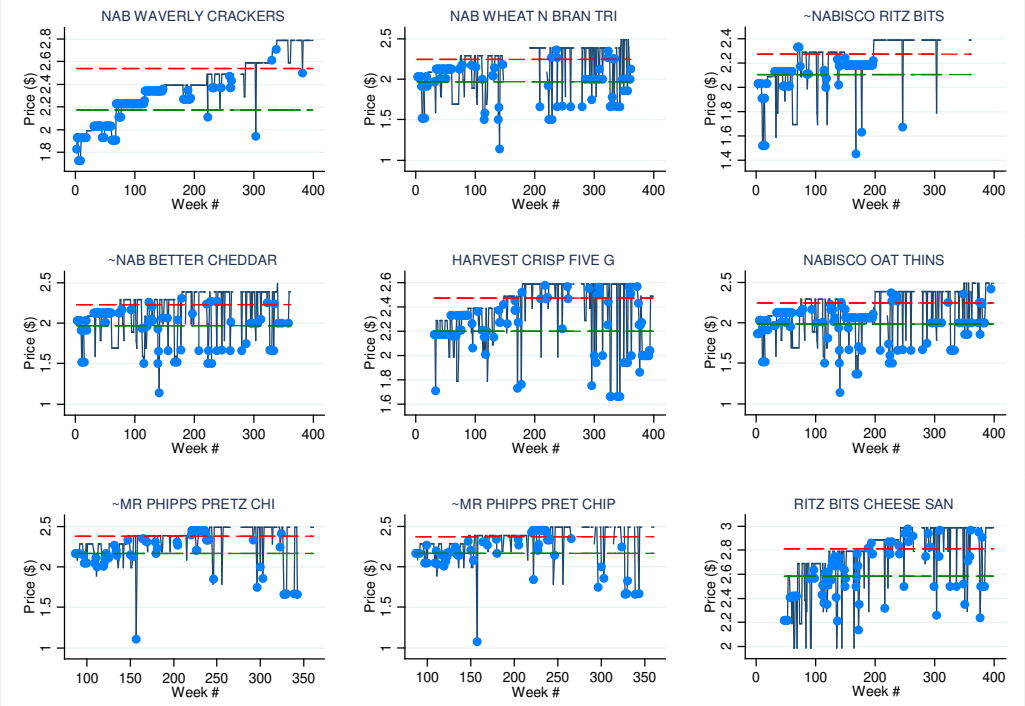


Figure F1. Retail Price of the Products in the Snack Crackers Category – Dominick's, September 14, 1989–May 7, 1997, Store No. 122, 2575 W. Golf Rd., Hoffman Estates, IL (cont.)

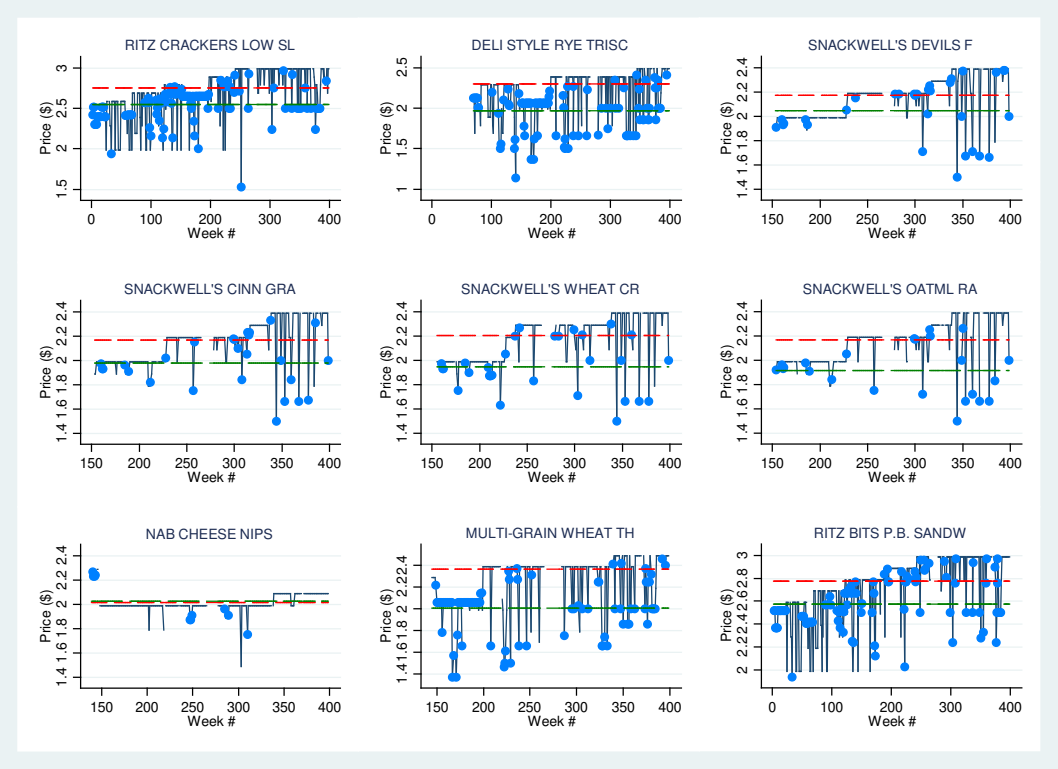
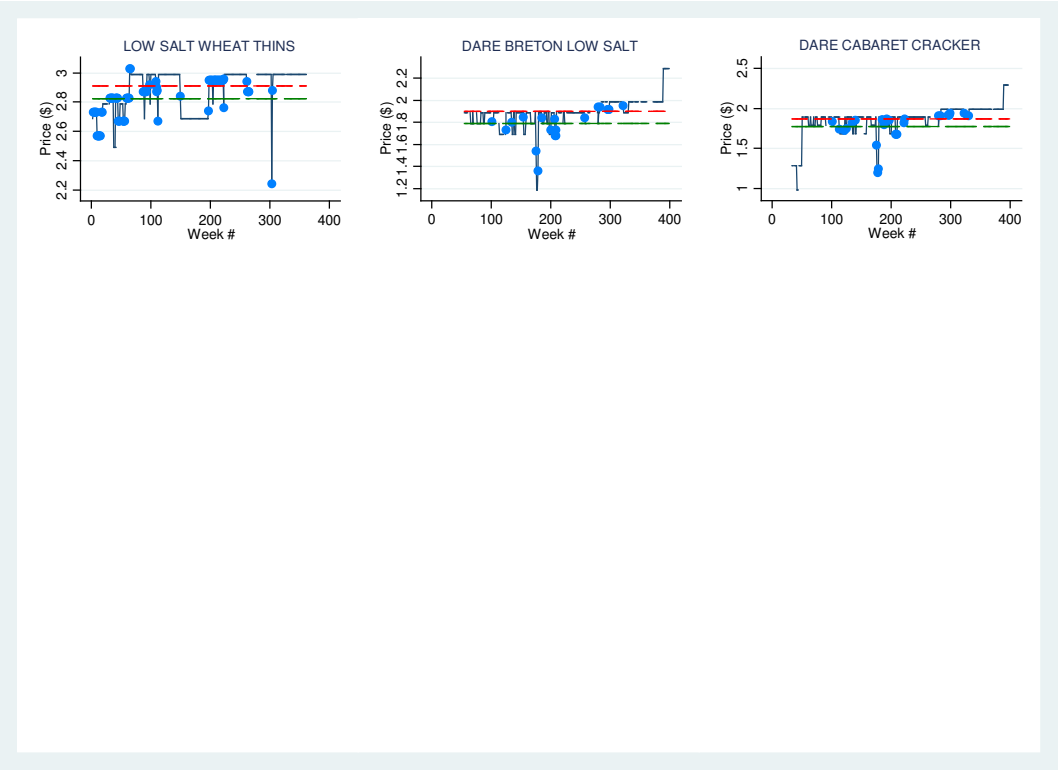


Figure F1. Retail Price of the Products in the Snack Crackers Category –
Dominick's, September 14, 1989–May 7, 1997,
Store No. 122, 2575 W. Golf Rd., Hoffman Estates, IL (cont.)



APPENDIX G. 9-ENDING VS. NON 9-ENDING PRICES, FOR INDIVIDUAL PRODUCTS AT THE STORE-LEVEL

It could be that the stores that have higher than average prices also have higher than average shares of 9-ending prices. In that case, even if 9-ending prices are the lowest within each store, we might still find that across all stores 9-ending prices are higher than the corresponding non-9 ending prices.

In addition, some of Dominick's product categories include several sub-categories. If 9-ending prices are more prevalent in sub-categories with relatively high prices than in sub-categories with lower prices, then even if 9-ending prices are the lowest within each sub-category, we might still find the opposite at the category level.

To explore these possibilities, we calculate for each product at each store, the percentage difference between the average 9-ending and non 9-ending prices. We calculate percentage differences as log-differences. In the paper, in Figure 3, we use the resulting figures to plot a histogram that shows the frequency distribution of the percentage differences for all products combined together. Here we present the frequency distribution histograms of the percentage differences at the category-level, for each one of the 29 product categories. See Figure G1. In Table G1, we report the corresponding descriptive statistics. These statistics include the median, the average, the standard deviation, the skewness, and the kurtosis for each product category.

Inspecting the plots in Figure G1, and the corresponding descriptive statistics in Table G1, we see that at the product-store level, in 25 of the 29 product categories, the average of the percentage difference is positive. Thus, in vast majority of categories, the average 9-ending prices are higher than the average non 9-ending prices even when we look at the level of a specific product, at a specific store.

We can also see that in 26 of the 29 product categories, the median of the percentage difference is positive, suggesting that the higher average 9-ending prices are not caused by outliers. Rather 9-ending prices are higher on average because more product-store combinations have higher average 9-ending than average non 9-ending prices.

According to Table G1, the skewness is positive in 18 of the 29 product categories,

which means that in these product categories, the distribution of the percentage difference is skewed to the right. Therefore, in addition to the finding that in most categories there are more product-store combinations with higher average 9-ending than average non 9-ending prices, we also find a longer tail on the right-hand side of the distribution. In other words, in these categories, we also find more extreme cases where the average 9-ending price is much higher than the average non 9-ending price than cases where the average 9-ending price is much lower than the average non 9-ending price.

The values of the kurtosis statistics are all greater than 3, meaning that the tails of the distributions of the percentage gap are thicker in comparison to the Normal Distribution, in all 29 product categories. Importantly, the kurtosis attains particularly high values in cases where the skewness is positive and large. Indeed, the correlation between the measures of skewness and kurtosis is 0.91, exceptionally high.

Figure G1. Frequency Distribution of the Percentage Differences between the Average 9-Ending and Non 9-Ending Prices, by Product Category at the Product-Store Level, Dominick's, September 14, 1989–May 8, 1997

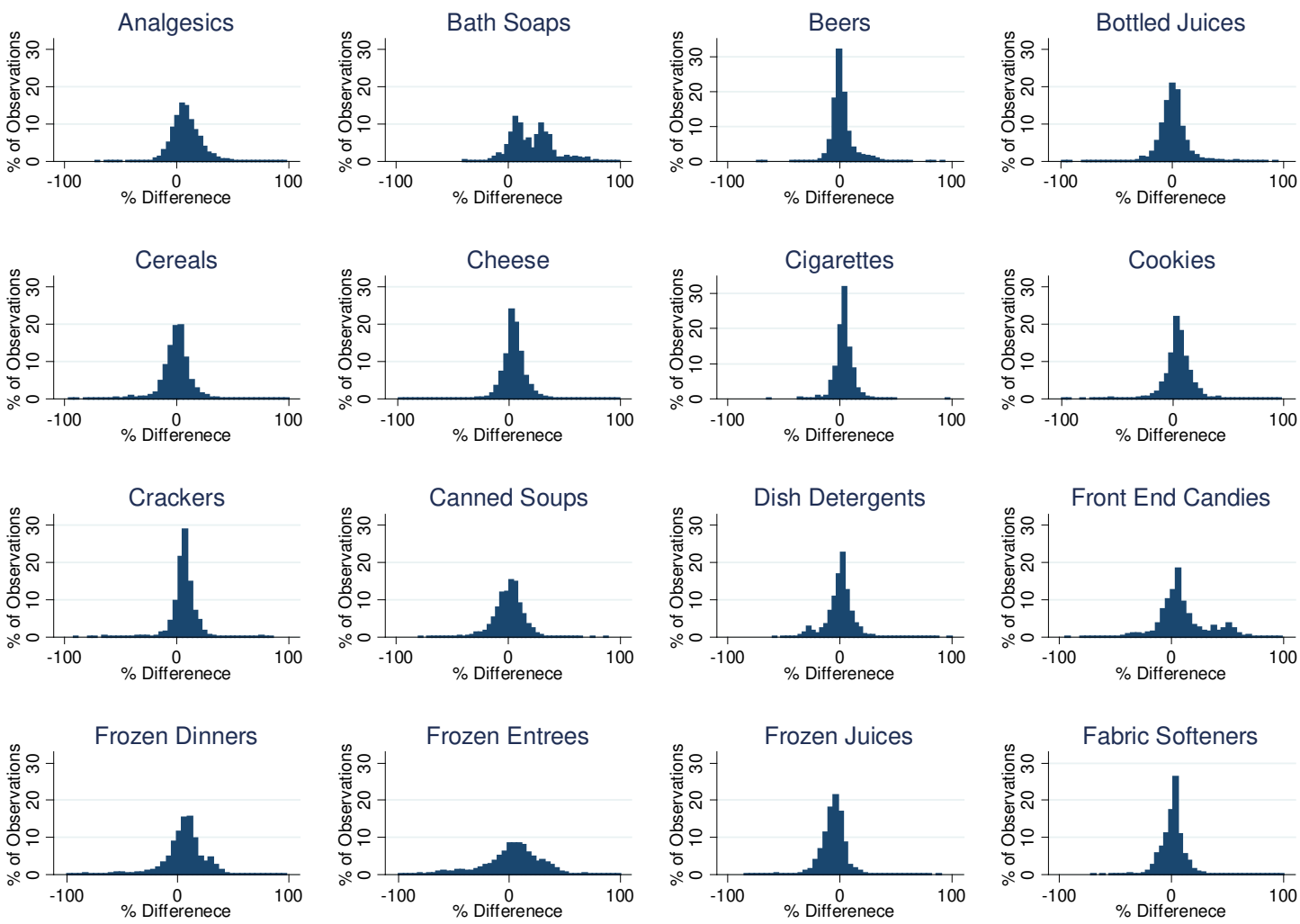


Figure G1. Frequency Distribution of the Percentage Differences between the Average 9-Ending and Non 9-Ending Prices, by Product Category at the Product-Store Level, Dominick's, September 14, 1989–May 8, 1997 (Cont.)

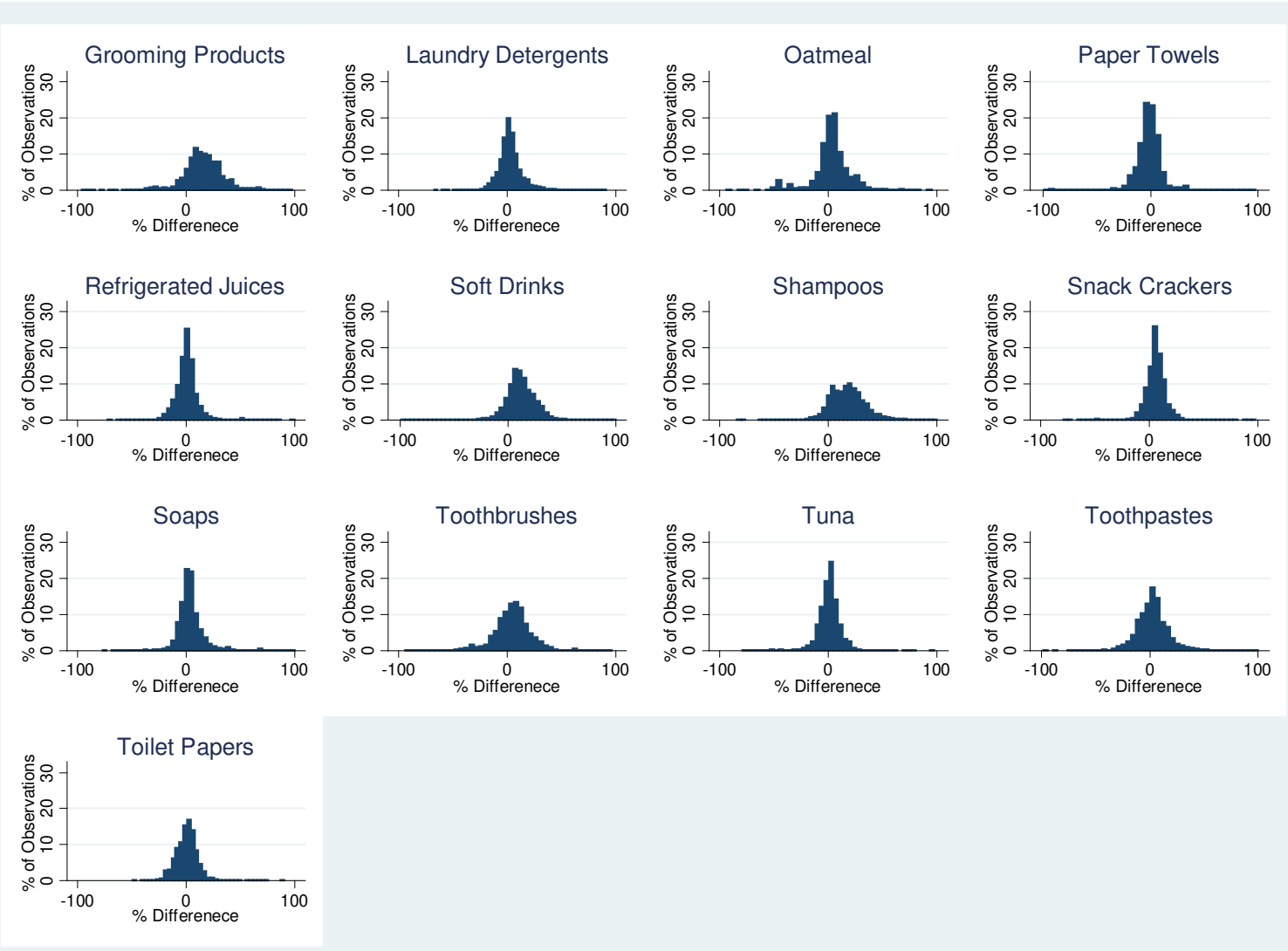


Table G1. Moments of the Distribution of the Percentage Differences between the Average 9-Ending and the Average Non 9-Ending Prices, Dominick's, September 14, 1989–May 8, 1997

Category	**Median**	**Average**	**Std. Dev.**	**Skewness**	**Kurtosis**	***N***
Analgesics	7.3%	8.8%	15.1%	5.85***	175.71***	21,360
Bath Soaps	17.9%	20.7%	20.5%	1.93***	25.78***	5,125
Beer	0.1%	1.8%	10.9%	13.87***	671.37***	12,224
Bottled Juices	−0.0%	0.4%	13.5%	0.44***	17.28***	30,962
Cereal	0.5%	−0.1%	115.5%	−0.19***	15.38***	28,530
Cheese	3.6%	4.0%	12.2%	−0.28***	20.26***	41,122
Cigarettes	3.8%	3.3%	8.2%	0.95***	43.75***	15,385
Cookies	4.9%	4.8%	14.5%	−0.35***	22.32***	57,404
Crackers	6.7%	6.2%	12.5%	−1.38***	23.37***	17,608
Canned Soups	1.3%	0.1%	12.4%	−0.67***	6.00***	29,272
Dish Detergents	1.0%	−0.5%	11.9%	−0.06***	6.89***	16,191
Front-End-Candies	6.0%	10.2%	23.7%	0.86***	6.89***	20,819
Frozen Dinners	7.0%	5.0%	21.5%	−1.03***	7.95***	17,534
Frozen Entrees	4.4%	0.3%	30.0%	−1.03***	5.47***	55,140
Frozen Juices	−5.4%	−5.8%	12.4%	0.86***	18.43***	12,269
Fabric Softeners	2.0%	1.7%	12.6%	1.78***	15.34***	19,172
Grooming products	15.1%	15.7%	19.2%	0.01	9.78***	54,048
Laundry Detergents	1.8%	3.0%	12.1%	1.30***	10.81***	33,057
Oatmeal	3.5%	3.0%	17.6%	−0.33***	7.39***	5,844
Paper Towels	−1.3%	−2.1%	15.8%	−1.48***	21.17***	7,245
Refrigerated Juices	0.5%	0.6%	11.8%	1.34***	17.75***	14,867
Soft Drinks	10.9%	12.2%	22.8%	1.86***	45.34***	74,387
Shampoos	17.1%	17.8%	18.0%	0.67***	7.16***	63,011
Snack Crackers	5.4%	5.5%	12.0%	2.02***	250.37***	25,042
Soaps	2.7%	4.1%	15.0%	2.20***	18.98***	17,442
Toothbrushes	5.3%	5.0%	17.6%	0.18***	6.02***	18,940
Tuna	1.3%	0.4%	11.0%	−1.44***	16.12***	16,324

Toothpastes	2.2%	2.7%	15.8%	1.05***	10.09***	27,731
Toilet papers	0.7%	0.4%	10.5%	0.50***	8.29***	8,252

Notes

In the table, we report the descriptive statistics of the distribution of the percentage difference between the average 9-ending and the average non 9-ending prices, at the product-store level, by product category. Skewness statistic is estimated using Fischer's Skewness Measure. Its statistical significance is based on the test of D'Agostino, et al (1990), which compares the skewness in a given sample to the skewness of the normal distribution, where the latter equals 0. Kurtosis statistic is estimated using the Moment Coefficient of Kurtosis. Its statistical significance test compares it, in a given sample, to the kurtosis of the normal distribution, which equals 3. *** indicates statistical significance at the $p < 0.01$ level.

APPENDIX H. 9-ENDING VS. NON 9-ENDING PRICES, FOR INDIVIDUAL PRODUCTS AT THE STORE-LEVEL, ENTIRE DATASET

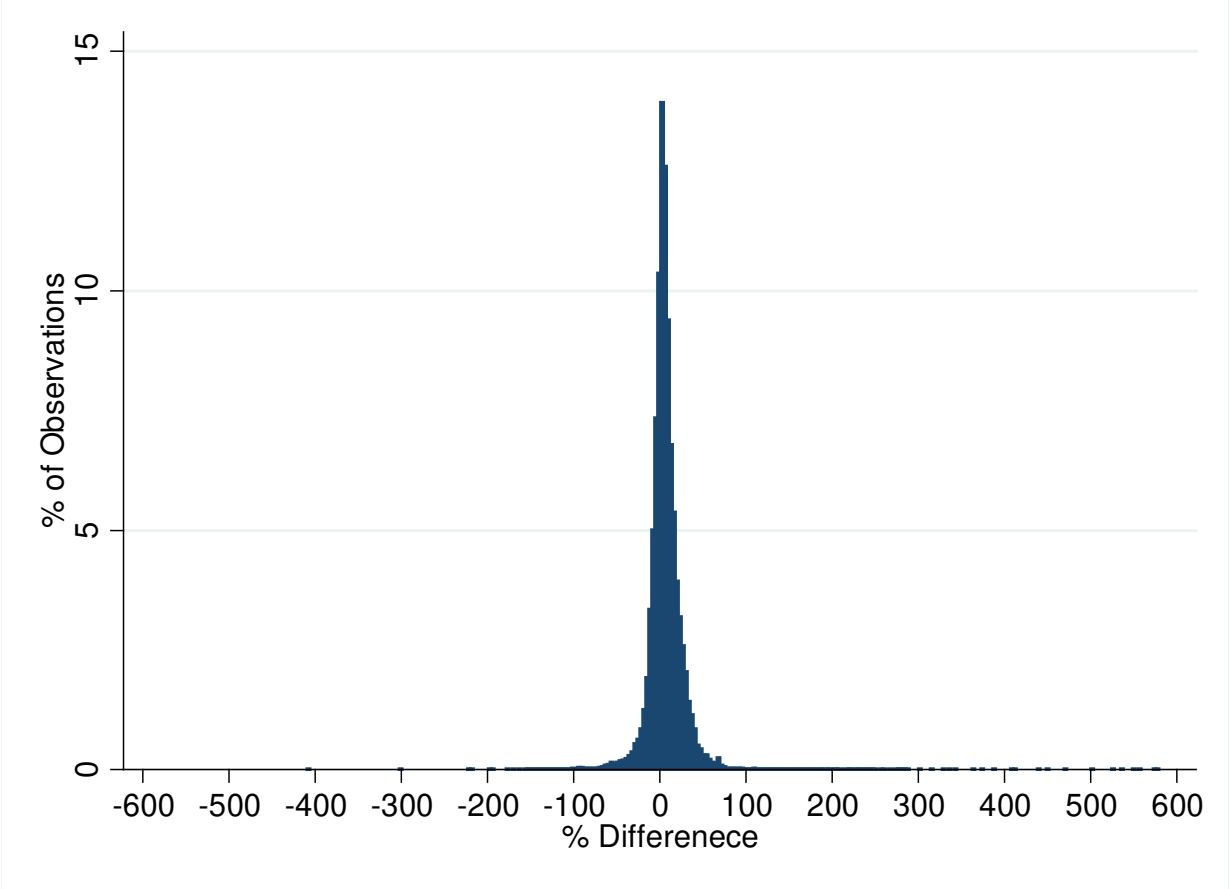
In the paper, in Figure 3, we present the frequency distribution of the % difference between the average 9-ending and non 9-ending prices for the entire dataset. The figure in the paper, however, excludes outlier observations, defined as percentage differences in excess of 100% in absolute value, i.e., on both sides of the distribution, in order to better show the mid-part of the distribution. Figure H1 below presents the same distribution, but this time with all the observations included.

The descriptive statistics of the distribution shown in Figure H1 are identical, up to three digits after the decimal point, to the descriptive statistics that we report for the distribution shown in Figure 3 in the paper for the data with outliers excluded. That is because the number of outlier observations, 1,654, comprise about 0.2% of the total number of observations.

Thus, the descriptive statistics are as follows. The average of the distribution is 5.97 (standard deviation = 18.68), confirming that 9-ending prices exceed non 9-ending prices on average. The median of the distribution is 4.74, suggesting that the higher average 9-ending prices are not caused by outliers. The skewness is 0.43, meaning the distribution of the % difference is skewed to the right. Kurtosis of the distribution, 23.7 > 3, implying that the tail of the distribution is thicker in comparison to the Normal Distribution. Formal skewness and kurtosis tests reject the null of normality at 1%. This confirms that 9-ending prices exceed non 9-ending prices at the level of individual products and stores.

We thus rule out the possibility that 9-ending prices are lower than non 9-ending prices at the level of individual products and stores. In Web Appendix G, we present the same frequency distributions at the category level, with similar findings.

Figure H1. Frequency Distribution of the Percentage Differences between the Average 9-Ending and Non 9-Ending Prices, Entire Dataset, at the Product-Store Level, Dominick's, September 14, 1989–May 8, 1997



Note

The figure is based on all 98,914,300 weekly retail price observations of Dominick's, at 93 stores for 400 weeks, from September 14, 1989 to May 8, 1997.

APPENDIX I. ESTIMATING PRICE DIFFERENCES BETWEEN 9-ENDING AND NON 9-ENDING PRICES USING PRICE ZONES AS CLUSTERS

To formally test whether 9-ending prices are higher or lower on average than non 9-ending prices, while controlling for the effect of time trend, we estimate in the paper a series of log-linear OLS regressions with fixed effects at the category level. The dependent variable in these regressions is the log of the price, which allows us to interpret the estimated coefficients in percentage terms. The main independent variable in all the regressions is a dummy for 9-ending prices, which equals 1 if the price is 9-ending, and 0 if the price ends with any other digit. The coefficient of the 9-ending price dummy therefore gives the expected percentage difference between 9-ending and non 9-ending prices.

In the analyses that we report in the paper, we cluster the standard errors at the store level. However, Dominick's data manual suggests that stores were divided into zones depending on their location and the level of local competition, and that the prices within each zone were usually the same. This suggests that a suitable level for clustering might be the level of price zones, rather than individual stores. We therefore replicate the estimations we perform in the paper, but this time we are clustering the errors at the level of the price zones, as given by the Dominick's data manual. We report the results in Table I1.

In column (1) of the table, we report the estimation results of a regression, which includes dummies for weeks and for subcategories-store. Thus, we control for the effects of different subcategories at the store level, and for the overall price trend. In 22 out of the 29 product categories, the expected 9-ending prices are higher than the expected non 9-ending prices. The differences are statistically significant at the 1% level in 19 of the cases, and in one more, the difference is significant at the 10% level.

In column (2), we use a stronger test. Here we add subcategories-store-week dummies. Thus, we control for inflation at the subcategory-store level. The 9-ending price dummy should therefore capture the differences between goods that belong to the

same subcategory at the same store and on the same week. In other words, the differences that we find between the expected values of the 9-ending and non 9-ending prices, represent the expected differences that exist within a store on a given week between the prices of goods that belong to the same product subcategories.

Using this specification, we find that the expected 9-ending prices are higher than the corresponding expected non 9-ending prices in 23 of the 29 product categories. The differences are statistically significant at the 1% level in 20 of the cases.

As an additional test, we perform an even more restrictive analysis, by looking at the prices of individual products within individual stores over time and compare the prices when each good is sold at 9-ending and at non 9-ending prices. It might be that even if 9-ending prices are not necessarily the lowest within each sub-category, they still represent a good purchase opportunity because they are associated with times when individual goods are offered at low prices.

In column (3) of the table, we report the estimation results of this test. The independent variables are a dummy for 9-ending prices, and fixed effects for products at the store-level, and for weeks. Here we find that in 25 out of the 29 product categories, the expected 9-ending prices are higher than corresponding non 9-ending prices. Thus, even for individual goods at individual stores, in almost all product categories, 9-ending prices are expected to be higher than non 9-ending prices.

To summarize, the results of the three regressions suggest that even after we control for time trend by using week fixed effects, we still find that the expected 9-ending prices are higher than the expected non 9-ending prices in the majority of product categories. This is true whether we compare the prices of products within the same sub categories and controlling for stores, when we compare the prices of products within the same subcategory in the same store and on the same week, and even when we compare the 9- and non 9-ending prices of individual products at an individual store.

In the paper, we also estimate a series of OLS regressions after separating the data into observations on regular and sale prices, using a sale filter that identifies a sale if the price decreases and then returns to the same level or above. Below we replicate the same

regressions but this time we cluster the standard errors at the price zone level rather than the store level.

We report the estimation results in Table I2. The figures in the table are the coefficient estimates of the 9-ending dummy, which equals 1 if the price ends with 9, and 0 otherwise. A positive coefficient indicates that 9-ending prices are on average higher than non 9-ending prices.

In columns (1)–(3), we report the estimation results for regular prices, and in columns (4)–(6) for sale prices. In columns (1) and (4), the regressions include controls for weeks and for subcategories-store. In columns (2) and (5), the regressions include controls for subcategories- store-weeks. In columns (3) and (6), the regressions include controls for weeks and for products-store.

For regular prices, in column (1) the coefficient estimate is positive and statistically significant for 18 product categories. In one more category, bottled juices, it is marginally significant. In column (2), it is positive and statistically significant for 18 product categories. In column (3), it is positive and statistically significant for 22 product categories, and negative but statistically insignificant in one category (Frozen Dinners). Thus, for regular prices, at the level of individual products within stores, in 23 out of 29 product categories, the expected 9-ending prices are either higher, or no different, than the expected non 9-ending prices.

For sale prices, in column (4), the coefficient estimate is positive and statistically significant for 14 product categories, negative and statistically significant for 9 product categories, negative and marginally significant for one product category, and there is no statistically significant difference in five product categories. In column (5), it is positive and statistically significant for 15 product categories, positive and marginally significant for one category, negative and statistically significant for 9 product categories, and there is no statistically significant difference in four product categories. In column (6), it is positive and statistically significant for 12 product categories, negative and statistically significant for 15 product categories, and there is no statistically significant difference in two product categories.

Overall, the results are consistent with the results we report in Table 5 in the paper. We find that for regular prices, which in our data comprise 88.68 percent of all prices, 9-ending prices are higher than non 9-ending prices in the majority of the product categories, irrespective of which regression we estimate.

For sale prices, the results are more mixed. According to column (6), which compares the prices of products within stores, the expected 9-ending sale prices are higher than the expected non 9-ending sale prices in only 12 categories. That is, in most categories, 9-ending sale prices are either lower than, or no different from, non 9-ending sale prices.

Table I1. Regression Analyses of the Percentage Difference between 9-Ending and Non 9-Ending Prices, Dominick's, September 14, 1989–May 8, 1997

	(1)	**(2)**	**(3)**	***N***
Analgesics	0.13 (0.008)***	0.13 (0.008)***	0.15 (0.001)***	3,040,172
Bath Soaps	0.02 (0.020)	0.03 (0.019)	0.12 (0.001)***	418,097
Beer	0.03 (0.007)***	0.03 (0.006)***	−0.02 (0.001)***	1,966,148
Bottled Juices	0.03 (0.009)***	0.03 (0.009)***	0.02 (0.000)***	4,325,024
Cereal	−0.02 (0.001)***	−0.02 (0.001)***	0.01 (0.000)***	4,707,776
Cheese	0.11 (0.003)***	0.08 (0.003)***	0.15 (0.000)***	6,752,326
Cigarettes	0.59 (0.085)***	0.02 (0.002)***	0.27 (0.001)***	1,801,444
Cookies	−0.09 (0.07)***	0.00 (0.006)	−0.00 (0.000)***	7,568,352
Crackers	0.06 (0.002)***	0.07 (0.002)***	0.03 (0.000)***	2,228,268
Canned Soups	0.09 (0.016)***	0.09 (0.016)***	0.06 (0.000)***	5,504,492
Dish Detergents	0.03 (0.016)*	0.03 (0.010)***	0.02 (0.000)***	2,164,793
Front-End-Candies	0.39 (0.004)***	0.38 (0.004)***	0.24 (0.000)***	4,437,054
Frozen Dinners	−0.01 (0.019)	−0.01 (0.019)	0.04 (0.000)***	1,654,053
Frozen Entrees	0.06 (0.011)***	0.05 (0.013)***	0.01 (0.000)***	7,172,075
Frozen Juices	−0.07 (0.007)***	−0.08 (0.007)***	−0.06 (0.000)***	2,368,157
Fabric Softeners	−0.03 (0.007)***	−0.03 (0.007)***	0.02 (0.000)***	2,278,995
Grooming products	0.21 (0.003)***	0.16 (0.003)***	0.17 (0.000)***	4,065,689
Laundry Detergents	0.10 (0.005)***	0.13 (0.005)***	0.12 (0.001)***	3,277,444
Oatmeal	−0.02 (0.015)	−0.01 (0.015)	0.02 (0.000)***	981,037
Paper Towels	0.14 (0.024)***	0.14 (0.024)***	0.05 (0.001)***	940,757
Refrigerated Juices	0.06 (0.001)***	0.06 (0.001)***	0.06 (0.001)***	2,166,755
Soft Drinks	0.69 (0.015)***	0.30 (0.009)***	0.30(0.000)***	10,741,742
Shampoos	0.16 (0.022)***	0.12 (0.014)***	0.12 (0.000)***	4,666,565
Snack Crackers	0.03 (0.009)***	0.03 (0.008)***	0.05 (0.000)***	3,487,564
Soaps	0.15 (0.009)***	0.15 (0.009)***	0.11 (0.001)***	1,835,196
Toothbrushes	−0.03 (0.009)***	−0.01 (0.009)	0.02 (0.000)***	1,772,158

Tuna	0.19 (0.007)***	0.19 (0.007)***	0.10 (0.001)***	2,382,983
Toothpastes	0.01 (0.010)	0.01 (0.009)	−0.01 (0.000)***	2,981,532
Toilet papers	0.41 (0.015)***	0.41 (0.015)***	0.11 (0.001)***	1,149,972
Dummies for weeks	√		√	
Dummies for product-store			√	
Dummies for sub-categories-store	√			
Dummies for sub-categories-store-weeks		√		

Notes

In the table, we report the coefficient estimates of a 9-ending dummy in log-linear OLS regressions with fixed effects, where the dependent variable is the log of the prices. The 9-ending dummy equals 1 if the price ends with 9, and 0 if the price ends with any other digit. In column (1), the regression includes controls for weeks and for subcategories-store. In column (2), the regression includes controls for subcategories-stores-weeks. In column (3), the regression includes dummies for weeks and for product-store. In parentheses, we report robust standard errors, clustered at the zone level. * $p < 0.10$ ** $p < 0.05$, *** $p < 0.01$.

Table I2. Regression Analysis of the Percentage Difference between 9-Ending and Non 9-Ending Prices, Regular and Sale Prices, Dominick's, September 14, 1989–May 8, 1997

	Regular Prices				Sale Prices			
	(1)	**(2)**	**(3)**	***N***	**(4)**	**(5)**	**(6)**	***N***
Analgesics	0.13*** (0.008)	0.13*** (0.008)	0.15*** (0.001)	2,924,303	0.00 (0.003)	0.01* (0.003)	−0.01*** (0.002)	115,869
Bath Soaps	−0.01 (0.023)	−0.01 (0.022)	0.11*** (0.001)	405,439	0.02 (0.015)	0.03** (0.012)	−0.04*** (0.003)	12,658
Beer	0.02** (0.008)	0.02** (0.008)	−0.04*** (0.001)	1,660,236	0.11*** (0.009)	0.09*** (0.008)	−0.03*** (0.002)	305,912
Bottled Juices	0.02* (0.011)	0.02 (0.011)	0.02*** (0.000)	3,753,608	0.06*** (0.010)	0.05*** (0.009)	−0.00*** (0.001)	571,416
Cereal	−0.02*** (0.001)	−0.02*** (0.001)	0.01*** (0.000)	4,379,009	−0.01* (0.005)	−0.02*** (0.007)	−0.03*** (0.001)	328,767
Cheese	0.12*** (0.005)	0.08*** (0.004)	0.16*** (0.000)	5,684,114	−0.01*** (0.002)	−0.01*** (0.002)	0.03*** (0.001)	1,068,212
Cigarettes	0.59*** (0.085)	0.02*** (0.003)	0.27*** (0.001)	1,793,459	0.01 (0.258)	−0.05** (0.019)	0.21*** (0.019)	7,985
Cookies	−0.13*** (0.008)	−0.03*** (0.006)	−0.04*** (0.000)	6,725,729	−0.06*** (0.001)	−0.03*** (0.001)	−0.03*** (0.001)	842,623
Crackers	0.07*** (0.003)	0.07*** (0.002)	0.02*** (0.000)	1,943,794	−0.08*** (0.003)	−0.07*** (0.001)	−0.06*** (0.001)	284,474
Canned Soups	0.09*** (0.017)	0.08*** (0.017)	0.06*** (0.000)	5,018,750	0.12*** (0.004)	0.11*** (0.004)	0.01*** (0.001)	485,742
Dish Detergents	0.03*** (0.018)	0.04*** (0.011)	0.02*** (0.000)	1,973,399	−0.04*** (0.004)	0.05*** (0.005)	−0.04*** (0.001)	191,394
Front-End-Candies	0.39*** (0.004)	0.38*** (0.004)	0.24*** (0.000)	4,189,543	0.18*** (0.007)	0.20*** (0.005)	0.06*** (0.001)	247,511
Frozen Dinners	−0.06*** (0.017)	−0.07*** (0.017)	−0.01 (0.000)	1,391,236	0.07*** (0.014)	0.04*** (0.018)	0.01*** (0.001)	262,817
Frozen Entrees	0.01 (0.012)	0.00 (0.013)	−0.05*** (0.000)	6,289,007	0.00 (0.000)	−0.01 (0.009)	0.00 (0.001)	883,068

Frozen Juices	−0.07*** (0.007)	−0.08*** (0.007)	−0.06*** (0.000)	2,016,638	−0.07*** (0.003)	−0.09*** (0.004)	−0.02*** (0.001)	351,519
Fabric Softeners	−0.04*** (0.007)	−0.05*** (0.007)	0.01*** (0.001)	2,101,762	0.10*** (0.003)	0.15*** (0.004)	0.01*** (0.002)	177,233
Grooming products	0.20*** (0.003)	0.14*** (0.002)	0.16*** (0.004)	3,806,684	0.18*** (0.008)	0.08*** (0.004)	0.07*** (0.001)	259,005
Laundry Detergents	0.08*** (0.006)	0.12*** (0.005)	0.12*** (0.001)	3,002,713	0.18*** (0.013)	0.17*** (0.012)	0.07*** (0.001)	274,731
Oatmeal	−0.03*** (0.015)	−0.03*** (0.014)	−0.01*** (0.000)	898,099	−0.05*** (0.004)	0.00 (0.007)	−0.03*** (0.002)	82,938
Paper Towels	0.15*** (0.003)	0.15*** (0.003)	0.07*** (0.001)	807,388	0.03** (0.011)	0.01 (0.011)	0.01*** (0.002)	133,369
Refrigerated Juices	0.07*** (0.011)	0.08*** (0.011)	0.07*** (0.001)	1,702,858	0.01 (0.005)	0.01** (0.005)	0.01*** (0.001)	463,897
Soft Drinks	0.76*** (0.021)	0.34*** (0.016)	0.30*** (0.001)	8,516,259	0.56*** (0.012)	0.14*** (0.006)	0.20*** (0.001)	2,225,483
Shampoos	0.15*** (0.024)	0.11*** (0.016)	0.10*** (0.000)	4,416,767	−0.08*** (0.009)	−0.05*** (0.004)	−0.00 (0.001)	249,798
Snack Crackers	0.01** (0.011)	0.02*** (0.011)	0.03*** (0.000)	3,019,467	−0.03*** (0.003)	−0.03*** (0.003)	−0.04*** (0.001)	468,097
Soaps	0.16*** (0.010)	0.15*** (0.010)	0.12*** (0.001)	1,662,739	0.07*** (0.008)	0.07*** (0.007)	0.01*** (0.001)	172,457
Toothbrushes	−0.04*** (0.008)	−0.02** (0.009)	0.02*** (0.000)	1,662,831	0.01** (0.004)	0.00 (0.005)	−0.07*** (0.001)	109,327
Tuna	0.20*** (0.007)	0.20*** (0.007)	0.10*** (0.001)	2,183,367	−0.03*** (0.007)	−0.05*** (0.006)	−0.01*** (0.002)	199,616
Toothpastes	−0.00 (0.010)	0.00 (0.009)	−0.02*** (0.000)	2,709,365	0.01*** (0.003)	0.03*** (0.002)	−0.03*** (0.001)	272,167
Toilet papers	0.43*** (0.017)	0.43*** (0.017)	0.13*** (0.001)	983,422	0.20*** (0.009)	0.23*** (0.010)	−0.03*** (0.002)	166,550
Dummies for weeks	√		√		√		√	
Dummies for product-store			√				√	
Dummies for sub-categories-store	√				√			

Dummies for sub-categories-store-weeks	√	√

Notes

In the table, we report the coefficient estimates of a 9-ending dummy in a number of log-linear OLS regressions with fixed effects, where the dependent variable is the log of the prices. In columns (1)–(3), we report the results when we estimate the regression using data on regular prices only. In columns (4)–(6), we report the results when we estimate the regression using data on sale prices only. We identify sale prices using a sale filter that identifies a price as a sale if the price decreases and then increases to the same level or above. In columns (1) and (4), the regression includes controls for weeks and for subcategories-store. In columns (2) and (5), the regression includes controls for subcategories-stores-weeks. In columns (3) and (6), the regression includes dummies for weeks and for product-store. In the parentheses we report robust standard errors, clustered at the zone level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

APPENDIX J. DYNAMICS OF 9-ENDING AND NON 9-ENDING PRICES: REGULAR PRICES VS SALE PRICES USING STORE, PRODUCT CATEGORIES AND PRODUCT SUB CATEGORIES DUMMIES

In the paper, in Table 6 we report results of regressions testing the differences between 9- and non 9-ending prices among regular and sale prices over time. In this appendix, we estimate the same regressions. However, instead of controlling for individual products in individual stores, the regressions we estimate here include dummy controls for stores, product categories, product sub-categories, and weeks. The independent variable is the log of the prices. The main independent variable in all the regressions is a 9-ending dummy. Its coefficient should capture the expected percentage difference between 9- and non 9-ending prices. A positive (negative) 9-ending dummy coefficient indicates that the expected 9-ending prices are higher (lower) than the expected non 9-ending prices. Table J1 reports the results.

We find that until 1993, with the exception of 1990, the expected difference between 9- and non 9-ending prices was larger among sale prices than among regular prices. In other words, while 9-endings were more common among sale prices than among regular prices, 9-ending prices tended to exceed non 9-ending prices among sale prices more than among regular prices. Thus, although 9-ending prices were common in that period among sale prices, 9-ending prices were not associated with particularly large price cuts on average.

After 1993, the expected difference between 9- and non 9-ending prices among regular prices increased, reaching 12–14 percent during 1995–1997. In parallel, the expected difference between 9- and non 9-ending prices decreased to 2–6 percent in that period.

It therefore seems that while Dominick's was increasing the prices of regular 9-ending prices relative to non 9-ending regular prices, it was at the same time decreasing the 9-ending sale prices relative to non 9-ending sale prices. In other words, as 9-ending regular prices were increasing, noticing that 9-ending sale prices are frequently higher than non 9-ending prices, was getting harder. These results are consistent with the pattern we report in the paper.

Table J1. Annual Regressions of the Percentage Difference between 9-Ending and Non 9-Ending Prices, Dominick's, September 14, 1989–May 8, 1997

	All Observations		Regular Prices		Sale Prices	
Year	**9-Ending**	***N***	**9-Ending**	***N***	**9-Ending**	***N***
1989	0.10*** (0.003)	2,570,474	0.10*** (0.004)	2,362,875	0.17*** (0.004)	207,599
1990	0.04*** (0.002)	9,228,965	0.04*** (0.002)	8,366,677	0.02*** (0.002)	862,288
1991	0.03*** (0.003)	10,650,384	0.02*** (0.003)	9,552,147	0.06*** (0.001)	1.098.237
1992	0.07*** (0.005)	13,731,259	0.06*** (0.005)	12,343,849	0.07*** (0.004)	1,387,410
1993	0.07*** (0.002)	14,023,602	0.06*** (0.002)	12,549,782	0.06*** (0.002)	1,473,820
1994	0.11*** (0.001)	13,645,820	0.10*** (0.001)	11,905,363	0.03*** (0.001)	1,740,457
1995	0.14*** (0.001)	13,424,315	0.13*** (0.002)	11,544,459	0.03*** (0.001)	1,879,856
1996	0.15*** (0.001)	14,238,652	0.14*** (0.001)	12,524,236	0.02*** (0.001)	1,714,416
1997	0.13*** (0.001)	5,156,434	0.12*** (0.001)	4,769,776	0.06*** (0.001)	386,658

Notes.

The table reports the coefficient estimates of a 9-ending dummy in fixed effect log-linear OLS regressions, where the dependent variable is the log of the prices. The regressions are estimated for each year over all stores and products. 9-ending dummy equals 1 if the price ends with 9, 0 otherwise. The regressions include controls for stores, product categories, product sub-categories, and years. We identify sale prices using a sales filter that identifies a sale if the price decreases and then increases back to the previous level or above. The regressions also include fixed effects for stores, categories, sub−categories and weeks. *** $p < 0.01$.

References

Besley, T., and H. Rosen (1999), "Sales Taxes and Prices: An Empirical Analysis," ***National Tax Journal***, 52, 157–178.

Chen, H., D. Levy, S. Ray, and M. Bergen (2008), "Asymmetric Price Adjustment in the Small," ***Journal of Monetary Economics***, 55(4), 728–737.

Chintagunta, P., J. Dubé, and V. Singh (2003), "Balancing Profitability and Customer Welfare in a Supermarket Chain," ***Quantitative Marketing and Economics*** 1, 111–147.

Dominick's Data Manual (2018), Booth School of Business, University of Chicago.

Ellickson, P., and S. Misra (2006), "Supermarket Pricing Strategies," ***Marketing Science*** 27(5), 811–828.

Hoch, S., B.D. Kim, A.L. Montgomery, and P.E. Rossi (1995), "Determinants of Store-Level Price Elasticity," ***Journal of Marketing Research*** 32(1), 17–29.

Midrigan, V. (2011), "Menu Costs, Multiproduct Firms, and Aggregate Fluctuations," ***Econometrica*** 79(4), 1139–1180.

Nakamura, E., and J. Steinsson (2008), "Five Facts about Prices: a Reevaluation of Menu Cost Models," ***Quarterly Journal of Economics***, 123(4), 1415–1464.

Peltzman, S. (2000), "Prices Rise Faster than They Fall," ***Journal of Political Economy***, 108(3), 466–502.

Schindler, R.M. (2001), "Relative Price Level of 99-Ending Prices: Image vs Reality," ***Marketing Letters***, 12(3), 239–247.

Schindler, R.M. (2006), "The 99 Price-Ending as a Signal of a Low-Price Appeal," ***Journal of Retailing***, 82(1), 71–77.

Schindler, R.M. and T.M. Kibarian (2001), "Image Communicated by the Use of 99 Endings in Advertised Prices," ***Journal of Advertising***, 30(4), 95–99.

Schindler, R. and P. Kirby (1997), "Patterns of Rightmost Digits Used in Advertised Prices: Implications for 9-Ending Effects" ***Journal of Consumer Research*** 24, 192–201.

Stiving, M. (2000), "Price-Endings When Prices Signal Quality," ***Management Science***, 46(12), 1617–1629.

Stiving, M. and R.S. Winer (1997), "An Empirical Analysis of Price Endings Using Scanner Data," ***Journal of Consumer Research***, 24, 57–67.