Holiday Price Rigidity and Cost of Price Adjustment*

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Abstract

The Thanksgiving-Christmas holiday period is a major sales period for US retailers. Due to higher store traffic, tasks such as restocking shelves, handling customers' questions and inquiries, running cash registers, cleaning, and bagging, become more urgent during holidays. As a result, the holiday-period opportunity cost of price adjustment increases dramatically for retail stores, which should lead to greater price rigidity during holidays. We test this prediction using weekly retail scanner price data from a major Midwestern supermarket chain. Our data provides a *natural experiment* for studying variation in price rigidity because most aspects of market environment such as market structure, industry concentration, the nature of long-term relationships, contractual arrangements, etc., do not vary between holiday and non-holiday periods. We, therefore, are able to rule out these commonly used alternative explanations for price rigidity.

1. Introduction

> "It's a madhouse during the holidays. There is no time to do anything that is marginal or incremental—you have to focus on the essential issues, keeping items in stock, keeping the registers manned, and making the store presentable. The key is to manage the flow of goods and customers through the store."
>
> Brett Drey, Retail Manager

Holidays are arguably the most important sales periods for US retailers. For example, Barsky and Warner (1995) suggest that the Thanksgiving-Christmas period is the busiest shopping period. Chevalier, et al. (2003, p. 20) focusing on the consumption of food, state that "it is apparent that Christmas and Thanksgiving represent the overall peak shopping periods for Dominick's." Indeed, our conversations with supermarket managers indicate that these two holiday periods constitute the busiest shopping period in their stores.

In this paper we focus on pricing decisions during this holiday season. There is a literature that studies pricing patterns during holiday periods, which focuses on the increase in demand during holiday periods—studying how firms incorporate these demand effects into higher or lower price levels during holiday periods (see, e.g., Pashigian and Bowen 1991, Barsky and Warner 1995, and Chevalier, et al. 2003). This emphasis on the *demand side* and its implications for holiday pricing is interesting and important.

We explore the missing piece in this literature—*supply side* issues during holiday periods—by focusing on the cost of price adjustment during holiday periods. We argue that the costs of price adjustment increase during holidays. Due to higher store traffic, other tasks such as restocking shelves, handling customers' questions and inquiries, running cash registers, cleaning, and bagging, become more urgent during holidays and thus receive priority, which increases the opportunity costs of price adjustment. This observation is consistent with the existing evidence on price adjustment processes and their costs in the retail industry (e.g., Levy, et al. 1997). Indeed, statements made by retail pricing managers confirm that their opportunity cost of price adjustment increases dramatically during holiday periods.

The most direct implication of higher costs of price adjustment should be nominal price rigidity (Mankiw, 1985; Ball and Mankiw, 1994). Thus, we expect to see greater price rigidity during holiday periods. We test this hypothesis using weekly scanner data set consisting of retail and wholesale prices for thousands of products at a large US supermarket Chain, Dominick's. Indeed, we find greater price rigidity during the holiday periods in comparison to the non-holiday periods, as predicted by the menu cost theory.

As Konieczny and Fisher (2005) and Konieczny and Skrzypacz (2004) note, the empirical evidence supporting the menu cost theory is mixed, although some studies that use high and moderate inflation period data such as Lach and Tsiddon (1996), provide evidence consistent with it. However, some studies, e.g., Carlton (1986), report findings of frequent small price changes which appear to go against the simple menu cost theory.[1]

Much of the recent theoretical work on price rigidity relies on cost of price adjustment as a critical theoretical lynchpin (Blinder, et al., 1998). However, very little is known about the actual empirical relevance of these costs. This study contributes to that literature by demonstrating the critical importance of price adjustment costs for price rigidity in a retail food industry, an industry with a substantial economic significance. Our findings, therefore, reinforce the likely importance of costs of price adjustment as a source of price rigidity, at least in the retail multi-product setting.

A unique aspect of our study is that our data form a *natural experiment* to study variation in price rigidity, as they enable us to rule out many common explanations offered for price rigidity (Carlton and Perloff, 1994). This is because the stores, market arrangements, industry concentration, nature of relationships, or other institutional features do not vary between holiday and non-holiday weeks, back and forth.

The rest of the paper is organized as follows. In the section 2, we briefly discuss our theoretical prediction. In section 3, we describe the data. In section 4 we report the findings. We conclude in section 5.

2. Theoretical Prediction

Our theoretical prediction is fairly straightforward. We argue that the costs of price adjustment increase during holidays, drawing on managerial information and the existing studies of price adjustment costs. This observation leads to our hypothesis—that retail prices should be more rigid during holiday periods in comparison to the rest of the year.

The initial insight about higher holiday price adjustment costs came from discussions with retail price managers. The conversations we had with them confirm the existence of higher costs of price adjustment during holidays. For example, Bob Venable, an expert in

[1] Lach and Tsiddon (2005) offer a possible resolution of the small price change puzzle. See Cecchetti (1986), Caplin (1993), Sheshinski and Weiss (1993), and Wolman (2005), for surveys.

the supermarket industry, stated that:

> "These costs of price adjustment increase substantially during holiday periods. The limited managerial resources are spent on other tasks, and the value of price changes is lower here."

Debra Farmer, manager of a large supermarket, provided the following description of the difficulties her organization faces when it comes to changing prices during holidays:

> "Changing prices during the Thanksgiving and Christmas holidays? That's very difficult. We do not have enough people to do that. It is almost impossible. During regular weeks, we restock the shelves during late night and early morning hours. But during these holidays, we have to do it every hour; we do not have enough manpower to do that."

Lisa Harmening, a manager at a large packaged goods manufacturer stated that:

> "When talking with retailers, they made it clear that they didn't want to deal with prices during the holidays. They wanted minimal pricing hassle during those seasons, and price changes were decided well in advance."[2]

Consistent with this anecdotal evidence, the existing studies of costs of price adjustment (i.e., "menu costs") at large U.S supermarkets, identify the labor input as the most important component of price adjustment costs. For example, Levy, et al. (1997) document in detail the process these retailers follow to adjust prices. They find that the resources that go into the price change process consist of mostly labor input, and include the time spent on (1) price tag change preparation, (2) removing old price tags and putting up new price tags, (3) verifying that the price changes were done correctly, and (4) correcting mistakes. Further, they report that this process is very labor intensive. Indeed, according to the measurements of Levy, et al. (1997, p. 800) for large U.S supermarket chains, labor cost "… is the single largest component of the menu costs… making up about 70.1 percent of the total menu costs for these chains on average."[3] Thus, labor input costs of changing prices are the largest component of menu costs in these establishments.

During the holiday season the opportunity cost of using employee time to change prices rather than perform other tasks rises substantially. This is due to the larger volume of customer traffic during holidays. At the retailer we study, the volume of items sold

[2] Barsky and Warner (1995) also report that in the retail establishments they study, the sale prices are often planned in advance of the holidays.

increases 6% on average during holidays. The increase in the number of shoppers necessitates that more labor time be used for running the cash registers, restocking the shelves, cleaning, handling customers' questions and inquiries, bagging, etc. Since the goodwill of customers is affected by these activities (Oliver and Farris, 1989), retailers emphasize these activities to maintain their goodwill during the busy holiday periods.

An additional reason for the increase in the opportunity cost of price adjustment during the holidays is the increase in the costs of mistakes that occur during the price change process. When prices are changed, the new price needs to be posted in both the shelf label and in the cash register database. Often mistakes are made leading to a mismatch between the shelf and the price programmed in the cash register. Levy, et al. (1997) report that the costs of pricing mistakes, which include (1) lost cashier time, (2) scan guarantee refunds, and (3) stock-outs (if the shelf price is lower than intended), comprise about 19 percent of the total costs of price adjustment. The cost of pricing mistakes increases during holidays because the lines at cash registers are longer and a "price check" will create greater delay and dissatisfaction among customers.

Retailers could resolve this labor shortage difficulty by hiring, temporary workers. However, according to Debra Farmer, a manager of a large supermarket:

> "... it is difficult to find temporary workers for the weeks of these two holidays because the high school and college students, which is the group from which the supermarkets usually hire their temporary workers for the summer months, are not available during these holiday weeks."[4]

Unable to adjust the number of workers during holiday periods, supermarkets try to adjust the number of hours worked.[5] Many of their workers are employed on a part time basis and during holidays they are asked to add extra hours for which they are paid

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[3] Dutta, et al. (1999) find that labor input cost of price change preparation, implementation, and verification constitutes 79 percent costs of price adjustment at large US drugstore chains.

[4] An added difficulty in hiring college and university students is that they let out for the holiday season around the second week in December, making it difficult to properly train cashier help and other workers (R. DeGross and D. McClurkin, "Stores Starting Regular Holiday Hunt," *Atlanta Journal and Constitution*, November 18, 2000, pages H1, H5).

[5] It turns out that the increased demand for temporary workers during holiday periods is not limited to the retail supermarket industry. According to L. Eaton ("Retailers Scramble for Holiday Help," *New York Times*, Monday, September 27, 1999, p. A19), this is a more general and recurring phenomenon affecting many other types of retail as well as non-retail establishments including electronics stores and superstores, museums, bookstores, drugstores, high-priced boutiques and apparel chains, gift shops, furniture and home household goods, and jewelry stores.

overtime wage rates.[6] But these extra labor hours are not used to change prices.[7] Instead, according to Ms. Farmer, they are used to perform other, more urgent tasks like, packing bags, opening extra cash registers, bringing products from storage rooms to shelves, checking prices, and customer service. Workers are routinely moved from task to task as needed. For example, Shayne Roofe, the manager of a Harp's Food Store in Rector, AR, is trained to use a key-cutting machine located in the store (*Progressive Grocer*, February 1993, p. 43). Similarly, according to Jack Koegel, the President of Twin Value Foods headquartered in Green Bay, Wis., "... he and his executives are not averse to doing such chores as mopping a floor, if necessary" (*Progressive Grocer*, October 1992, p. 56).

Thus, the workers employed by the supermarket chains are always busy and the opportunity cost of changing price is positive. During the holiday periods, the opportunity costs increase substantially, making price changes more costly. We, therefore, predict that prices will be more rigid during holiday periods in comparison to the rest of the year.

3. Data

Our dataset contain product-level retail price and wholesale cost scanner data from a large supermarket chain, Dominick's which operates 94 stores in the Greater Chicago metropolitan area with a market share of about 25 percent (Hoch, et al., 1995).[8] The chain is similar to other large, multiple-store supermarket chains currently selling in the U.S. In 1992, large supermarket chains of this type made up $310.1 billion in total sales, which constituted about 86.3% of total supermarket chain sales in 1992 (*Supermarket Business*, 1993), or about 14 percent of the total US retail sales of $2.25 trillion.

The data set we have assembled consists of product-level retail prices and wholesale costs for over 4,500 products in 18 product categories.[9] In Table 1 we list the product

[6] For example, holiday-period tight labor markets force the retailers "… to become more generous with wages, bonuses" and some retail establishments are even forced to offer signing bonuses, "… a practice already familiar to many area retailers," as well as better discounts, flexible schedules, and bigger commissions (R. DeGross and D. McClurkin, "Stores Starting Regular Holiday Hunt," *Atlanta Journal and Constitution*, November 18, 2000, page H1).

[7] Changing prices require more specialized skills and tasks than many other activities (Levy, et al., 1997). According to Robert Venable, the number of people a store will trust to change prices is limited, so it is unlikely that stores would assign this task to new, less skilled, or untrained employees.

[8] The data are available through the University of Chicago's marketing department web page at www.gsb.uchicago.edu/research/mkt/MarketingHomePage.html.

[9] Dominick's data actually include products in 29 categories but for many products the price/cost data are missing because they were not always recorded. That is especially true for some critical holiday weeks,.

categories and the number of products for which data were available in each category. In addition, the data are weekly, and reflect actual prices at each retailer for each product studied; the retail prices in this dataset are not aggregated in any way. The data cover the period from the week of September 14, 1989 to the week of May 8, 1997, a total of 399 weeks, where a week is defined from Thursday to Wednesday. Having weekly time series offers an important advantage for studying price-setting behavior in a market where the actual pricing cycle is also weekly (Levy, et al., 1997).

Our price and cost data come from a subset of six stores of the chain.[10] Dominick's has three price zones, and each store belongs to one of the zones. The 6 stores in our sample are in the mid-price zone. The chain defines the store type based on the competitive environment the store faces. Thus the stores belonging to the mid-price tier face similar competitive environments.[11] Prices for all stores within the chain are set centrally at corporate headquarters and implemented by the stores.

For the price to consumers at the retail level, the weekly data are from the scanner database of the supermarket chain. The prices are the posted shelf prices, and are usually the same as the transaction prices.[12] Price changes are performed once per week (on Wednesday nights), which is the standard practice in this industry. Thus, the data we use are the actual shelf prices in effect in the given week.

The weekly wholesale cost data also come from the chain's scanner database and represent a weighted average of the amount the retailer paid for their entire inventory. The wholesale cost data do not include lumpy payments like slotting allowances, manufacturer-provided services such as direct store delivery, or other manufacturer-level support. However, our discussions with pricing managers indicate that they rely on these wholesale cost series to make their pricing decisions. Other studies in this context (e.g., Hoch, et al., 1995) confirm this observation. Further, our discussions with managers indicate that the use of the lumpy-payment schemes does not vary systematically between

[10] During the period in which the data was collected pricing experiments were conducted at some stores within the chain. For the present analysis we use only data from control stores to avoid confounding effects.

[11] We also analyzed the data for three stores in the chain that faced the most price competition. We find that all the results reported in this paper for the six mid-tier stores also hold for the more price competitive stores. Therefore, to save space we do not report these results in the paper.

[12] We note that coupon data is missing. However, coupons are offered by the manufacturer and not the retailer and thus do not reflect a retailer's pricing decisions. Furthermore, only a small portion of customers redeems the coupon when it is available. By contrast, temporary price discounts are offered by the retailer and affect all sales. As a result, the omission of coupon data is not felt to be a major limitation.

holiday and non-holiday periods, which are the focal interest of this study.

There are many holidays throughout the year, but few are as closely associated with retail sales in the U.S. as Thanksgiving and Christmas. Following Barsky and Warner (1995) and Chevalier, et al. (2003), we define the week before Thanksgiving through the week of Christmas, a total of six week period, as the holiday period in each year.[13]

4. Econometric Estimation Results

Our data allow us to test the hypothesis of increased holiday rigidity in two ways. First, we assess changes retail price rigidity during holiday periods by counting the frequency of price changes. Second, we construct a model that incorporates factors such as promotions and the magnitude of a cost change, that, in addition to the holiday period store demands, influence the likelihood of a price change.

a) Frequency of Retail Price Changes

As a first test of our hypothesis, we compare the mean number of price changes performed each week, per store, by category, during holiday and non-holiday periods. Table 2 reports the results, along with the percentage difference. In the last column of the table we report the *t*-statistic for testing the null hypothesis that the average numbers of weekly price changes during holiday and non-holiday periods are equal against the alternative that the average number of price changes decreases during the holiday period.

With the exception of just one category (snack crackers), the average number of price changes per week during holidays is lower in comparison to non-holiday weeks. For 15 categories, the price change frequency for the holiday period is less than for the non-holiday period by more than 10 percent, and for 11 categories the difference exceeds 15 percent, with the maximum difference of 38 percent. Moreover, for 13 of the 18 cases, the difference is statistically significant. When aggregated over all categories, we find that price change activity drops by 14% during the holiday weeks in comparison to non-holiday weeks (with a statistical significance of 1 percent). Thus, the first test of our hypothesis shows that nominal price rigidity increases during holiday periods.

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[13] We also considered other combinations of holiday weeks including two weeks before and after Christmas. Our results were similar for all of the alternative combinations we ran. We also considered including the Memorial Day, 4th of July, and the Labor Day holidays, but we found that the holiday-period price rigidity results we report primarily hold for the Thanksgiving and the Christmas holidays.

b) Retailer's Promotional Activity

We now consider the possibility that the retailer may emphasize greater promotional activity instead of price changes during the holiday period. We define promotions as any combination of in-store display and newspaper advertisement; because often these promotional activities are accompanied by a temporary price decrease. Our data on promotions are product-specific.

The number of promotions per week is listed in Table 3, by category, and by holiday versus non-holiday periods. For 11 categories, the average number of weekly promotions during the non-holiday period is higher in comparison to the holiday period and this holds even if we aggregate across all categories. Thus, we do not see an increase in promotional activity as we move from non-holiday to holiday period. To the contrary, we find that during holiday weeks promotional activity seems to decrease on average.

c) Price Response to Changes in Costs

Price rigidity is perhaps better defined as a lack of response of prices to changes in costs or demand. We have found that the frequency of price changes decreases during holidays. To bolster this result, we demonstrate that the likelihood of a price change decreases during holidays, even if factors such as promotions and cost changes are accounted for. That is, we show that the decrease in price change activity during holidays is not driven by holiday-related changes in promotional or wholesale pricing activities. To assess the likelihood of a price change, a logistic regression model is constructed:

$$\text{Log } [p_t /(1 - p_t)]) = \alpha + \beta_1 \text{ Holiday}_t + \beta_2 \text{ Promotion}_t + \beta_3 \text{ Impact}_t + \gamma_i \, d_j + \varepsilon_t$$

where p_t denotes the probability of a price change during week t, the variables "Holiday," "Promotion," and d_j's, are all dummy variables, and the variable "Impact of Cost Change" measures the magnitude of the economic effect a cost change might have.

The "Holiday$_t$" dummy variable equals 1 if week t belongs to the six-week holiday period from Thanksgiving to Christmas and 0 otherwise. If prices are more rigid during holiday periods, then the likelihood of a price change will be lower during holiday periods, and the coefficient on the "Holiday" dummy variable will be negative ($\beta_1 < 0$).

Promotions are often initiated by manufacturers by offering incentives such as discounts and allowances with the expectation that the retailer will promote the product through special displays, advertising, and, often, a temporarily lowered price. Since our focus is on the likelihood of a price change, we need to take into account any promotional price changes of this sort. The variable "Promotion$_t$" is a dummy variable and it equals 1 if during week t there is a promotion and 0 otherwise. We expect that when there is a promotion, there is a greater likelihood of a price change ($\beta_2 > 0$).

The variable "Impact of a Cost Change$_t$" is a measure of the potential impact a cost change might have on profits. We incorporate this measure in the model to account for the possibility that changes in retail price change activity may be driven by changes in either wholesale cost change activity or customer demand during holidays.

To assess the impact of a cost change on profit, we assume that the retailer can do one of two things in response to a cost change: (i) it can maintain the current price (i.e., do nothing), or (ii) it can pass through the entire cost change.[14] We define the impact of a cost change as the difference in expected profit between passing through the change and doing nothing. That is, the variable "Impact of Cost Change$_t$" is an estimate of the profit that would be earned if the price were changed by fully passing through the cost change minus the profit that would be earned if the price were not changed. This variable captures not only the changes in wholesale costs, but also changes in demand which often occur during the holiday periods. We expect that the greater the likely impact of a wholesale cost change, the greater the likelihood of the price change ($\beta_3 > 0$).

To construct the impact variable, we first estimate the profit when managers maintain the current price and no price change is undertaken in response to a cost change. This is estimated as the new per-unit profit margin times the number of units sold in the previous week. We use the prior week's sales volume because given that there is no price change, ceteris paribus, expected unit sales would not change either:

$$\pi_{\text{do nothing}} = (p_{t-1} - w_t)\, m_{t-1}$$

where p_{t-1} denotes the price in prior period, w_t denotes the new wholesale cost, and m_{t-1}

[14] This formulation assumes 100 percent pass-through rate when the retailer changes its price in response to a cost change. While this assumption may not hold for all items, the empirical results with respect to the holiday variable are not dependent on the rate of pass-through. Also, a recent study by Dutta, et al. (2002) reports a very fast (often within 1–2 weeks) and complete pass-through of cost changes onto prices. Our assumption, therefore, is a reasonable approximation of what actually happens in this market.

denotes units sold in prior week.

Second, we estimate the profit when the entire cost change is passed through. If prices adjust in response to a cost change, the expected profit is given by:

$$\pi_{\text{change price}} = [p_{t-1} + (w_t - w_{t-1}) - w_t] * [m_{t-1} + ((w_t - w_{t-1})/ p_{t-1}) * E * m_{t-1}]$$

where the term in the first brackets is the old price plus adjustment minus the new cost, the term in the second brackets is the previous number of units sold plus the expected change in units sold due to price change, and E denotes the average price elasticity.

The elasticity measures come from Hoch, et al. (1995) who use the same data to estimate individual product category demand elasticity. The price elasticity model fit the data quite well; R^2 ranges from 0.76 to 0.94. Errors in the elasticity measure do not affect our results because they are absorbed in the error term (Greene, 1997).

Combining the terms and simplifying, the impact of a cost change becomes:

$$\begin{aligned} \text{Impact}_t &= \pi_{\text{change price}} - \pi_{\text{do nothing}} \\ &= m_{t-1}[(w_t - w_{t-1}) + (p_{t-1} - w_{t-1})((w_t - w_{t-1})/p_{t-1})* E]. \end{aligned}$$

The variables d_j are manufacturer specific dummy variables which are used to account for individual manufacturers' effect on their products' retail prices through own company channels that may not be captured by the "Promotion" variable. Also, some manufacturers may be more important for the retailer due to higher profitability, greater support or slotting allowances and therefore, may be treated differently by the retailer. Based on a log-likelihood test using the Schwartz Criterion to adjust for the number of terms and the number of observations, we find that these dummies are necessary.[15]

We estimate the model for each product category using the maximum likelihood; the results are reported in Table 4. The figures in the first column are of particular interest. The estimated coefficients on the "Holiday" dummy variable are all negative, except two categories, dish detergents and tooth pastes, where the estimated coefficients are positive but not statistically significant. Of the 16 categories with negative coefficients, for 13 of

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[15] The manufacturers' dummies enable us to capture any variation there may be across the different manufacturers. While there may also be a product-specific variation, an inclusion of the individual product dummies would exhaust all the degrees of freedom the data provide.

the categories the coefficients are statistically significant.

The estimated coefficients on the "Promotion" variable are all positive and statistically significant at 1 percent in each category. Thus, manufacturers' promotional activity tends to increase the odds ratio in favor of a price change. Also, the estimated coefficients of the "Impact of Cost Change" variable are all positive and statistically significant at 1 percent in each category. The larger the impact of a cost change on the profit, the higher the odds ratio in favor of a price change in response to a cost change. Finally, the manufacturer dummies are statistically significant in all categories, indicating that there is a manufacturer-specific variation in the retail price rigidity across holiday/non-holiday periods.[16]

Thus, a price change probability decreases during the holiday period, even when we account for holiday-related demand shifts, changes in manufacturer pricing activity, and promotional efforts.

5. Conclusion

Using large weekly scanner price and cost data from a large U.S retail supermarket chain, we demonstrate that prices are more rigid during holiday periods than non-holiday periods. We show that this rigidity is primarily caused by higher price adjustment costs the retailers face during the holiday periods. The anecdotic evidence we provide based on conversations with practitioners and pricing managers is consistent with these findings. Indeed, we have heard managers laugh at the thought of running price change experiments during holidays. For example, when attending a price consulting meeting at a large department store, the managers laughed at the suggestion of doing pricing experiments during holidays stating that it would be "crazy" to think of doing that during holiday weeks.[17]

This study, thus, suggests a more important role for costs of price adjustment in determining the holiday pricing patterns than the existing literature recognizes. Based on our experience in the field, we suspect that the findings of holiday price rigidity would likely generalize to other multi-product retail settings with posted prices such as department stores (Target, Sears, Best Buy, etc.) and other major retail outlets. Nevertheless, it will be useful to go beyond this data set to see whether the results indeed generalize across other retail formats (such as e-commerce), markets, and industries.

Our findings complement the existing literature that studies variations in price rigidity across dimensions such as time, markets, and products.[18] We add to this literature by documenting an additional form of heterogeneity in price rigidity– variation in price rigidity across holiday and non-holiday periods. This is particularly valuable because it occurs within just a one-year period of time. As such, it offers a natural experiment because most factors that have been traditionally proposed as explanations for price rigidity, such as variation in industry concentration, in implicit and/or explicit contracts, in the nature of long-term relationships, or in the market structure, do not vary within the year back and forth between holiday to non-holiday periods.

[16] We do not report these coefficient estimates because of their large number in each regression equation.
[17] They clearly understood the value of price adjustment; they just were amazed at how little we knew about the price adjustment costs.
[18] See Levy, et al. (2002) and the studies cited therein.

Table 1. Product Categories and Number of Products per Store

No.	*Product Category*	*Number of Products*
1	Analgesics	227
2	Bottled Juices	263
3	Cereals	290
4	Cheeses	377
5	Crackers	137
6	Canned Soups	304
7	Dish Detergents	181
8	Frozen Entrees	551
9	Frozen Juices	117
10	Fabric Softeners	196
11	Laundry Detergents	360
12	Paper Towels	85
13	Refrigerated Juices	112
14	Soft Drinks	611
15	Snack Crackers	228
16	Canned Fish	168
17	Toothpastes	255
18	Toilet Tissues	70
	Total	4,532

Table 2. Average Number of Price Changes per Week per Store

Product Category	*Non-Holiday*	*Variance*	*Holiday*	*Variance*	*% Change*	*t-statistic*
Analgesics	13.5	91.2	11.2	25.1	–17%	–1.87[b]
Bottled Juices	27.5	286.1	22.3	106.9	–19%	–2.11[b]
Cereals	22.8	601.1	14.5	113.9	–36%	–2.95[a]
Cheeses	47.3	489.1	43.7	333.4	–8%	–0.90
Crackers	15.2	71.5	12.7	89.9	–16%	–1.23
Canned Soups	28.8	342.5	28.0	115.1	–3%	–0.32
Dish Detergents	11.8	42.6	10.7	31.8	–10%	–0.94
Frozen Entrees	56.0	748.0	35.0	191.9	–38%	–6.05[a]
Frozen Juices	17.7	83.2	15.7	57.1	–11%	–1.19
Fabric Softeners	11.2	41.7	8.3	28.5	–25%	–2.38[a]
Laundry Detergents	18.7	88.1	14.7	45.5	–21%	–2.60[a]
Paper Towels	7.3	15.5	5.7	12.6	–23%	–2.14[b]
Refrigerated Juices	19.0	54.1	16.7	41.9	–12%	–1.63[c]
Soft Drinks	121.2	842.0	111.5	785.5	–8%	–1.58[c]
Snack Crackers	25.2	197.6	31.3	224.8	25%	1.91[b]
Canned Fish	14.0	61.9	11.5	30.1	–18%	–1.98[b]
Toothpastes	18.8	136.3	15.5	133.7	–18%	–1.33[c]
Toilet Tissues	9.0	22.7	6.8	15.4	–24%	–2.48[a]
Total	485.0	4,220.2	415.7	2,382.9	–14%	–6.27[a]

Note: In this and the following tables, superscripts a, b, and c indicate statistical significance at 1, 5, and 10 percents, respectively. The corresponding critical values are 2.33, 1.64, and 1.28, respectively.

Table 3. Average Number of Promotions per Week for All Products per Store

Product Category	*Non-Holiday*	*Variance*	*Holiday*	*Variance*	*% Change*	*t-statistic*
Analgesics	4.7	13.9	7.5	18.3	61%	3.09[a]
Bottled Juices	14.3	650.5	12.0	26.2	–16%	–1.80[b]
Cereals	11.8	46.2	7.0	23.2	–41%	–4.38[a]
Cheeses	18.2	219.3	20.5	130.1	13%	0.91
Crackers	7.3	14.7	10.5	10.8	43%	4.36[a]
Canned Soups	9.8	186.1	17.0	444.8	73%	1.62[c]
Dish Detergents	5.7	14.5	5.0	9.5	–12%	–0.97
Frozen Entrees	28.5	487.5	12.5	217.6	–56%	–4.68[a]
Frozen Juices	9.2	28.2	9.2	37.5	0%	0.00
Fabric Softeners	5.8	16.2	3.5	4.4	–40%	–4.48[a]
Laundry Detergents	11.7	20.9	7.0	7.0	–40%	–7.32[a]
Paper Towels	4.7	7.3	4.2	2.6	–11%	–1.29
Refrigerated Juices	10.8	21.0	8.5	12.2	–22%	–2.96[a]
Soft Drinks	67.7	189.8	60.3	297.2	–11%	–2.00[b]
Snack Crackers	9.8	139.9	17.8	318.1	81%	2.14[b]
Canned Fish	4.3	25.4	15.3	6.5	254%	17.24[a]
Toothpastes	14.0	73.8	9.3	39.3	–33%	–3.27[a]
Toilet Tissues	4.8	8.6	4.7	4.9	–3%	–0.33
Total	243.2	1,621.7	231.8	1,610.2	–5%	–1.30[c]

Table 4. Price Rigidity Estimation Results for All Products

Product Category	*(Holiday)* β_1	*(Ad)* β_2	*(Impact)* β_3
Analgesics	–0.1948[b]	0.4918[a]	0.5702[a]
Bottled Juices	–0.3093[a]	0.6431[a]	0.1966[a]
Cereals	–0.3671[a]	1.2690[a]	0.0764[a]
Cheeses	–0.2279[a]	1.3276[a]	0.1182[a]
Crackers	–0.2489[a]	0.5518[a]	0.2575[a]
Canned Soups	–0.1008[b]	1.5303[a]	0.0065[a]
Dish Detergents	0.0588	1.3866[a]	0.1735[a]
Frozen Entrees	–0.2192[a]	1.7355[a]	0.0912[a]
Frozen Juices	–0.1545[b]	1.8239[a]	0.0763[a]
Fabric Softeners	–0.1377	0.5439[a]	0.4205[a]
Laundry Detergents	–0.2513[a]	0.7818[a]	0.1855[a]
Paper Towels	–0.4895[a]	1.6889[a]	0.0110[a]
Refrigerated Juices	–0.2529[a]	1.0781[a]	0.0398[a]
Soft Drinks	–0.0073	1.2724[a]	0.0023[a]
Snack Crackers	–0.0192	0.5519[a]	0.3452[a]
Canned Fish	–0.4166[a]	0.9438[a]	0.0004[a]
Toothpastes	0.0228	1.3904[a]	0.5414[a]
Toilet Tissues	–0.5062[a]	0.9611[a]	0.0025[a]

Table 5. Average Number of Cost Changes per Week for All Products per Store

Product Category	*Non-Holiday*	*Variance*	*Holiday*	*Variance*	*% Change*	*t-statistic*
Analgesics	33.5	101.0	31.3	67.3	–6%	–1.18
Bottled Juices	61.7	266.3	60.3	144.5	–2%	–0.49
Cereals	64.3	569.1	65.2	487.8	1%	0.17
Cheeses	109.0	426.1	108.5	341.8	0%	–0.12
Crackers	19.7	91.0	16.2	108.4	–18%	–1.56[c]
Canned Soups	62.5	325.9	64.5	87.4	3%	0.86
Dish Detergents	23.8	53.7	23.5	35.3	–1%	–0.25
Frozen Entrees	104.5	718.8	90.0	534.3	–14%	–2.84[a]
Frozen Juices	36.2	93.8	31.7	51.7	–12%	–2.76[a]
Fabric Softeners	26.0	47.1	23.0	34.6	–12%	–2.30[b]
Laundry Detergents	41.8	95.3	41.5	55.9	–1%	–0.20
Paper Towels	15.2	14.2	13.7	10.1	–10%	–2.13[b]
Refrigerated Juices	38.7	60.1	38.2	51.1	–1%	–0.32
Soft Drinks	143.2	1247.1	129.0	960.2	–10%	–2.07[b]
Snack Crackers	33.8	262.7	37.8	262.2	12%	1.14
Canned Fish	25.5	75.2	22.5	35.3	–12%	–2.19[b]
Toothpastes	34.2	148.8	31.7	124.1	–7%	–1.02
Toilet Tissues	16.8	17.6	14.8	10.1	–12%	–2.79[a]
Total	890.3	4,613.8	843.3	3,402.0	–5%	–3.64[a]

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