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Abstract

Analyzing a large weekly retail transaction price dataset, we uncover a surprising regularity—small price increases occur more frequently than small price decreases for price changes of up to about 10 cents, while there is no such asymmetry for larger price changes. The asymmetry holds for the entire sample and for individual categories. We find that while inflation can explain some of the asymmetry, inflation is not the whole story as the asymmetry holds even after excluding inflationary periods from the data, and even for products whose price had not increased over the eight-year period. The findings hold for different measures of inflation and also after allowing for lagged price adjustments. We offer a consumer-based explanation for these findings.

1. Introduction

A longstanding question in price adjustment literature is whether patterns of price increases are different from patterns of price decreases (see, e.g., Ball and Mankiw 1994, Cecchetti 1986, Carlton 1986, Mankiw and Romer 1991, and studies cited therein). We sometimes hear about gas prices that are "rising like rockets... [but] falling like feathers" (*Octane*, V.13-3, June 1999, pp. 6-7) or about food prices, where "retail pork prices do not come down even if hog prices do" (*New York Times*, Jan. 7, 1999). Although economists have devoted considerable attention to this issue (recent studies include Davis and Hamilton 2004, Rotemberg 2002, and Peltzman 2000), the link between the extent of asymmetry and the size of price changes has not received much attention.[1]

In this paper we offer evidence on an unusual type of asymmetric price adjustment. We analyze transaction price data for 29 product categories over an 8-year period from a large Mid-western supermarket chain. The dataset is quite large containing about 100 million weekly price observations for 18,037 products. We uncover a surprising regularity in these data—small price increases are more frequent than small price decreases for price changes of up to about 10 cents. There is no such asymmetry for larger price changes. These results hold for the full dataset and for almost every individual product category. We find that while inflation can explain some of the asymmetry, inflation is not the whole story. For example, we find that the asymmetry is still present even if (a) we consider only a low-inflation period sample, or (b) we consider only a deflation-period sample, or (c) we focus only on the products whose price had not increased over the eight-year period. These findings are robust across different measures of inflation, and after allowing for lagged price adjustments.

Building on emerging theories in economics and marketing, we offer a consumer-based explanation for these findings. We argue that time-constrained consumers may ignore small price changes if the cost of processing information on small price changes exceeds the benefit. Thus, in a "small region" around the current price, the demand is less elastic, giving the retailers incentive to make more frequent small price increases than decreases.

Several implications are highlighted. First, as far as we know, this type of asymmetry has not been reported in the literature before, and so far has gone unnoticed.

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[1] Asymmetric price adjustment has been studied for gasoline (Bacon, 1991; Karrenbrock, 1991; Davis and Hamilton, 2004), fruit and vegetables (Pick, Karrenbrock and Carmen, 1991; Ward, 1982), banking (Hannan and Berger, 1991; Neumark and Sharpe, 1993) and pork (Boyde and Brorsen, 1988), and across a broad range of product markets (Peltzman 2000).

Indeed, we discuss several studies whose data contain asymmetric price adjustment in the small although the authors fail to notice it. Second, the explanation we offer for our findings is novel because it suggests that existence of price adjustment costs combined with a channel structure can lead to asymmetric price adjustment (Blanchard 1983 and 1987, Gordon 1990, Basu 1995, Chevalier et al 2003, Ray et al 2006). Third, the explanation we offer for the finding of asymmetric price adjustment in the small offers micro-based evidence on the importance of rational inattention for individual price dynamics. Fourth, our findings suggest that there might be important differences in the response of markets to small vs. large changes, consistent with recent micro-level empirical findings. Finally, our theory offers a possible explanation for the presence of small price changes, which has been a long standing puzzle in the literature (Carlton 1986, Warner and Barsky 1995, Lach and Tsiddon 2006, Sheshinski and Weiss 1993).

We proceed as follows. In section 2, we describe the data. In section 3, we discuss the findings. In section 4, we discuss possible explanations for the findings. Section 5 concludes by discussing some potential implications.

2. Data

We use scanner price data from Dominick's—one of the largest supermarket chains in the Chicago area, operating 94 stores with a market share of about 25 percent. Large chains of this type made up about $310 billion in total sales in 1992, which was 86.3% of total retail grocery sales (*Supermarket Business*, 1993). In 1999 the retail grocery sales have reached $435 billion. Dominick's, thus, is representative of a major class of the retail trade. Moreover, the sales of Dominick's type large supermarket chains constitute about 14 percent of the total retail sales of about $2.25 trillion in the U.S. Because the retail sales account for about 9.3 percent of the GDP, our data set is a representative of as much as 1.30 percent of the GDP, which is substantial. Thus the market we are studying has quantitative economic significance as well.

We have 400 weekly observations of retail prices in 27 product categories that represent 30 percent of the chain's revenues, from September 14, 1989 to May 8, 1997.[2] The length of individual series varies depending on when the data collection for the specific category began and ended. In Table 1, we list the product categories along with some descriptive statistics. As the table indicates, the data set contains more than 98

[2] Two additional categories (beers and cigarettes) are not discussed here because of the regulations and tax rules imposed on them, although we do present their plots for the sake of completeness. See Barsky, et al. (2003a) for more details about the data.

million weekly price observations.

The data come from the chain's scanner database, and contains the prices paid at the cash register.[3] The data consist of the actual transaction prices which is the kind of data Lach and Tsiddon (1992, 1996) recommend for studying price adjustment because they most closely resemble the data envisioned by pricing theory: price quotations at the level of the price setter.

3. Empirical Findings

Before presenting the findings, consider a sample series from the data. Figure 1 displays the weekly prices of Heritage House frozen concentrate orange juice, 12oz, from Dominick's Store No. 78. The series contain the following "small" price changes:

(1) **1¢**: 9 positive (weeks 13, 237, 243, 245, 292, 300, 307, 311, and 359) and 6 negative (weeks 86, 228, 242, 275, 386, and 387);
(2) **2¢**: 7 positive (weeks 248, 276, 281, 285, 315, 319, and 365) and 1 negative (week 287);
(3) **3¢**: 3 positive (weeks 254, 379, and 380) and 2 negative (weeks 203 and 353);
(4) **4¢**: 4 positive (weeks 23, 197, 318, and 354) and 1 negative (week 229); and
(5) **5¢**: 1 positive (week 280) and 1 negative (week 302).

Thus, in these series there are more positive than negative price changes up to 4¢. Below we analyze the patterns of price changes using the entire data set as well as individual categories. We begin by studying the patterns of price changes for each possible size of a price change by calculating the frequency of positive and negative price changes in cents, 1¢, 2¢, 3¢,..., 50¢.[4]

3.1. Findings for the Full Sample

Figure 2 shows the cross-category average frequency of positive and negative price changes. We immediately note an interesting and robust regularity: there are more frequent small price increases than decreases. We call this *asymmetry "in the small*." The asymmetry lasts for price changes of up to about 10-15 cents, which is equivalent to about 5 percent given that the average price at a retail supermarket is about $2.50 (Levy,

[3] If the item was on sale or if the retailer's coupon was used, then the data reflect that. The prices are set on a chain-wide basis but there is some variation across the stores (Barsky et al 2003a, Chevalier et al 2003). We use the data available from all stores.
[4] All the analyses reported below were repeated for price changes in percents (1%, 2%,... 50%). Our substantive conclusions remain unchanged. We do not report the results here for the sake of brevity, but they are available from the authors upon request.

et al., 1997; Bergen, et al., 2004). Beyond that, the two lines crisscross each other and thus, the systematic asymmetry disappears.

In Figures 3a-3c, we plot the frequency of positive and negative price changes by product categories. Table 2 reports the corresponding *z*-test results. Under the null, there are equal number of price increases and decreases for each size of price change. We define an "asymmetry threshold" as *the last point at which the asymmetry is supported statistically*, that is, the last point at which the frequency of price increases exceeds the frequency of price decreases of the same absolute magnitude ($z \geq 1.96$).[5] As shown in the "Full Sample" column, in four categories the asymmetry threshold is below 5¢, and in two categories it exceeds 25¢. In most categories, however, the asymmetry threshold falls in the range of 5¢-25¢, averaging 11.3¢."[6]

*3.2. Could It Be Inflation? Findings for Low-Inflation and Deflation Period*s

The most immediate explanation for the above findings might be the U.S inflation during the sample period (see the PPI-inflation figures in Table 3).[7] During inflation we expect more price increases than decreases, *ceteris paribus* (Ball and Mankiw, 1994).[8] We, therefore, ask whether the asymmetry found in the full sample, also holds when inflationary periods are excluded from the analysis. Given the large sample we have, such an analysis is indeed feasible.

We conduct two specific analyses. The first includes only those observations during which the *monthly* PPI inflation does not exceed 0.1 percent, which we define as a *low-inflation* period. In the second analysis, we include only those observations in which the *monthly* PPI inflation rate is non-positive, which we define as a *deflation*-period.[9]

For the low-inflation sample (the middle column of Table 2), the asymmetry

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[5] Out statistical procedure allows for no asymmetry as well as for reverse asymmetry. In this particular analysis, we do not find any such case. There are very few of them in later analyses too (see Tables 4-9).

[6] Considering price changes of up to 50¢ appears sufficient given our focus on the asymmetry in the *small*. We have actually calculated the price changes of *all sizes*, and found that most price changes are indeed smaller than 50¢. Further, the full sample contains a total of 10,298,995 price increases and 9,438,350 price decreases, and thus in total, there are more price increases than decreases. Further, 1¢, 2¢, 3¢, 4¢, and 5¢ increases account for 3.60%, 3.50%, 3.39%, 3.30%, and 3.20% of all price increases, respectively. In other words, 17.09% of the price increases are of 5¢ or less. In contrast, 1¢, 2¢, 3¢, 4¢, and 5¢ decreases account for 2.49%, 2.88%, 2.75%, 2.99%, and 2.88% of all price increases, respectively. In other words, 14.00% of price decreases are of 5¢ or less. Thus, our findings hold for the entire data set as well.

[7] These findings cannot be explained by promotions or sales, as promotions likely generate more price decreases than increases, which is opposite to what we observe. In addition, a sale-related temporary price reduction is usually followed by a price increase at the end of the sale period (Rotemberg 2002). Price promotions, therefore, cannot produce the observed asymmetry.

[8] A counter-argument to this idea is that if the reason for the asymmetry was inflation, then we would see the asymmetry not only "in the small" but also "in the large." The data, however, do not exhibit asymmetry "in the large."

[9] The frequency plots for the low inflation and the deflation periods are included in the referee appendix available upon request.

threshold is 8.2¢ on average. At the category level, the asymmetry holds in all but one category (bath soap), with some decrease in the thresholds, the majority falling between 2¢ and 20¢. In the deflation period sample, column 3 of Table 2, the threshold is 6.2¢, on average. At the category level, we still find asymmetry "in the small" for all but two categories, bath soap and frozen entrees.

Thus, the asymmetry thresholds decrease as we move from the full sample to the low inflation sample and further to the deflation sample, suggesting that inflation likely plays a role in the asymmetry. However, a substantial proportion of the asymmetry remains unexplained.

3.3. Robustness Checks

The above analyses suggest that inflation cannot explain fully our findings. We check the robustness of this conclusion by using six different tests. All confirm the conclusion that inflation at best offers a partial explanation for the documented asymmetry.

(i) Lagged Price Adjustment

The analysis so far assumed instantaneous price adjustment. We now allow lagged adjustment. The speed of adjustment of retail prices vary between 4 weeks (Dutta, et al. 2002; Müller and Ray, 2007) and 16 weeks (Bils and Klenow, 2004). Therefore, we repeat the analysis under four possible lags: 4 weeks, 8 weeks, 12 weeks, and 16 weeks. The results, reported in Table 4**,** suggest that the asymmetric adjustment in the small holds for 25 of the 27 categories, the exception being bath soups and shampoos. In 99 of the 108 cases presented in the table, that is, in 92 percent of the cases, the thresholds are positive, averaging 6.6¢.

(ii) Alternative Measures of Inflation

The above analysis was based on the PPI. We, therefore, repeat the analysis using two other measures of inflation: CPI, and CPI-Chicago. The latter is useful as it covers the area where most Dominick's stores operate. The CPI and CPI-Chicago inflation series (Table 3) indicate fewer deflationary periods, reducing the sample size even further. Yet, the results remain unchanged. According to Table 5 there is asymmetry in all but two categories, with the average threshold of 6.9¢.

(iii) Alternative Measures of Inflation with Lagged Price Adjustment

The analysis in (ii) assumes flexible prices. To allow for lagged price adjustment, we repeat the analysis with 4-, 8-, 12-, and 16-week adjustment lags using the CPI and the CPI-Chicago measures of inflation. The figures in Table 6 suggest that for the overwhelming majority of the categories, the asymmetry still holds. Of the 216 cases reported in the table, in 185, i.e., in 86% of the cases, the asymmetry still remains, with the average threshold of 4.5¢.

(iv) Products for Which Prices Have Not Increased During the Sample Period

As another test we consider only the products for which prices have not increased during the sample period.[10] The figures in Table 7 indicate that in 23 of the 27 categories, i.e., in over 85 percent of the cases, we observe asymmetry. Thus, even if we limit the analysis only to the products whose prices have not increased, we find that the asymmetry in the small still holds.

(v) First Year of the Sample Period vs. the Last Year of the Sample Period

The period from September 1989 to May 1997 is characterized by a downward inflation trend. For example, the inflation rate was higher during 1989–1990 (the start of our sample) than during 1996–1997 (the end of our sample): PPI, 5.0 percent vs. -0.01 percent; CPI, 5.3 percent vs. 2.2 percent; and CPI-Chicago, 4.8 percent vs. 2.2 percent. If inflation is the main reason for the asymmetry, then the asymmetry should be stronger during the first 12 months than during the last 12 months. The results are reported in Table 8. Six of the 27 product categories had no observations during the first year. In the remaining 21 categories, we have only two categories (canned tuna and soft drink), where the asymmetry threshold is higher in the first 12 months. In the remaining 19 categories, that is, in over 90 percent of the categories, we see greater asymmetry in the last 12 months of the sample, averaging 9.0¢ in comparison to 0.6¢ in the first 12 months. A paired *t*-test comparing the asymmetry thresholds across the 19 product categories indicates that on average the asymmetry threshold is bigger in the last 12 months than in the first 12 months of the sample ($t_{20} = 4.799$, $p = .000$).[11] Thus, for the overwhelming majority of the cases, there was a stronger asymmetry at the end of the sample when

[10] We compare the average prices during the first 4-weeks and the last 4-weeks of the sample period. The use of an 8-week window yielded similar results. In this comparison, we use the list price, if it differs from the actual price, in order to avoid any effect of sales on the results. In conducting the asymmetry analysis, however, we use the actual prices to make the current results comparable to the previous results.

[11] Since the average sample size for the last 12 months was larger than that in the first 12 months, we considered the five categories where the reverse was true, i.e. the sample size of the first 12 months was larger than that of the last 12 months. The asymmetry threshold was still greater in the last 12 months for these categories. So, sample size does not explain these results.

inflation was low.

(vi) Asymmetry and Annual Inflation Rates

In our data, deflation months are scattered throughout the eight-year period. Therefore, in order to further check how asymmetry varies with inflation rates, we calculate the asymmetry threshold for each product category for each of the 7 calendar years in the data, and match them up with the annual inflation rates (see Table 9). This analysis reveals a negative linear relationship between the asymmetry threshold and the annual inflation rate (with PPI, $t = 1.87$, $d.f. = 171$, 1-tailed $p = .03$; with CPI-national, $t = 3.15$, $d.f. = 171$, $p < .01$; with CPI-Chicago $t = 2.04$, $d.f. = 171$, $p < .05$). Thus the asymmetry diminishes as inflation increases, further calling into question the role of inflation as a sole cause of the observed asymmetry.

4. Explaining Asymmetric Price Adjustment "in the Small"

"MINNEAPOLIS (AP) - The cost of General Mills cereals such as Wheaties Cheerios, and Total is increasing an average of 2 percent. The price jump averages out to roughly 6 or 7 cents a box for cereals such as Chex, Total Raisin Bran and Total Corn Flakes, ... which typically cost around \$3 in the Minneapolis area, ... John French, 30, *doubted he would even notice* the higher prices for cereal on his next grocery trip. 'A few cents? Naw, that's no big deal,' said French, of Plymouth, MN" (our emphasis.)

Associated Press, June 2, 2001, 7:20am ET ("General Mills Hikes Prices")

The analyses presented in section 3 suggest that inflation cannot account fully for the observed asymmetry in the small. Next, therefore, we examine the possibility that other existing theories of price adjustment can explain our findings. The main existing theories of asymmetric price adjustment besides inflation include capacity constraints, vertical market linkages, imperfect competition, and menu costs under inflation (Blinder, et al. 1998).

Although these theories can explain asymmetric price adjustment in general, it appears that they are unable to explain the specific form of asymmetric price adjustment we document here. For example, the theory of capacity constraints emphasizes the asymmetry in the sellers' ability to adjust inventory to price fluctuations. This theory, however, predicts that asymmetric adjustment should be observed especially for large price changes because small price changes are less likely to make capacity constraints binding. This is the opposite of what we observe in our data. Similarly, theories based on vertical channel linkages (Peltzman 2002) and imperfect competition (Neumark and Sharpe, 1992) cannot explain simultaneous asymmetry in the small and symmetry in the large because it is hard to see how market or the channel structure can vary systematically between small and large price changes. Clearly, large-scale changes in the market or the channel structure are too slow and infrequent to explain variation in adjustment across small and large price changes.[12] Another possible explanation is menu cost (Levy et al., 1997 and 1998; Dutta et al., 1999) under inflation (Tsiddon, 1993; Ball and Mankiw, 1994). However, if the reason for the asymmetry we find were inflation and menu cost, then we should not have seen asymmetry in periods of low-inflation, and even more so in periods of deflation. Therefore, it is unlikely that the observed asymmetry is completely driven by inflation.[13]

Thus, the findings of asymmetric price adjustment in the small but symmetric adjustment in the large seem inconsistent with the existing models of price adjustment. We, therefore, offer another possible explanation. We posit that consumers may choose to be inattentive to information about small price changes if processing and responding to such information is costly. Customers are often engaged in purchasing tens and occasionally hundreds of—different goods. The costs of processing and reacting to the large amount of information are non-trivial. Calculating the optimal purchase behavior for every possible price, for example, is a costly process requiring time and mental resources. Because consumers have limited time and other resources to process the large amount of information they face every day, they must rely on cost-benefit analysis to decide what information is worth their attention. If the cost of processing information on a price change exceeds the benefit, then the customer might choose to ignore and not react to the price change. This is most likely to happen for small price changes, because the costs of processing and reacting to small price changes might outweigh the benefits. Yet, when the price changes are large, the benefit of processing the price change information might exceed the cost, and thus the consumer will likely respond to large price changes. This explanation is consistent with the recent literature on rational inattention (Akerlof, 2000; Ball, Mankiw and Reis, 2005; Adam, 2005; Mankiw and Reis 2002; Sims, 2003; Reis 2006a, 2006b; Woodford 2002; Shugan, 1980).

Now, consider a retailer who faces inattentive customers and thus sees a region on the demand curve around the current price where his customers' price sensitivity is low for both small price increases *and* small price decreases. The consumers' reduced

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[12] This conclusion likely holds for any explanation that relies on institutional features and arrangements.

[13] If we consider a broader notion of price adjustment costs which might include managerial costs (Zbaracki et al 2004), then price adjustment costs could lead to asymmetry: the cost of price increase could be higher than the cost of price decrease. The reason might be consumer anger or fairness (Rotemberg 2002; Kahneman et al 1986), consumer goodwill loss (Bergen et al 2004; Levy and Young, 2004), or search triggered by a price increase. This, however, predicts more price *decreases than increases*.

price sensitivity to small price decreases makes small price decreases less valuable to the retailer because the lower price does not trigger the consumer's response: she does not buy more. However, a small price increase will be very valuable to the retailer for the same reason: his consumer will not reduce her quantity purchased. In other words, the reduced price sensitivity in both directions will give the retailer an incentive to undertake more frequent small price increases than decreases. A large price change, however, triggers customer reaction, and thus the retailer has no incentive to make asymmetric price changes. Consumers know that retailers know about their inattention. Both firms and consumers, therefore, will expect asymmetric price adjustment in the small and thus asymmetric price adjustment in the small can emerge as an equilibrium outcome.[14, 15]

The idea that there exists a small region of inattention around the current price along the demand curve is consistent with the theoretical findings of Fibich, et al. (2007), as well as with the experimental evidence of Kalwani and Yim (1992), showing that promotional price changes must exceed certain minimum thresholds to produce any effect on purchase behavior. Our findings are also consistent with the empirical findings reported in the marketing literature on "price indifference bands" (Kalyanaram and Little, 1994). For example, according to McKinsey & Company (Baker, et al. 2001) the price indifference band is 17 percent for health-and-beauty products and 10 percent for engineered industrial components. Consistent with this, the common managerial intuition is that price reductions of less than 15 percent do not attract enough customers to a sale (Della, et al 1980; Gupta and Cooper 1992). This region of inaction is consistent also with the literature on "just noticeable difference" in marketing (Monroe, 1970) suggesting that, in lieu of Weber's Law, people may be unable to perceive small

[14] We shall note that in a world inhabited by inattentive consumers, small price decreases are still possible. The costs of consumer information processing may depend on, among other things, consumer's opportunity cost of time, the ease with which she can carry out such calculations, her experience with doing this type of calculations which may be a function of the retail competitive environment among other things, and the amount of the calculations required. Pricing decisions, therefore, could vary over seasons (e.g., holiday vs. non-holiday), over competitors' actions, across individual products, across product categories, etc. because of the variation in the level of customer attentiveness across these and other dimensions. Also, there might be other possible reasons for why supermarket chains might choose to reduce prices by small amounts. First, small price changes may be induced by competitive factors, such as price guarantees and price matches (Levy, et. al., 1997 and 1998), as well as by changes in supply conditions (Dutta, et. al., 2002; Levy, et al., 2002) and demand conditions (Warner and Barsky, 1995; Chevalier, et. al., 2003). Second, some food items sold by retail supermarket chains have an expiration date, and some of these products may go on sale as their expiration date approaches. And third, managers may be following simple pricing rules, such as "reduce all prices in some categories by 2%," which could lead to small price reductions.

[15] There is a limit on the surplus a retailer can extract from consumers by strategically taking advantage of the customer's information-processing costs. For example, if information-processing is costly, the customer may rely on the price for which she has last optimized to determine her quantity demanded. That means the retailer can only raise its price to the upper bound of the region of inattention. Any additional price increase beyond that will push the price far enough from the last optimization price to trigger a re-optimization and consequently a reduction in her purchase. Thus, indefinite continuous small price increases are not feasible.

differences in the stimulus, and with Emery's (1970) observation that "there is a region of indifference about a standard price such that changes in price within this region produce no change in perception."[16]

The difference in how consumers react to small versus large price changes resonate with Samuelson and Zeckhauser's (1988, p. 35) claim that in the context of retail shopping, "... it may be optimal for individuals to perform an analysis once, as their initial point of decision, and defer to the status quo choice in their subsequent decisions, *barring significant changes in the relevant circumstances*" (emphasis ours). To a similar effect, Tobin (1982, p. 189) observes that "Some decisions by economic agents are reconsidered daily or hourly, while others are reviewed at intervals of a year or longer *except when extraordinary events compel revisions*" (our emphasis). Frank and Jagannathan (1998, p. 188) suggest a similar mechanism in explaining stock price behavior: "The idea is that for many investors it is not worth paying attention to small dividends, while at sufficiently high dividend levels almost all investors pay attention."

5. Potential Implications and Conclusion

We find overwhelming evidence of asymmetry for price changes of up to about 10 cents or 5 percent, on average. The asymmetry disappears for larger price changes. In other words, we find a form of downward price rigidity which holds only "in the small." These results hold for the full dataset and for almost every individual product category. We find that inflation can offer only a partial explanation. Indeed, we find asymmetry even if we consider only a low-inflation period sample, or only a deflation-period sample, or if we consider only the products whose price had not increased. The findings are robust across different measures of inflation, and after allowing for lagged price adjustments. We explain our findings by arguing that price-setters might act strategically to take advantage of the fact that their consumers face information processing costs by making asymmetric price adjustments "in the small."

Several implications follow. First, as far as we know, this type of asymmetry has not been reported in the literature before, often flying under the radar screen. For example, Peltzman (2000) finds no asymmetry in Dominick's dataset (because of his focus on large and more time aggregated—i.e., monthly instead of weekly—price

[16] The possibility that consumers may be inattentive to small price changes is also consistent with the observation that the retailers find it necessary to alert the public about their promotions by posting sale signs (often large and in color, and at the end of the aisle) indicating the new reduced price. Such signs help ensure that shoppers *notice and react to* the price discounts.

changes). Baudry, et al. (2004) study French micro data for the 1994-2003 period. Figure 9 in their paper (on p. 55) clearly indicates an asymmetric price adjustment "in the small" although the authors fail to "notice" it... and thus they never discuss it. A similar form of asymmetry is found also in Spanish data for the 1993-2001 period (Álvarez and Hernando, 2004), although these authors also fail to notice and discuss it. These suggest that asymmetric price adjustment in the small might be more prevalent than we think.[17]

Second, the explanation we offer for our findings is novel because it suggests that the existence retail price adjustment costs combined with a channel structure can lead to asymmetric price adjustment. It is widely accepted that price adjustment costs can be a source of price rigidity (e.g., Mankiw, 1985). However, if we think of the information processing cost of consumers as a form of price adjustment cost in a broad sense of the term, then it follows that price adjustment cost in a channel setting can also lead to asymmetric price adjustment in the small, i.e., to downward price rigidity "in the small" (Blanchard 1983 and 1987, Gordon 1990, Basu 1995, Chevalier et al 2003, and Ray, et al, 2006).

This explanation for the finding of asymmetric price adjustment in the small is consistent with the idea of rational inattention, as formulated by Akerlof, 2000; Ball, Mankiw and Reis, 2005; Adam, 2005; Mankiw and Reis 2002; Sims, 2003; Reis 2006a, 2006b; and Woodford 2002. Most of these studies, however, focus on aggregate implications of rational inattention. We believe that our findings offer micro-based evidence on a possible importance of rational inattention for the dynamics of individual prices. In addition, at the level of individual price fluctuations, we find patterns that are different from what the standard monetary economy models predict. This adds additional micro-level evidence to the findings of Golosov and Lucas (2003), Klenow and Kryvtsov (2003), Klenow and Willis (2006), Warner and Barsky (1995), and Knotek (2006) who explore explanations for the divergent behavior of individual prices on the one hand and aggregate price level on the other.

Taken together, our findings and their explanation suggest that there might be important differences in the response of markets to small vs. large changes. This is consistent with recent empirical findings that price reactions to small cost shocks differ from price reactions to large cost shocks (Dutta, et al. 2002), and with recent empirical field work that studies organizations' conduct when they face decisions about small vs.

[17] Indeed, in his discussants' comments on this study, Cecchetti (2004) demonstrated that in Europe the phenomenon of asymmetric price adjustment in the small is widespread and is not limited to food store prices.

large price changes (Zbaracki, et al. 2004 and 2006). This is also consistent with theoretical work exploring how the size of the price change impacts firms pricing decisions (Cecchetti 1986, Rotemberg 1987, and Blinder et al 1998).

Our theory, thus, offers a possible explanation for the presence of small price changes, which has been a long standing puzzle in the price adjustment literature. See, for example, Carlton (1986), Kashyap (1995), Warner and Barsky (1995), Sheshinski and Weiss (1993), and Lach and Tsiddon (2007). Our theory suggests that when the costs of making small changes (menu costs) are offset by the possible gains accrued from an inelastic demand curve, firms may find it optimal to engage in small price changes, especially in small price increases.

We conclude with a brief discussion of the likely generalizability of our results. In our setting, the retailer faces buyers with little at stake in the price of an individual item. It is likely, therefore, that asymmetric price adjustment in the small will be present in other settings such as Target, Wal-Mart, etc., where low-priced, commonly consumed retail goods are sold. It is unclear, however, how generalizable our findings are to other types of goods or markets. We know that are markets where attention is critical. For example, in financial and business-to-business markets where transactions often involve large quantities of the same asset, buyers will be more attentive. In fact, in these markets, there are people whose only job is to pay attention to pennies or even less. In such settings, it is unlikely to see asymmetry in the small. It is less clear whether inattentive behavior will be optimal in other settings. For example, in markets for big-ticket items people are likely to be more attentive because these transactions involve large expenditures (Bell, et al., 1998; Nagle and Holden, 2002). However, even when considering big-ticket items, shoppers might be inattentive—they may ignore some rightmost digits (Lee et. al., 2006). For example, car shoppers may choose to be inattentive to the rightmost digits, and thus focus on fourteen thousand eight hundred dollars when the actual price is $14,889.00. This would create some room for asymmetric price adjustment in the small. In future work, therefore, it will be valuable to study other data sets, products, and markets.

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Table 1. Descriptive Statistics

Category	Number of Observations	Proportion of the Total	Number of Products	Number of Stores	Mean Price	Std. Dev.	Min. Price	Max. Price
Analgesics	3,059,922	0.0310	638	93	$5.18	$2.36	$0.47	$23.69
Bath Soap	418,097	0.0042	579	93	$3.16	$1.60	$0.47	$18.99
Bathroom Tissue	1,156,481	0.0117	127	93	$2.10	$1.68	$0.25	$11.99
Beer	1,970,266	0.0200	787	89	$5.69	$2.70	$0.99	$26.99
Bottled Juice	4,324,595	0.0438	506	93	$2.24	$0.97	$0.32	$8.00
Canned Soup	5,549,149	0.0562	445	93	$1.13	$0.49	$0.23	$5.00
Canned Tuna	2,403,151	0.0244	278	93	$1.80	$1.07	$0.22	$12.89
Cereals	4,747,889	0.0481	489	93	$3.12	$0.76	$0.25	$7.49
Cheeses	7,571,355	0.0767	657	93	$2.42	$1.12	$0.10	$16.19
Cigarettes	1,810,614	0.0183	793	93	$7.69	$7.90	$0.59	$25.65
Cookies	7,634,434	0.0774	1,124	93	$2.10	$0.63	$0.25	$8.79
Crackers	2,245,305	0.0228	330	93	$2.01	$0.57	$0.25	$6.85
Dish Detergent	2,183,013	0.0221	287	93	$2.34	$0.90	$0.39	$7.00
Fabric Softeners	2,295,534	0.0233	318	93	$2.82	$1.45	$0.10	$9.99
Front-End-Candies	3,952,470	0.0400	503	93	$0.61	$0.24	$0.01	$6.99
Frozen Dinners	1,654,051	0.0168	266	93	$2.37	$0.89	$0.25	$9.99
Frozen Entrees	7,231,871	0.0733	898	93	$2.33	$1.06	$0.25	$15.99
Frozen Juices	2,373,168	0.0240	175	93	$1.39	$0.45	$0.22	$6.57
Grooming Products	4,065,691	0.0412	1,381	93	$2.94	$1.37	$0.49	$11.29
Laundry Detergents	3,302,753	0.0335	581	93	$5.61	$3.22	$0.25	$24.49
Oatmeal	981,106	0.0099	96	93	$2.65	$0.66	$0.49	$5.00
Paper Towels	948,550	0.0096	163	93	$1.50	$1.41	$0.31	$13.99
Refrigerated Juices	2,176,518	0.0221	225	93	$2.24	$0.91	$0.39	$7.05
Shampoos	4,676,731	0.0474	2,930	93	$2.95	$1.79	$0.27	$29.99
Snack Crackers	3,509,158	0.0356	420	93	$2.18	$0.57	$0.10	$8.00
Soaps	1,834,040	0.0186	334	93	$2.51	$1.48	$0.10	$10.99
Soft Drinks	10,547,266	0.1069	1,608	93	$2.34	$1.89	$0.10	$26.02
Toothbrushes	1,852,487	0.0188	491	93	$2.18	$0.85	$0.39	$9.99
Toothpastes	2,997,748	0.0304	608	93	$2.43	$0.89	$0.31	$10.99
Total	**98,691,750**	**1.0000**	**18,037**	**93**				

Note:

The figures in the table are based on all price data of Dominick's in its 93 stores for 400 weeks from September 14, 1989 to May 8, 1997. The data are available at: http://gsbwww.uchicago.edu/kilts/research/db/dominicks/

Table 2. Asymmetry Thresholds in Cents Based on PPI-Measure of Price Level

	Full Sample	**Low-Inflation Sample**	**Deflation Sample**
Analgesics	30	10	10
Bath Soap	6	0	0
Bathroom Tissues	6	4	4
Bottled Juices	12	15	12
Canned Soup	12	12	10
Canned Tuna	1	2	1
Cereals	29	24	1
Cheeses	9	9	9
Cookies	11	11	9
Crackers	10	2	4
Dish Detergent	5	4	6
Fabric Softeners	5	11	7
Front-end-candies	5	5	5
Frozen Dinners	2	10	6
Frozen Entrees	20	22	0
Frozen Juices	9	9	10
Grooming Products	20	12	12
Laundry Detergents	16	13	17
Oatmeal	25	2	5
Paper Towels	2	2	2
Refrigerated Juices	15	9	6
Shampoos	0	10	10
Snack Crackers	11	2	2
Soaps	1	1	1
Soft Drinks	5	3	5
Tooth Brushes	20	3	3
Tooth Pastes	18	14	6
Average	**11.3**	**8.2**	**6.2**

Note:

*PPI = Producer Price Index

*The figures reported in the table are the cutoff points of what might constitute a “small” price change for each category. The cutoff point is the last point at which the asymmetry is supported statistically ($z \geq 1.96$). Thus, for example, in the Analgesics category, when the entire sample is used, we see that for price changes of up to 30 cents, there is asymmetry.

Table 3. Three Measures of Inflation (PPI, CPI, and CPI-Chicago), September 1989–May 1997

Year	Month	PPI	%ΔPPI	CPI	%ΔCPI	CPI-Chicago	%ΔCPI-Chicago
1989	September	113.6	-	125.0	-	127.1	-
1989	October	114.9	1.14	125.6	0.5	126.8	–0.2
1989	November	114.9	0.00	125.9	0.2	126.7	–0.1
1989	December	115.4	0.44	126.1	0.2	126.5	–0.2
1990	January	117.6	1.91	127.4	1.0	128.1	1.3
1990	February	117.4	–0.17	128.0	0.5	129.2	0.9
1990	March	117.2	–0.17	128.7	0.5	129.5	0.2
1990	April	117.2	0.00	128.9	0.2	130.4	0.7
1990	May	117.7	0.43	129.2	0.2	130.4	0.0
1990	June	117.8	0.08	129.9	0.5	131.7	1.0
1990	July	118.2	0.34	130.4	0.4	132.0	0.2
1990	August	119.3	0.93	131.6	0.9	133.2	0.9
1990	September	120.4	0.92	132.7	0.8	133.8	0.5
1990	October	122.3	1.58	133.5	0.6	133.3	–0.4
1990	November	122.9	0.49	133.8	0.2	134.2	0.7
1990	December	122.0	–0.73	133.8	0.0	134.6	0.3
1991	January	122.3	0.25	134.6	0.6	135.1	0.4
1991	February	121.4	–0.74	134.8	0.1	135.5	0.3
1991	March	120.9	–0.41	135.0	0.1	136.2	0.5
1991	April	121.1	0.17	135.2	0.1	136.1	–0.1
1991	May	121.8	0.58	135.6	0.3	136.8	0.5
1991	June	121.9	0.08	136.0	0.3	137.3	0.4
1991	July	121.6	–0.25	136.2	0.1	137.3	0.0
1991	August	121.7	0.08	136.6	0.3	137.6	0.2
1991	September	121.4	–0.25	137.2	0.4	138.3	0.5
1991	October	122.2	0.66	137.4	0.1	138.0	–0.2
1991	November	122.3	0.08	137.8	0.3	138.0	0.0
1991	December	121.9	–0.33	137.9	0.1	138.3	0.2
1992	January	121.8	–0.08	138.1	0.1	138.9	0.4
1992	February	122.1	0.25	138.6	0.4	139.2	0.2
1992	March	122.2	0.08	139.3	0.5	139.7	0.4
1992	April	122.4	0.16	139.5	0.1	139.8	0.1
1992	May	123.2	0.65	139.7	0.1	140.5	0.5
1992	June	123.9	0.57	140.2	0.4	141.2	0.5
1992	July	123.7	–0.16	140.5	0.2	141.4	0.1
1992	August	123.6	–0.08	140.9	0.3	141.9	0.4
1992	September	123.3	–0.24	141.3	0.3	142.7	0.6
1992	October	124.4	0.89	141.8	0.4	142.1	–0.4
1992	November	124.0	–0.32	142.0	0.1	142.4	0.2
1992	December	123.8	–0.16	141.9	–0.1	142.9	0.4
1993	January	124.2	0.32	142.6	0.5	143.2	0.2
1993	February	124.5	0.24	143.1	0.4	143.6	0.3
1993	March	124.7	0.16	143.6	0.3	144.1	0.3
1993	April	125.5	0.64	144.0	0.3	144.7	0.4
1993	May	125.8	0.24	144.2	0.1	145.7	0.7
1993	June	125.5	–0.24	144.4	0.1	145.6	–0.1
1993	July	125.3	–0.16	144.4	0.0	145.5	–0.1
1993	August	124.2	–0.88	144.8	0.3	146.1	0.4

1993	September	123.8	–0.32	145.1	0.2	146.7	0.4
1993	October	124.6	0.65	145.7	0.4	147.2	0.3
1993	November	124.5	–0.08	145.8	0.1	146.4	–0.5
1993	December	124.1	–0.32	145.8	0.0	146.1	–0.2
1994	January	124.5	0.32	146.2	0.3	146.5	0.3
1994	February	124.8	0.24	146.7	0.3	146.8	0.2
1994	March	124.9	0.08	147.2	0.3	147.6	0.5
1994	April	125.0	0.08	147.4	0.1	147.9	0.2
1994	May	125.3	0.24	147.5	0.1	147.6	–0.2
1994	June	125.6	0.24	148.0	0.3	148.1	0.3
1994	July	126.0	0.32	148.4	0.3	148.3	0.1
1994	August	126.5	0.40	149.0	0.4	149.8	1.0
1994	September	125.6	–0.71	149.4	0.3	150.2	0.3
1994	October	125.8	0.16	149.5	0.1	149.4	–0.5
1994	November	126.1	0.24	149.7	0.1	150.4	0.7
1994	December	126.2	0.08	149.7	0.0	150.5	0.1
1995	January	126.6	0.32	150.3	0.4	151.8	0.9
1995	February	126.9	0.24	150.9	0.4	152.3	0.3
1995	March	127.1	0.16	151.4	0.3	152.6	0.2
1995	April	127.6	0.39	151.9	0.3	153.1	0.3
1995	May	128.1	0.39	152.2	0.2	153.0	–0.1
1995	June	128.2	0.08	152.5	0.2	153.5	0.3
1995	July	128.2	0.00	152.5	0.0	153.6	0.1
1995	August	128.1	–0.08	152.9	0.3	153.8	0.1
1995	September	127.9	–0.16	153.2	0.2	154.0	0.1
1995	October	128.7	0.63	153.7	0.3	154.3	0.2
1995	November	128.7	0.00	153.6	–0.1	154.0	–0.2
1995	December	129.1	0.31	153.5	–0.1	153.8	–0.1
1996	January	129.4	0.23	154.4	0.6	154.6	0.5
1996	February	129.4	0.00	154.9	0.3	155.2	0.4
1996	March	130.1	0.54	155.7	0.5	156.3	0.7
1996	April	130.6	0.38	156.3	0.4	156.4	0.1
1996	May	131.1	0.38	156.6	0.2	156.9	0.3
1996	June	131.7	0.46	156.7	0.1	157.6	0.4
1996	July	131.5	–0.15	157.0	0.2	157.7	0.1
1996	August	131.9	0.30	157.3	0.2	158.1	0.3
1996	September	131.8	–0.08	157.8	0.3	158.3	0.1
1996	October	132.7	0.68	158.3	0.3	158.8	0.3
1996	November	132.6	–0.08	158.6	0.2	159.4	0.4
1996	December	132.7	0.08	158.6	0.0	159.7	0.2
1997	January	132.6	–0.08	159.1	0.3	160.4	0.4
1997	February	132.2	–0.30	159.6	0.3	161.1	0.4
1997	March	132.1	–0.08	160.0	0.3	161.0	–0.1
1997	April	131.6	–0.38	160.2	0.1	160.9	–0.1
1997	May	131.6	0.00	160.1	–0.1	161.1	0.1

Note: PPI – Producer Price Index

CPI – Consumer Price Index

CPI-Chicago – CPI for the Chicago Metro Area

Table 4. Asymmetry Thresholds in Cents for the PPI-Deflationary Period with Lagged Price Adjustment

	4-Week Lag	**8-Week Lag**	**12-Week Lag**	**16-Week Lag**
Analgesics	12	5	10	0
Bath Soap	0	0	(1)	(1)
Bathroom Tissues	4	4	4	5
Bottled Juices	10	2	6	24
Canned Soup	11	10	12	18
Canned Tuna	2	2	1	2
Cereals	25	0	25	28
Cheeses	9	2	9	9
Cookies	11	10	11	10
Crackers	4	2	4	2
Dish Detergent	10	2	6	5
Fabric Softeners	13	2	1	5
Front-end-candies	4	6	2	9
Frozen Dinners	9	9	2	2
Frozen Entrees	4	20	10	19
Frozen Juices	9	1	6	1
Grooming Products	18	18	10	8
Laundry Detergents	13	11	5	2
Oatmeal	4	4	12	3
Paper Towels	2	2	2	1
Refrigerated Juices	6	18	11	5
Shampoos	5	5	(1)	0
Snack Crackers	2	2	2	2
Soaps	2	1	1	1
Soft Drinks	2	9	2	0
Tooth Brushes	1	10	8	2
Tooth Pastes	6	7	20	6
Average	**7.3**	**6.1**	**6.7**	**6.2**

Note:

The figures reported in the table are the cutoff points of what might constitute a "small" price change for each category. The cutoff point is the last point at which the asymmetry is supported statistically. The figures in parentheses indicate a reverse asymmetry, and 0 means that there is no asymmetry. For example, for Bath Soap, 12-week lag, the asymmetry threshold is (1), meaning that there are statistically significant more price *decreases* than increases at 1 cent, but not beyond that. For Analgesics, 16-week lag, the asymmetry threshold is 0, meaning that the number of price increases is statistically not different from the number of price decreases at 1 cent.

Table 5. Asymmetry Thresholds in Cents, Deflation Period, Based on CPI-Chicago and CPI

	CPI-Chicago	**CPI**
Analgesics	7	10
Bath Soap	(1)	(1)
Bathroom Tissues	4	9
Bottled Juices	8	9
Canned Soup	14	10
Canned Tuna	1	1
Cereals	33	28
Cheeses	5	8
Cookies	4	11
Crackers	1	1
Dish Detergent	9	7
Fabric Softeners	8	3
Front-end-candies	7	9
Frozen Dinners	1	1
Frozen Entrees	11	10
Frozen Juices	5	7
Grooming Products	23	13
Laundry Detergents	20	9
Oatmeal	4	2
Paper Towels	2	2
Refrigerated Juices	9	6
Shampoos	5	(1)
Snack Crackers	6	3
Soaps	6	2
Soft Drinks	2	1
Tooth Brushes	1	8
Tooth Pastes	6	6
Average	**7.4**	**6.4**

Note:

The figures reported in the table are the cutoff points of what might constitute a “small” price change for each category. The cutoff point is the last point at which the asymmetry is supported statistically. The figures in parentheses indicate a reverse asymmetry, and 0 means that there is no asymmetry.

Table 6. Asymmetry Thresholds in Cents Based on CPI-Chicago and CPI with Lagged Price Adjustment

	4-Week Lag		8-Week Lag		12-Week Lag		16-Week Lag	
	CPI-Chicago	**CPI**	**CPI-Chicago**	**CPI**	**CPI-Chicago**	**CPI**	**CPI-Chicago**	**CPI**
Analgesics	(1)	1	(1)	0	5	(5)	14	0
Bath Soap	0	(3)	0	0	0	0	0	0
Bathroom Tissues	4	5	4	4	4	4	3	6
Bottled Juices	10	2	16	2	0	(7)	2	3
Canned Soup	12	11	13	2	11	2	12	8
Canned Tuna	1	1	2	1	1	1	1	1
Cereals	29	0	29	21	(1)	25	29	28
Cheeses	9	12	10	2	6	1	2	10
Cookies	11	3	11	5	12	5	10	10
Crackers	1	7	3	4	6	10	2	6
Dish Detergent	5	1	2	4	1	1	2	3
Fabric Softeners	2	5	1	0	1	1	1	2
Front-end-candies	6	9	5	6	2	6	1	1
Frozen Dinners	2	2	3	1	1	2	1	1
Frozen Entrees	3	10	0	12	(1)	0	4	9
Frozen Juices	1	1	9	1	14	5	2	4
Grooming Products	5	13	12	8	18	14	6	1
Laundry Detergents	3	0	1	3	1	12	3	13
Oatmeal	5	2	1	4	3	4	4	17
Paper Towels	1	2	2	2	2	2	1	2
Refrigerated Juices	3	6	3	2	6	9	9	5
Shampoos	5	(1)	2	(1)	(1)	8	(1)	0
Snack Crackers	2	2	2	5	2	1	2	2
Soaps	1	1	1	2	1	1	1	1
Soft Drinks	5	1	1	4	3	3	3	2
Tooth Brushes	1	(1)	8	0	2	(1)	2	2
Tooth Pastes	6	10	18	8	10	0	12	3
Average	**4.9**	**3.8**	**5.9**	**3.8**	**4.0**	**3.9**	**4.7**	**5.2**

Note:

The figures reported in the table are the cutoff points of what might constitute a "small" price change for each category. The cutoff point is the last point at which the asymmetry is supported statistically. The figures in parentheses indicate a reverse asymmetry, and 0 means that there is no asymmetry.

Table 7. Asymmetry Thresholds in Cents for Products for which the Average Price during the First 4 Weeks Was Greater or Equal to the Average Price during the Last 4 Weeks

	Asymmetry Threshold
Analgesics	3
Bath Soap	(1)
Bathroom Tissues	5
Bottled Juices	5
Canned Soup	0
Canned Tuna	1
Cereals	14
Cheeses	1
Cookies	2
Crackers	2
Dish Detergent	5
Fabric Softeners	1
Front-end-candies	(1)
Frozen Dinners	2
Frozen Entrees	14
Frozen Juices	9
Grooming Products	2
Laundry Detergents	12
Oatmeal	2
Paper Towels	2
Refrigerated Juices	7
Shampoos	0
Snack Crackers	2
Soaps	1
Soft Drinks	1
Tooth Brushes	3
Tooth Pastes	10
Average	**3.9**

Note:

The figures reported in the table are the cutoff points of what might constitute a “small” price change for each category. The cutoff point is the last point at which the asymmetry is supported statistically. The figures in parentheses indicate a reverse asymmetry, and 0 means that there is no asymmetry.

Table 8. Asymmetry Thresholds in Cents, First 12-Month Period vs. Last 12-Month Period of the Sample

	Sample Size		**Asymmetry Threshold**	
	First 12 Months	**Last 12 Months**	**First 12 Months**	**Last 12 Months**
Analgesics	312534	430029	0	16
Bath Soap	0	98529	-	-
Bathroom Tissues	111584	165986	2	4
Bottled Juices	391379	611627	11	12
Canned Soup	657039	406997	0	24
Canned Tuna	290860	203939	3	2
Cereals	550364	672046	0	13
Cheeses	748883	949382	(1)	22
Cookies	970126	922640	1	10
Crackers	242707	402834	1	11
Dish Detergent	266158	308769	(4)	15
Fabric Softeners	243900	299302	0	1
Front-end-candies	525912	517081	(1)	1
Frozen Dinners	0	327646	-	-
Frozen Entrees	782633	976451	1	20
Frozen Juices	236961	306801	1	13
Grooming Products	0	1010036	-	-
Laundry Detergents	347556	376475	1	6
Oatmeal	0	168849	-	-
Paper Towels	100437	119194	1	4
Refrigerated Juices	192878	319187	0	10
Shampoos	0	1209605	-	-
Snack Crackers	377000	460508	(1)	3
Soaps	0	354449	-	-
Soft Drinks	918306	1890469	0	(1)
Tooth Brushes	226573	238089	(3)	1
Tooth Pastes	317591	424639	1	2
Average			**0.6**	**9.0**

Note:

In six product categories, the sample size was 0 for the first 12 months, and thus no comparison could be performed. The figures reported in the table are the cutoff points of what might constitute a “small” price change for each category. The cutoff point is the last point at which the asymmetry is supported statistically. The figures in parentheses indicate a reverse asymmetry, and 0 means that there is no asymmetry.

Table 9. Asymmetry Threshold in Each of the Seven Years

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Analgesics	(1)	7	8	3	0	8	3
Bath Soap	-	-	0	(1)	0	0	(1)
Bathroom Tissues	3	1	1	4	6	9	5
Bottled Juices	15	0	4	7	5	1	18
Canned Soup	0	12	0	10	11	8	9
Canned Tuna	1	1	2	2	1	0	2
Cereals	4	24	0	25	19	1	12
Cheeses	(1)	5	1	9	2	2	23
Cookies	4	(1)	4	8	14	3	10
Crackers	1	2	1	2	4	1	10
Dish Detergent	(3)	2	2	10	4	2	11
Fabric Softeners	0	5	11	5	1	1	1
Front-end-candies	(1)	1	1	15	0	1	10
Frozen Dinners	-	-	9	4	1	1	1
Frozen Entrees	(1)	0	10	10	(1)	1	20
Frozen Juices	0	(2)	2	3	9	9	9
Grooming Products	-	-	12	20	5	1	16
Laundry Detergents	(4)	3	2	9	1	1	2
Oatmeal	-	5	12	4	1	2	9
Paper Towels	1	0	1	1	2	9	1
Refrigerated Juices	0	4	2	8	3	9	25
Shampoos	-	-	6	20	2	(1)	(1)
Snack Crackers	(2)	0	2	2	1	12	9
Soaps	-	-	4	6	1	1	1
Soft Drinks	1	(1)	(1)	5	3	4	13
Tooth Brushes	(1)	8	8	(1)	3	7	1
Tooth Pastes	1	7	0	6	2	12	(1)
Average	**0.8**	**3.8**	**3.9**	**7.3**	**3.7**	**3.9**	**8.1**

Note:

The figures reported in the table are the cutoff points of what might constitute a "small" price change for each category. The cutoff point is the last point at which the asymmetry is supported statistically. The figures in parentheses indicate a reverse asymmetry, and 0 means that there is no asymmetry.

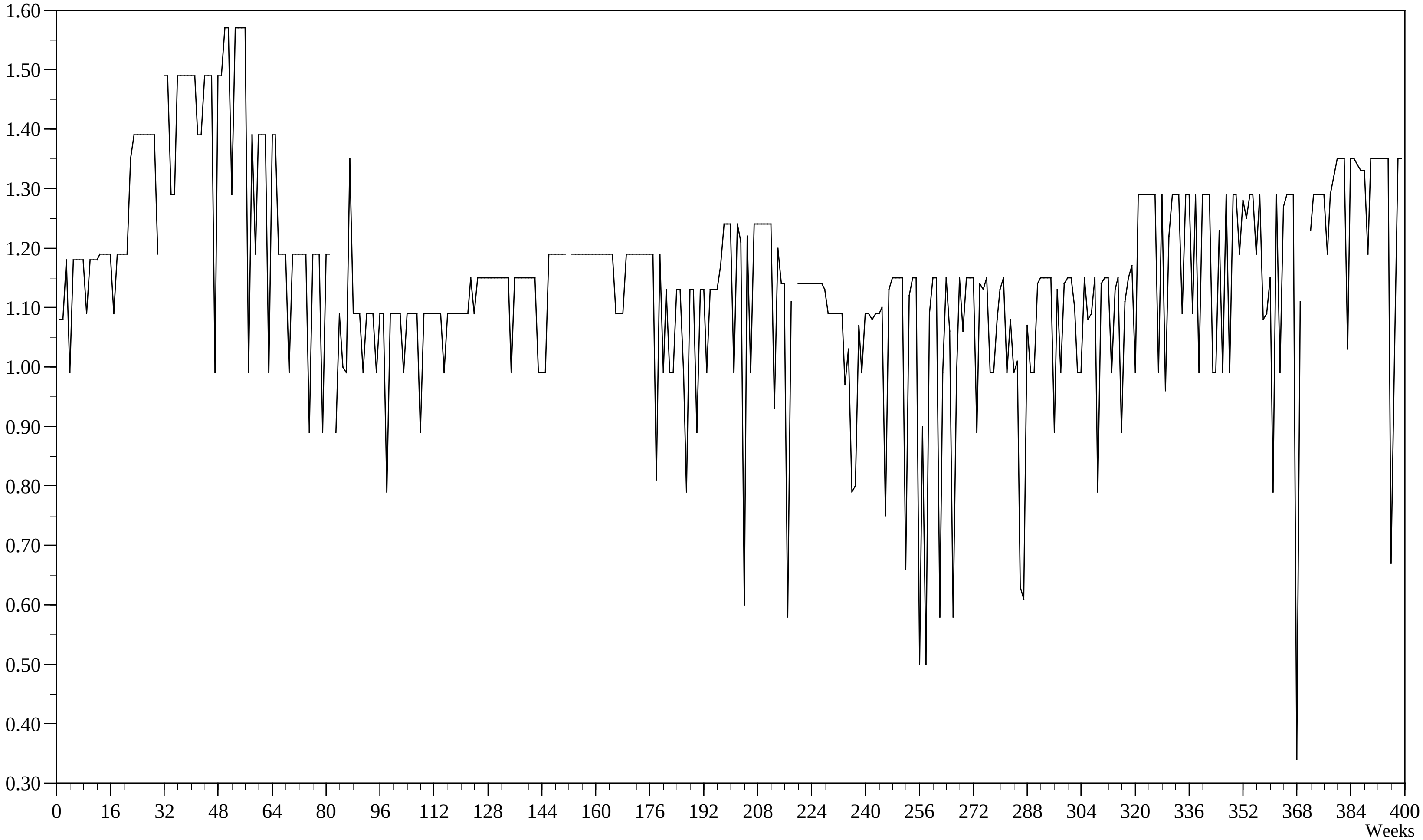

Figure 1. Price of Frozen Concentrate Orange Juice, Heritage House, 12oz (UPC = 3828190029, Store 78), September 14, 1989–May 8, 1997 (Source: Dutta, et al., 2002, and Levy, et al., 2002).

Notes: (1) Week 1 = Week of September 14, 1989, and Week 399=Week of May 8, 1997.
(2) There are 6 missing observations in the series.
(3) A careful visual examination of the plot will reveal that the series contain many small price changes. See the text for details.

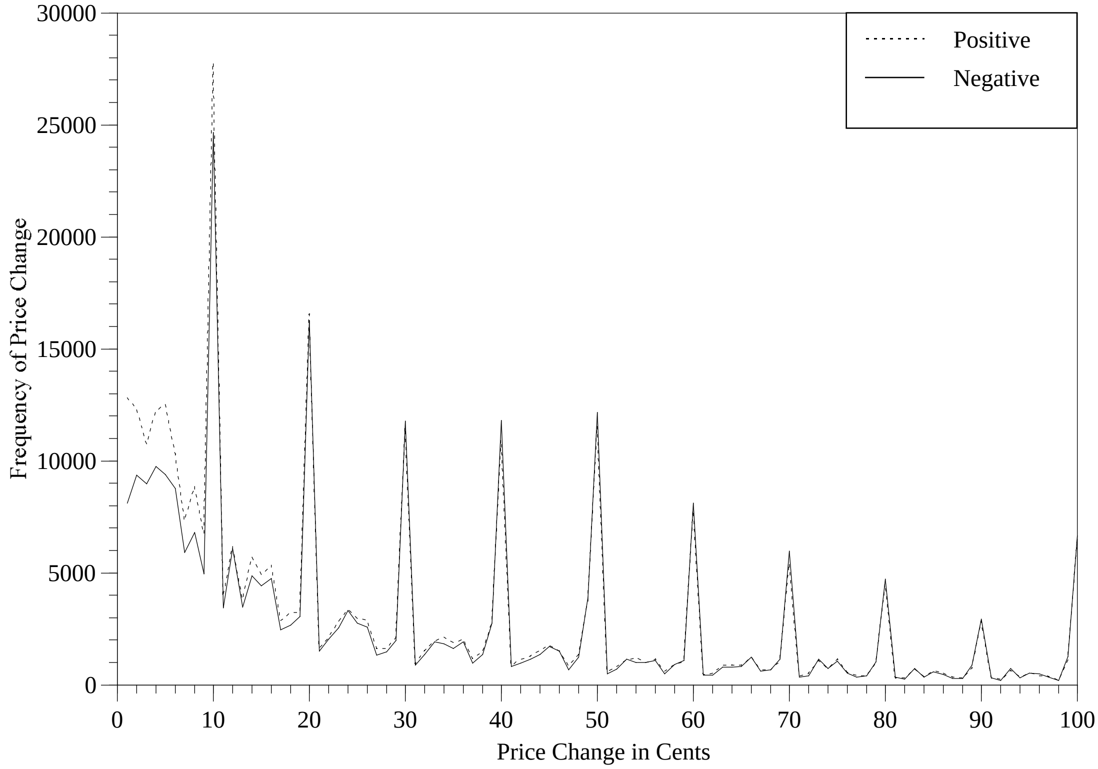

Figure 2. Average Frequency of Positive and Negative Price Changes, All 29 Categories

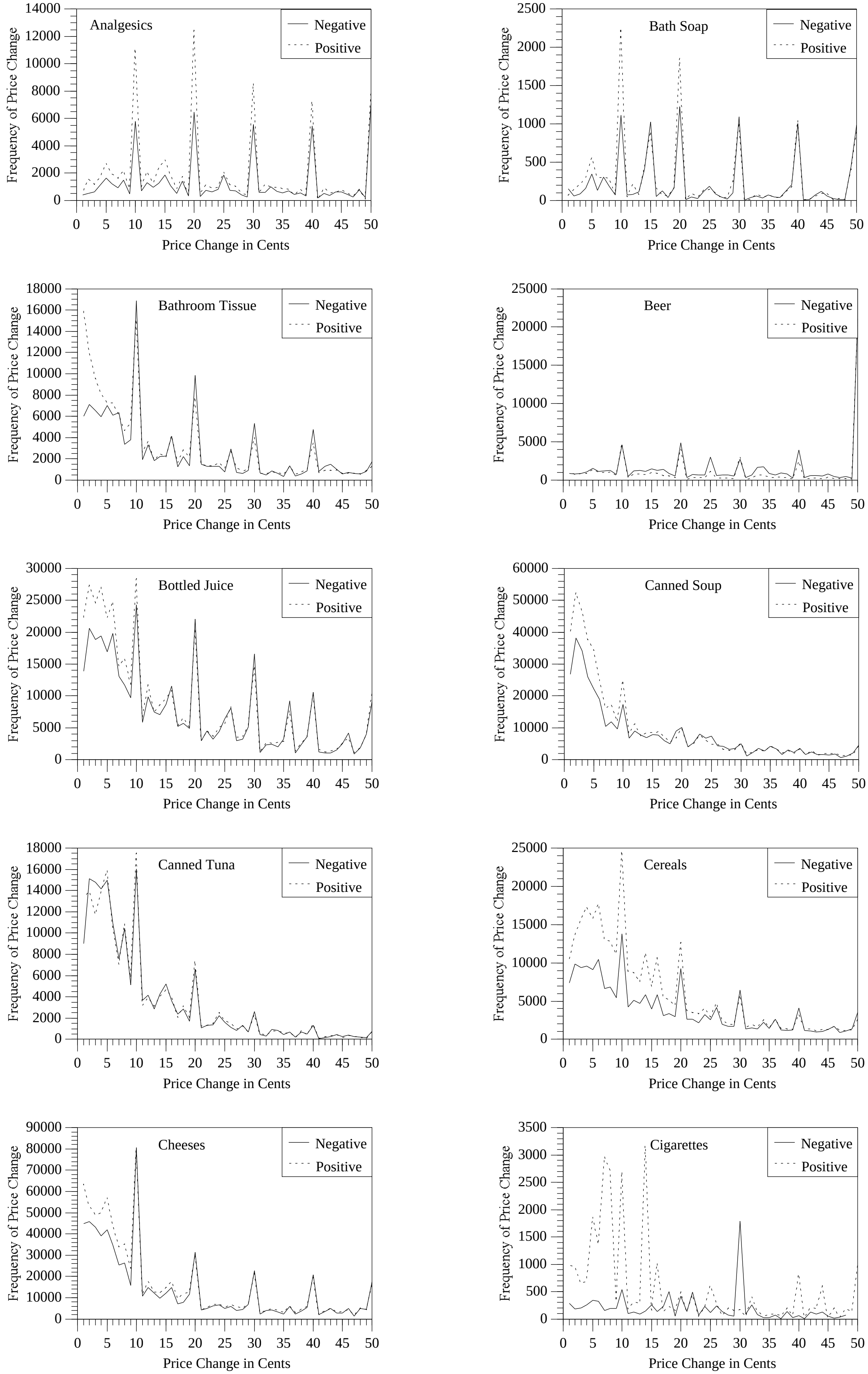

Figure 3a. Frequency of Positive and Negative Price Changes in Cents by Category

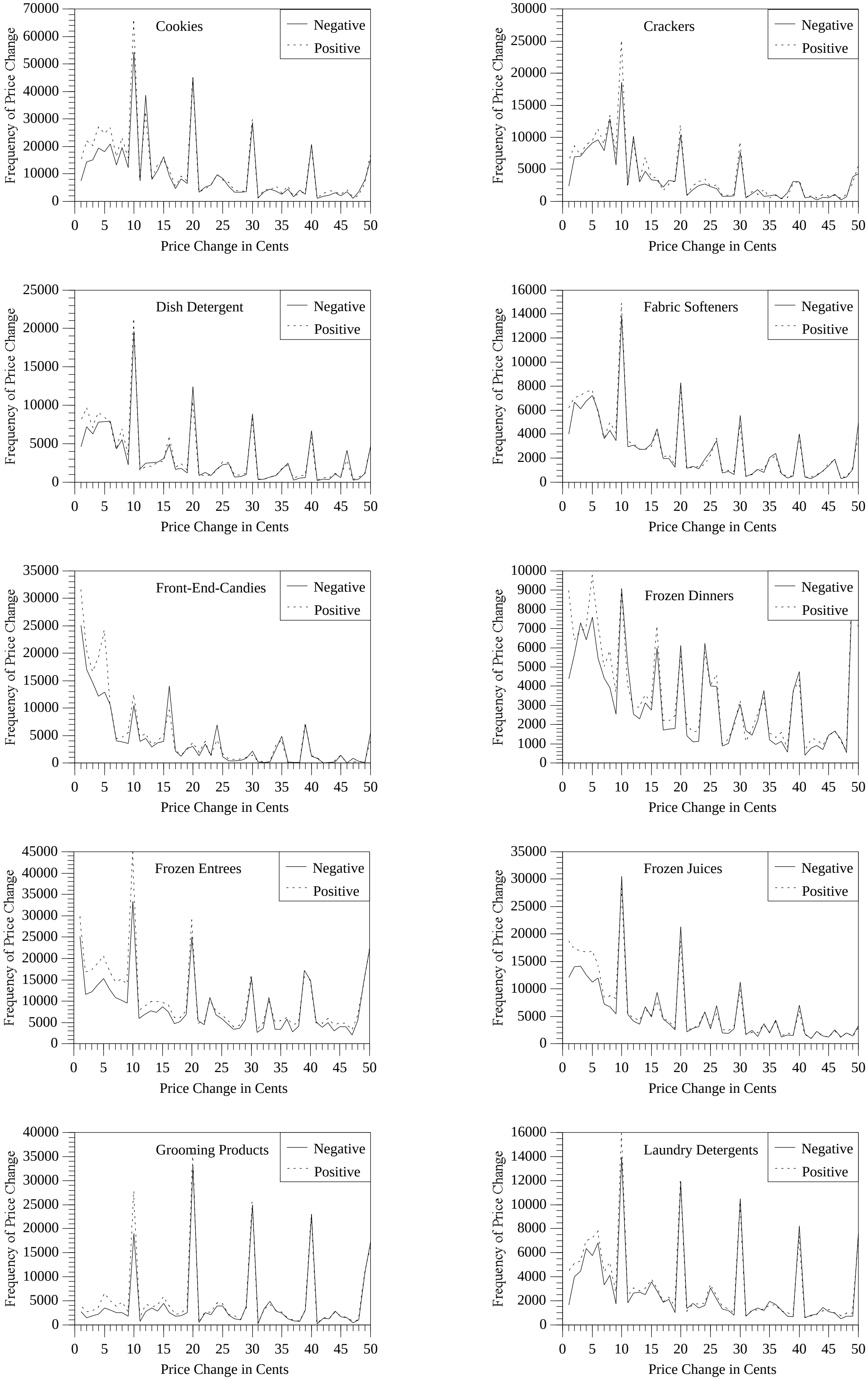

Figure 3b. Frequency of Positive and Negative Price Changes in Cents by Category

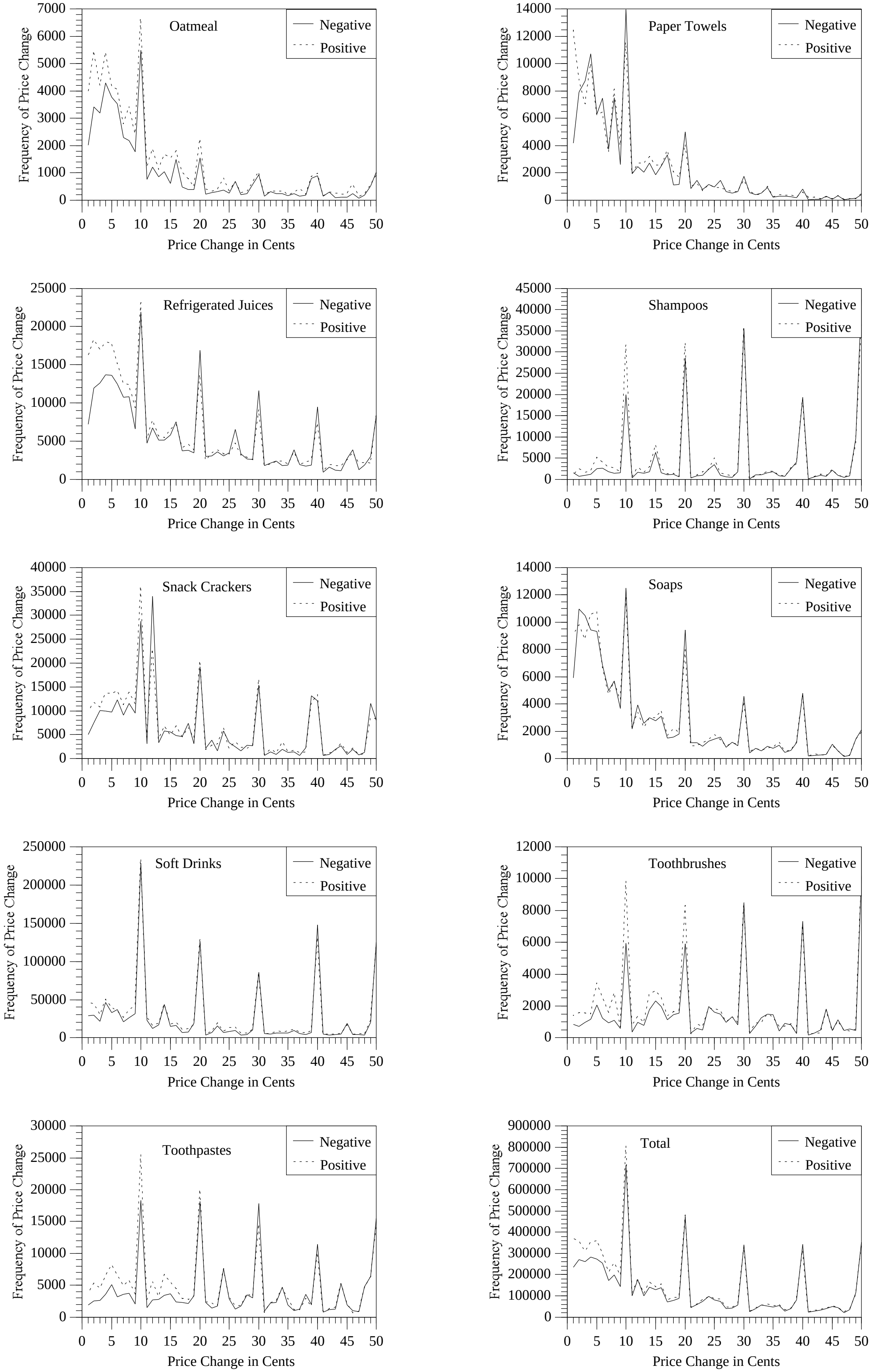

Figure 3c. Frequency of Positive and Negative Price Changes in Cents by Category

Referee Appendix

In Figure R1 we present the cross-category average frequency of positive and negative price changes in cents for the low/zero-inflation period sample.

In Figures R1.1a–R1.1c we present the frequency of positive and negative price changes in cents by categories for the low/zero-inflation period sample.

In Figure R2 we present the cross-category average frequency of positive and negative price changes in cents for the deflation period sample.

In Figures R2.1a–R2.1c we present the frequency of positive and negative price changes in cents by categories for the deflation period sample.

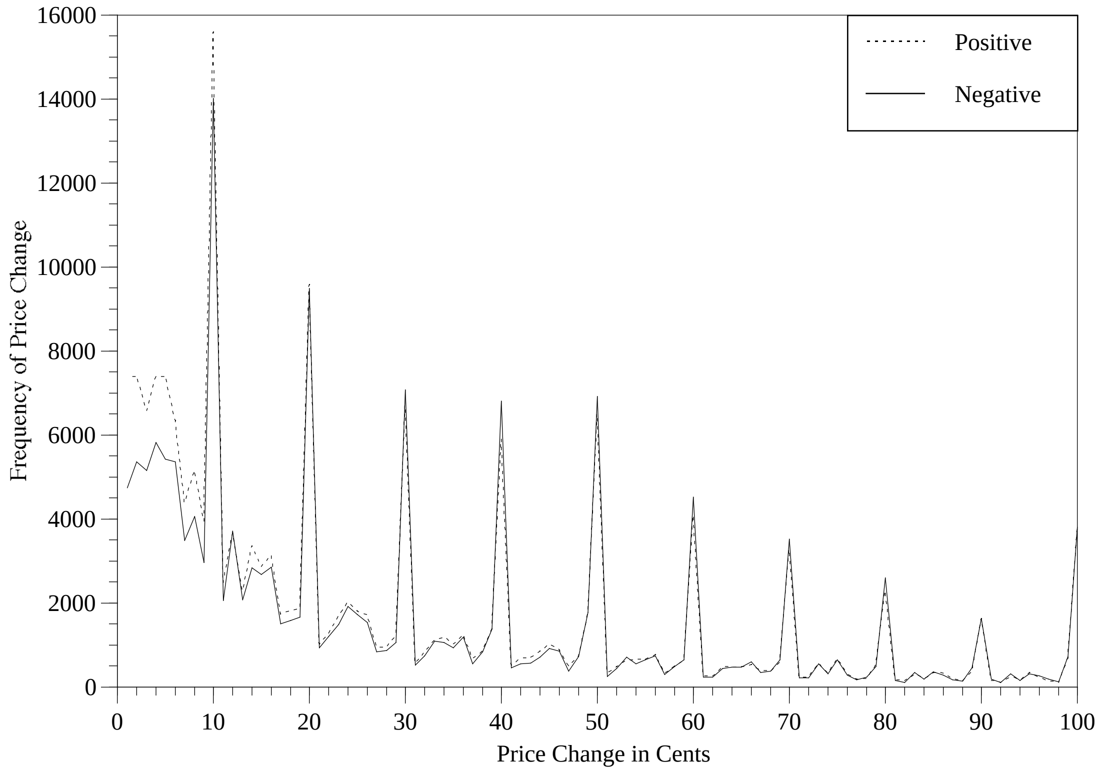

Figure R1. Average Frequency of Positive and Negative Price Changes
All 29 Categories, Low/Zero Inflation Period

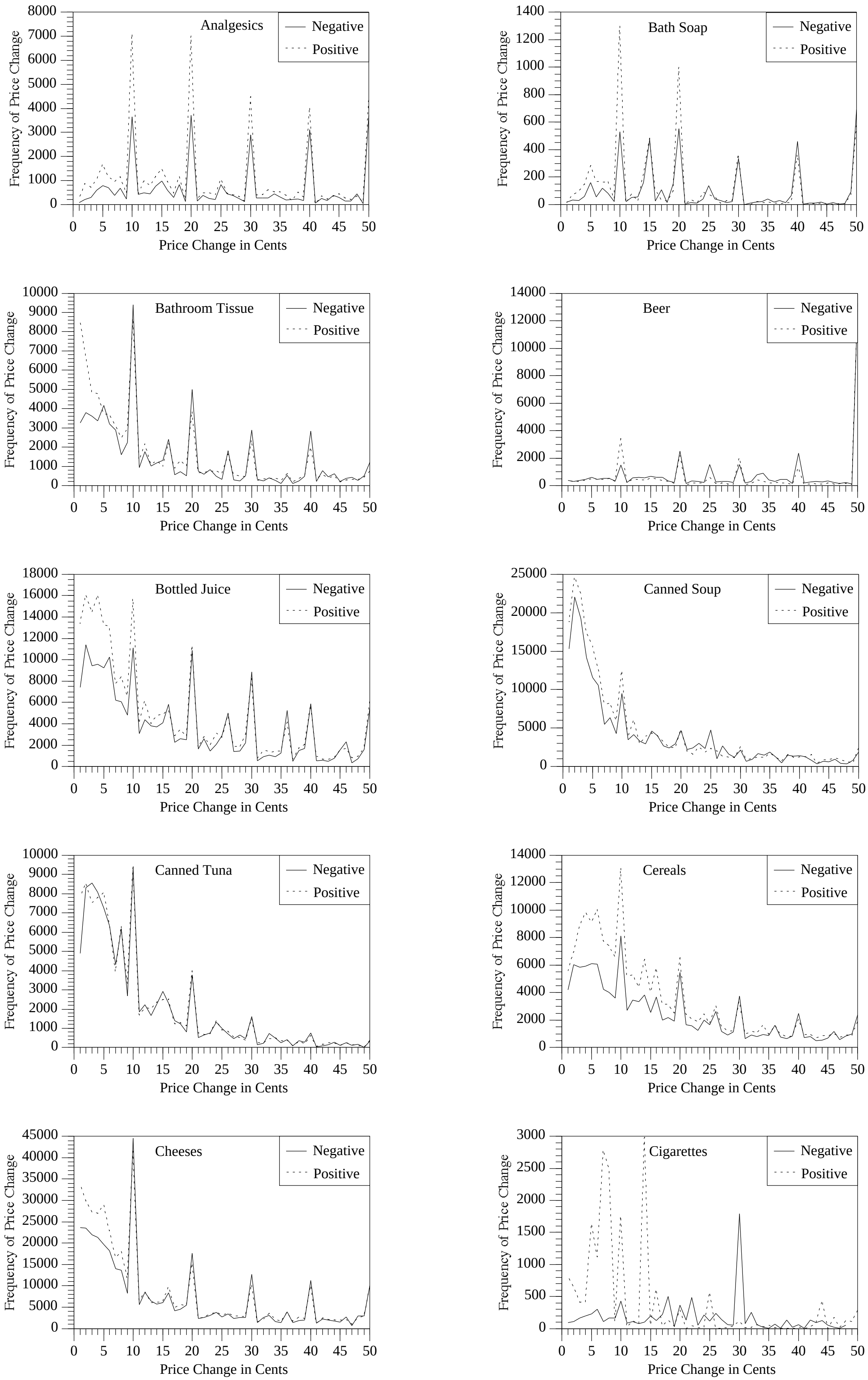

Figure R1.1a. Frequency of Positive and Negative Retail Price Changes in Cents by Category, Low/Zero Inflation Period

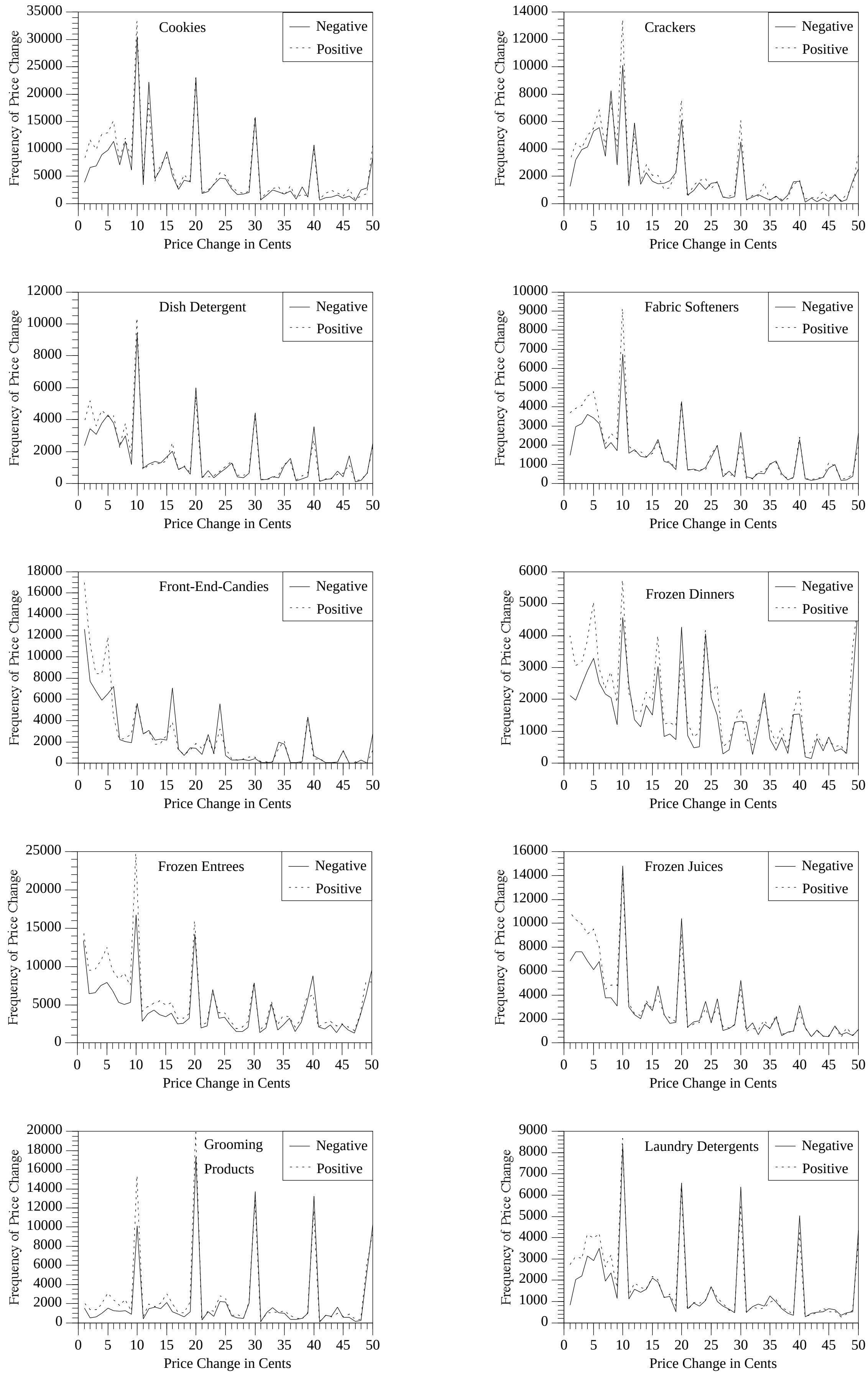

Figure R1.1b. Frequency of Positive and Negative Retail Price Changes in Cents by Category, Low/Zero Inflation Period

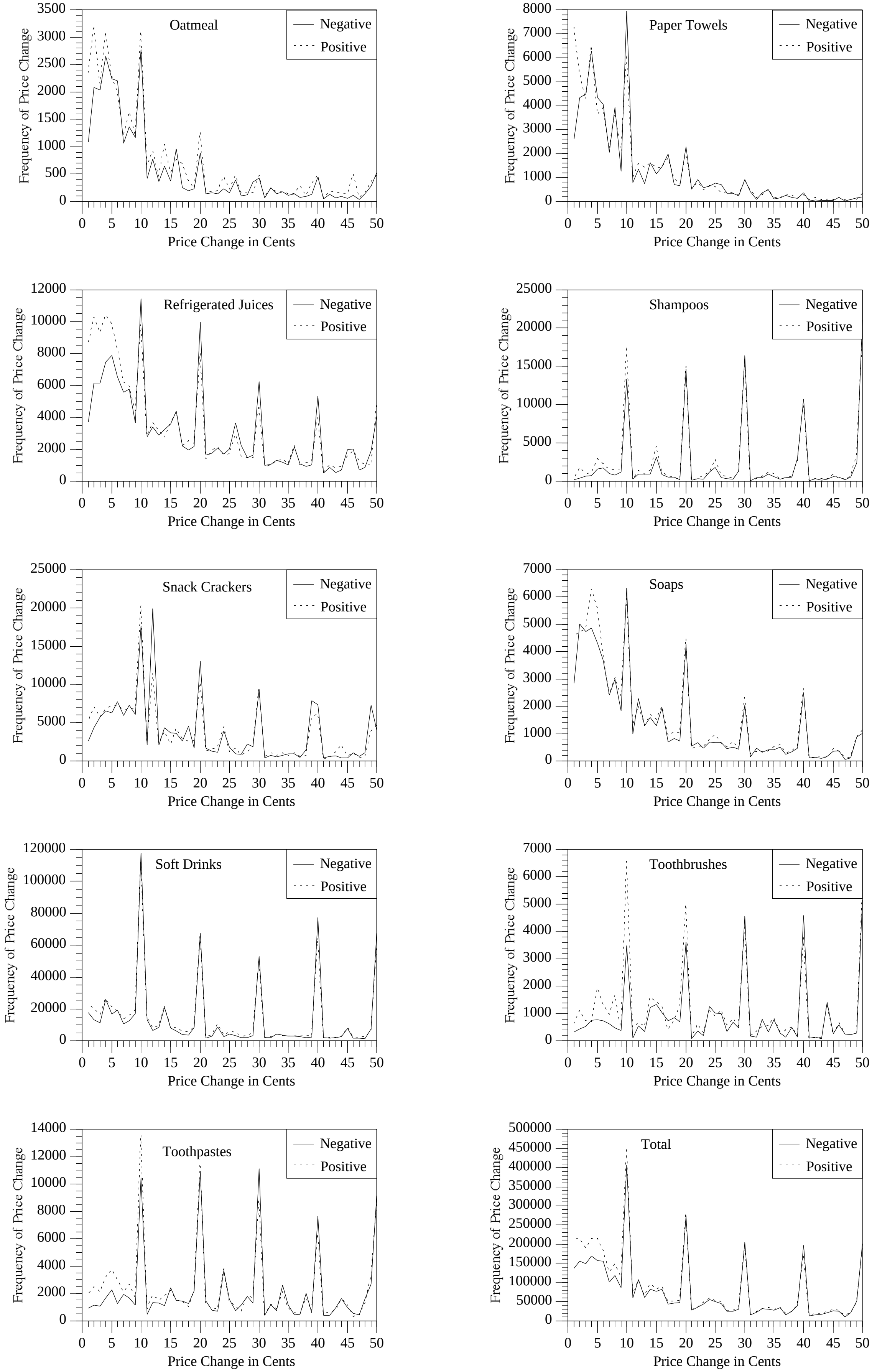

Figure R1.1c. Frequency of Positive and Negative Retail Price Changes in Cents by Category, Low/Zero Inflation Period

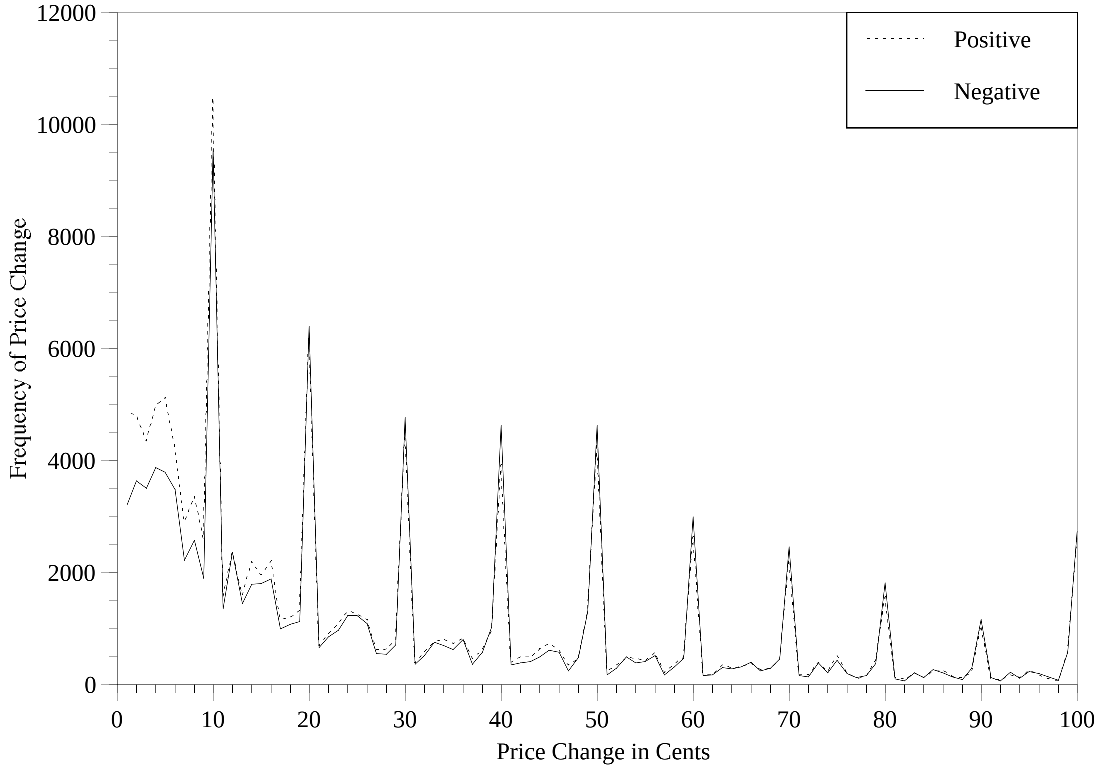

Figure R2. Average Frequency of Positive and Negative Price Changes
All 29 Categories, Deflation Period

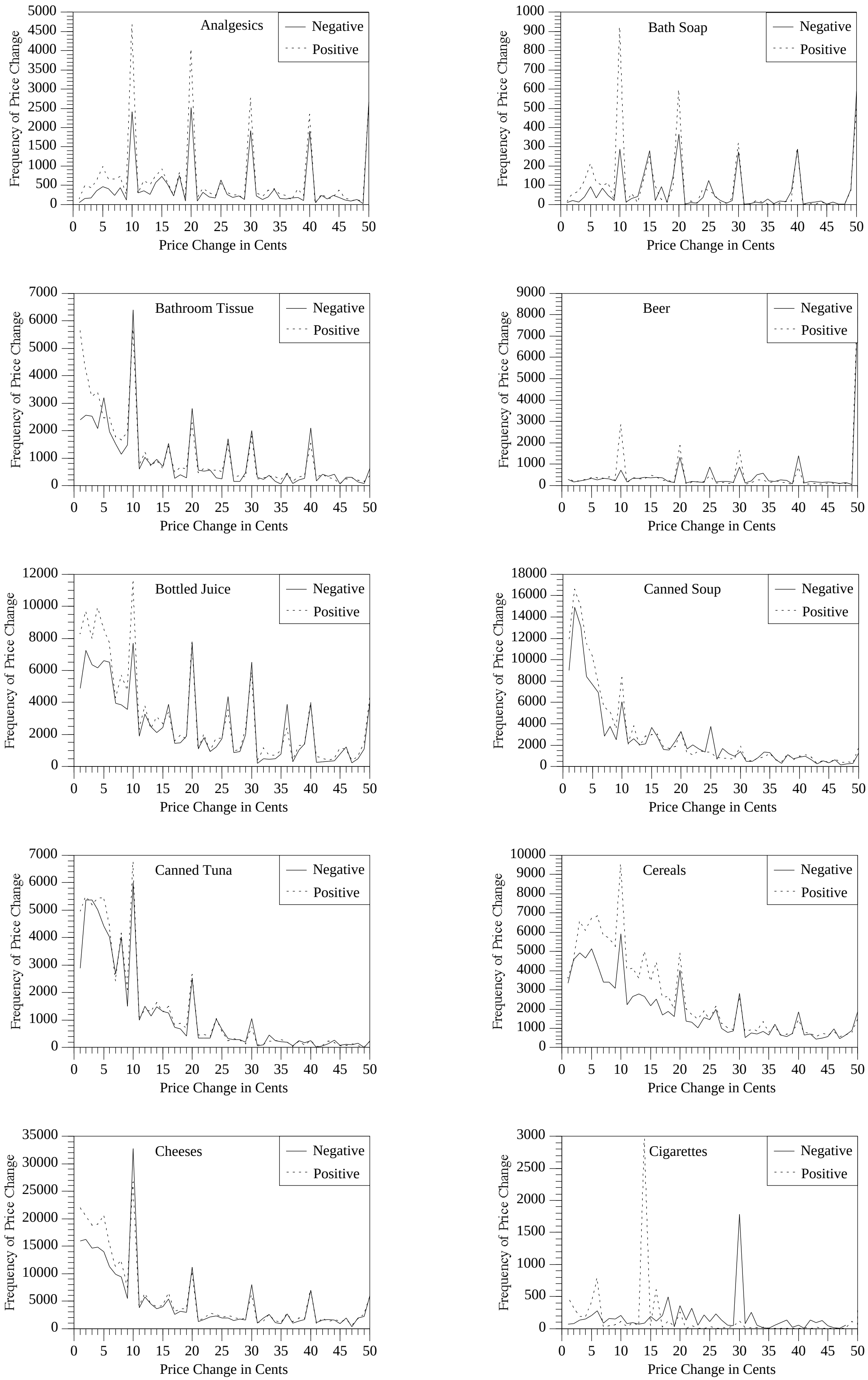

Figure R2.1a. Frequency of Positive and Negative Retail Price Changes in Cents by Category, Deflation Period

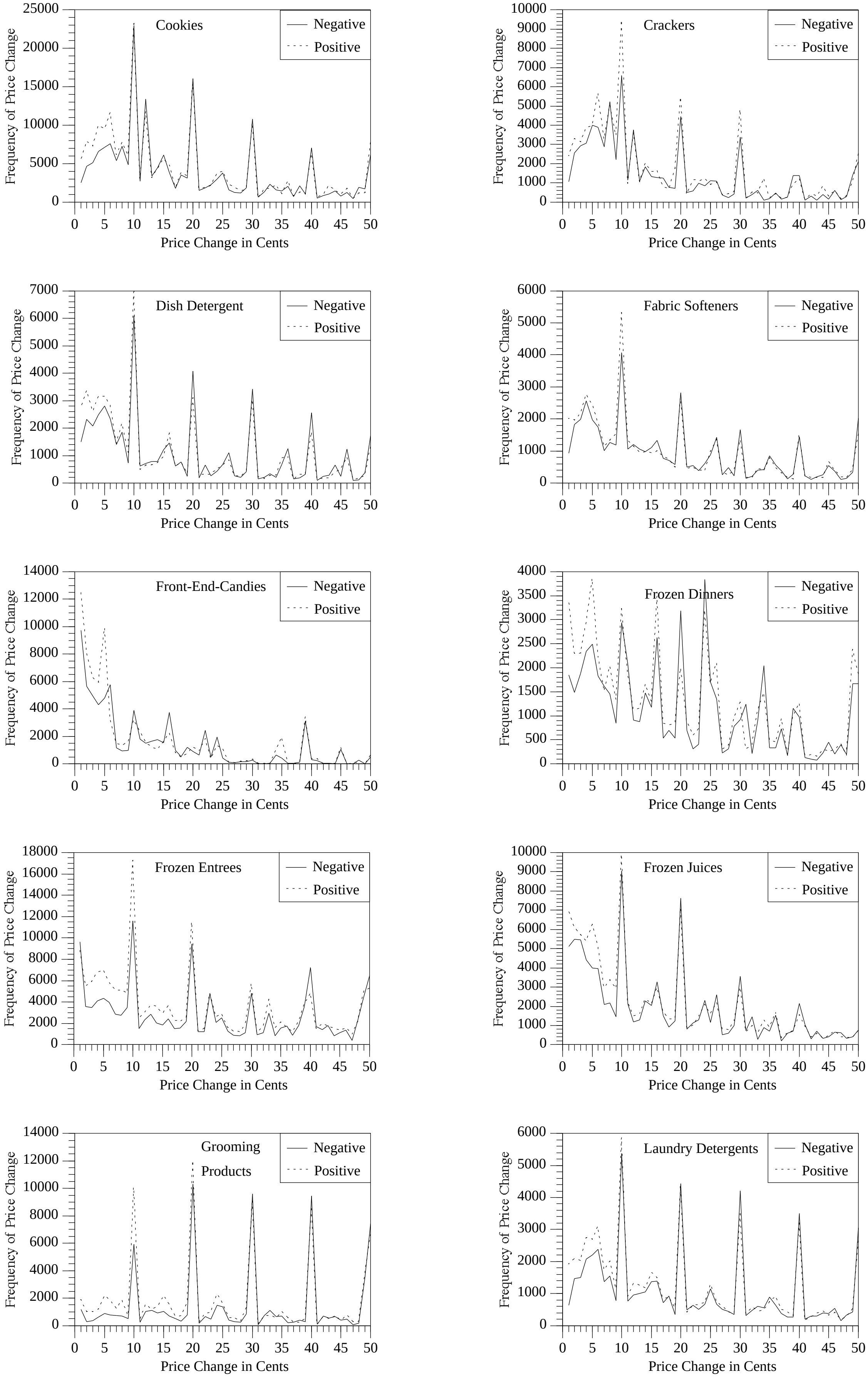

Figure R2.1b. Frequency of Positive and Negative Retail Price Changes in Cents by Category, Deflation Period

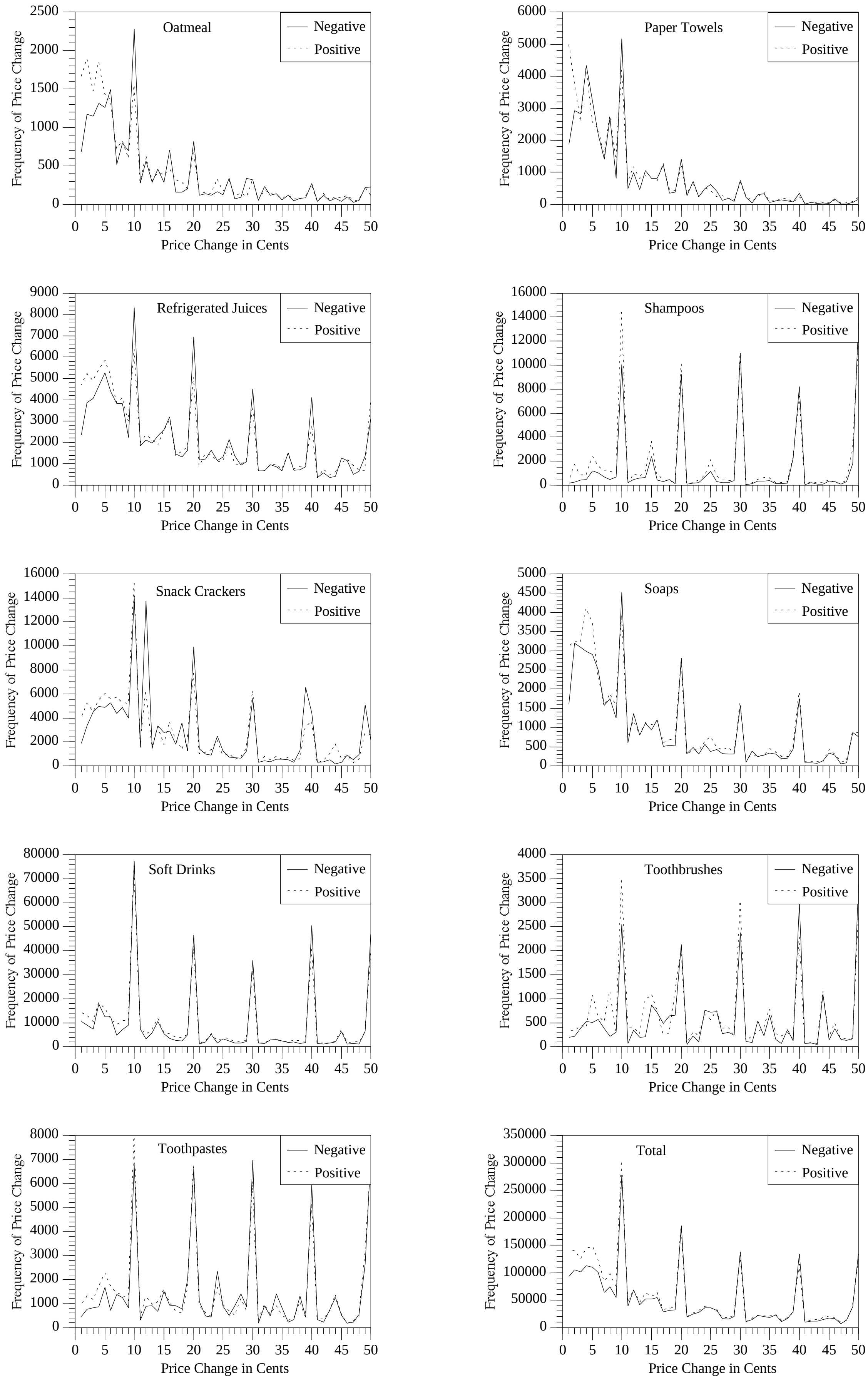

Figure R2.1c. Frequency of Positive and Negative Retail Price Changes in Cents by Category, Deflation Period