

Sales, Quantity Surcharge, and Consumer Inattention*

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Abstract

Quantity surcharges occur when firms market a product in two sizes and offer a promotion on the small size: the large size then costs more per unit than the small one. Quantity surcharges occur often and when they do, the sales of the large size decrease only slightly despite the fact that the small size is a cheaper option – a clear arbitrage opportunity. Moreover, consumers do not substitute from the small to the large pack when the latter is promoted. We label these the promotion substitution anomalies. This behavior is consistent with the notion of rationally inattentive consumers that has been developed in models of information frictions. We discuss implications for theories of firm pricing, notably nonlinear pricing and promotion theory, and for demand estimation.

Keywords: quantity surcharge, sales, promotions, consumer inattention, quantity discounts, nonlinear pricing.

JEL Classification: L12, L13, D4.

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1 Introduction

A key prediction of the textbook model of nonlinear pricing is that price per unit should be decreasing in quantity sold (Stole, 2007). Quantity discounts are indeed ubiquitous. Items sold in grocery stores are frequent used as examples of nonlinear pricing because most people are familiar with them. Grocery store items are also often used as examples of sales. Sales, or promotions, are sharp but temporary reductions in price that are designed to move large quantities of a product.¹ When a product is available in two (or more) sizes and retailers decide to promote the small size, its price per unit may drop below that of the large pack size. When this happens, we say that there is a *quantity surcharge*.² Price is a nonlinear function of size, but the relation is convex rather than concave, as in the textbook example of nonlinear pricing.³

We study demand responses to quantity surcharges in the context of the Dutch laundry detergent market. Although quantity surcharges are rare overall, they occur regularly during promotions. About one third of the sales in our sample generate a quantity surcharge. Since the small and large pack sizes contain the same physical product, a cost-minimizing consumer who cares only about the total amount of product purchased, should never buy the large pack size if she can get the same amount of product by buying multiple units of the small pack size. This is the case in our sample since the small pack is typically about half the size of the large one. Our study is the first one that we are aware of in the economic literature that studies the impact of promotions across different sizes of the product.

We find that consumers do not fully arbitrage during quantity surcharge periods. In the raw data, sales of the large pack size during a quantity surcharge decrease relative

¹The economic literature has predominantly used the term “sales” to refer to temporary price reductions. This might cause some confusion as the term is used to describe price reductions of a more general nature, such as clearance sales (it also has the meaning of “quantities sold”, which adds to the confusion). The term “promotion” conveys more accurately the temporary nature of the phenomenon. Throughout the paper we use the two terms interchangeably.

²The term has been used in the marketing literature, where studies of grocery pricing have shown that quantity surcharges occur for a small fraction of the products offered (Sprott, Manning, and Miyazaki, 2003; Abdulai, Kuhlitz, and Schmitz, 2009). There is no consensus on what explains quantity surcharges in this setting.

³Convex pricing in the form of increasing block pricing is often used to price resources such as water or electricity.

to the week preceding the surcharge by only 14% (in the median case). This result is robust to formal econometric testing where we control for other factors. If consumers would arbitrage, one would expect that demand should decrease by 100%. The absence of demand response is not due to an error in the reporting of the promotion period in our dataset. In fact, sales of the promoted product increase by a factor of ten relative to non-promotion periods, which is consistent with past studies of promotions (Pesendorfer, 2002; Hendel and Nevo, 2006b; Berck, Brown, Perloff, and Villas-Boas, 2008). One may argue that the small response occurs because the savings from arbitrage are small. This is not the case. The median saving from switching to the small size is 15 percent. This is about twice the median savings that can be obtained from buying the large pack at a quantity discount during regular periods. The failure of consumers to exploit blatant arbitrage opportunities constitutes our first anomaly.

We also look at demand substitution responses when the large pack is promoted. In that case, one cannot argue that all buyers of the small pack should switch to the large pack because the two options are not equivalent. But consumers buy laundry detergent regularly and they could anticipate their next purchase. Because the price decrease during promotions is substantial, standard theory (with or without storage) implies that one would expect a decrease in the sales of the small pack when the large pack is promoted. Marginal consumers, who are indifferent between the small and the large pack during regular periods, should substitute to the large pack during promotions. Yet our estimated response is very small and statistically insignificant. The finding of zero substitution when the large size is promoted is our second anomaly.

What is striking about the anomalies we document - particularly the first one - is that consumers select an option that is clearly dominated. It is very difficult to come up with a realistic explanation why they would *consciously* do so. Rather, it seems that this must be a result of consumers not checking prices systematically every time they go to the store, which leads to them missing out on some good deals. Such behavior is not necessarily irrational. A recent literature in macroeconomics and financial economics centers around the idea that consumers can not possibly keep track of all available information and have to allocate their attention to collecting and processing the information that would be most valuable to them. In these models, not paying attention to all prices at all time is fully rational because the costs of doing so outweigh the benefits. This behavior is labeled

“rational inattention”. Rational inattention may arise for several reasons. One notion that is relevant to our study is that of “sticky information”. In this context consumers only update their information (such as prices) periodically, leading to information being “sticky” during the time between updates. Our evidence is consistent with this notion; in fact, our study is unique in providing *direct* evidence of inattentive behavior. We pursue this explanation further in section 5.

Showing that consumers occasionally buy dominated options is of little interest if such events are rare and occur in random situations for arbitrary consumers. Our two substitution anomalies, however, suggest that this behavior is systematic. Let’s examine the former claim that our anomalies are evidence of inattention. The first anomaly shows that during quantity surcharge periods, the large pack continues to sell although this option is dominated by buying two small packs. The second anomaly shows that when the large pack is promoted, there is no substitution although this option should dominate the small pack for some consumers. Why is this evidence different from random inattention? Inattention systematically happens for the regular buyers of laundry detergent during promotion periods. But not all consumers are inattentive during promotion periods. The fact that promotions trigger large sales responses suggest that the consumers who respond to promotions do pay attention.

Two additional pieces of evidence further demonstrate that a particular segment of consumers is more prone to inattention and only in some specific circumstances. We distinguish consumer response for value brands (such as private labels) and premium brands. For value brands, the sales of the large pack decreases by a sizable 40 percent during quantity surcharges. For premium brands, there is no statistically significant decrease in sales. We conclude that buyers of value brands are more attentive to promotions than buyers of premium brands. This is consistent with the notion that buyers of value brands are relatively price sensitive and are therefore more likely to exploit arbitrage opportunities when those become available. We also find that quantity surcharge events are less frequent for value brands than for premium ones. We interpret this as evidence that firms are aware of the consumer tendencies we identify and offer their promotions in the types of product where cannibalization of their other products is least likely.

We also contrast the evidence on short term substitution (response to temporary price

decreases) with evidence on substitution in response to permanent changes in price. We find that consumers do substitute in response to permanent price changes, both for value and for premium brands. This additional evidence suggests that inattention is a short run phenomenon. Consumers are inattentive to temporary price changes but respond to permanent ones.

These additional pieces of evidence further establish our claim that inattention cannot be ignored for some consumer segments (the consumers who buy during regular periods) during specific circumstances (promotion periods). We argue that ignoring consumer inattention in the grocery market, an application that has received much attention in both economics and marketing, could have important consequences for demand estimation and also for our understanding theories of firm pricing (non-linear pricing and promotion theory).

The rest of this paper is organized as follows. The next section presents our case study and data. We then show our main evidence on the absence of arbitrage during quantity surcharge periods followed by evidence on substitution to permanent changes in price. The final sections discuss our results and conclude.

2 Industry, data, and quantity surcharge

Our analysis is based on a unique dataset from the laundry detergents market in the Netherlands. We focus on Albert Heijn which is generally recognized as the market leader.⁴ Albert Heijn has about 750 stores and a 27% market share. The data cover a period of 120 weeks from September 2002 to December 2004 and include every pack of every brand sold by Albert Heijn. Our results are not based on some idiosyncratic subset of products, but comprises the vast majority of the laundry detergents sold in the Netherlands. We observe 90 pack sizes for 43 products that belong to 12 different brands, and for each pack size, we observe the total quantity sold and the sales-weighted average price.

⁴The market description is primarily based on “The Netherlands: An overview of food retailing,” *Food International*, April 7, 2008. Available at <http://tinyurl.com/c8u9uz> [accessed April 27, 2009].

There are three main multinationals manufacturers in our sample, as well as a store label that has a significant presence.⁵ Each of the four manufacturers promotes several brand names and each brand name is carried by several products. Each product is typically offered in one or two pack sizes (containing the same physical product), respectively 45% and 54% of the times, and very rarely in three sizes.

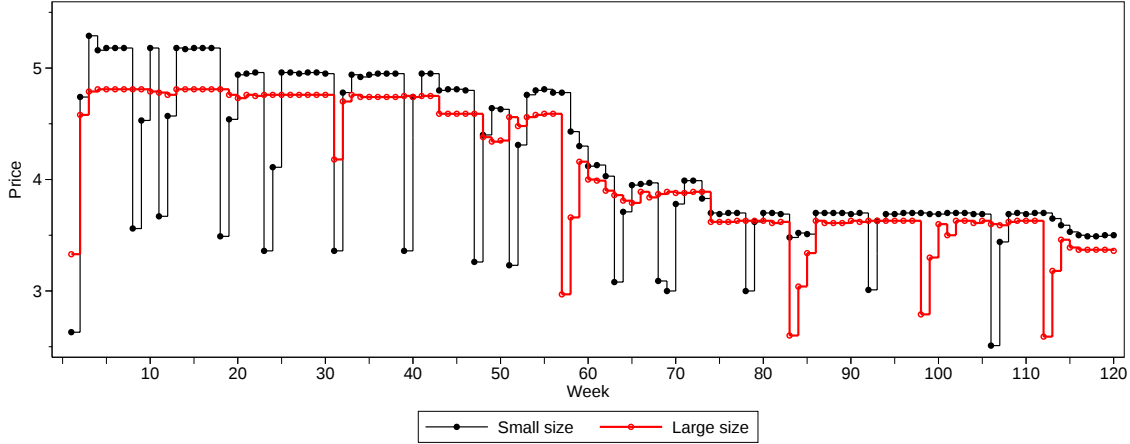


Figure 1: Price paths for a selected product line

Figure 1 illustrate the source of price variations we will use to compute our demand substitution estimates. It plots the temporal evolution of price for a selected product sold in the same two sizes every week throughout the period. Promotions are easy to identify in this plot as large and temporary downward deviations from the regular price. In each promotion the price drops sharply for a week, partially recovers in the following week and returns to its original level the week after that. Thus promotions last for between one and two weeks. In the first week all units are sold at the discounted price while in the second week some units are sold at the discounted price and others at the regular price, leading to a sales-weighted price lying somewhere between the two.

The price-per-unit of the small pack is usually higher than the price-per-unit of the large pack. This corresponds to quantity discounts, a practice that has been explained in the context on grocery products by nonlinear pricing theory (Cohen, 2008; Allenby, Shively, Yang, and Garratt, 2004; Iyengar and Gupta, 2009). When the small pack is promoted, however, the price order is reversed: the price per unit is lower for the small

⁵Another manufacturer with a very small market share is not considered in the analysis.

pack. When this happens, we say that there is a quantity surcharge. It is important to note that quantity surcharge always happens when the small pack is promoted and that the price differential between the small and large pack can be substantial (of the order of 20 to 40%).

Figure 1 displays two other features we will leverage in the analysis. First, note that the large pack size is also occasionally promoted and the price difference between the large and small pack increases substantially when this happens. We will use these events to compare demand substitution responses when the small and the large packs are promoted. Second, there are also some permanent changes in the level of prices and in the relative prices. Most strikingly, the price series feature a notable structural break around week 60. At that time (November 2003) the Albert Heijn chain initiated an aggressive pricing strategy and sharply cut prices on a large number of products. It is obvious from the plot that laundry detergents were among those products; the mean price of each pack was about 22% lower in the second sub-period than it was in the first. The price differential between the two packs also changed, with the discount from buying the large pack being lower in the second sub-period. We will leverage this event, as well as other non-promotional price variation, to compute demand substitution across pack sizes in response to permanent price changes.

In order to proceed with our analysis we need to provide an operational definition of what constitutes a promotion. In the spirit of existing literature, we identify a promotion as a temporary decrease in price of at least 10%.⁶ In practice this is implemented by looking at a six-week window around any given price. If the price in the current period is at least 10% lower than the modal price during the six-week window, then the current period is labeled as a promotion period. Promotions lasting more than one week are counted as one event. The use of the six-week window to define promotions means that we cannot identify promotions in the first and last three weeks of the sample, leaving us with 114 weeks of data.

This procedure identifies 390 promotions, the properties of which are summarized in Table 1. In the rest of this paper, we call the weeks without a promotion the regular periods for that pack and the buyers who buy that pack in these weeks the regular

⁶Some authors use a 5% threshold. We prefer to be more conservative on what constitutes a promotion.

Table 1: Descriptive statistics on promotions

	Total proms	Promotions per item			% time on prom.		% prom. discount	
		Mean	Median	Max.	Mean	Median	Mean	Median
Firm 1	152	5.4	4	14	6.9	5.4	26.5	28.9
Firm 2	105	7.4	8	12	7.3	7.0	28.2	30.3
Firm 3	101	5.0	4	11	6.5	7.3	25.6	27.8
Firm 4	32	3.6	4	7	5.1	3.9	25.9	27.7
Overall	390	5.6	5	14	6.7	5.9	26.7	29.1

Table 2: Quantity surcharge and promotions

	Periods with no promotions	Periods with promotions	All periods
Quantity discount	1,447	75	1,522
Quantity surcharge	122	114	236
Total	1,560	189	1,758
% of time with quantity discount	92.2%	39.7%	86.6%

Note: this table considers only products coming in two or more sizes.

buyers. Firm 1 does the most promotions (152), but it also has the most products. Firm 2 is actually the most frequent promoter in relative terms as it averages 7.4 promotions per item and its products are on promotion 7.3% of the time on average. Firm 4 (the private label) is the least frequent promoter. The depth of promotional discounts is in the range 25-30% and is very similar across firms. These price patterns are consistent with those reported elsewhere (Hosken and Reiffen, 2004, among others).

Out of the 390 promotions we identify, 177 involve single-item product lines. Of the remaining 213 instances, the large size is promoted 82 times and the small size 131 times. The frequency of quantity surcharges is summarized in Table 2. The pricing schedule displays quantity discounts 92.2% of the time during periods without promotions, which is broadly consistent with nonlinear pricing theory. In promotion periods, this percentage drops to 39.7%. This is quite striking, and it demonstrates that quantity surcharges occur frequently when a promotion takes place.

The large discounts on offer during promotion periods suggest that there is substantial incentive to substitute. When the small pack is promoted, for example, the median surcharge for the large pack is 29.2%. In absolute terms, this corresponds to a median saving of €0.83 per kilogram. The savings exceed one euro per kilogram in 45% of promotion events. Quantity surcharges occurring during non-promotion periods are substantially smaller, with a median of 5.3% or €0.22 per kilogram. Because quantity surcharges outside promotions are smaller and less frequent, we do consider them further and focus on demand response during promotion-induced quantity surcharges only.

Promotions of the large size also provide opportunities for substantial savings. The price of the large size decreases by 27.8% during the median promotion. In contrast, the median quantity discount during non-promotion periods for the large pack is only 6.7%. Promotions of the large pack increase the quantity discount to 28.1%.⁷ The savings obtained from buying the large size increase substantially during promotions.

To illustrate our main substitution anomalies, consider the 114 quantity surcharge events that are caused by a promotion. The sales of the large pack decrease by only 14.4% (for the median case) during the week of the surcharge relative to the preceding week. If consumers would arbitrage (choose the least costly combination of pack sizes to acquire a given amount) one would expect a decrease in sales of 100 percent. By comparison, the 14.4% figure seems surprisingly small.

3 Substitution during promotions

In this section we use regression analysis to formally test whether consumers fail to substitute during promotion periods. We follow a reduced-form approach that links the quantity sold of a particular pack to whether there is currently a promotion of either the pack itself or other packs of the same product.

We test two substitution hypotheses. Quantity surcharges present a clear arbitrage opportunity: consumers can save by purchasing the same quantity in two small containers

⁷The 28.1 figure may seem small and this is due to the fact that there is variability around the different medians. If there were no variability around the medians, the quantity discount during promotion should increase by $1 - (1 - 0.278)(1 - 0.067)$ which gives the higher figure of 32.6%.

than in one larger one. According to rational choice, all consumers should substitute to the small size during a quantity surcharge. This is an extreme prediction. One may argue that for some consumers two small packs are not identical to a large back because they are used to certain feel, handling experience, or storage space constraint (two small sizes may take more space than a large one).⁸ Most people would argue that this is a weak argument and would be surprised not to observe an outcome close to full substitution under rational behavior. An empirical issue of interest is what fraction of consumers fail to take advantage of arbitrage opportunities.

When the large pack is promoted, one may not necessarily expect consumers of the small pack to substitute. Partial substitution could be explained by rapidly diminishing marginal utility, but this is not a convincing explanation for a product that is consumed on a continuous basis. An explanation with more bite is the existence of storage costs. Individuals with low consumption would have to store a large container for a long period of time and may be unwilling to incur that cost in order to save a euro. It is not clear how much substitution should take place but one would expect *some* substitution in response to the large decrease in price. A conservative hypothesis is that the sales of the small size should decrease when the large size is promoted.

3.1 Evidence

The following specification allows us to test our hypotheses:

$$\begin{aligned}
\ln(q_{it}) = & \alpha_i + \theta_{bt} + \beta_1 \cdot \text{BothPromLarge}_{it} + \beta_2 \cdot \text{BothPromSmall}_{it} \\
& + \beta_3 \cdot \text{OwnPromSolo}_{it} + \beta_4 \cdot \text{OwnPromLarge}_{it} + \beta_5 \cdot \text{OwnPromSmall}_{it} \\
& + \beta_6 \cdot \text{CompPromSmaller}_{it} + \beta_7 \cdot \text{CompPromLarger}_{it} + \beta_8 \cdot \text{AfterProm}_{it} + \varepsilon_{it},
\end{aligned} \tag{1}$$

where q_{it} denotes the quantity sold of pack i at time t . Our sample includes cases where both sizes are promoted at the same time. The impact of simultaneous promotions is captured by the *BothProm** variables and is allowed to vary by size. The impact of an own promotion is captured by the variables *OwnProm** and is allowed to vary depending

⁸On the other hand, two small sizes provide more storage flexibility than one large one.

on whether the item is the only one in the product line (*Solo*) or whether it is the large size or the small size. The impact of a promotion of the competing size is captured by the *CompProm* variables and is allowed to vary according to whether the size being promoted is larger or smaller. The specification includes a pack fixed effect α_i that controls for the selection rule determining which products are promoted. If more popular products were more likely to be promoted, for example, the omission of such controls would lead to over-estimating the impact of promotion on sales. Finally, the *AfterProm* variable is a dummy for periods immediately following a promotion and it is included as a control variable for promotions lasting for more than a week.⁹

Endogeneity of the promotion variables is typically a cause for concern in specifications similar to ours. This would be an issue, for example, if promotions were offered in response to demand shocks. But it is hard to imagine why product-specific demand shocks would occur every few weeks. Another possibility is that promotions are offered to boost sales of products losing market share. Again, this is not borne out either in the sales data or in the observed promotion patterns. The most plausible explanation for the timing of promotions and the choice of item to be promoted is probably that provided by Hosken and Reiffen (2007), who argue that promotions are part of retailers' efforts to attract customers into the store and have little to do with the particular product that is being promoted.

A limitation of our data is that we do not have any information on advertising or other non-price related marketing campaigns. This could affect our results in the following way. Suppose a promotional discount on a particular item is accompanied by an advertising campaign that promotes the brand in general. The discounted item will benefit from both of those practices. For non-discounted items belonging to the promoted brand, there will be opposing effects: a positive impact due to the advertising campaign and a negative impact as consumers switch to the discounted item. If the first effect dominates, then a specification that does not fully account for the campaign will attribute the gain in sales of the non-discounted item to the discount, leading us to erroneously infer that the discount has a positive effect on the competing, non-discounted items.¹⁰

⁹As a robustness check we also estimated the model excluding all observations for which *AfterProm* = 1. There was no difference in the coefficients of interest.

¹⁰It will also overestimate the impact of own promotion, though we are less interested in that.

Table 3: Impact of sales

Promotion of large when both promoted (β_1)	0.616** (0.117)	0.454** (0.117)
Promotion of small when both promoted (β_2)	2.605** (0.118)	2.175** (0.117)
Own promotion when no other size exists (β_3)	2.385** (0.046)	2.102** (0.151)
Own promotion of large size (β_4)	1.368** (0.089)	1.385** (0.085)
Own promotion of small size (β_5)	2.434** (0.062)	2.340** (0.059)
Promotion of smaller alternative (β_6)	-0.114 [†] (0.062)	-0.184** (0.059)
Promotion of larger alternative (β_7)	-0.024 (0.085)	-0.045 (0.082)
Brand-week fixed effects included	NO	YES
Obs.	5,726	5,726
F-stat	609.69	16.14

Estimates from fixed effect estimation at the individual item level.

We do not report the constant term and the coefficient on the *AfterProm* variable. Significance levels: [†] : 10%, * : 5%, ** : 1%.

We can partially control for this possibility by including brand-week fixed effects θ_{bt} . Recall that there are 14 different brands and 220 packs in our sample. We get identification from the fact that different packs of the same brand are promoted in different weeks. Thus we control for marketing and advertising campaigns or other interventions that affect a specific brand in a particular period. On the other hand, we can not control for product-specific marketing campaigns. Our results are then valid to the extent that most advertising campaigns are at the brand level rather than at the product level.

Estimates from equation (1) with and without brand-week fixed effects are reported in Table 3. We first note that adding the fixed effects causes the coefficients on own promotion to fall (except one of them which increases slightly) and the coefficients on a competing promotion to rise (in absolute terms). This is consistent with the argument above and confirms that brand-week fixed effects are effective in soaking up promotional

activity at the brand level. Our discussion of the results will therefore focus on the coefficients in the last column.

The first two variables capture the effect of promotions when both sizes are promoted. Those are included primarily as control variables and the estimated coefficients are not of interest. The next three variables capture the impact of a single promotion on own sales for solo, large and small items respectively. A large impact is estimated in all three cases. Sales of promoted items multiply by factors of 4 (large size) to 10 (small size). These magnitudes are broadly consistent with past studies of promotion Pesendorfer (2002); Hendel and Nevo (2006b) and give support to our data and empirical specification.

The last two coefficients test our main hypotheses. The impact of a promotion of the small size on sales of the large size is estimated at -0.184, corresponding to a 16.8% drop in sales. This is higher than the 14.4% that comes out of the raw data but still surprising low. Under perfect arbitrage, sales would drop by 100%. Yet the large container only loses 16.8% of its sales relative to periods when it does not face competition by a promoted smaller size. The limited degree of substitution in the presence of clear arbitrage opportunities rejects our first hypothesis. This is a puzzle because a fully rational consumer who is informed about prices should always make the cost minimizing choice.

The last coefficient tests our second substitution hypothesis. We would expect some substitution when a promotion of the large pack takes place. The second hypothesis states that a promotion of the large size should have a negative impact on sales of the small size. The last coefficient in Table 3 is indeed negative but small at -0.045 and statistically insignificant. This seems surprising given the substantial savings made possible by a promotion of the large size.¹¹

It seems clear that some consumers buy dominated options during promotion periods. They do not take advantage of the promoted product. The substantial responses to promotion makes it equally clear that other consumers do. This behavior is consistent with the idea that some consumers check prices more regularly and spot short term changes in prices.

¹¹The main results do not change when we include coarser controls or in specifications with only item fixed effects and a time trend variable or with week fixed-effects instead.

Table 4: Impact of sales by product type

	Premium brands	Value brands
Own promotion when no other size exists	2.235** (0.057)	1.749** (0.137)
Own promotion of large size	1.419** (0.085)	0.512** (0.106)
Own promotion of small size	2.432** (0.061)	2.066** (0.097)
Promotion of larger alternative	-0.045 (0.108)	-0.145 (0.121)
Promotion of smaller alternative	-0.076 (0.070)	-0.504** (0.105)
Obs.	3,742	1,984
F-stat	17.50	8.89

Item and brand-week fixed effects are included.

Significance levels: † : 10%, * : 5%, ** : 1%.

3.2 Branded versus value products

Is the trait of consumer inattention correlated with other consumer characteristic? In the absence of consumer level data, it is difficult to make definite progress on the issue. We can, however, investigate whether consumer inattention depends on the type of product. An important distinction in the context of groceries is between branded products and value products (private labels). We can indirectly investigate whether inattention is related to consumer characteristics because price sensitive consumers are more likely to buy “value” brands such as store labels rather than the premium brands sold by the big multinationals. This raises the question: Are buyers of value labels more likely to identify and exploit arbitrage opportunities than buyers of premium brands?

Our data allows us to test this hypothesis. We split the brands in our sample into value brands and premium brands and estimated separate responses to sales for each group.¹² The results are presented in Table 4. The impact of own promotion is greater for premium brands across the board and the difference is statistically significant at the 1% level. It

¹²Value labels are the store label plus Henkel’s Witte Reus and Unilever’s Sunil. The latter two brands sell at a substantial discount relative to other brands sold by the three multinationals.

could be that promotions of premium brands are more likely to induce switching from consumers who would otherwise buy a different product.

But it is the four coefficient estimates on the two bottom lines that are of primary interest to us. Comparing the two coefficients for the value brands with those for the premium brands, we note that the impact of a promotion on the competing size is much greater for value brands than it is for premium brands; the two coefficients on the right column are several orders of magnitude greater than those on the left column. The difference is statistically significant at the 1% level in the case of promotions of the small size. A promotion of the small size of value brands leads to a 40% ($\approx \exp\{0.504\} - 1$) decrease in the sales of large sizes. For premium brands, however, there is no significant change in sales. Interestingly, all the substitution that takes place during quantity surcharge is done by buyers of value brands.

These estimates lend support to the hypothesis that consumers who are more price sensitive are also more attentive and more likely to switch across brands and sizes. This finding further supports the conjecture that there is heterogeneity in inattention across consumers.

The evidence is consistent with the following interpretation. Attentive consumers purchase value brands and take advantage of promotions while inattentive ones have strong brand preferences and do not check prices often. Sales of value brands and sales of promoted items add up to roughly half the total sales in our sample. Assuming that those items are purchased primarily by attentive consumers, we can take this as a rough estimate of the relative size of the two consumer segments.

3.3 Is this a data artifact?

We rule out three obvious explanations for the substitution anomalies. One possibility is that consumers cannot substitute because retailers run out of stock and the promoted size is not always available. This would lead to lower substitution than under unlimited supply.¹³ But this is inconsistent with the fact that we do find very large increase in

¹³In fact, in extreme cases this could even lead to reverse substitution. Suppose that consumers substitute during the first half of the week, until the product stocks out. For the rest of the week, buyers

sales of the promoted product, similar or larger to existing estimates in the literature. As a further robustness check against the possibility of stockouts, we measured substitution during the first week of promotions that last two weeks. Stocking out cannot be an issue in the first week because the promotion carries on to the second week. When we restrict the analysis to these observations we are left with 121 promotions. The results do not change. We find large promotion responses and no substitution responses. We therefore rule out stocking out as a candidate explanation.

A second explanation relates to the fact that our data are aggregated to the chain level. This allows for the possibility that the promoted pack sizes are available only in stores that do not offer the other pack sizes. Consumers would not be able to substitute within-store because the competing pack size is not available. This could happen either because not all stores carry all products or because promotions are not offered in all stores. Without information at the store level, we cannot directly rule out this possibility. We conducted a phone survey of store managers to investigate this issue. We asked managers whether promotions can be limited to some stores and all responded that promotions are always chain-wide. We can thus rule out the possibility that promotions are offered only in some stores. We also asked whether all stores carry the same sizes. We were not able to get the responses we were looking for as managers were not familiar with what other stores are carrying. Our conclusion is that (almost) all stores carry the small sizes but some of the smaller stores may not carry the larger sizes. This would lead to us underestimate the impact of a promotion of the small size but it can not explain a zero impact. As long as both products are available in *some* stores, we should still observe an impact. The fact that we do observe substitution for value products also suggests that both sizes are available.

A final explanation could be that promoted products could be placed in different locations within each store. They might still be available in each store but consumers may not be able to easily make unit pricing comparisons because the two packs of the same products are rarely located nearby. We have also addressed this issue in our survey of store managers. All managers responded that promoted items may be placed at the end of the aisle but they are usually left in the regular location. Hence promoted items

have no choice but to buy non-promoted size. If the reverse substitution in the second half of the week exceeds substitution in the first half then we would observe the opposite impact of what we would expect

would be easily seen by consumers.¹⁴

Based on this additional evidence, we conclude that some consumers are oblivious to promotion prices. They end up buying dominated options during promotion periods. We could not find any obvious explanation for why a large fraction of consumers fail to switch pack size during promotions.

4 Response to permanent price changes

Consumer inattention is by definition a short-run phenomenon. Consumers who do not check prices every time they go to a store might miss out on some good deals that are offered for short periods of time. An implication of inattention is that substitution across pack sizes should increase as consumer become aware of price changes. For example, if a promotion lasts several weeks one would expect that more and more of the consumers who buy premium brands would gradually become aware of it and progressively change their purchasing behavior. This hypothesis would be testable if promotions of varying lengths were observed in the data. Unfortunately this is not the case, as the promotions in our sample typically run for just one week and rarely for more than two.

We formulate an alternative hypothesis that can be tested using the data at our disposal. If buyers of premium brands are not inattentive in the long-run, then we would expect to see substitution between sizes when relative prices change permanently. The extent of substitution that would be considered reasonable is of course hard to quantify, but certainly we would expect to see *some* substitution for premium brands. In order to test our hypothesis we leverage changes in the overall level of prices during our two-year period – notably the price war that took place in November 2003 – to estimate demand substitution responses to non-temporary changes in price. We exclude from our estimation sample all observations for which any size of the product is promoted during the same week. We are excluding ‘promotion observations’ because we want to focus on permanent price changes and price changes during promotions are not permanent.

¹⁴Even if it is the case the promoted items are located elsewhere, it is still a puzzle. Consumers who visit the store often should know that this is the case and look for them.

We estimate simple reduced-form demand functions by regressing sales on own price and on the price of the competing pack size (all in logarithms):

$$\ln(q_{it}) = \alpha_i + \theta_{bt} + \beta_1 \cdot \ln(p_{it}) + \beta_2 \cdot \ln(p'_{it}) + \varepsilon_{it}, \quad (2)$$

where p_{it} is own price of item i and p'_{it} is the price of the competing size.

There are two main differences between this analysis and the one presented in the previous section. We are now computing price elasticities using variations in prices over time, while Table 3 and 4 presented demand responses to promotion events (defined as temporary price decreases of 10% or more). The two types of demand response are estimated from two different sources of price variation in the data.¹⁵ As before, we include brand-week fixed effects that control for many sources of price variation that could be endogenous at the brand level (advertising, response to competitors, etc.). This greatly reduces the concern for endogeneity. We also note that much of our non-promotion price variation comes the price war initiated at around the midpoint of our sample, and which was an exogenous event.¹⁶

In order to be able to interpret the coefficients in equation (2) as responses to permanent price changes (long-term demand elasticities) we remove all observations where promotions take place. This ensures that the price variation we leverage is non-temporary.¹⁷ In order to have a basis of comparison, we also estimate the same specification with all data. In both cases, single-item products are necessarily excluded from the sample as there is no competing size.

The estimates are reported in Table 5. Looking first at estimates obtained using all data, we note that both own and cross price elasticities are quite high. They are also not very different between premium and value brands (even though differences are

¹⁵We note that the two analyses (Table 4 and 5) differ from the notion of short- and long-term response in the demand literature, which deals with responses to the *same* price change measured over two different horizons. See Bentzen and Engsted (1993) for an example of the latter.

¹⁶In fact the addition of brand-week fixed effects in this specification did not change estimates much. This is consistent with our explanation of what these effects capture.

¹⁷One reservation (that would also hold for the literature on long-term demand response) is that, even after eliminating the promotion periods, some of the price changes in our sample period do not have a permanent component. This is not a concern in our sample as we find that the results are robust when we use solely the price variation created by the price war (use the median demand and price in the pre and post price war).

Table 5: Estimates of simple demand functions

	All data		Non-promotion data	
	Premium	Value	Premium	Value
Own price	-4.037** (0.503)	-4.240** (0.303)	-1.600* (0.643)	-3.276** (0.609)
Price of competing size	1.797** (0.446)	2.168** (0.336)	0.924* (0.446)	2.137** (0.533)
Obs.	2,994		2,447	

Item and brand-week fixed effects are included. Robust standard errors are reported. Significance levels: † : 10%, * : 5%, ** : 1%.

statistically significant). When we remove promotion observations from the data, the picture is quite different. Estimated elasticities are smaller and more in line with what is considered normal for this type of product. Demand for value brands is more elastic than demand for branded products. Both own and for cross price elasticities are higher for value brands and the differences are significant at the one percent level. This is consistent with the interpretation that buyers of value products are more price sensitive than buyer of premium brands.

We also observe that the estimated demand elasticities for value brands are roughly equivalent to the substitution responses reported in Table 4. Consider the case of the small product (whose estimate of substitution response is significant in Table 4). The cross-price elasticity in Table 5 is about .93. In the case of promotion responses, we find a response of 40% in Table 4 for a 29% price decrease on average, giving an elasticity of roughly 1.38. Demand for value brands is therefore more responsive to temporary than to permanent price changes. This further demonstrates that buyers of value and branded products behave very differently in response to promotions and to permanent price changes. Buyers of value brands pay less per unit of laundry detergent, are more price sensitive, are more likely to substitute during promotion periods, and are more likely to substitute in response to permanent price changes. Consumer inattention is correlated with price sensitivity and willingness to substitute.

The key finding in Table 5 is that buyers of premium brands do respond to relative price changes over the long-run. We can therefore reject the hypothesis that the demand

for branded products does not depend on the price of other packs.¹⁸ It is possible that some consumers are inattentive in the long-run, but we reject the hypothesis of inattention at the aggregate level. Buyers of the branded products are inattentive to changes in prices during promotions but they do respond to change in prices that are more permanent. This suggests that inattention is a short term phenomenon.

5 Discussion

Some consumers are inattentive during promotion periods: they do not substitute in response to large price reductions. In the case of quantity surcharge, the striking feature of our evidence is that there is no obvious barrier to arbitrage. In addition, we reject the hypothesis that consumers are inattentive to long term price changes. Consumer inattention is inconsistent with the paradigm that consumers are fully informed and make rational choice. What could explain why consumers are inattentive? What are the implications?

5.1 Rational inattention?

A useful notion that has been proposed in the macroeconomic literature is that of sticky information.¹⁹ The idea is that information is costly to acquire, absorb, and process and economic agents only go through that process periodically. In these models, the consumer has to pay a cost each time she wants to update consumption plans (Reis, 2006) or faces a constraint on how much information she can use to make forecast (Sims, 2003). As a result, the consumer sometimes makes choices that are sub-optimal relative to the choice she would have made with (costless) full-information. The literature has labeled these consumers as “rationally inattentive”.²⁰

¹⁸The results are robust to decomposition by pack size as in Table 4. The estimated coefficients do not change although they become insignificant at conventional levels for the small pack size.

¹⁹Sims (1998, 2003) is usually credited with starting this literature. More recent work includes Reis (2006), Mackowiak and Wiederholt (2009) and Mondria (forthcoming).

²⁰Alternatively, it could also be that some consumers only look at products of a given pack size. For example, Piccione and Spiegler (2009) have argued that consumers may follow procedural rules to decide what product to purchase. They first choose a pack size and then select a product of that size. Lack of arbitrage is consistent with such decision rules. According to that explanation, however, consumers would have to sometimes change procedural rules to accommodate the fact that substitution takes place

Our evidence on lack of substitution during promotion can be interpreted in light of the concept of costly information. A literal interpretation would say that the consumer optimization problem includes many products and it is costly to check all options at the store. As a result, some consumers may decide (rationally) to not compare prices each time they visit a store. The consumers who do not systematically compare prices may end up purchasing dominated options. The concept of costly information can be made somewhat more concrete in our application. The consumer does not have to check many prices to take advantage of promotion opportunities. For example, consumers could follow simple rules such as ‘*buy the cheapest per-unit pack of product X*’. Consumers who would adopt such rules would do better than the consumers in our sample. Unit price comparison was possible in our application because information on unit pricing was posted together with the product’s price.²¹

Why would it be rational for consumers to not make simple unit price comparisons? After all, the cost of visually scanning the supermarket aisle for possible promotions seems quite small and the savings of roughly one euro are not negligible. This, however, is not the correct comparison. The potential savings have to be adjusted by the probability that an item will actually be on promotion on the particular day. If that probability is, say, 10%, then the expected savings from looking for promotions is only 10 cents. An alternative way to think of this issue is to consider a consumer who prepares a shopping list for a trip to her grocery store. The consumer knows that some items on her list will be on promotion but she does not know which ones.²² She can either go through the retailer’s advertising leaflet in order to identify the weekly promotions or she can look for them once she gets to the store. Either way, there is a cost involved with identifying promotions which may easily exceed with the potential benefit from identifying the two or three promotions that are of interest to her. There is some empirical evidence that consumers do not compare unit price information. Lennard, Mitchell, and McGoldrick (2003) find that only half of the consumers use unit pricing as an information source to find the best option. The other consumers find that the information is too complicated

in the long run.

²¹The European Parliament and the European Council (1998) established directive 98/6/EC on consumer protection, compelling stores to display unit prices in an unambiguous, easily identifiable, and clearly legible way.

²²The idea that only a small number of different products are promoted at the same time is consistent with the theoretical model by Hosken and Reiffen (2007).

to use or report that they do not have the time to compare prices.

The concept of inattention is related to Chetty, Looney, and Kroft (2009) who demonstrate that posting tax-inclusive price tags reduce demand. Consumers do take into account the price tag of the items they purchase and do correctly report the tax rate. Consumers under-reaction to taxes that are not salient (not posted on the price tag) implies that they do not process the information on the price tag in a fully rational way. This is not inconsistent with our evidence. We show that consumers do not make unit price comparisons for identical products. Both studies show that consumer purchasing behavior violates not only the full-information rational choice model but also simple and intuitive heuristics.

The large increase in sales during promotions shows that some consumers do check weekly prices. In addition, we find some substitution for value products but none for branded ones. Clearly there is heterogeneity across consumers, perhaps in the value of time, information gathering costs, or degree of brand loyalty. If buyers of value brands have a lower cost of time, this would explain why they are more likely to make unit price comparisons. The important point is that any explanation for the substitution anomalies will have to address the issue of consumer heterogeneity.

5.2 Implications

Some consumers are inattentive to sales. But not all consumers are equally inattentive. These two stylized facts are inconsistent with most models of consumer decision making that have been used to explain firm pricing (nonlinear pricing or promotion) and to estimate consumer demand for grocery products. These models are based on assumptions that do not correctly capture consumer responses to short and long term price changes. This can have important consequences. For the sake of conciseness, we only highlight a few key points that demonstrate the relevance of the anomalies.

A casual observer may argue that the evidence of quantity surcharge during promotion periods is a challenge to nonlinear pricing theory. The main explanation for quantity discounts is price discrimination (Stole, 2007; Maskin and Riley, 1984)).²³ But this is not

²³Both the economic and marketing literatures have applied the theory of nonlinear pricing to consumer

the case once one accounts for the fact that regular consumers do not respond to promotion opportunities. The assumption at the heart of nonlinear pricing theory, that the buyers of the large pack would substitute to the low pack in the event of quantity surcharge does not hold for short term price decreases. Firms violate the concavity of their product lines for short periods of time in a promotion, but there is little cost doing so.²⁴ Everything else equal, firms will promote less often products for which there is more substitution. Interestingly, value brands, for which there is more substitution, are promoted less often than premium brands. This indicates that firms internalize the fact that promotions can come at the cost of losing sales from competing packs—the cannibalization effect.

Our findings also have implications for the specification of discrete choice models used to estimate demand in the context of nonlinear pricing (Cohen, 2008; Thomas, 2009) or consumer inventory (Hendel and Nevo, 2006a,b). Current models typically assume that consumers know all prices, and most importantly, that they purchase the item with the lowest price. This is inconsistent with the finding that some consumers do not always buy the cheapest option while other consumers take advantage of promotions. Not accounting for consumer short-term inattention, and not acknowledging that inattention varies across consumers, would over-estimate short-run demand elasticities for those consumers who buy during regular periods.

There is another striking feature of demand responses that is difficult to explain with current demand models. Sales of the promoted pack increase by several orders of magnitude during a promotion while sales of the other pack do not change much. This implies large own price elasticities and zero cross price elasticity. In the long run, however, the patterns seem more consistent with standard demand models. Current models of demand for grocery products or incapable of explaining such differences. For example, own and cross price elasticities are linked by a single parameter in the logit model. But even more sophisticated models allowing for much richer patterns of substitution would have

packaged goods and most empirical studies use grocery data. McManus (2007) applies the theory of nonlinear pricing to the market for coffee drinks, Cohen (2008) to the paper towel market, and Allenby, Shively, Yang, and Garratt (2004) to the beer market. In a review of nonlinear pricing for the *Handbook of Pricing Research in Marketing*, Iyengar and Gupta (2009) quotes consumer package goods as one of the leading applications of nonlinear pricing.

²⁴Another implication is that one should be careful in the conduct of empirical analysis of nonlinear pricing and distinguish promotion and non-promotion periods. Our results suggest that the nonlinear price schedule should be computed using long term substitution responses.

a difficult time matching the observed patterns.

6 Summary and conclusions

We document four stylized facts from the Dutch grocery market for laundry detergent. (a) Most consumers continue to purchase the large pack during quantity surcharge periods despite the fact that it would be cheaper to purchase multiple units of the small pack size. (b) Substitution responses are small and insignificant when the large pack size is promoted. We label these first two stylized facts the promotion substitution anomalies. (c) The consumers who purchase private label products are more likely to substitute across pack sizes when promotions take place. (b) All consumers respond to permanent changes in relative prices of the small and large pack sizes.

The promotion substitution anomalies (first two stylized facts) imply that some of the regular buyers are inattentive in the sense that they buy a dominated option during promotion periods. The buyers of private label products are more attentive than the buyers of premium brands. We reject the hypothesis that consumers are inattentive to permanent price changes. Consumers in our application could eliminate the downside of inattention by following very simple shopping rules that require checking only two prices for each product they purchase. A plausible explanation for why some consumers do not make unit price comparisons each time they make a purchase is that there is a perceived cost of information acquisition and processing. Information complexity does not have to be great to generate significant deviations from the predictions of the standard rational model.

Consumers respond differently to temporary price decreases (promotions) and to permanent price changes. The traditional explanation for why long term responses are greater than short term ones is because of storage capacity, commitment, adjustment friction, or switching cost. Our evidence suggests that demand substitution may be small in the short run for entirely different reasons. There is no adjustment friction or switching cost in our application. The only friction that prevent consumers from switching is whether they process price information. The evidence suggest that they don't in the short run while they do in the long run.

We argue that the substitution anomalies are not mere curiosities. They are inconsistent with most models of consumer decision making that have been used in the context of grocery products to explain firm pricing practices (nonlinear pricing and sales) and to estimate consumer demand. Future research on consumer demand for groceries will have to allow for consumer inattention in general but also for substantial heterogeneity in inattention across consumers.

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