Informational Rigidities and the Stickiness of Temporary Sales

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We use unique price data to study how retailers react to underlying changes in costs. Temporary sales account for 95% of all price changes in our data. Simple models would, therefore, suggest that temporary sales also play a central role in how prices adjust to cost shocks. Yet, we show that, in response to a wholesale cost increase, retailers raise their prices entirely by raising the regular price. Sales actually respond temporarily in the *opposite* direction from regular prices, as though to conceal the price hike. In addition to our evidence on wholesale cost shocks, we also provide evidence that temporary sales fail to react to commodity cost shocks and changes in unemployment. We show that the institutional features of price-setting are consistent with these empirical findings: sales are "sticky plans," whose magnitude and timing is determined to a large degree with a long lead time—hence, despite generating a large number of price changes, they contribute little to the responsiveness of prices to cost shocks.

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JEL Classification: E30, L11, M30.

1. Introduction

The speed of price adjustment to aggregate shocks is a central determinant of the effects of demand shocks on output and in particular the effects of monetary and fiscal policy. In an influential study, Bils and Klenow (2004) showed that consumer prices adjust quite frequently. Subsequent empirical work has shown, however, that much of this price flexibility is due to temporary sales, which have vastly different empirical characteristics than "regular" price changes (Nakamura and Steinsson, 2008). An important question is to what extent price changes associated with temporary sales contribute to the adjustment of the aggregate price level to aggregate shocks.

A growing literature on sticky information points out that even if prices do change, they may fail to respond to recent economic shocks if the information set the price changes are contingent on is old (e.g., Mankiw and Reis, 2002; Burstein, 2005). In these cases, the prices may be flexible but follow "sticky plans" whereby pricing decisions are made only periodically. As we discuss later in the paper, the institutions of price-setting in the consumer packaged goods industry are such that the timing and magnitude of sales are determined by trade promotion budgets and schedules that are largely fixed at low frequencies.

Motivated by this institutional evidence, we investigate to what extent temporary sales appear to reflect "sticky plans" as opposed to playing an important role in how the retailer responds to cost shocks. Our main empirical exercise is to study how retailers respond to wholesale cost increases. In response to a wholesale cost increase, a retailer might: (1) raise the regular price, (2) decrease the frequency or size of sales, or both. If both regular prices and sales were equally flexible margins, one might expect that retailers would respond to an increase in marginal cost by both raising regular retail prices and reducing the frequency and size of temporary sales. Since temporary sales account for 95% of all price changes, one might think that sales would account for a large share of retail price adjustment to cost shocks.

Our findings contrast strongly with this view. In a substantial fraction of cases when the base wholesale price increases, the regular retail price responds quickly and completely. In the remaining cases, the regular retail price responds more incompletely and with some delay. In neither of these cases do we find any evidence of a decrease in the frequency or size of temporary sales. To the contrary, we find that retailers temporarily *increase* discounts when

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regular retail prices increase in response to a wholesale price increase — suggesting that retailers are trying to mask the associated regular price increase.

This finding may at first appear to be at odds with Eichenbaum et al. (2011) (henceforth, EJR). EJR use a measure of wholesale prices including trade deals and find that the vast majority of sales are associated with a change in wholesale prices. Does this imply that sales are, in fact, a key part of the response to wholesale price movements? Not necessarily. In the section of our paper on the institutions of sales, we show that sales are often "paid for" by trade deal budgets which the retailer is "spending down" when he holds a sale. Measured movements in wholesale prices associated with such trade deals are, thus, *not* in fact movements in the retailer's marginal cost (much like plane tickets purchased with points are not free). A key advantage of our dataset is that it allows us to distinguish explicitly between true changes in the retailer's marginal cost and this variation associated with trade deals. We focus only on the former in our empirical analysis and find that in response to increases in marginal costs, retailers do not reduce the frequency or size of sales.

We analyze this using an exceptionally detailed dataset on retail prices and wholesale prices from a large US retailer over the period 2006-2009. The data reflects the internal pricing database of the firm and explicitly identifies regular prices and temporary sale prices. This unique feature of our dataset avoids having to identify temporary sales using a "sale filter," as in the prior literature.

In addition to our analysis of wholesale cost increases, we also analyze how retail and wholesale prices respond to underlying manufacturing costs—specifically, the commodity cost run-up of 2007-2008—and to demand shocks associated with local unemployment shocks. While the frequency of regular price increases roughly quadrupled in response to the sharp commodity price increases in the middle part of our sample, we find no apparent response of sales. Furthermore, a one percentage point increase in the relative unemployment rate in a store leads to a significant decrease in regular retail prices, but there is no significant effect of the increase in unemployment on the frequency of temporary sales.

To help interpret and explain these findings, we analyze the institutions of pricing and trade promotions. We emphasize several institutional features of trade promotions. First, the timing of trade promotions is planned up to a year in advance as part of a "trade promotion

calendar." As a consequence, the timing of temporary retail sales follow "sticky plans."[1] Second, the retail price change is negotiated as part of the trade promotion and trade promotion funding is typically conditional on the temporary sale occurring at the time of the trade promotion. In other words, temporary sales are a part of a contingent contract with manufacturers. Third, temporary sales are typically "funded" out of finite trade deal budget. Since the retailer is "spending down" its finite trade deal budget when it puts item on sale, trade deals typically do not represent commensurate drops in the retailer's marginal cost.

In contrast, base wholesale price changes are announced by the wholesaler with shorter lead times before they come into effect. The retailer can decide whether or not to change the retail price – the retail price is not discussed as part of the wholesale price negotiations. Moreover, the change in the base wholesale price is not conditional on the retail price response. These features make changes in the base wholesale price far easier to interpret as changes in marginal cost.

Our paper is related to several recent papers that study the behavior of regular prices and sales. Eichenbaum et al. (2011), show that "price plans" consisting of a small set of prices are quite inertial and argue that this inertial behavior can be represented by the behavior of a "reference price." Coibon et al. (2013) argue that the frequency of temporary sales decreases when unemployment rates increase, yet the inflation rate for effective price paid by consumers decreases. They document consumer switching between retailers that reconciles these two seemingly contradictory facts. Chevalier and Kashyap (2011) consider the implications of temporary sales for price indexes. Klenow and Willis (2007) argue that the size of sale-related price changes is more responsive to inflation than the size of regular price changes. Hendel and Nevo (2011) estimate a micro-founded model in which temporary sales arise out of a motive to price discriminate between more and less price sensitive consumers. Chu and Nevo (2013) show that households had a higher propensity to buy on sale during the Great Recession.

Beyond these studies, a recent literature investigates other arguments, complementary to ours, for why it may be important to distinguish between regular prices and sales in measuring the flexibility of prices. Kehoe and Midrigan (2012) point out that even if temporary sales were

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[1] In a separate study, two of the authors were involved in manipulating the depth of temporary discounts on a sample of items. Even though they were merely varying the prices (and not which items were to be discounted), the lead time on making these decisions was almost four months. We discuss these issues in greater detail in Section 8.

completely responsive to movements in underlying costs, the temporary nature of sales implies that they contribute much less to the adjustment of the aggregate price level than regular price changes. Guimares and Sheedy (2011) develop a model in which temporary sales are strategic substitutes, implying that they tend to average out in the cross-section, and again limiting their impact on aggregate statistics.

The paper proceeds as follows. Section 2 describes the data. Section 3 presents summary statistics on price change. Section 4 presents our analysis of retail price movements in the days surrounding a base wholesale price change. Section 5 presents our evidence on price responses to the commodity cost run-up and relative unemployment rates. Section 6 discusses the institutions of manufacturer trade deals and retailer temporary sales, and the implications of the institutions for how to interpret wholesale cost series in standard datasets. Section 7 concludes.

2. Data

Our data come from a large retailer that sells products in the grocery, health and beauty, and general merchandise categories. It contains 195 weeks (15 quarters) of store transactions at a sample of 102 stores. The 195 weeks extend from the first quarter of 2006 through the end of the third quarter of 2009.[2]

For this sample, we have data on the number of units sold each week for each product at the Stock Keeping Unit (SKU) level at each store.[3] The dataset reports three price measures: (1) the Regular Retail Price, (2) the Retail Price that was actually paid (including any temporary sales), and (3) the Base Wholesale Price of the item.

A unique advantage of our data is the availability of the Regular Retail Price variable. Related data sets, such as the Dominick's data, track revenue but do not typically record the regular (or "shelf") price. As a consequence, syndicated data providers such as SymphonyIRI

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[2] The stores were selected as a control group for a pricing test conducted by the retailer and are considered representative of the retailer's stores. The stores are located in 14 Mid-West and East Coast states. Because they are in different "price zones," the Regular Retail Price and the Retail Price (including temporary sales) for an SKU in a given week is not always the same at all stores.

[3] We exclude private label items and "Direct Store Delivery" (DSD) categories (primarily alcohol, beverages and dairy). DSD categories and private label items have very different institutional features. We discuss the implications of excluding the direct store delivery (DSD) categories in Appendix A.

and Nielsen have created algorithms to impute the regular price from the observed average prices. Analogous sale filters have been adopted by academics (e.g., Nakamura and Steinsson, 2008; Chahrour, 2011, Kehoe and Midrigan, 2012). These imputation algorithms will, however, naturally introduce some noise into the regular price variable.

Differences between the Retail Price and the Regular Retail Price are attributable to temporary sales. The overwhelming majority of temporary sales are "advertised promotions" (88%). These are advertised in the store's weekly flyer. Seasonal markdowns account for 4% of temporary sales. Only 1% of temporary sales are due to clearance sales.

An important departure from previous studies is that we focus on a Wholesale Price measure that does not include discounts associated with trade promotions. In the late 1960's and early 1970's trade promotions could be interpreted as unanticipated cost shocks to a retailer. As we will explain in detail in Section 6, trade promotions are now planned events that are predictable well in advance as part of a joint manufacturer-retailer annual promotion planning cycle. The retail response to the trade promotion is also generally negotiated in advance. In contrast, changes in the Base Wholesale Price are events that are immediately reflected in the Base Wholesale Price measure (unlike datasets in which the wholesale price is an "average acquisition cost"). Moreover, these Base Wholesale Price changes are not conditional on a retail price response. As a result, Base Wholesale Price changes can be thought of as changes in marginal cost that the retailer decides whether (and how) to respond to.[4] We believe that the availability of this Base Wholesale Price measure is a key advantage of the data that we use in this paper.

As in other scanner price datasets, each of the price measures in our dataset represents a weighted average over all of that week's retail transactions for the item in that store. This implies that if the Regular Retail Price changes in the middle of the week then the price we observe is an average of the price before and after the change, weighted by the number of items purchased at the different price levels. Similarly, if an item is temporarily discounted but customers only receive the discount if they present the retailer's frequent shopping card then the Retail Price will

represent a weighted average of the price paid by customers who receive the discount and those who do not. To avoid double-counting price changes that occur mid-week when calculating the frequency of price changes, we exclude price changes less than 1-cent in magnitude, and price changes that are in the same direction as a price change in the immediately preceding week.[5]

Many items have multiple color or flavor variants (e.g. orange versus mint flavored 1oz tic tac candy). The individual flavors of 1oz tic tac candy are identified at the SKU-level, while all of the flavors of 1oz tic tac candy share a common item-number. All SKUs under a single item-number have the same Regular Retail Price at a store in any week. They also share any temporary discounts and generally have the same Wholesale Price (although in some cases there is small variation in the Wholesale Price across different SKU numbers that share the same item-number). In our analysis we will cluster standard errors at the item level to account for the interdependence in price movements across stores and/or across SKUs that share the same item number.

Finally, in our analysis of the reaction of retail and wholesale prices to underlying costs and regional unemployment, we use additional data on the spot price of a gallon of diesel and CBSA-level unemployment rates. The diesel price data was downloaded from the US Energy Information Administration website and is for the Los Angeles price of a gallon of ultra-low-sulfur number 2 diesel fuel. The CBSA-level unemployment rates were obtained from the Bureau of Labor Statistics Local Area Unemployment Statistics program. In cases where the stores in our main dataset are located in rural areas that are not part of a CBSA for which an unemployment rate is available, we manually match the store with the closest CBSA, and use the unemployment rate for that CBSA.

3. Summary Statistics

Using a representative item in our dataset, we illustrate in Figure 1 the three price measures in our dataset: the Retail Price, Regular Retail Price, and Base Wholesale Price. The

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[5] If a price reduction occurs in the middle of week t and continues in week t+1 then the average price paid will be *both* lower in week t than week t-1, and lower in week t+1 than week t. This introduces a risk of double-counting price changes. Excluding price changes in the same direction as a price change in the immediately preceding week addresses this.

figure reveals that Wholesale and Regular Retail Prices exhibit similar dynamics, adjusting both infrequently and persistently, while Retail Prices (including sales) adjust much more frequently due to the presence of temporary sales.

Table 1 quantifies these (well-known) facts for a broader sample of products. Table 1 reports the average weekly frequency and average size of price changes for all three price measures, weighted by total unit sales for each item.[6] While not shown in Table 1, it is important to note that most temporary sales are very short in duration. Over 52% of temporary sales last just 1 week and the average duration of temporary sales is 1.9 weeks.

The weekly frequencies of price change for Base Wholesale and Regular Retail Prices are 0.86% and 1.07% respectively (this implies durations of 26.8 and 21.6 months respectively). As has been observed in many other datasets, the frequency of retail price change including sales is an order of magnitude higher—21.97% per week (implied duration of 1.1 months). Retail price changes including sales are also far larger than Base Wholesale or Regular Retail price changes.[7] These patterns are robust to using unweighted averages and to relaxing the restriction on price changes in the immediately preceding week.

Although these findings are well-established, they provide important motivation for the analysis that follows. Over 95% of the price changes in our dataset are due to temporary sales. Does this mean that sales are responsible for the lion's share of the retail price response to a wholesale cost increase? In the next section, we investigate this question empirically.

4. Do Sales Respond to Wholesale Costs?

If sales represent an additional dimension of flexibility for retailers to respond to underlying movements in costs over and above changes in Regular Retail Prices, then when wholesale costs increase we should expect to see both increases in Regular Retail Prices and reductions in the size and frequency of sales. In a simple model, one might expect that sales

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[6] The average absolute size of the price changes is measured as a percentage of the average regular price (calculated for that SKU in that store across the entire 195 week period).

[7] The sizes of the price changes are calculated as a percentage of the midpoint of the current and previous weeks' prices, ensuring that the calculation does not introduce an asymmetry in the magnitude of price increases versus price decreases.

would be responsible for a large fraction of the responsiveness of prices to costs, given that they account for 95% of all price changes.

To investigate this hypothesis, in this section, we consider the evolution of retail prices surrounding increases in the Base Wholesale Price.[8] We focus on the Base Wholesale Price because, as we discuss later in the paper, changes in this variable represent true variations in the retailer's marginal costs. We will argue that wholesale price variations due to trade deals are associated with complex contingent contracts and cannot be viewed as a true measure of the retailer's marginal cost.

We identify the 38,015 Wholesale Price increase events in the data, and for each event we construct a sample that includes the week of the event, the prior 50 weeks and the subsequent 50 weeks. For some cost increase events several observations are missing either because there were no sales in one of these weeks, or because the cost increase event occurred too close to the start or end of the data period. Pooling across the 38,015 events yields a total panel sample of 2,146,597 observations.

We estimate the following equation,

$$Y_{ist} = \sum\mu_i + \sum\mu_t + \sum\beta Period_{est} + \varepsilon_{ist}, \tag{1}$$

where Y_{ist} refers to the relevant price measure (for item i in store s in week t). The μ_i terms are item fixed effects and the μ_t terms are time fixed effects. The $\beta Period_{est}$ term refers to a set of dummy variables identifying blocks of weeks before and after the cost increase event (e).[9] We estimate the model using weighted OLS, where the observations are weighted by the total unit sales of the SKU in the store and the standard errors are clustered at the item level, to account for any correlation in the errors across events, stores and/or SKUs that share the same item number.

We analyze the response of four different price measures:

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[8] We have also analyzed the effects of wholesale price decreases. However, in line with previous analysis by Anderson et al. (2012) and McShane et al. (2013), we find that the wholesale price decreases have a much smaller effect on regular retail prices—and therefore are less useful in testing our central hypothesis regarding the relative flexibility of regular prices versus sales.

[9] For example, Week -50 corresponds to weeks -50 to -46, Week -45 corresponds to weeks -45 to -41, Week 5 corresponds to week 1 to week 5, and so on, for Weeks -50 to 50, in 5 week intervals.

$$Wholesale\ Price\ Index_{ist} = \frac{Wholesale\ Price_{ist}}{Average\ Regular\ Price_{ist}}$$

$$Retail\ Price\ Index_{ist} = \frac{Retail\ Price_{ist}}{Average\ Regular\ Price_{ist}}$$

$$Regular\ Price\ Index_{ist} = \frac{Regular\ Price_{ist}}{Average\ Regular\ Price_{ist}}$$

$$Discount\ Index_{ist} = \frac{Average\ Discount_{ist}}{Average\ Regular\ Price_{ist}}\ .$$

Note that our measure of discounts is defined such that $Retail\ Price_{ist} = Regular\ Price_{ist} - Average\ Discount_{ist}$. Each price index is normalized using the average Regular Price (calculated using the entire 195 week data period), so as not to reveal the level of prices (for confidentiality reasons).

Results

Figure 2 presents the results. In each case, we have normalized the price series to have a value of zero in the period prior to the Wholesale Price change. The sharp increase in the Wholesale Price index at time 0 is by construction—we have selected these instances precisely as periods when the wholesale price increases. Panel A of Figure 2 shows, however, that there is also a sharp and immediate response of Regular Retail Prices. The immediate "pass-through" of Wholesale Prices into Regular Retail Prices is roughly "cent-for-cent."[10] Recall that the series are all indexed against the same base (the average Regular Price), and so movements in each series represent the same dollar-for-dollar change.

If sales and regular prices play a similar role in the price adjustment process, one might expect to see a decline in the frequency and size of sales around the time of the wholesale price increase. For example, Kehoe and Midrigan (2012) present a model in which regular prices and sales both respond to underlying changes in marginal costs.

Panel B of Figure 2 presents the response of discounts following the wholesale price increase. Sales do not respond strongly. But if anything, there is a temporary *increase* in sales following the wholesale cost increase. In other words, sales actually *hinder* the increase in retail

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[10] This result is consistent with the results of Nakamura and Zerom (2010) and Goldberg and Hellerstein (2013), who find that retail prices respond quickly to wholesale price changes.

prices following the cost increase, as opposed to accelerating the speed of the price adjustment. One potential interpretation of this pattern is that the retailer increases discounts following the regular price increase so as to make it more difficult for the consumer to notice the price increase.

Recall that the model includes time fixed effects. Therefore, the lines in the figures should be interpreted as prices of products contingent on a wholesale cost increase in week 0 *relative* to what we would have expected without this contingency. The trend in the sample is positive, since prices generally increase over time. Hence, in the weeks before and after week "0" when the cost change occurs, the product's price is getting eroded relative to other products in the sample. This explains the negative trends that arise before and after week "0" in Figure 2. We also report the results without time fixed effects in the Appendix, and these figures do not exhibit a negative trend.

Table 2 presents the results in tabular forms, with the average short-term price response (weeks -20 to -1 versus weeks 1 to 20) and the average long-term price response (weeks -50 to -21 versus weeks 21 to 50).[11] The table shows that in the short-term the Wholesale Price increased by 3.2%, which led to a 2.8% increase in the Retail Price. Regular Retail Prices rose by 4.4% but this was offset by a 1.6% increase in discounts. In the long-term there was no change in the Discount Component. Instead the 2.8% increase in Retail Prices is almost completely attributable to an increase in the Regular Retail Price. Figure 3 presents the same information as Table 2 in the form of a figure.

The evidence that the Discount Component returns to its pre-event level after six months is perhaps unsurprising. If every Wholesale price increase led to permanent increases in the Discount Component, this would lead to accumulated increases in the Discount Component over time. Eventually the Discount Component would reach its natural limit: discounts all of the time. The fact that we do not see this requires that increases in the Discount Component are not permanent.

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[11] These results were estimated by re-estimating Equation 1 using separate dummy variables identifying these sets of weeks.

With and Without a Nearby Regular Price Change

One might ask whether the reason that sales fail to play any role in the adjustment to a wholesale cost increase is precisely *because* regular retail prices adjust so completely. Perhaps if regular retail prices did not increase, then sales would adjust in their stead. Table 3 addresses this question by considering the effect of wholesale price increases in two cases: those with a nearby regular price change and those without a nearby regular price change (where "nearby" is defined as within 10 weeks of the event).

Based on this definition, 82.6% of our wholesale cost increase events do exhibit a nearby regular price change, while the remaining 17.4% do not. When there is a nearby change, the regular retail price responds quickly and completely. In the remaining cases, the regular retail price responds incompletely and with some delay.

In neither of these cases do we find any evidence that a decrease in the frequency or size of temporary sales helps accelerate the adjustment to the wholesale price increase. In the former case, where the regular retail price increases, we observe a transitory increase in sales, as we discuss above. However, this does not occur in the case without a nearby regular price change—substantiating the view that the increase in sales is intended to mask the increase in regular retail prices.

In the long-run, the wholesale cost increase has no impact on sales in either the case with or without the regular price increase. The long-run increase in retail prices is also very similar in the two cases. In the latter case with no nearby price change, the increase in regular retail prices occurs outside the short-term window. Notably, even in these situations the retailer does not use temporary sales as a way of adjusting prices in the short-term.

5. The Response of Prices to Commodity Costs and Unemployment Rates

The Effect of the Commodity Cost Boom of 2007-2008

Our sample period coincides with a rapid rise and fall in the price of oil and other commodities in 2007-2008. To the extent that temporary sales are used to respond to underlying movements in production costs, we should expect to see the frequency and depth of discounts change in response to the commodity cost fluctuations.

Figure 4 (Panel A) plots the average weekly frequency of Regular Retail and Base Wholesale Price increases and decreases (left axis), along with changes in diesel prices (right axis) on a biannual basis. Panel B presents analogous statistics for temporary sales. The frequencies of price change are weighted by total unit sales, and are adjusted for the seasonal pattern observed in 2006.[12] The diesel price variable is the 12-month change in diesel prices, lagged by one quarter.[13]

Figure 4 (Panel A) shows that the increase in diesel prices in 2008 was matched by a sharp rise in the frequency of Wholesale Price increases (the correlation between the two series is 0.90). In conversations with managers at the retailer, they attributed the spike in the frequency of Wholesale Price increases in 2008 to the commodity price changes. The frequency of Regular Retail Price increases also spikes sharply at this time. In stark contrast, Panel B shows that the frequency and depth of temporary sales were unaffected by the huge run up and subsequent fall in diesel and other commodity prices.

The Effect of Unemployment Rates

Next we study the responsiveness of the different forms of price change to variation in unemployment across different Core Based Statistical Areas (CBSAs).[14] Table 4 presents results from the following weighted OLS regression,

$$Y_{ist} = \sum \mu_i + \sum \mu_t + \beta_1 Change\ in\ Unemployment_{st} + \varepsilon_{ist}, \tag{2}$$

where the μ_i terms are item fixed effects and the μ_t terms are time fixed effects. We use three different outcome measures, Y_{ist}, including the Retail Price Index, the Regular Price Index, and the Discount Index. We do not report the results for the Regular Wholesale Price Index as this

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[12] The frequency of price change is considerably higher in the first quarter of the year than in other quarters, consistent with the seasonal pattern found in Nakamura and Steinsson (2008). To adjust for this pattern, we subtract from each frequency statistic the average frequency of price change for that time period in 2006, relative to the overall frequency for that year.

[13] Lagging the change by a quarter recognizes that there is a lead-time between the timing of the diesel price change, the timing of wholesale and retail pricing decisions, and the implementation of those decisions.

[14] Core Based Statistical Areas are geographic areas consisting of a county or set of counties that include a core urban area with a population of at least 10,000 people and the surrounding areas that are linked to the core by a high degree of social and economic integration as measured by commuting patterns. Core Based Statistical Areas are defined by the Office of Management and Budget.

variable is determined almost exclusively at the national level, implying that there is little variation across regions.

The *Change in Unemployment$_{st}$* variable, is defined in a similar way to the change in diesel prices in the previous section. In particular, it is calculated as the 12-month change in the monthly unemployment rate in that CBSA, lagged by one quarter. We use the same sample of roughly 5 million observations weighted by the total unit sales of the SKU in the store. The inclusion of the time fixed effects means that we identify the impact of changes in unemployment on retail prices solely using variation in regional unemployment (where the regions are represented by the store locations) relative to the average unemployment rate across regions.

Table 4 shows that a one percentage point increase in the relative regional unemployment rate led to significantly lower retail prices. However, this reduction arose entirely from regular prices, as opposed to sales. The change in the unemployment rate had no effect on the discount index.[15]

6. Institutions of Manufacturer Trade Deals and Retailer Temporary Sales

To help interpret and explain these findings, we analyze the institutions of pricing and trade promotions. The information in this section is based on interviews with both the firm that provided data for this study and a convenience sample of manufacturers and retailers. We should note that the details of these promotion funding mechanisms differ across manufacturers and retailers.[16] However, we know from surveys of manufacturers that a large fraction of these mechanisms share the key features that we emphasize (see, e.g., Acosta, 2012). We have organized our findings into six stylized facts.

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[15] This result is consistent with Coibon et al. (2013), who also find no impact of the unemployment rate on the frequency of sales.

[16] Precisely documenting how the promotion funding mechanisms work for every manufacturer and every retailer is extremely difficult. For example, in 2002 two of us (Anderson and Simester) sent an MBA student to intern for 10 weeks at a retailer and document promotion funding. We learned that there was no uniform promotion funding practice among manufacturers selling to the retailer and the retail category managers could not easily document the flow of promotion funds. The most senior retail managers admitted that the promotion funding process had become extremely complicated and difficult to trace. At that time, determining the true marginal cost of a promoted item proved almost impossible.

A. Temporary Sales Follow "Sticky Plans"

From a logistical point of view, temporary sales are complicated events that require a substantial amount of planning and coordination between retailers and manufacturers. For example, when a promotion is run at a retail chain it may be accompanied by coupons, radio-television advertising, digital marketing, in-store displays, feature advertising, or product sampling. Retailers and manufacturers both understand that these demand generating activities are highly complementary with temporary sales and thus need to be coordinated carefully. In addition, there is often coordination with the retailer to ensure that sufficient inventory is available.[17] As a result, most retailers and manufacturers jointly set a schedule for temporary sales and associated promotional activity – a promotion calendar – through an annual planning process. In other words, temporary sales follow sticky plans that are generally updated at an annual frequency. A detailed example of a manufacturer's annual promotion plan is provided by Blattberg and Neslin (1990, p. 392). The plan provides details on the specific price promotions and the associated cost to the manufacturer.

B. Temporary Sales Are "Paid For" Out of Trade Deal Budgets

A central feature of promotion funding mechanisms for understanding the incentives faced by retailers is that manufacturer "funding" of promotions at a given retailer is determined by a trade deal budget. For example, suppose a manufacturer's product normally has a regular retail price of $2.49, but the manufacturer wants to encourage the retailer to lower the price to $1.99 for one week eight times during the year. To "fund" the $0.50 discount the retailer may be "paid" $0.35 per unit sold at $1.99 during the eight promotion weeks.[18] This amount will be deducted from a manufacturer trade deal budget that is specific to each retail account. In addition to "funding" temporary sales, the trade deal budget can be used to fund advertisements, in store displays and other demand generating activity associated with the temporary sale.

Importantly, the amount of funds in a trade deal budget limits the overall amount of

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[17] See for example Anderson and Simester (2001) and Anderson, Fitzsimmons and Simester (2006).

[18] In many cases, the amount that is paid out of the accrual account (e.g., $0.35 per unit) is designed to keep the retailer satisfied with the total dollar margin during the promoted weeks. So, if the retailer earns a 33% gross margin per unit at the regular price then the retailer may be happy to run a promotion that yields 25% gross margin but substantially greater unit volume.

support that the manufacturer provides for temporary sales and associated promotional activity. Thus, if the retailer wants support for frequent or deep discounts early in a particular planning period, he must recognize that this will have the consequence that there will be less funds in the trade deal budget to support discounts later in the planning period. Reductions in the wholesale price associated with trade deals therefore do not reflect reductions in the retailer's marginal cost – since the retailer is spending down a finite resource (the trade deal budget). An implication of this is that the wholesale price variables in scanner price datasets used in the macroeconomics and industrial organization literatures must be interpreted with great caution, since these variables often include trade deal funding, and therefore cannot be viewed as measures of the retailer's marginal cost.

C. *Manufacturers and Retailers Jointly Determine the Timing and Depth of Temporary Sales*

The joint planning of the annual promotional calendar implies that manufacturers and retailers collaborate to determine the timing and depth of temporary sales. While the overall level of discount activity is constrained by the size of the manufacturer trade deal budget for each retailer, the retailer can influence the exact timing and depth of each discount. For many promotions, the manufacturer plan may allow for a "trade deal window" of several weeks where retailers can execute a promotion (see Blattberg and Neslin 1990, p. 319). This flexibility allows retailers to adjust their promotion plan to local market conditions. For example, if a competing retailer is expected to offer a deep discount on Coke then a retailer may decide to promote a different carbonated soft drink, such as Pepsi. In a subsequent week, the retailer may take advantage of the trade deal window to promote Coke. In contrast, if this is a week with high store traffic, such as 4th of July, the competing retailers may promote multiple soft drink brands (e.g., both Coke and Pepsi may be promoted that week). These facts contrast with stylized theoretical models that assume a manufacturer makes a take-it-or-leave-it offer to all retailers in a market in a given week. Instead, it is important to recognize that the observed timing and depth of promotions is the result of a flexible, joint planning process.

D. *Manufacturer Trade Deals are Contingent Contracts*

An important challenge faced by manufacturers is how to induce retailers to promote their products effectively. In the late 1960s and early 1970s, manufacturers would simply offer retailers a temporary discount to the wholesale price. So, instead of a base wholesale price of $10

per case, a manufacturer may have temporarily lowered the price to $8 per case. The intent of the manufacturer was to induce the retailer to hold a temporary sale.

This funding strategy by manufacturers for sales was not incentive compatible. Anticipating the return of the higher normal base wholesale price, some retailers would "forward buy," i.e., purchase large quantities of the product at the discounted price. They would also not reduce the retail price (i.e., not hold a temporary sale), presumably because they understood that a unit of inventory sold at a sale price during the week when the manufacturer prices was temporarily low was just as likely to have to be replenished in the following weeks at the normal base wholesale price as a unit sold a few days earlier or later. In addition, intermediaries would arbitrage geographic and temporal price differences; a new market emerged where retailers could purchase "diverted" goods from intermediaries. Finally, retailers would fail to execute in-store programs, such as in-store displays, that had been agreed upon in the promotion planning process.

In response to these incentive problems, manufacturers have begun requiring retailers to verify "performance" in order to receive trade deals funds. In the case of a temporary sale, the retailer must prove that it has indeed put the product in question on sale in order to release the funds from the trade deal budget. Several different mechanisms are used in the industry to verify performance. For example, the retailer might have to submit scanner price data showing that it lowered the price to $1.99 in the example above. Alternatively, the manufacturer's sales-force may be responsible for verifying retailer compliance with a promotion.

As we discuss the introduction, we believe that facts B and D are key to understanding why EJR find that retail sales almost always coincide with wholesale cost changes, whereas we find little role for sales in responding to wholesale cost increases. Recall that we focus on changes in the Base Wholesale Price as our measure of wholesale cost changes—and do not include wholesale cost changes due to trade deals. We do this because changes in the wholesale cost associated with trade deals do not constitute true changes in the retailer's marginal cost (Fact B) and because retailers are often contractually required to reduce retail prices when they take trade deal funding (Fact D).

In fact, if trade deals did not constitute contingent contracts, it would be surprising to observe sharp drops in observed wholesale prices associated with sharp contemporaneous drops

in retail prices (Eichenbaum et al., 2011). If such sharp drops in wholesale prices really reflected reduction in marginal cost, one would expect an optimizing retailer to respond instead to such discounts by stocking up on inventory for the product in question.

E. *Trade Deal Budgets Accumulate Funds Like Frequent Flyer Accounts*

When you fly on, say, United Airlines, you accrue "miles" in your frequent flyer account for every mile that you fly. Sometimes you accrue double miles or triple miles; sometimes you accrue miles for adopting a credit card or buying groceries. But, in the end you have an account of miles that you can redeem for free travel, upgrades and other offers provided by United Airlines. The accumulation of funds in trade deal budgets often works in a similar manner.

A manufacturer typically establishes an accrual rate, perhaps 6%, and then this determines how many dollars (points) accrue for the retailer. If a retailer buys $10,000 worth of product that accrues at 6% then the retailer has "earned" $600 in accruals. Accruals can also be based on a dollars-per-case metric, but this is less common. Just like frequent flyer programs, the accrual rates may vary over time. So, during some periods a manufacturer may offer 9% accruals rather than 6% accruals.

The goal of an accrual mechanism is to enhance the incentives of the retailer to support a manufacturer's brand in both promoted and non-promoted periods. Volume purchased during the non-promoted periods accrues trade funds that can be used to support promotional activities such as price discounts, in-store displays and feature advertising. Incentives are aligned in the sense that more volume leads to greater trade funds that can be used to fund future promotions, which in turn will drive additional volume.

Not all trade promotion budgets are accrual accounts. In some cases, trade promotion budgets are simply fixed budgets—i.e., the manufacturer allocates a fixed dollar amount to a retail account each year. However, accrual accounts are very common for large retailers such as the one we study. Acosta (2012) reports that 83% of manufacturers with sales over $1 billion indicated that trade funding is based on accruals.

F. *Managers Pay Attention to Regular Prices*

A key concern that macroeconomists have had about analyzing data on regular prices is: How do we know that regular prices are relevant in determining the ultimate price faced by the

consumer? What if actual prices are set entirely independently from regular prices—making regular prices a vacuous concept?

One way of investigating this question is to ask which price measures firms' senior managers believe are most important. At the firm we study, Regular Retail Prices and Base Wholesale Prices are clearly viewed as the primary measures of the firm's pricing policy and costs. These two metrics are summarized in monthly pricing reports that are shared among senior leaders in the company.[19] The monthly pricing report lists every change in the Base Wholesale Price and the Regular Retail Price (in the "main" pricing zone) that occurred in the calendar month. It then summarizes the impact on profit margins by category and at the aggregate firm level. In this report, the Base Wholesale Prices and the Regular Retail Prices are interpreted as the true variable cost of a unit and the true price of a unit. Notably there is no reference to temporary sale prices or the funding of temporary sales by manufacturers. In several years of conducting research with this firm we (Anderson and Simester) have never observed a regular management report describing temporary sale prices or the amount of manufacturer trade deal funding.

These findings are relevant to interpreting studies on pricing such as the seminal work by Blinder et al. (1998) and the many follow-up studies using similar methodologies. These studies interview managers about their pricing practices and yield a frequency of price change of close to one year. Bils and Klenow (2004) note that these studies yield frequencies of price change much lower than those observed in consumer price data including sales, and suggest that this difference may arise from a difference in industry composition. An alternative explanation, consistent with our institutional findings, is that when managers are asked about changes in the firm's "price" they interpret this question as referring to changes in the firm's regular price—which changes much less frequently than prices including sales.

7. Conclusion

Sale prices can result in an extremely high frequency of price changes in retail price data.

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[19] Doubtless, the use of regular prices varies across firms. We believe, however, that the importance of the regular price is likely to hold true for other retailers of consumer packaged goods.

In our data, temporary sales account for 95% of all price changes. A key question is whether these frequent price changes facilitate rapid responses to changing economic conditions, or whether they are merely part of a "sticky plan" that is determined substantially in advance and therefore not responsive to changing conditions. We use an exceptionally detailed dataset on retail and wholesale prices to investigate this question.

We show empirically that, while regular retail prices respond strongly and immediately to wholesale cost increases, temporary sales play no role in facilitating the upward adjustment of retail prices. This is true even in cases where regular retail prices fail to respond immediately — even in these cases there is no immediate response of sales. To the extent that sales do respond, it is the "wrong" direction—i.e., sales appear to rise temporarily following regular retail price increases, perhaps to conceal the price increase. Similarly, we find no evidence that temporary sales respond to increases in manufacturer costs associated with the commodity cost run-up or to change in the unemployment rate.

These empirical findings are consistent with the institutional evidence we present that temporary sales are "funded" via trade promotion budgets, and are orchestrated according to trade promotion calendars set substantially in advance. Changes in wholesale prices associated with trade deals do not, therefore, constitute true changes in the retailer's marginal cost, and the retailer response to such movements is often part of a contingent contract whereby retailers cannot collect trade deal funds without demonstrating "performance." These facts help clarify the empirical and institutional differences between regular prices and sales.

Appendix A: Direct Store Delivery

Direct Store Delivery (DSD) refers to the practice of manufacturer of bypassing the retailer's distribution system and delivering certain goods directly to individual retail stores. In the analysis we omit DSD categories, primarily alcohol, beverages, and dairy.[20] There are important institutional differences in how pricing decisions are made in DSD categories, which imply that both the Wholesale Price and the Regular Retail Price measures – key features of our dataset – cannot be interpreted in the same way in these categories as in other categories.

Most important for our purposes, accrual accounts are not used to "fund" temporary discounts in DSD categories. In the case of alcohol, this is the result of legal restrictions. In the other categories, it may be because the incentive problems accrual accounts are designed to solve are not as severe in the case of DSD items since retailers hold no inventory apart from what is on the shelf at each time (so "forward buying" in response to discounts is not possible) and since the manufacturer can better monitor performance.

Manufacturers play a more direct role in setting retail prices in DSD categories.[21] Temporary sales on DSD items are often funded by temporary reductions in the Wholesale Price. Moreover, temporary price fluctuations are often coded as movements in the Regular Retail Price in the DSD category and discounts are more persistent. Approximately 20% of the Retail Price changes on DSD items arise because of long sales of 13 weeks or more, compared to just 1% to 2% for non-DSD items.

For non-DSD categories, we have argued that institutional features of how prices are set – arising because of incentive problems associated with the implementation of temporary sales – imply that Regular Prices respond to cost and demand shocks, while temporary sales do not and are instead purely associated with intertemporal price discrimination. It may be that managers

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[20] Firms cannot legally store alcohol unless they are a bonded wholesaler, which in practice requires that wholesalers deliver directly to stores. As a consequence, alcohol items are always DSD items.

[21] Perhaps for this reason, in DSD categories, both Wholesale and Retail prices vary much more across stores in response to regional competition. Regular Retail Prices and Retail Prices may vary at the region level in DSD categories, rather than at the "pricing zone" level for other products. In addition, whereas for almost all other products Wholesale Prices are constant across the national chain, Wholesale Prices for DSD items may also vary at the regional level.

use a similar two-part approach to setting prices in DSD categories. Unfortunately, for the institutional reasons discussed above, this decomposition does not coincide with the Regular Retail Price vs. Retail Price distinction as it does in non-DSD categories, so our data are not able to speak to this issue.

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Table 1
Frequency and Size of Wholesale and Retail Price Changes

	Average Weekly Frequency	Average Absolute Size
Base Wholesale Price Changes		
Any Change	0.86%	
Increases	0.75%	4.55%
Decreases	0.11%	4.50%
Regular Retail Price Changes		
Any Change	1.07%	
Increases	0.95%	8.87%
Decreases	0.11%	12.03%
Retail Prices (including temporary sales)		
Any Change	21.97%	
Increases	11.05%	26.54%
Decreases	10.92%	25.77%

The table reports the average weekly frequency of price changes and the average absolute percentage size of the price changes. The average absolute size of the price changes is measured as a percentage of the average regular price (calculated for that SKU in that store across the entire 195 week period). The unit of observation is a SKU at a store in a week and for the frequency measures the sample size is 5,394,146. Not all items have price changes in every week and so the sample sizes for the absolute size measures range from 6,052 (Wholesale Price decreases) to 602,678 (Retail Price decreases). The observations are weighted by total unit sales for the SKU in that Store (across all 195 weeks).

Table 2

Change in Price Indices around the Wholesale Price Increase Events

|	Short-Term Comparison	Long-Term Comparison
Wholesale Price Index	3.165%[**] (0.395%)	1.535%[**] (0.289%)
Retail Price Index	2.775%[**] (0.441%)	2.839%[**] (0.432%)
Regular Price Index	4.386%[**] (0.571%)	2.999%[**] (0.618%)
Discount Index	1.611%[**] (0.540%)	0.160% (0.352%)

This table reports the change in the four price indices in the periods after the Wholesale Price increase events compared to the corresponding periods before the events. The "Long-Term Comparison" compares weeks -50 to -21 with weeks 21 to 50, while the "Short-Term Comparison" compares weeks -20 to -1 with weeks 1 to 20. Positive values indicate that the prices index was higher after the event. The sample sizes are all 2,145,952. Observations are weighted by Total Unit Sales (across the entire 195 week period), and standard errors are clustered at the item level.

Table 3
Change in Price Indices around the Wholesale Price Increase Events
Conditional on whether there was a Nearby Regular Price Change

	Nearby Regular Price Change		No Nearby Regular Price Change	
	Short-Term Comparison	Long-Term Comparison	Short-Term Comparison	Long-Term Comparison
Wholesale Price Index	3.009%** (0.431%)	1.256%** (0.298%)	3.754%** (0.614%)	3.247%** (0.757%)
Retail Price Index	3.124%** (0.575%)	2.744%** (0.470%)	-0.220% (0.657%)	3.046%** (1.178%)
Regular Price Index	4.960%** (0.704%)	2.739%** (0.696%)	-0.427% (0.465%)	2.919%** (1.182%)
Discount Index	1.836%** (0.600%)	-0.005% (0.379%)	-0.207% (0.529%)	-0.127% (0.512%)

This table reports the change in the four price indices in the periods after the Wholesale Price increase events compared to the corresponding periods before the events. The "Long-Term Comparison" compares weeks -50 to -21 with weeks 21 to 50, while the "Short-Term Comparison" compares weeks -20 to -1 with weeks 1 to 20. Positive values indicate that the prices index was higher after the event. The sample sizes are all 1,833,831 and 312,121 (No nearby Regular Price Change). Observations are weighted by Total Unit Sales (across the entire 195 week period), and standard errors are clustered at the item level.

Table 4
Regional Variation in Unemployment and the Frequency of Price Changes

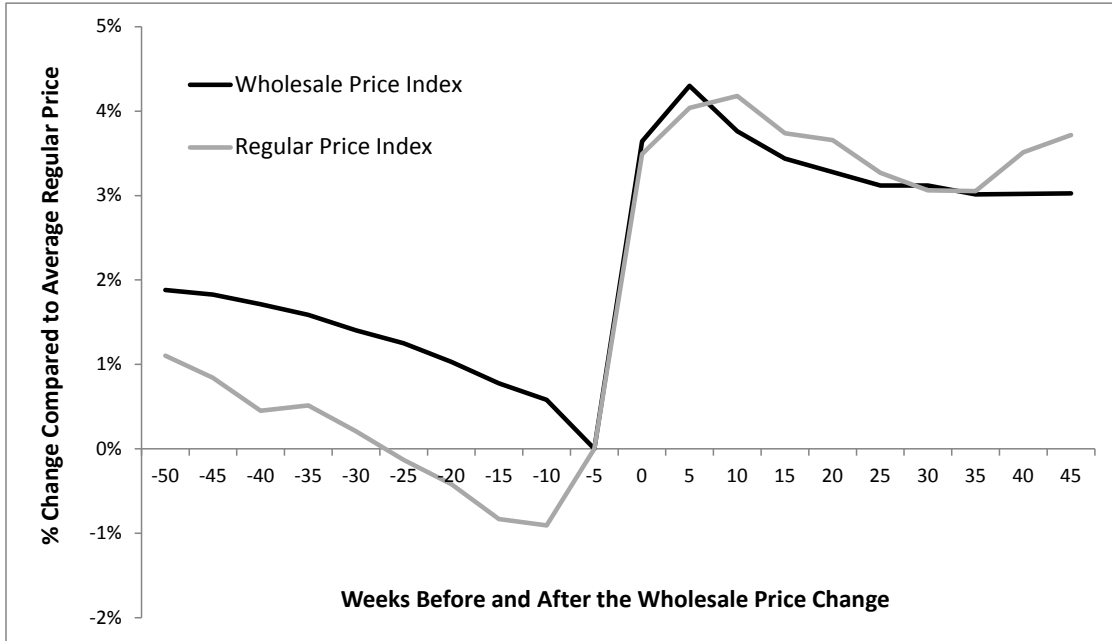|	Retail Price Index	Regular Price Index	Discount Index
Change in Unemployment (3 month lag)	-0.2254%** (0.0319%)	-0.2105%** (0.0343%)	0.0149% (0.0198%)
R^2	0.2834	0.3666	0.2576

The table reports coefficients from estimating Equation 2 on each dependent variable. The coefficients reflect the percentage point increase in the dependent variable. Standard errors are clustered by Item and reported in parentheses and the observations are weighted by total unit sales. Item x week fixed effects (and a constant) are included but omitted from the table. The unit of observation is an item x week and the sample sizes are 5,394,146. *Significantly different from zero, $p < 0.05$, ** significantly different from zero, $p < 0.01$.

Figure 1
Price Series: Example
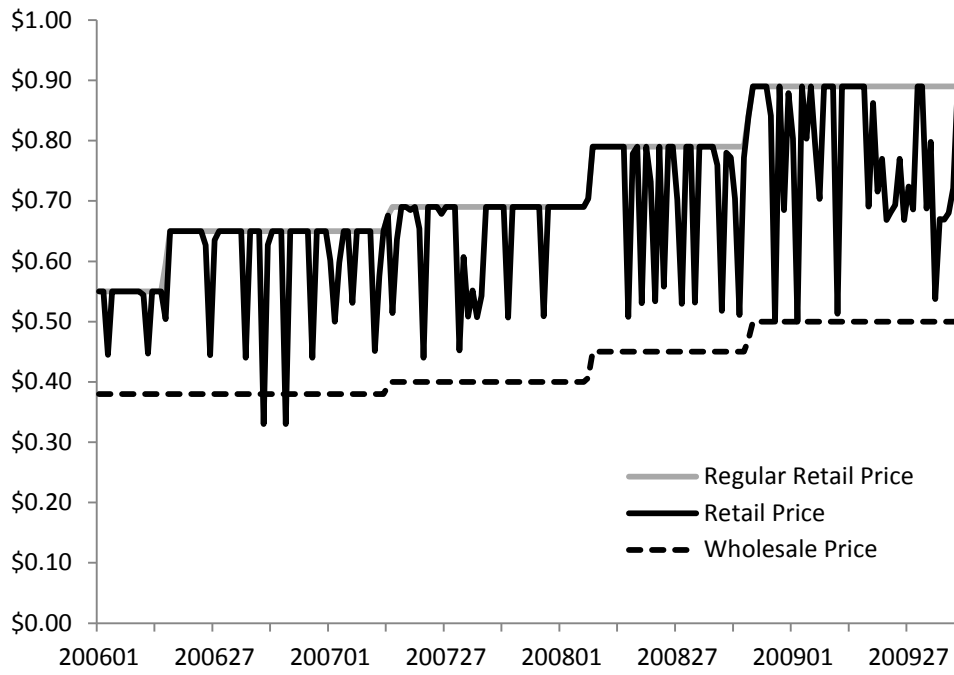
The figure reports the price trends for the three price variables for an arbitrarily chosen SKU at a single store that had sales of SKU in all 195 weeks of the data period.

Figure 2
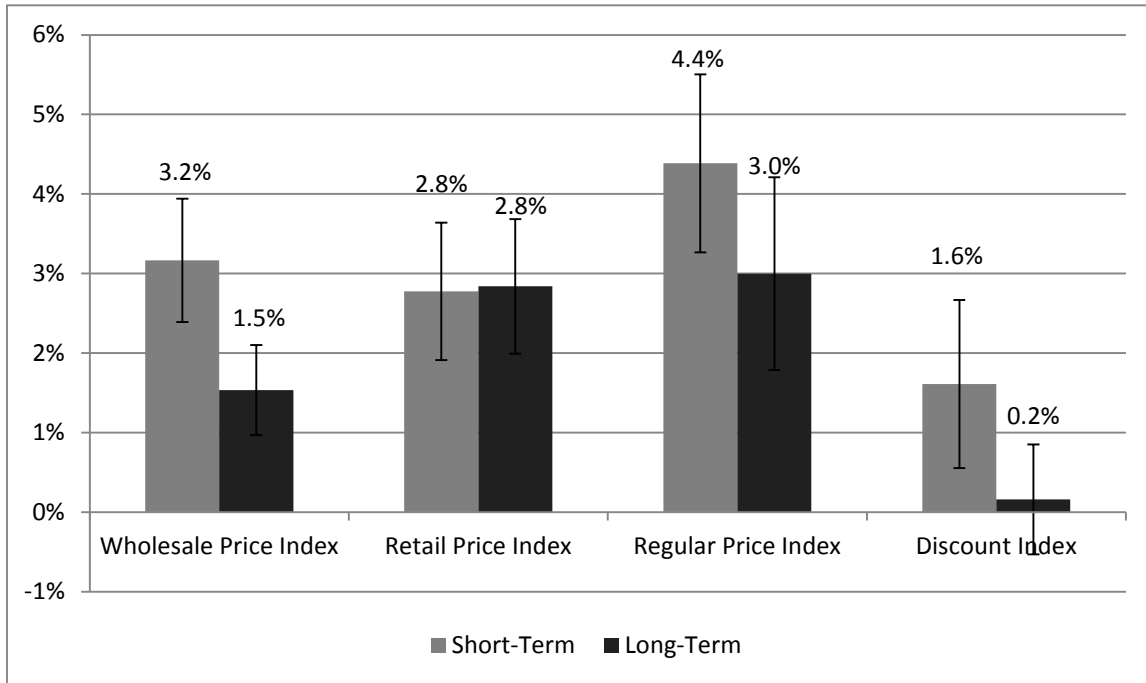**Response to a Base Wholesale Price Increase**

Panel A: Wholesale Price and Regular Price Index
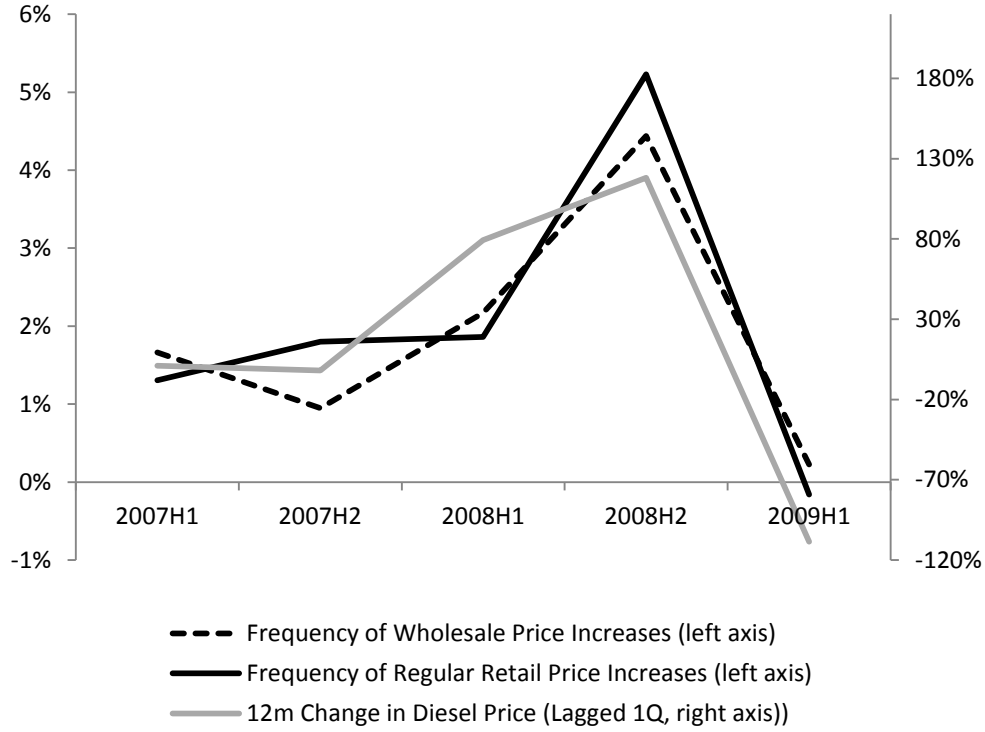

Panel B: Wholesale Price and Discount index

This figures report the coefficients identifying the weeks before and after a Wholesale Price increase. The coefficients are obtained from estimating Equation 1 on each dependent variable. Fixed effects identifying each item and each time period were included in the model but are not reported. The sample sizes are all 2,145,952. Observations are weighted by Total Unit Sales (across the entire 195 week period), and standard errors are clustered at the item level.

Figure 3
The Response to a Wholesale Price Increase
**Short and Long-Term Comparison**

The figure reports the change in the four price indices in the periods after the Wholesale Price increase events compared to the corresponding periods before the events. The "Long-Term Comparison" compares weeks -50 to -21 with weeks 21 to 50, while the "Short-Term Comparison" compares weeks -20 to -1 with weeks 1 to 20. Positive values indicate that the prices index was higher after the event. The sample sizes are all 2,145,952. Observations are weighted by Total Unit Sales (across the entire 195 week period), and standard errors are clustered at the item level. The error bars are 95% confidence intervals.
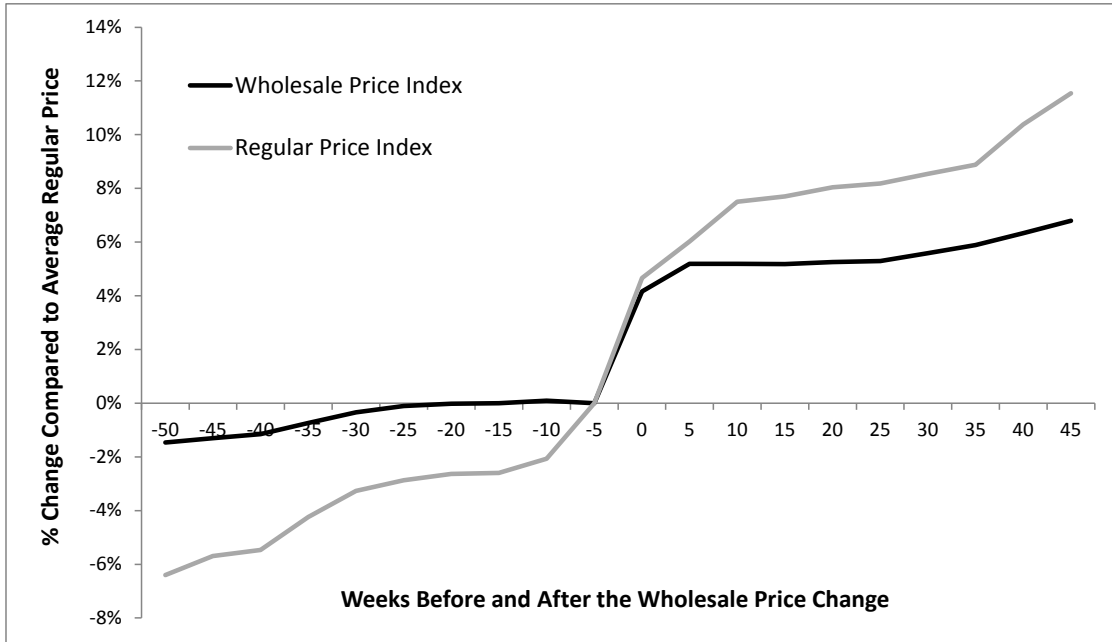
Figure 4
Price Adjustment and Diesel Prices

Panel A: Regular Prices and Base Wholesale Prices
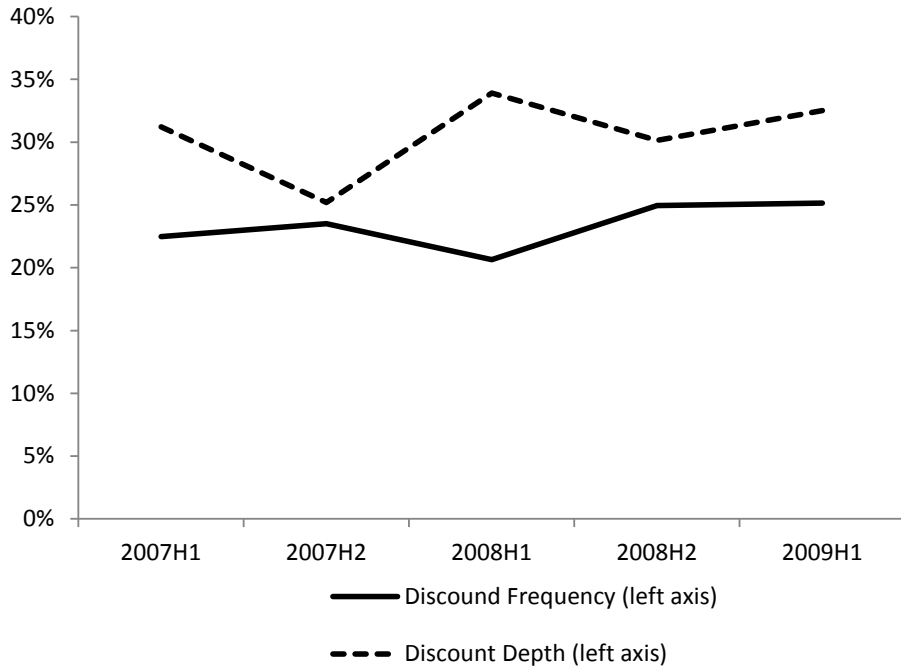
Panel B: Temporary Sales

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Response to a Base Wholesale Price Increase: No Time Fixed Effects

Panel A: Wholesale Price and Regular Price Index

Panel B: Wholesale Price and Discount index

This figure reports the coefficients identifying the weeks before and after a Wholesale Price increase. The coefficients are obtained from estimating a modified version of Equation 1 on each dependent variable. Equation 1 was modified to remove the time fixed effects. Fixed effects identifying each item were included in the model but are not reported. The sample sizes are all 2,145,952. Observations are weighted by Total Unit Sales (across the entire 195 week period), and standard errors are clustered at the item level.