Five Facts About Prices:

A Reevaluation of Menu Cost Models

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Abstract

We establish five facts about prices in the U.S. economy: 1) The median duration of consumer prices when sales are excluded at the product level is 11 months. The median duration of finished goods producer prices is 8.7 months. 2) One-third of regular price changes are price decreases. 3) The frequency of price increases responds strongly to inflation while the frequency of price decreases and the size of price increases and price decreases do not. 4) The frequency of price change is highly seasonal: It is highest in the 1st quarter and lowest in the 4th quarter. 5) The hazard function of price changes for individual consumer and producer goods is downward sloping for the first few months and then flat (except for a large spike at 12 months in consumer services and all producer prices). These facts are based on CPI microdata and a new comprehensive data set of microdata on producer prices that we construct from raw production files underlying the PPI. We show that the 1st, 2nd and 3rd facts are consistent with a benchmark menu-cost model, while the 4th and 5th facts are not.

Keywords: Price Rigidity, Hazard Functions, Menu Cost Models.

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1 Introduction

The nature of price setting has important implications for a range of issues in macroeconomics including the welfare consequences of business cycles, the behavior of real exchange rates and optimal monetary policy. For this reason, macroeconomists have had a persistent interest in micro-level empirical evidence about the behavior of prices. We use BLS microdata underlying the consumer and producer price indices to document five basic features of price adjustment. We interpret this evidence through the lens of a benchmark menu cost model.

We begin by estimating the frequency of price change. Until recently, the best sources of information on U.S. pricing behavior were studies of price adjustment for particular products (Cecchetti, 1986; Kashyap, 1995), broader surveys of firm managers (Blinder et al., 1998), and evidence on the dynamics of industrial prices (Carlton, 1986). The conventional wisdom from this literature was that prices adjusted on average once a year. Bils and Klenow (2004) dramatically altered this conventional wisdom by showing that the median frequency of price change for non-shelter consumer prices in 1995-1997 implied an expected duration of 4.3 months. They suggested that the difference between their results and the results of earlier studies was mainly due to the fact that their estimate was based on a much broader sample of products.

We use a substantially more detailed dataset than Bils and Klenow (2004), which contains the micro-level price data that underlay the non-shelter component of the consumer price index.[1] We find that the median implied duration of non-shelter U.S. consumer prices excluding sales at the product level was 11 months in 1998-2005. The difference between our results and those of Bils and Klenow (2004) arises due to three features. First, the median frequency of price change is about 2.5 percentage points lower in 1998-2005 than in 1995-1997 due to a fall in the rate of inflation. Second, we focus on price changes of identical products and therefore exclude price changes due to product substitutions. This lowers the median frequency of price change by between 1 and 2 percentage points. Third, we exclude sales and promotions at the product level. This lowers the median frequency of price change by about 10 percentage points, from 19.4% to 8.7%.[2]

[1] Bils and Klenow (2004) used the BLS Commodities and Services Substitution Rate Table for 1995-1997. This data set contains average frequencies of price changes and substitutions by disaggregated product categories over the 1995-1997 period. In contrast, the CPI research database contains the actual data series on prices underlying the consumer price index for the 1988-2005 period. See section 2 for a more detailed discussion of the data. The CPI Research Database was also used by Klenow and Kryvtsov (2005) to analyze price adjustment behavior.

[2] We decompose the difference between our results and those of Bils and Klenow in more detail in table 2, which we discuss in more detail in section 3.1.

Excluding sales at the product level lowers the median frequency of price change by more than 50% even though only about 20% of price changes in the dataset are due to sales. The reason for this is that sales are concentrated in a few sectors—such as food and apparel—and these sectors tend to have frequencies of price change that are close to the median. The frequency of price change in these sectors drops by much more than 20% when sales are dropped from the data set. This leads to a very large change in the median frequency of price change. Because of data limitations, Bils and Klenow assumed that the fraction of price changes associated with sales was the same in all sectors. This leads them to underestimate the effect of sales substantially—their estimate of the median implied duration excluding sales is 5.5 months. Our results on the median frequency of price change excluding sales are roughly in line with recent evidence on the frequency of price change in Europe based on CPI micro-data (Dhyne et al., 2006).[3]

It is not a priori clear whether sales should be excluded when thinking about the macroeconomic implications of price rigidity. If the timing and size of sales are orthogonal to the macroeconomy, it seems sensible to filter them out when studying the effects of price rigidity on macroeconomic outcomes. However, if the frequency and size of sales vary with the business cycle, it becomes important to include them in both the theory and empirics. We present results both including and excluding sales. We show that sales are different from other price changes in several important ways. The most important differences are: 1) Prices return to their original level after most sales. 2) Sales are much shorter than other price spells on average, implying that the hazard function of price change including sales is very different from that of regular prices. 3) The absolute size of price changes due to sales is more than twice that of regular price changes. These features are difficult to reconcile with standard models of price setting. In contrast, we show that standard models are substantially more successful at explaining the dynamics of non-sale consumer prices as well as producer prices.

We also present the first broad-based evidence on pricing dynamics at the producer level in the U.S.. In order to do this, we created a new data set on producer prices from the production files used by the BLS to construct the Producer Price Index. The median duration of finished goods producer prices was 8.7 months in 1998-2005. The median duration of intermediate goods

[3]The frequency of price change estimates in Dhyne et al. (2006) include price changes due to sales. However, Dhyne et al. report that in cases where sales could be identified they had little impact on the frequency of price change suggesting that sales are less important in Europe than in the U.S.

producer prices was 6.5 months in 1998-2005, while it was 0.2 months for crude materials. Price rigidity in finished goods producer prices thus seems comparable to the rigidity of consumer prices excluding sales but substantially more than the rigidity of prices including sales. Also, the rigidity of product's price seems to be positively related to how processed the product is.

The second feature of price change that we investigate is the fraction of price changes that are price decreases. We find this fraction to be roughly one-third in both consumer prices excluding sales and finished goods producer prices. We present a benchmark menu cost model along the lines of Golosov and Lucas (2006) and show that the fraction of price changes that are decreases helps pin down the key parameters of this model. Building on the insights in Golosov and Lucas (2006), we find that the combination of the fact that 1/3 of price changes are price decreases and the fact that the average absolute size of price changes is large favors a model in which large but relatively transient idiosyncratic shocks to firms are an important driving force behind most price changes.

The third feature of price change that we investigate is how the frequency and size of price changes respond to variations in the inflation rate. We find that the frequency of price increases is highly responsive to the rate of inflation, while the frequency of price decreases and the size of price increases and decreases are not. This fact provides a natural test for our calibrated benchmark menu cost model. We find that the model matches the data quite well along this dimension. The frequency of price increases is much more responsive to inflation than the other three components in the model as in the data. Klenow and Kryvtsov (2005) also study the relationship between inflation and the frequency and size of price adjustment. They do not distinguish between price increases and price decreases and conclude that most of the variation of inflation can be accounted for by the variation in the average size of price changes. We show that variation in the frequency of price increases is an important driving force behind variation in the average size of price changes.

There is no evidence of a trend increase in the frequency of regular price change in the data. In fact, the frequency of price change fell between 1988-1997 and 1998-2005. Since our model is able to match the evolution of the frequency of price change over this period with a constant menu cost, we attribute this fall in the frequency of price change to the fact that inflation was lower during the latter period. In contrast, the frequency and size of sales has increased dramatically over the period 1988-2005.

The fourth feature of price change that we investigate is the extent of seasonal synchronization of price changes. We find that price rigidity is highly seasonal both for consumer and producer prices. Prices are substantially more likely to change in the first quarter than in other quarters—the difference is particularly large for producer prices. For consumer prices, we furthermore find a consistent pattern within quarter. The frequency of price change is highest in the first month of each quarter and falls monotonically across months within the quarter. This feature of price change does not arise in our benchmark menu cost model. It may be evidence of a time-dependent element of the pricing decisions of firms.

The fifth and final issue that we investigate is the hazard function of price change. We are primarily interested in the slope of the hazard function. The hazard function implied by our calibrated benchmark menu cost model is sharply upward sloping for the first few months. This implies that prices are unlikely to change again in the month immediately following a price change. We investigate whether this feature of the model is borne out by the data.

The main empirical challenge in estimating the hazard function of price change is the fact that heterogeneity in the level of the hazard function across products—if not properly accounted for—leads to a downward bias in the slope of the hazard function. We account for heterogeneity in two ways. First, we divide the data set into groups and estimate the hazard function separately for each group. Second, within each group we allow the level of the hazard function for each product to differ. The empirical model we use is an extension of the model applied by Meyer (1990) to analyze the hazard function of unemployment spells. This model has not previously been used to analyze price dynamics. An important advantage of our data set in identifying the effect of heterogeneity on the hazard function of price change is that we observe multiple price spells for each product.

The estimated hazard function of price change for both consumer prices excluding sales and producer prices is slightly downward sloping for the first few months and then mostly flat. The only substantial deviation from a flat hazard after the first few months is a large spike in the hazard at 12 months for services and producer prices. We also estimate the hazard of price changes for consumer prices including sales. It is much more sharply downward sloping for categories with frequent sales.

The model therefore differs from the data in at least two significant ways. First, it implies a low and sharply rising hazard in the first few months while the data show a large and slightly falling hazard. Second, the menu cost model does not give rise to a spike in the hazard function at 12 months. It is perhaps most natural to interpret this 12 month spike in the hazard function as evidence that pricing decisions of firms have a time-dependent component, though it may also reflect seasonal movements in costs. The downward slope of the empirical hazard function in the first few months is more prominent in sectors with large idiosyncratic shocks—such as unprocessed food. Extentions of the basic menu cost model that modify the process for idiosyncratic shocks have the potential to match this fact—e.g., heteroskedasticity.

While accounting for sales lowers the median frequency of price change of consumer prices by over 50%—from 19.4% to 8.7%—it lowers the mean frequency of price change by much less—from 26.5% to 21.1%. In Nakamura and Steinsson (2006a), we calibrate a multi-sector menu cost model to the sectoral distribution of the frequency and absolute size of price changes excluding sales. The degree of monetary non-neutrality implied by this multi-sector model is triple that implied by a one-sector model calibrated to the mean frequency of price change of all firms and roughly equal to that implied by a one-sector model calibrated to the median frequency of price change of all firms.[4]

An important body of work on the nature of price adjustment in the European context has been carried out by the Inflation Persistence Network (IPN) of the European Central Bank. Álvarez et al. (2005b) and Dhyne et al. (2006) summarize the conclusions of a number of papers on the frequency of price adjustment in consumer prices (including sales) for the countries of the Euro Area. Fabiani et al. (2004) summarizes the conclusions of a set of papers that analyze survey evidence on price adjustment in the Euro Area. A number of other recent papers have studied the size and frequency of price changes using disaggregated price data, including Lach and Tsiddon (1992), Konieczny and Skrzypacz (2005), Baharad and Eden (2004), Kackmeister (2005), Gopinath and Rigobon (2006), Hobijn et al. (2006) and Midrigan (2005). Hosken and Reiffen (2004) use CPI data to analyze the ability of industrial organization models to explain the sales observed in consumer prices, concluding that none of the existing models are particularly successful.

A considerable amount of research has focused on determining the empirical shape of the hazard function, since the shape of the hazard function is an intuitive and observable implication of pricing models. Within the IPN, Baumgartner et al. (2005), Álvarez et al. (2005a), Jenker et al. (2004), Dias et al. (2005) and Fougere et al. (2005) analyze the hazard function of price adjustment. Other papers that estimate hazard functions of price change include Cecchetti (1986), Goette et al. (2005),

[4]Bils and Klenow (2002) and Carvalho (2006) study this same issue in time-dependent models.

Gagnon (2005) and Campbell and Eden (2004). The evidence on the shape of the hazard function from these papers is mixed. Some find that the hazard function is upward sloping while others find that it is downward sloping. Most of the papers in this literature do not account for unobserved heterogeneity at the good level. However, several of them use the conditional logit specification to account for unobserved heterogeneity. Unfortunately, this specification yields inconsistent estimates of the shape of the hazard function, as discussed in Willis (2006).

The paper is organized as follows. In section 2, we describe the data. In section 3, we present evidence on the frequency of price change, the fraction of price changes that are price increases, the absolute size of price changes and temporary sales. In section 4, we present and calibrate the menu cost model. In section 5, we present evidence on how the frequency and size of price changes respond to inflation. In section 6, we present evidence on the seasonality of price changes and sales. In section 7, we present our estimates of the hazard function of price change. Section 8 concludes.

2 The Data

We use two data sets gathered by the Bureau of Labor Statistics (BLS) in this paper. The first is the CPI Research Database. This is a confidential data set that contains product level price data used to construct the Consumer Price Index (CPI). The second is an analogous data set of producer prices that we have created from the production files underlying the Producer Price Index (PPI). We will refer to this data set as the PPI Research Database. The CPI Research Database has been used by Klenow and Kryvtsov (2005).[5] The PPI Research Database has not been used before.

2.1 The CPI Research Database

Each month the BLS collects prices of thousands of individual goods and services for the purpose of constructing the CPI. The CPI Research Database contains the non-shelter component of this data set from 1988 to the present. The goods and services included in the CPI Research Database constitute about 70% of consumer expenditures. Prices are sampled in 87 geographical areas across the United States. Prices of all items are collected monthly in the three most populous locations (New York, Los Angeles and Chicago). Prices of food and energy are collected monthly in all other

[5]Bils and Klenow (2004) used the BLS Commodities and Services Substitution Rate Table for 1995-1997. The Substitution Rate Table contains the average frequency of price change including product substitutions and imputed missing values for all products in the CPI.

locations as well. Prices of other items are collected bimonthly. In most of our analysis, we use only monthly observations.

The CPI Research Database identifies products at an extremely detailed level. In general, two products are considered different products in the database if they carry different bar codes. In addition, the same product at two different outlets are considered different products in the database. An example of a product in the database is a 2 liter bottle of Diet Coke sold at a particular supermarket in New York. The database reports whether or not a product was "on sale" when its price was sampled in a particular month.[6] We use this sales flag to calculate statistics about the frequency and size of price change excluding sales. Some prices in the database are derived from the price of other products rather than being based on a collected price. We drop all such observations.[7]

We present results for consumer prices at three levels of aggregation. First, we report statistics that are calculated using the entire cross section of goods. Second, we break the data set into 11 "Major Groups" (see table 4). Third, we report results for so called Entry Level Items (ELIs). Examples of ELIs are "Bread", "Carbonated Drinks", "Washers & Driers", "Woman's Outerwear" and "Funeral Expenses". Before 1998, the BLS divided the data set into roughly 360 ELIs. In 1998, the BLS revised the ELI structure of the data set. Since then, it has divided the data set into roughly 270 ELIs.[8] The revision in the ELI structure of the data set in 1998 implies that in many cases we must report separate estimates for the periods 1988-1997 and 1998-2005. Most of our results are similar for the two sample periods. For concreteness, we will refer to the estimates for the latter period in the text unless we indicate otherwise.

In all of the statistics we present on the frequency and size of price changes, we focus on weighted medians across ELIs. The weights we use are CPI expenditure weights from 1990 for the period 1988-1997 and from 2000 for the period 1998-2005. The statistics at the ELI level are unweighted

[6]BLS field agents are instructed to mark a price as a sale price if it is considered by the outlet to be lower than the regular selling price, temporarily, and is available to all consumers. If an outlet never sells a product at its "regular" price—i.e. the product is always on sale—the BLS field agent is directed not to label it as a sale price. Sales available to customers with savings or discount cards are reported as sales only if the outlet confirms that more than 50% of its customers use these cards. Bonus items may be reported as sales, as long as they satisfy the normal criteria for sales described above. Chapter 10 of the unpublished BLS manual Price Reporting Rules contains a more detailed description of the definition of sales used by the BLS.

[7]Chapter 17 of the BLS Handbook of Methods (U.S. Department of Labor, 1997) contains a far more detailed description of the consumer price data collected by the BLS.

[8]See table 16, for a complete list of the ELIs used since 1998.

averages within the ELI.

2.2 The PPI Research Database

The PPI Research Database contains an unbalanced panel of raw data from the productions files used to construct the PPI. The earliest prices in the database are from the late 1970's. For most categories, however, the sample period begins some time during the early to mid 1980's. Throughout the sample period a number of categories are discontinued and others appear. To a large extent this "churning" reflects, on the one hand, ongoing modernization of the data set, and on the other hand, the expansion of the data set into new sectors, such as services. For the period 1988-2005—which we focus on in most of our analysis—the PPI Research Database contains data for categories that constitute well in excess of 90% of the value weight for the Finished Goods PPI.[9]

The definition of a good in the PPI Research Database is extremely detailed. It is meant to capture all "price-determining variables". In its Handbook of Methods, the BLS says: "For example, if a company charges more for a red widget than a white one, color is one of the price-determining variables." Price-determining variables include the type of buyer, the quantity being bought, the method of shipment, the transactions terms and the day of the month on which the transaction takes place.

The data in the PPI Research Database are gathered by the BLS through a survey of firms. Stigler and Kindahl (1970) criticized the methodology used to gather this data because it relied on "list" prices rather than transaction prices. They argued that this meant that the PPI data was not well suited for the study of price rigidity. Since then the BLS has revamped its data collection methodology to focus expressly on collecting actual transaction prices.

The BLS publishes producer price indexes based on several different classification systems. The most important classification systems are industry classifications and stage of processing classifications. Indexes in all classification systems are based on the same pool of price information. We use the stage of processing classifiction system. This classification system groups goods according to the class of buyer and the amount of physical processing or assemby the products have undergone. The BLS constructs indexes for three different stages of processing: finished goods, intermediate goods and crude material. We focus attention on finished goods, but also report basic results for

[9]The weights referred to here are the post-1997 value weights used to construct the Finished Goods PPI.

intermediate goods and crude materials. As with the consumer price data, we present results at three different levels of aggregation. First, we present results that are based on the entire cross section of goods. Second, we present results for 15 Major Groups. These Major Groups are the two digit stage of processing groupings used by the BLS. Third, we present results based on a matching between more disaggregated stage of processing groupings and CPI ELIs.

Our method for calculating statistics at various levels of aggregation in the PPI is somewhat more complicated than in the CPI. The most detailed grouping in the PPI research database is the cell code. We do not attempt to construct value weights at this level, since there is a substantial amount of churning in the cell codes used in the PPI from year to year. We instead obtain value weights for the PPI at the 4-digit commodity code level. We then construct statistics on the frequency of price change at the 4-digit commodity code level in the following way. First, we calculate the unweighted average frequency of price change within cell codes. Next, we calculate the unweighted median frequency of price change across cell codes within the 4-digit commodity code. Finally, we construct aggregate statistics by taking value weighted medians over the median price change frequencies at the 4-digit commodity code level. For the purpose of matching PPI categories with CPI ELIs, we also construct statistics at the 6-digit and 8-digit level. These statistics are unweighted medians analogous to the statistics we calculate at the 4-digit level.

3 How Often and How Much Do Prices Change?

The goal of this section is to calculate the frequency and size of price changes. In principle, calculating the frequency of price change is straightforward. It simply involves creating an indicator variable of when prices change and calculating the average of this variable. In our case, this process is complicated by three features of the data. First, the data contain missing values as a consequence of stockouts. For missing values, our baseline procedure is the following. If a product's price is observed in two consecutive months, and the price differs between the two months, we define this as a price change; if the price is the same in the two months, we define this as no change. However, if either the current price or the price in the previous month are missing, we record a missing value in our price change indicator variable.

Second, the BLS field agents will sometimes need to substitute a closely related item for the item they have been sampling. This may occur because the item that was being sampled is no longer being sold at the outlet or has been replaced by a new version. In our baseline procedure, we record a missing value in our price change variable when a product substitution occurs. Our baseline frequency of price change estimates therefore measure the frequency of price change for identical products. However, we also report estimates of the frequency of price change including price changes due to product substitutions.

Third, as in Bils and Klenow (2004), Klenow and Kryvtsov (2005) and Midrigan (2005), we would like to construct statistics for price changes excluding retail sales. The BLS reports for each price observation in the CPI Research Database whether the product was on sale when its price was collected. We use this "sale flag" to identify retail sales. Our baseline procedure for calculating the frequency and size of price changes excluding sales—which we refer to as regular price changes—is to drop sale observations from the data set and calculate the frequency and size of price changes as described above on the remaining observations.[10]

Figure 1 graphically illustrates our baseline methodology for dealing with missing values and sales. The two panels in the figure report the first 10 observations for two hypothetical products. At the top of each panel, we record the value of the sale flag variable for these 10 observations. The letter "R" denotes "regular price" while the letter "S" denotes "sale". Below the sale flag is a graph of the evolution of the price of the product for these 10 observations. At the bottom of each panel, are two indicator variables that record price changes and regular price changes, respectively. First, notice that the price change variable and the regular price change variable are missing for the first observation. This is because the price in the previous month is not observed. Second, notice that the fifth price observation is missing. This yields two missing values in the price change variables. Third, notice that for the 8th observation the sale flag indicates that this price observation is a sale. In both panels, the sale yields two price changes in the "raw" price change variable. However, dropping the sale observation from the data set yields two missing observations for the regular price change variable.

The key difference between the two panels is that in panel B a regular price change occurs during the sale. It may at first seem that our procedure necessarily underestimates the frequency of regular price change because it does not count regular price changes during sales. In this regard, it is important to consider that while our procedure causes us to drop a price change in the situation

[10] We also investigated the effect of using a "sale filter" (described in Nakamura and Steinsson, 2006b) to identify additional sales. This procedure yielded very similar results to using the BLS sale flag alone.

depicted in panel B, it also causes us to drop a no change in the situation depicted in panel A. If the frequency of regular price change is the same during sales as it is in other periods, our measure of the frequency of regular price change is a good measure of the overall frequency of regular price change. We consider two alternative procedures for accounting for regular price changes during sales below.

Our baseline approach has the appealing feature that it does not impose any a priori assumptions on the hazard function of price changes across months. The drawback of this is that it does not use information in the data set about price changes and the absence of price changes when observations are missing. This means that in our baseline results we completely throw out all the bimonthly data in the data set as well as information from non-contiguous data points in the monthly part of the data set. As a robustness test, we compared the bimonthly frequency of price change in the portion of our dataset that is sampled bimonthly to the bimonthly frequency of price change in the portion of our dataset that is sampled monthly. We found that the bimonthly frequency of price change is slightly lower in the bimonthly data than the monthly data.

3.1 The Frequency of Price Change

Table 1 reports our estimate of the median frequency of price change for non-shelter goods and services in the CPI. This statistic is estimated by first calculating the mean frequency of price change for each ELI and then taking a weighted median across ELIs. For raw prices, the median frequency of price change in 1998-2005 is 19.4%, while it is 20.3% in 1988-1997. We define the corresponding median implied duration to be $d = -1/\ln(1-f)$, where f is the median frequency.[11] Measured in this way, the median implied duration of raw prices in 1998-2005 was 4.6 months, while it was 4.4 months in 1988-1997. Table 1 also reports the median frequency of price change when sales are dropped from the data set. The median frequency of regular price change is 8.7% in 1998-2005 and 11.1% in 1988-1997. The corresponding median implied durations are 11.0 months in 1998-2005 and 8.7 months in 1988-1997.

Bils and Klenow (2004) report that the median frequency of price change including price changes that occur because of product substitution in 1995-1997 was 20.9%. The corresponding median

[11] A constant hazard λ of price changes implies a monthly probability of a price change equal to $f = 1 - e^{-\lambda}$. This implies $\lambda = -\ln(1-f)$ and $d = 1/\lambda = -1/\ln(1-f)$. An alternative definition for the implied duration is $\tilde{d} = 1/f$. This definition would be appropriate if prices changed at most once in any month. It leads to a slightly longer estimate of the implied duration. See Dias et al. (2004) for a detailed discussion of this issue.

implied duration is 4.3 months. Our results differ from those of Bils and Klenow for three reasons. First, our sample period is different from theirs. Second, their estimates include price changes due to product substitutions, while our baseline estimates do not. Third, we account for sales at the product level, while their results include price changes due to sales. Table 2 decomposes the difference between our results and those of Bils and Klenow into these three components. Since the implied duration is a non-linear function of the frequency of price change, the decomposition depends on the order in which these three features are considered. In all four cases, including sales roughly doubles the frequency of price change.

Adjusting for sales makes such a large difference not only because sales are common in the data—21.5% of price changes are due to sales (table 3)—but also because of the uneven distribution of sales across goods. Table 4 reports the fraction of price change due to sales by Major Group. Clearly there is a huge amount of heterogeneity across Major Groups regarding the prevalence of sales. On the one extreme, 87.1% of price changes in Apparel and 66.7% of price changes in Household Furnishings are due to sales. On the other, virtually no price changes in Utilities and Vehicle Fuel are due to sales and only 3.1% of price changes in Services—a category that has an expenditure weight of 38.5%—are due to sales.

From table 4 we see that the sectors that have relatively few sales tend to be the sectors with either very high (Utilities, Vehicle Fuel and Travel) or very low (Services) unadjusted frequency of price change. The sales adjustment is therefore concentrated in sectors that start off with a frequency of price change that is relatively close to the median frequency of price change. This heterogeneity in the prevalence of sales implies that the median frequency of price change drops by 55.2% relative to the number for prices including sales, rather than 21.5%.

Because of data limitations, Bils and Klenow (2004) were not able to adjust for sales at the product level. Instead, they provide an alternative statistic that is calculated by adjusting the median frequency of price change by the fraction of price changes due to sales in the entire data set. This procedure yields an estimate of the sales adjusted median duration of 5.5 months. It is valid under the assumption that sales account for the same fraction of price changes in all sectors. As we discuss above, this assumption is dramatically at odds with the data.

To see more clearly how heterogeneity in the prevalence of sales across sectors can lead to a large adjustment in the median frequency of price change, consider the three sector example presented in table 5. Suppose the three sectors in the economy are services, food and gasoline. Each has an expenditure weight of 1/3. Prices of services change once a year and have no sales. Prices of food change every other month, but 3/4 of these price changes are sales. The price of gasoline changes every month and gasoline never goes on sale. In this example—as in our data—sales are concentrated in the sector that is in the middle of the distribution of price change frequency. Adjusting for sales sector by sector yields a median frequency of regular price change of 1/8 and a median duration of 8 months.[12] However, a researcher that only knew that the overall fraction of price changes due to sales in the entire economy is 3/12 and adjusted the frequency of price change in all sectors using this number would conclude that the median frequency of price change is 3/8 and the median duration is 2.67 months.

Following Bils and Klenow (2004) and Dhyne et al. (2006), we have adopted a frequency based approach to estimating the median duration of price changes. A more direct approach would be to record the duration of each price spell and then find the weighted median duration across all price spells. However, the presence of a large number of censored price spells complicates this approach. To account for right-censoring, one must estimate a hazard model. This is complicated by several features of the data, including heterogeneity. Left censoring is even more problematic. The standard practice in the duration literature is to drop left-censored spells. This introduces an initial conditions problem that biases the estimated duration downward in the presence of heterogeneity (Heckman and Singer, 1986). Intuitively, longer spells are more likely to be left-censored.

So far, we have focused on the frequency of price change for identical products, not counting product substitions as price changes. In some product categories the prevalence of product substitutions may provide an imperfect measure of the prevalence of the introduction of new products. Since product introductions are associated with pricing decisions, the prevalence of product introductions in a particular product category may provide a useful additional measure of the frequency with which pricing decisions are made in that product category. However, since decisions about product introduction and product termination are largely motivated by other factors than a firm's desire to set a new price, pricing decisions that occur at the time of product introduction are not equivalent to price changes that occur primarily because a firm's existing price is far from its current desired price. Price changes due to product introduction are more akin to Calvo-type random

[12] For simplicity, we assume that only one price change can occur per month in this example.

opportunities to change prices.

In tables 1 and 4 we report the frequency of price change including price changes due to product substitutions. Consistent with the results of Bils and Klenow (2004), we find that in most product categories including price changes associated with substitutions has little effect. The main exception is Apparel where including price changes associated with substitutions raises the frequency of regular price change from 3.6% to 8.1%.

Table 6 presents statistics on the median frequency of price change for producer prices at three different stages of processing: finished goods, intermediate goods and crude materials. The median frequency of price change of finished producer goods in 1998-2005 is 10.8%. The corresponding median implied duration is 8.7 months. The median frequency of price change of intermediate goods in 1998-2005 is 13.3% and the corresponding median implied duration is 7.0 months. In contrast to finished goods and intermediate goods, crude materials seem to have almost completely flexible prices. The median frequency of price change of crude materials in 1998-2005 is 98.9% and corresponding median implied duration is 0.2 months. Sales do not appear to be common in our producer price data set.[13] We therefore make no adjustment for sales when analyzing producer prices.

In the PPI, a relatively small (value-weighted) fraction of the categories have a frequency of price change close to the median. Most of the categories with frequencies of price change above the median, have frequencies of price change substantially higher than 10%. As a consequence, the 55th percentile is 18.7% for 1998-2005, while the median is 10.8%. In contrast, for the CPI the 55th percentile is 10.1% for 1998-2005, while the median is 8.7%.

There is a large amount of heterogeneity across sectors in the frequency of price change. Table 4 documents this for Major Groups in our sample of consumer prices. This heterogeneity is even more evident in table 16, which reports the frequency of price change in consumer prices by ELI. Some goods—such as gasoline—have virtually completely flexible prices, while others—such as legal services—have extremely rigid prices. We find that the same is true for producer prices. Table 7 reports results on the frequency of price change of producer prices by two digit Major Groups. As in the case of consumer prices, there is a large amount of heterogeneity across sectors.[14]

[13] The PPI database does not include a sales flag. We used the sales filter described in Nakamura and Steinsson (2006b) to assess the importance of sales in the producer price data. This sales filter identified very few sales.

[14] More detailed statistics on the frequency of price change for producer prices by four digit product-code will be available in an appendix on our websites.

The finding that finished goods producer prices exhibit a substantial degree of rigidity confirms for a broader set of products the results of a number of previous studies. Blinder et al., (1998) surveyed firm managers about their pricing practices and found that prices changed on average once a year. Carlton (1986) estimated the rigidity of prices in the Stigler-Kindhal data set. He also found a substantial degree of price rigidity. Most of the prices analyzed in these studies were producer prices.

Interpreting this evidence is, however, more complicated than interpreting evidence on consumer prices. Buyers and sellers often enter into long-term relationships in wholesale markets. It is therefore possible that buyers and sellers enter into long-term "implicit contracts" in which observed transaction prices are essentially payments on a "running tab" that the buyer has with the seller (Barro, 1977). In such cases, the buyer would perceive a marginal cost equal to the shadow effect of purchasing the product on the total amount he would eventually pay the seller. But this shadow price would be unobserved. Of course, it is not clear why buyers or sellers would choose to enter into such implicit contracts, or how and why they then choose to subsequently uphold them. In this type of situation retail prices would react to changes in manufacturer price even if wholesale prices did not change.

3.2 The Relative Frequency of Price Increases and Price Decreases

Most models of price rigidity make the simplifying assumption that price changes occur only in response to aggregate shocks.[15] With even a modest amount of inflation, these models imply that almost all price changes are price increases. Table 1 shows that this assumption is far from being realistic. The weighted median fraction of regular price changes in consumer prices that are price increases is 64.8%, while the weighted median fraction of price changes including sales that are increases is 57.1%.[16] Table 6 shows that the same pattern emerges for producer prices. The fraction of price changes in producer prices are increases is 60.6%. This result has important implications for the calibration of models of price rigidity. Along with the large average size of price changes—emphasized by Golosov and Lucas (2006)—it provides strong evidence for the hypothesis that idiosyncratic shocks are an important driving force of price changes.

[15] Examples include, Taylor (1980), Calvo (1983), Caplin and Spulber (1987), Dotsey et al. (1999) and Mankiw and Reis (2002). A notable exception is Golosov and Lucas (2006).

[16] These statistics are calculated as follows. First, we calculate the fraction of price changes that are increases by ELI. Then, we calculate the weighted median of these statistics across ELI.

3.3 The Size of Price Changes

Tables 8 and 9 report the median absolute size of log changes in consumer prices and finished goods producer prices, respectively. For consumer prices excluding sales, the median absolute size of price changes is 8.5%, while it is 7.7% for finished goods producer prices.[17] These tables also report the absolute size of price change by Major Group. Price changes that are due to sales in consumer prices are on average much larger than regular price changes. Table 8 reports that the median absolute size of price changes due to sales is 29.5%, more than three times the size of regular prices.

Another result that emerges from tables 8 and 9 is that the median size of price decreases is 3.2 percentage points larger than the median size price increases for consumer prices and 1 percentage points larger for producer prices. The median size of price decreases is larger than that of price increases for 10 of 11 Major Groups for consumer price and 11 of 15 Major Groups for producer prices.

3.4 The Behavior of Prices During and After Sales

Most of the existing literature on menu cost models does not attempt to fit the behavior of retail sales. Rather, this literature seeks to fit the behavior of prices excluding sales (see, e.g., Golosov and Lucas, 2006; and Midrigan, 2005). Explanations for sales may be grouped into two categories. First, sales arise due to intertemporal price discrimination of retail outlets (Varian, 1980; Sobel 1984). Price changes due to this type of sales are plausibly orthogonal to macroeconomic aggregates. Second, sales are also used as a method for inventory management (Lazear, 1986; Aguirregabiria, 1999). Sales of this type are related to the macroeconomy to the extent that inventory is cyclical. Not all clearance sales are due to variation in aggregate demand. In some products—such as apparel—clearance sales may occur due to unpredictable shifts in tastes rather than shifts in aggregate demand (Pashigian, 1988). Pashigian and Bowen (1991) argue that price discrimination and clearance sales due to uncertainty about tastes account for most sales. Hosken and Reiffen (2001) document that sales are uncorrelated across retail outlets. They interpret this as evidence that retail sales are not primarily driven by changes in wholesale prices.

Sales are different from regular prices along important dimensions. Some features of sales seem

[17] For consumer prices, this statistic is calculated by finding the average log change in price by ELI and then taking the weighted median across ELI's. For producer prices, this statistic is calculated by finding the unweighted mean within 4 digit product code and then taking the weighted median across 4 digit product codes.

inconsistent with the menu cost paradigm. Table 10 documents a feature of sales that is particularly difficult to reconcile with the menu cost paradigm, namely, the fact the price of a product usually returns to its original regular price following a sale. The table presents statistics on sales for the 4 Major Groups for which sales are most important. For these 4 Major Groups, prices return to their original regular price between 53.7% and 85% of the time after a one period sale. This fraction is highly negatively correlated with the frequency of regular price change. The fact that prices of Unprocessed Foods return to their original level after sales only 53.7% of the time may seem low. However, given that the frequency of regular price change in Unprocessed Food is 25%, even if all sales in this Major Group last only one month the probability that the regular price does not change between the month before the sale and the month after the sale is 56.3%.[18]

We use these statistics to compare the frequency of regular price change during sales and the frequency of regular price change during non-sale periods. We calculate the fraction of one-period sales that have a different regular price immediately following the sale than immediately preceding the sale. From this number we calculate the monthly frequency of price change under the assumption that the hazard of price change was constant during this two month period. The resulting statistic is reported in column 2 of table 10. We find that the frequency of regular price change is slightly higher during sale periods than during other periods. The simple average of the difference across these 4 Major Groups is 1.9 percentage points.

We can adjust our statistics on the frequency of regular price change for the higher frequency of regular price change during sales using the formula $(1-s)f + sf'$, where s is the fraction of price change observations corresponding to sales, f is the original measure of price change frequency and f' is an imputed price change frequency from the fraction of prices changing during one and two month sales.[19] The median frequency of price change, adjusted in this way for regular price change during sales, is reported in table 11. For the period 1998-2005 it is 10.2%, while it is 9.8% for the period 1988-1997.

Our benchmark statistics do not include price changes straddling stockouts, as in Bils and Klenow (2004). We can use a similar procedure to analyze these types of price changes as the

[18] These statistics probably underestimate the fraction of sales that return to the regular price since they are based on monthly statistics. Sales shorter than one month may revert to the original price, and then experience a regular price change.

[19] We calculate $f' = f_1'\omega_1 + f_2'(1-\omega_1)$, where f_1' is the monthly frequency of price change during one period sales, f_2' is the monthly frequency of price change during two period sales and ω_1 is the fraction of sales that are one period sales.

procedure used for sales above. As in the case of sales, the monthly frequency of price change straddling missing spells is several percentage points higher in some categories than the frequency of regular price changes during other periods. Table 11 reports the frequency of price change allowing for a different frequency of regular price change during sales and stockouts. We apply the formula $(1-s)f+sf'$, where s is the fraction of price change observations corresponding to sales or stockouts lasting 5 periods or less, f is the original measure of price change frequency and f' is an imputed price change frequency from the fraction of prices changing during one and two month sales/stockout periods. We calculate f' using an analogous method to the one described for sales in the paragraph above. The resulting median frequency of price change is 9.6% for the 1998-2005 period and 11.8 for the 1988-1997 period. As in the case of substitutions, stockouts are partly motivated by other factors than a firm's desire to change its regular price. Price changes straddling stockouts may therefore be more akin to Calvo-type random opportunities to change prices than to the type of price changes that occur in a menu cost model.[20]

The last procedure we consider to adjust the frequency of price change for price changes during sales and stockouts is the following simple procedure. We simply carry forward the regular price during sales and stockouts, so long as the sale/stockout spell lasts 5 periods or less. This procedure is similar to the procedure used by Klenow and Kryvtsov (2005). Table 11 reports the results of this procedure. The median frequency of price change is 9.0% for the 1998-2005 period and 11.2% for the 1988-1997 period.

3.5 Frequency of Price Change: CPI vs. PPI

In order to compare price flexibility at the consumer and producer levels, we matched 153 ELI's from the CPI with product codes from the PPI [21] Table 12 presents comparisons between the frequency of price change at the consumer and producer level for the Major Groups in which a substantial number of matches were found. In all the Major Groups except Unprocessed Food, the median duration of producer prices is similar to the median duration of consumer prices excluding

[20] Table 11 also reports the median frequency of price change including price changes associated with substitutions for both the sales adjustment and the stockout adjustment for both time periods. In most cases, the inclusion of these price changes raises the overall frequency of price change by 1 to 2 percentage points.

[21] 42 ELI's were matched to PPI categories at the 8 digit product-code level, 71 ELI's were matched to PPI categories at the 6 digit product-code level and 40 ELI's were matched to PPI categories at the 4 digit product-code level. When an ELI was matched to a PPI category at, for example, the 6 digit product code level, the unweighted median of the mean frequency of price change of item codes within that 6 digit product code was used.

sales, but substantially longer than the median duration of raw consumer prices. For example, for Processed Food, we find that the median duration is 13.4 months for producer prices, 9.0 months for regular consumer prices and 3.3 months for consumer prices including sales. Similarly, for Household Furnishings, we find that the median duration is 17.3 months for producer prices, 14.9 months for regular consumer prices but only 3.8 months for consumer prices including sales. Over all 153 matches, the correlation between the frequency of price change for producer prices and regular consumer prices is 0.83, while the correlation for producer prices and raw consumer prices is 0.64.

4 A Benchmark Menu Cost Model

The facts we have established can help distinguish between different models of price setting behavior. We focus on a benchmark version of the menu cost model developed by Barro (1972), Sheshinski and Weiss (1977) and Golosov and Lucas (2006). We analyze whether the facts established in the preceding section are consistent with this model and what they imply about the values of its key parameters.

Consider the pricing decision of a single firm. This firm produces a good using a linear technology

$$y_t(z) = A_t(z)L_t(z), \tag{1}$$

where $y_t(z)$ denotes the output of the firm in period t, $A_t(z)$ denotes the productivity of the firm's labor force in period t and $L_t(z)$ denotes the quantity of labor hired by the firm for production purposes in period t. Assume that demand for the firm's good is

$$c_t(z) = C\left(\frac{p_t(z)}{P_t}\right)^{-\theta}, \tag{2}$$

where $c_t(z)$ denotes the quantity demanded of the firm's good in period t, $p_t(z)$ denotes the nominal price the firm charges in period t, P_t denotes the price level in period t and C is a constant which determines the "size of the market" for the firm's good. In order to generate price rigidity, we assume that the firm must hire an extra K units of labor in order to change its price.

For simplicity, we assume that the real wage rate in the economy is constant and equal to

$$\frac{W_t}{P_t} = \frac{\theta - 1}{\theta}, \tag{3}$$

where W_t denotes nominal wage rate in the economy at time t.[22]

Written in real terms, the firm's profit at time t is then given by

$$\Pi_t(z) = \frac{p_t(z)}{P_t} c_t(z) - \frac{W_t}{P_t} L_t(z) - K \frac{W_t}{P_t} I_t(z),$$

where $I_t(z)$ is an indicator variable that is equal to one if the firm changes its price in period t and zero otherwise. Using equations (1), (2), (3) and the fact that markets clear we can rewrite real profits as

$$\Pi_t(z) = C \left(\frac{p_t(z)}{P_t} \right)^{-\theta} \left(\frac{p_t(z)}{P_t} - \frac{\theta - 1}{\theta} \frac{1}{A_t(z)} \right) - \frac{\theta - 1}{\theta} K I_t(z), \tag{4}$$

Assume that the logarithm of productivity of the firm's labor force follows an AR(1) process:

$$\log(A_t(z)) = \rho \log(A_{t-1}(z)) + \epsilon_t(z), \tag{5}$$

where $\epsilon_t(z) \sim \mathrm{N}(0, \sigma_\epsilon^2)$ is an idiosyncratic productivity shock.

Assume that the logarithm of the price level fluctuates around a trend:

$$\log P_t = \mu + \log P_{t-1} + \eta_t, \tag{6}$$

where $\eta_t \sim \mathrm{N}(0, \sigma_\eta^2)$.

The firm maximizes profits discounted at a constant rate β. The value function of the firm is given by the solution to

$$V(p_{t-1}(z)/P_t, A_t(z)) = \max_{p_t(z)} \left[\Pi_t(z) + \beta E_t V(p_t(z)/P_{t+1}, A_{t+1}(z)) \right],$$

where E_t denotes the expectations operator conditional on information known at time t. The firm's problem has only two state variables—$p_{t-1}(z)/P_t$ and $A_t(z)$. This follows from two facts. First, profits are a function only of these two variables and the choice variable $p_t(z)$. Second, given equations (5) and (6), future values of $p_{t-1}(z)/P_t$ and $A_t(z)$ depend only on their current values, the choice variable and future shocks. We solve the firm's problem by Value Function Iteration on a grid. We approximate the processes for $A_t(z)$ and P_t using the method proposed by Tauchen (1986).

[22] In a general equilibrium model with linear disutility of labor and constant aggregate consumption, the real wage would be equal to $W_t/P_t = \alpha U_C(C_t)$, where α is the marginal disutility of labor. Under the additional assumption that prices are flexible, $W_t/P_t = (\theta-1)/\theta$. More generally, if the degree of monetary non-neutrality is small, variation in C_t will be small and the real wage will be approximately constant.

The solution to the firm's problem depends on the parameters of the model: β, θ, K/C, μ, ρ, σ_ϵ and σ_η. We set the monthly discount factor equal to $\beta = 0.96^{1/12}$. We choose $\theta = 3$ to roughly match estimates from the industrial organizations literature on markups of price over marginal costs.[23] We estimate $\mu = 0.0021$ and $\sigma_\eta = 0.0032$ from data on the CPI from 1998-2005. This sample period was chosen to correspond to the more recent sample period for which we report result from the CPI Research Database.

We choose the remaining three parameters to match our estimates of the frequency of price change, the fraction of price changes that are price increases and the size of price changes in 1998-2005. We minimize the squared deviations of the model implied values of these moments from their estimated values in the data. Using this loss function, the parameters are well identified. Since we are able to exactly match all three parameters, the relative weights on different parameters in the loss function do not matter.

We first consider a version of the model without idiosyncratic shocks. We set $K/C = 0.0025$ to match the 8.7% average frequency of price change observed in consumer price in 1998-2005. Figure 2 shows a typical 12 year sample simulated from the model under these assumptions about the parameters. Without idiosyncratic shocks, the model has the counterfactual prediction that 99.9% price changes are price increases. It also implies price changes that are much smaller on average than the what we observe in the data. The average absolute size of price changes in this case is 2.3% compared with a median absolute size of 8.5% in the data.

Golosov and Lucas (2006) argue that these counterfactual predictions imply that idiosyncratic shocks must play an important role in determining when and how much prices change. Building on their example, we recalibrate the model with idiosyncratic shocks to fit not only the frequency of price change but also the fraction of price changes that are increases and the median absolute size of price changes. The parameter values that imply that the model matches the data along these three dimensions are $K/C = 0.0188$, $\rho = 0.650$, $\sigma_\epsilon = 0.0435$. Figure 3 shows a typical 12 year sample simulated from the model calibrated in this way. Large idiosyncratic shocks relative to the rate of inflation imply that a substantial fraction of price changes are price decreases. Large idiosyncratic shocks also imply larger price changes. The size of price changes is also affected by

[23] Berry et al. (1995) and Nevo (2001) find that markups vary a great deal across firms. The value of θ we choose implies a markup close to the median markup found by Nevo (2001) but towards the high end of the markups estimated by Berry et al. (1995). Midrigan (2005) uses $\theta = 3$ while Golosov and Lucas (2006) use $\theta = 7$. The value of θ is not important for the points we make in this paper.

the persistence of the idiosyncratic shocks. The size of price changes is smaller the more persistent the idiosyncratic shocks since firms are more willing to incur the menu cost the more permanent they perceive the change in costs to be.

We can now test the model calibrated in this way by seeing how well it can account for other empirical features of price change. In the next three sections, we present several new empirical facts about price change and consider how well they line up with the implications of the model presented above.

5 Inflation and the Frequency of Price Change

The frequency of price change is not constant over time. As the rate of inflation varied over the period 1988-2005, the frequency of price change varied systematically along with it. This empirical result, which we document in this section, provides a natural test for our menu cost model.

5.1 Consumer Prices

We analyze the evolution of four components of aggregate inflation: the median frequency of price increases, the median frequency of price decreases, the median absolute size of price increases and the median absolute size of price decreases.[24] Figures 4 and 5 plot the annual evolution of these four series along with the evolution of CPI inflation.[25] Of these four components of aggregate inflation, only the frequency of price increases displays a strong systematic relationship with inflation. In contrast, the frequency of price decreases and the size of price increases and price decreases respond much less to variations in inflation.

The correlation between the frequency of price increases and inflation is 0.81. Furthermore, a regression of the median frequency of price increases on aggregate inflation over the period 1988-2005 indicates that a 1 percentage point increase in the inflation rate is associated with approximately a 1 percentage point increase in the median frequency of price increases. A back-of-the-envelope calculation indicates that the variation in the frequency of price increases is large

[24] Gagnon (2005) has emphasized the importance of distinguishing between price increases and price decreases in this context. Analyzing disaggregated Mexican consumer price data, he found that at low levels of inflation the overall frequency of price change responded little to inflation because movements in the frequency of price decreases partly offset movements in the frequency of price increases.

[25] As in section 3, these statistics are calculated by first calculating the mean frequency (size) within each ELI and then finding the weighted median across ELIs.

enough to account for most of the variation in aggregate inflation. A 1 percentage point increase in the monthly frequency of price increases, is associated with an increase of 0.1 percentage points in monthly inflation (since the average size of price increases is approximately 10%). This corresponds to approximately a 1 percentage point increase in annual inflation.

Table 13 conveys through regressions what figures 4 and 5 convey graphically. We regress the four components on the CPI inflation rate at the ELI-level. The regressions include ELI fixed effects and a time trend. We run such regressions both including and excluding sales and separately for 1988-1997 and 1998-2005 due the change in the ELI definitions that occurred in 1998. The response of the frequency price increases to inflation is always positive and statistically significant. The response of price decreases to inflation is always negative and statistically significant for regular price decreases. In contrast, the coefficients on the absolute size of price increases and decreases are inconsistent and never significantly different from zero.

Figures 6 and 7 compare the response of these variables in the model to their response in the data. We simulated the model 100,000 times for the actual evolution of the CPI over 1988-2005 and calculated the average frequency and size of price increases and decreases by year. Just as in the data, the frequency of price increases in the model responds much more strongly to inflation than the frequency of price decreases and the size of price increases and price decreases. For robustness, we also carry out this exercise in the general equilibrium model presented in Nakamura and Steinsson (2006a) and get virtually identical results.

The greater responsiveness of the frequency of price increases than the frequency of price decreases is a consequence of the fact that the price level is drifting upward. Positive inflation implies that the distribution of relative prices is asymmetric with many more prices bunched up towards the lower sS bound than the upper sS bound. The bunching toward the lower sS bound implies that the frequency of price increases responds more than the frequency of price decreases to shocks to the price level.

Figure 7 shows that the model also matches the fact that the median size of price decreases is larger than that for price increases. Ellingsen et al. (2006) show that this asymmetry can arise because the firm's profit function is asymmetric when the elasticity of demand for it product is constant. The relative size of price increases and price decreases also depends on the steady state rate of inflation. As the steady state rate of inflation rises the size of price increases eventually becomes larger than the size of price decreases.[26]

If new technologies cause the fixed costs of changing prices to fall, the frequency of price change should be increasing over time, other things equal. Figure 6 shows that we find no evidence of this phenomenon. To the contrary, our menu cost model with a constant menu cost is able to roughly match the evolution of the frequency of price change over the period 1988-2005 when we take into account the evolution of inflation.

The finding that the frequency of price changes is more responsive to variation in the inflation rate than the size of price changes is consistent with a number of previous empirical studies. Vilmunen and Laakkonen (2004) and Gagnon (2005) provide direct evidence for this phenomenon. Lach and Tsiddon (1992), Cecchetti (1986), Kashyap (1995), and Goette et al. (2005) all find that inflation has a substantial effect on the frequency of price change, but a much weaker effect on the absolute size of price changes. These facts have sometimes be interpreted in the context of Sheshinski and Weiss' (1977) findings on the relationship between a constant inflation rate and the size and frequency of price changes. In contrast, we consider the effects of stochastic variation in the frequency of price change on the size and frequency of price changes, holding fixed the mean inflation rate.

Klenow and Kryvtsov (2005) find that most of the variation of aggregate inflation stems from variation in the average size of price changes. At first glance, our results may seem to contradict theirs. Notice, however, that the average size of price change may be decomposed as $s_{all} = f_u s_u - f_d s_d$, where f_u and f_d denote the frequency of price increases and price decreases, respectively, and s_u and s_d denote the size of price increases and price decreases, respectively. We find that the frequency of price increases f_u is an important driving force behind variation in the average size of price changes.

5.2 Producer Prices

The response of producer prices to variation in inflation is similar to the response of consumer prices excluding sales. Table 14 reports regressions of the frequency and size of price increases and price

[26] A alternative explanation for the fact that price decreases are larger than price increases in the data is that we may have failed to filter out all sales. Recall from section 3.3, that the absolute size of sales is on average 2-3 times larger than the absolute size of regular price changes. If each sale involves one price increase and one price decrease but the frequency of regular price increases is larger than the frequency of regular price decreases, this could explain the larger observed average size of price decreases.

decreases on CPI and PPI inflation. We regress the four components on CPI and PPI inflation separately at the four digit level for the period 1988-2005. The regressions include product fixed effects and a time trend. The frequency of price increases is highly responsive to both inflation rates. The other three components of inflation are, however, not related to inflation in a statistically significant way.

5.3 Sales

The evolution of sales over the past two decades has been entirely different from the variation in the frequency of regular price changes. Figure 8 shows the annual evolution over the period 1988-2005 of the median fraction of price quotes that are sales for the four Major Groups for which sales are most important. There has been a remarkable increase in the frequency of sales over this period. The frequency of sales increases substantially in all four categories, doubling in both processed food and apparel. Figure 9 presents a similar graph for the size of sales.[27] The average size of sales has also increased substantially over the sample period in all of the categories except for household furnishings. The increase is most dramatic in processed food, where the size of sales has nearly doubled from about 20% to almost 40%. These facts extend the results of Pashigian (1988), who documented how the frequency and size of sales began trending upward in the 1960's.

As we discuss above, it is standard practice in macroeconomics to ignore sales. This is an innocuous practice as long as sales are orthogonal to macroeconomic factors. If firms, however, vary the frequency and/or size of sales in response to movements in inflation or aggregate demand, ignoring sales may be seriously misleading. The dramatic increase in the prevalence of sales over the last 20 years makes this concern all the more important.

Table 15 presents the results of regressions of the frequency and size of sales on CPI inflation, ELI fixed effects and a time trend. We do not find robust evidence of a relationship between either the size or frequency of sales and aggregate variables. For both 1988-1997 and 1998-2005, we find a negative coefficient on the inflation rate, but neither coefficient is statistically significant at the 5% level. This suggests that a small effect may exist, but greater variation in desired prices than is generated by the variation in aggregate inflation over our sample period may be necessary to

[27] The size of a sale is measured as the absolute change in prices at the start of a sale (when the sale flag switches from "R" to "S") or at the end of a sale (when the sale flag switches from "S" to "R"). Only sales in which prices before or after the sale are observed are included in this calculation. We found no significant difference between the size of the price decrease at the beginning of sales and the size of the price increase at the end of sales.

identify it.

6 Seasonality of Price Changes

The synchronization or staggering of price change plays a crucial role in the ability of many dynamic pricing models to match the size and persistence of business cycles. One form of synchronization of price change is seasonality. Analyses of price change behavior have often discussed the existence of a "pricing season". Yet the magnitude of this phenomenon, and the extent to which the pricing seasons are coordinated across firms, have not previously been documented. We find a substantial seasonal component of price changes for the US economy, for both consumer and producer goods.

6.1 Consumer Prices

Figure 10 presents the weighted median frequency of price change by quarter for consumer price excluding sales over the period 1988-2005. Consumer prices changed almost 30% more often in the first quarter than in the fourth quarter, declining monotonically over the four quarters. We also find a seasonal pattern within quarters. Figure 11 presents the frequency of price change by month for consumer prices. The figure shows that in all four quarters, the frequency of price change is largest in the first month of the quarter and declines monotonically within the quarter. This gives rise to the pattern of local peaks in the frequency of price change in January, April, July and October. Our findings are in line with Álvarez et al. (2005b), which finds that prices are significantly more likely to change in January in the Euro Area.

Price increases play a disproportionate role in generating seasonality in price changes. Figure 12 presents the weighted median frequency of price increases and decreases by month. The decline in the frequency of price increases between the first and fourth quarter is 1.9 percentage points, or 25%. In contrast, price decreases decline by 0.6 percentage point, or 18%, between the first and last quarter.

6.2 Producer Prices

The quarterly seasonal pattern in producer prices mirrors the seasonal patters in consumer prices qualitatively, but is substantially larger. Figure 13 presents the frequency of price change by quarter for finished producer goods. The frequency of price change falls monotonically over the quarters, from 16% in the first quarter to 8% in the fourth quarter. Figure 14 plots the weighted median frequency of price increases and price decreases by month for producer prices. Most of the seasonality in the frequency of price change in producer prices is due to the fact that producer prices are more than twice as likely to change in January than on average in other month of the year. As in consumer prices, most of the seasonality in the frequency price change comes from the frequency of price increases.

Olivei and Tenreyro (2005) show that the real effects of monetary policy shocks differ depending on the quarter of the year in which the shock hits. Monetary policy shocks that occur in the first half of the year have larger real effects than monetary policy shocks that occur in the second half of the year. They discuss anecdotal evidence that wages are negotiated disproportionately towards the end of the year in the U.S. economy with the new wage becoming effective at the beginning of the next year. They argue that this seasonality in the flexibility of wages can explain their empirical findings.

Our finding that the frequency of price change is highest in the first quarter may seem to contradict this story. However, if firms also disproportionately make decisions about price changes toward the end of the calander year with the new price becoming effective at the beginning of the new year, we would observe a disproportionate number of price changes in January. This is exactly what we observe—especially for producer prices. Since these price changes occur at the beginning of the first quarter, they do not reflect any monetary shock that might occur in that quarter. Of course, seasonality in price-setting may, in part, be an allocative effect of seasonality in wage setting.

6.3 Sales

The seasonal pattern in sales is very different from the seasonal pattern in regular price changes. Figure 15 plots the fraction of price quotes that are sales by month for the four Major Groups for with sales are most important. The Major Group with by far the most seasonal variation in sales is Apparel. The frequency of sales is about 10 percentage points higher in Apparel in December, January and June than in the months with the least sales. However, even in these other months, more than 25% of price quotes are sales in Apparel. The yearly winter and summer sales are clearly not the only sales in Apparel. The 10% point difference between the month with most sales and the month with least sales in Apparel has remained roughly unchanged between 1988-1997 and 1998-2005 while the overall level of sales in Apparel has increased dramatically. Today a higher fraction of clothes are on sale in April and October than were on sale in January and June in 1988. In contrast to Apparel, we find much less seasonality in sales in other Major Groups.

7 The Hazard of Price Changes

Are prices that have recently changed more likely than others to change again? Or is it the case that prices become more likely to change the longer they have remained unchanged? These questions are essentially questions about the shape of the hazard function of price change. Let T be a random variable that denotes the duration of a generic price spell. In discrete time, the hazard function is defined as

$$\lambda(t) = \mathrm{P}(T = t | T \geq t).$$

In other words, the hazard of a price change at time t is the probability that the price will change after t periods given that it has survived for t periods. If prices become more likely to change the longer they have remained unchanged, the hazard function of price change is upward sloping.

In a menu cost model, non-stationarity of marginal costs—e.g. due to inflation—gives rise to an upward sloping hazard function. Figure 16 illustrates this point. It plots the hazard function implied by the menu cost model with no idiosyncratic shocks. Figure 17 illustrates how the shape of the hazard function is affected by idiosyncratic shocks. As the variance of idiosyncratic shocks rises relative to the rate of inflation, the hazard function flattens out at longer durations but remains steeply upward sloping in the first few months.[28] In contrast, the Calvo model assumes a flat hazard function of price change.

We estimate the hazard function of price change for consumer and producer prices and investigate how it lines up with the implications of our calibrated menu cost model. The main empirical challenge we face in doing this is to account for heterogeneity across products. It is well known in the literature on duration models that estimates of hazard functions based on pooled data from many heterogeneous products leads to a downward bias in the estimated slope of the hazard func-

[28] The reason why idiosyncratic shocks flatten the hazard function is that they give rise to temporary price changes that are quickly reversed. Such price changes ocurr when the idiosyncratic shock is large enough that it is worthwhile for the firm to change its price temporarily to an "abnormal" level even though it realizes that it will soon have to change it back.

tion. Even if the hazard functions of all the goods are flat or upward sloping, heterogeneity in the level of the hazard function of different products can cause the estimated hazard function to be downward sloping.

To see this, consider the following simple example. Suppose the economy consists of only gasoline and haircuts and that the true hazard function of each of these products is flat but the level of the hazard of price change for gasoline is higher than for haircuts. Suppose we pool the price data from these two products and estimate the aggregate hazard function using the non-parametric Kaplan-Meier estimator.[29] In the first month, the set of price spells at risk of ending contains both gasoline and haircut spells. The hazard estimate in the first month will, therefore, be an average of the hazard for gasoline and haircuts. As time passes, the number of gasoline spells that survive drops more quickly than the the number of haircut spells since gasoline has a higher hazard of price change. The estimated hazard function will, therefore, progressively come to reflect the hazard for haircuts. This process implies that even though the true hazard for each product is flat the estimated hazard function will be downward sloping.[30]

We account for heterogeneity in two ways. First, we divide the products in our data set into groups and estimate hazard functions separately for each group. Second, within each group we allow for unobserved heterogeneity in the level of the hazard function for each product.[31] We do this by multiplying the hazard function by a product specific random variable.[32] In addition to allowing for unobserved heterogeneity, we want to avoid imposing any a priori constraints on the shape of the hazard function. This is particularly important in our case, because we want to allow the hazard function to have spikes in certain months—e.g. a spike at 12 months—and we do not want such spikes to distort the estimation of the hazard in other months. We therefore estimate the shape of the hazard in a completely non-parametric way. We assume that the hazard function is

$$\lambda_i(t|x_{i,j}) = \nu_i \lambda_0(t) \exp(x_{i,j}\beta) \quad (7)$$

where i indexes products, j indexes observations, ν_i is a product specific random variable that

[29]The Kaplan-Meier estimator gives the fraction of price spells that end of all price spells that are "at risk" or ending, i.e., have survived up to that point. Formally, $\hat{\lambda}_{km}(t) = d_t/N_t$, where d_t denotes the number of spells that end after t months and N_t denotes the number of spells that have survived t months. Specifically, $N_t = N_{t-1} - d_{t-1} - c_t$, where c_t are the number of spells that are censored after t months.

[30]See Kiefer (1988) for a survey of hazard function estimation.

[31]An example of a "product" is 16oz Kraft Singles sold at a particular supermarket in New York.

[32]The incidental parameters problem prevents the use of fixed-effects estimators in analyzing this problem.

reflects unobserved heterogeneity in the level of the hazard, $\lambda_0(t)$ is a non-parametric baseline hazard function with dummies for each month, $x_{i,j}$ is a vector of covariates for the jth observation of products i and β is a vector of parameters.[33] We assume that $\nu_i \sim \text{Gamma}(1, \sigma_\nu^2)$. This model can be motivated by a continuous time hazard model that is observed at infrequent intervals, or simply viewed as a convenient discrete time model. It was proposed and analyzed in detail by Meyer (1986, 1990). An important advantage of our data is that we observe multiple price spells for the same product. This fact substantially enhances our ability to identify the distribution of ν_i.[34]

We estimate the model by maximum likelihood. In order to estimate this model, it is necessary to truncate the price spells at some large number: we truncate the price spells at 18 months. In estimating the model, we often encounter price spells that are left or right censored, as a consequence of missing price observations or resampling of products. We assume that the censoring process is uncorrelated with the distribution of price changes. Under this assumption, right-censored spells are easily incorporated into the likelihood function. Left-censored spells, however, cannot be incorporated without imposing further assumptions about the shape of the hazard function. We choose instead to discard left-censored spells.[35]

7.1 Hazard Functions for Consumer Prices

After dropping left-censored spells, we are left with approximately 2.75 million price spell observations. When we exclude sales as well, we are left with 1.65 million observations. We begin by estimating the Kaplan-Meier hazard function using the entire data set (figure 18). It is sharply downward sloping with a very high hazard in the first few periods. Similar estimates are presented by Klenow and Kryvtsov (2005) and Álvarez et al. (2005a).

We divide the data set into groups at two levels of aggregation. The first set of groups we consider are the Major Groups we have used throughout the paper. The second set of groups are the ELIs. The results are quite similar at these two levels of disaggregation. For simplicity, we therefore focus on the results for the Major Groups. Figure 19 contains plots of the baseline

[33] The only covariates we consider are seasonal month dummies.

[34] See Honore (1993) for a discussion of identification results for multiple spell duration models.

[35] In the presence of heterogeneity, discarding left-censored spells leads us to disproportionately drop price spells arising from subjects with low values of ν_i, since long spells are disproportionately censored (Heckman and Singer, 1986) This does not bias our results about the shape of the hazard function under the proportional hazards assumption, though it does affect the estimated level of the hazard function.

hazard function from the model described by equation (7) for the 8 of the largest Major Groups. Each panel in this figure plots the hazard function separately for prices with and without sales and separately for 1988-1997 and 1998-2005.

For most Major Groups, the hazard function of regular prices is somewhat downward sloping for the first few months and then mostly flat after that.[36] The hazard function for several Major Groups seems to be downward sloping throughout (Unprocessed Food, Transportation Goods, Vehicle Fuel and Travel Services). We do not find any evidence of upward sloping hazard functions. This pattern holds even when we estimate our hazard model separately at the ELI level.[37] For the major groups in which sales occur frequently (i.e. Processed and Unprocessed Food, Household Furnishings and Apparel), the hazard function including sales is steeply downward sloping while the hazard function of regular prices is much less downward sloping. Evidently, sales have very different hazard functions than regular price spells. For a few Major Groups, we estimate a large spike in the hazard function at 12 months. This spike is perhaps most naturally interpreted as an element of time-dependence in firms' pricing decisions. Interestingly, such a 12 month spike is completely absent in many Major Groups.

We do not include information about the standard errors of our estimates in figure 19 because the standard errors are very small. To illustrate this, figure 20 plots the hazard function for Processed Food with standard errors for the sample period 1998-2005.[38] Another way to gauge the sampling error in the estimation of these hazard functions is to compare the estimates for the two sample periods in figure 19. In most cases, the shape of the hazard function is quite similar in the first few months. However, at longer durations the differences grow and become more erratic.

As we discuss in the introduction, the existing evidence on the shape of the hazard function is mixed. Empirical support for upward sloping hazard functions appears to arise mostly in studies in which almost all price changes are increases, indicating few idiosyncratic shocks (Goette et al. 2005; and Cecchetti, 1986), or in periods of very high inflation (Gagnon, 2005).[39] These facts line

[36]This finding lines up with the existing literature on the hazard function of price change. Most papers in this literature find downward sloping hazards for the first few months. (Campbell and Eden, 2004, Baumgertner et al., 2005) However, Fougére et al. (2005) find that they are not able to reject a constant hazard for a substantial portion of the products they study.

[37]More detailed results will be available in the appendix on our websites.

[38]Standard errors for all the hazard functions plotted in figure 19 will be available in the appendix on our websites.

[39]Although, the results from some of these studies are hard to interpret since they use the conditional logit formulation.

up well with the basic intuitions about the shape of the hazard function that arise from the menu cost model.

7.2 Hazard Functions for Producer Prices

After dropping left-censored spells, we have 1.95 million price spells for producer prices. We estimate the model described by equation (7) separately for the 15 two digit Major Groups. Figure 21 plots the hazard functions of eight of these Major Groups for the entire sample period for which we have data. For each Major Group, we plot the estimated hazard function for models with and without unobserved heterogeneity.

The main stylized facts about the shape of the hazard function are the same for producer prices as they are for consumer prices. The hazard functions for all the Major Groups except Farm Products are qualitatively very similar. They are downward sloping for the first few months, then mostly flat exect for a large 12 month spike. Accounting for heterogeneity leads to a substantial flattening of the hazard functions and a large increase in the size of the spike at 12 months. Interestingly, the 12 month spike in the hazard function is a much more pervasive phenomena in producer prices than in consumer prices.

7.3 The Empirical Hazard Function vs. the Model Implied Hazard Function

Figure 22 plots the hazard function for our calibrated menu cost model. It is sharply upward sloping in the first few months but then U-shaped at longer durations. The main difference between the model and the data is the behavior of the hazard in the first few months. In the data the hazard if large and falling while in the model it is small and rising sharply. For longer durations, the difference between the data and the model is less stark. The data imply a roughly flat hazard function while the model implies a U-shaped pattern. The main challenge posed by our empirical estimates of the hazard function of price change for the menu cost paradigm is therefore to understand what adjustments to the basic menu cost model can generate large and falling hazards of price change in the first few months after a price change.

8 Conclusion

In this paper, we present new evidence on price adjustment in the U.S. economy. Using BLS micro-data we document that the median duration of consumer prices excluding sales is 11 months, while the median duration of finished goods producer prices is 8.7 months. Accounting for sales at the product level raises the median duration for consumer prices by more than 50% due to the concentration of sales in sectors of the economy that have a frequency of price change relatively close to the median. We show that the fraction of price changes that are price increases is 2/3. Combined with the large average absolute size of price changes, the large number of price decreases observed in the data provides clear evidence that idiosyncratic shocks are an important source of price changes.

We document a dramatic secular rise in the frequency and size of sales in several sectors of the U.S. economy. We show that there are important differences between sales and regular price spells and that a benchmark menu cost model of price change is unable to match the behavior of sales. We do not find robust evidence that sales respond to aggregate variables. However, the growing prevalence of sales implies that even a weak relationship between sales and aggregate variables could have important macroeconomic implications.

We find that the frequency of price increases responds strongly to inflation while the frequency of price decreases and the size of price increases and price decreases do not. We show that this pattern is consistent with the implications of a benchmark menu cost model. We find that the frequency of price change is highly seasonal. It is highest in the 1st quarter and lowest in the 4th quarter. Furthermore, in consumer prices the frequency of price change is highest in the first month of each quarter and falls monotonically within quarter.

Finally, we estimate the hazard function of price change for consumer and producer prices accounting for heterogeneity at the product level. We find that this hazard function is slightly downward sloping for the first few months and then flat (except for a large spike at 12 months in consumer services and all producer prices). This pattern is not consistent with our benchmark menu cost model. The model yields a hazard function that is sharply upward sloping in the first few months and does not imply a spike at 12 months. The spike at 12 months may be evidence of a time-dependent element of price setting. The fact that the empirical hazard is large and falling in the first few months may be evidence of either learning or heteroskedasticity in marginal costs.

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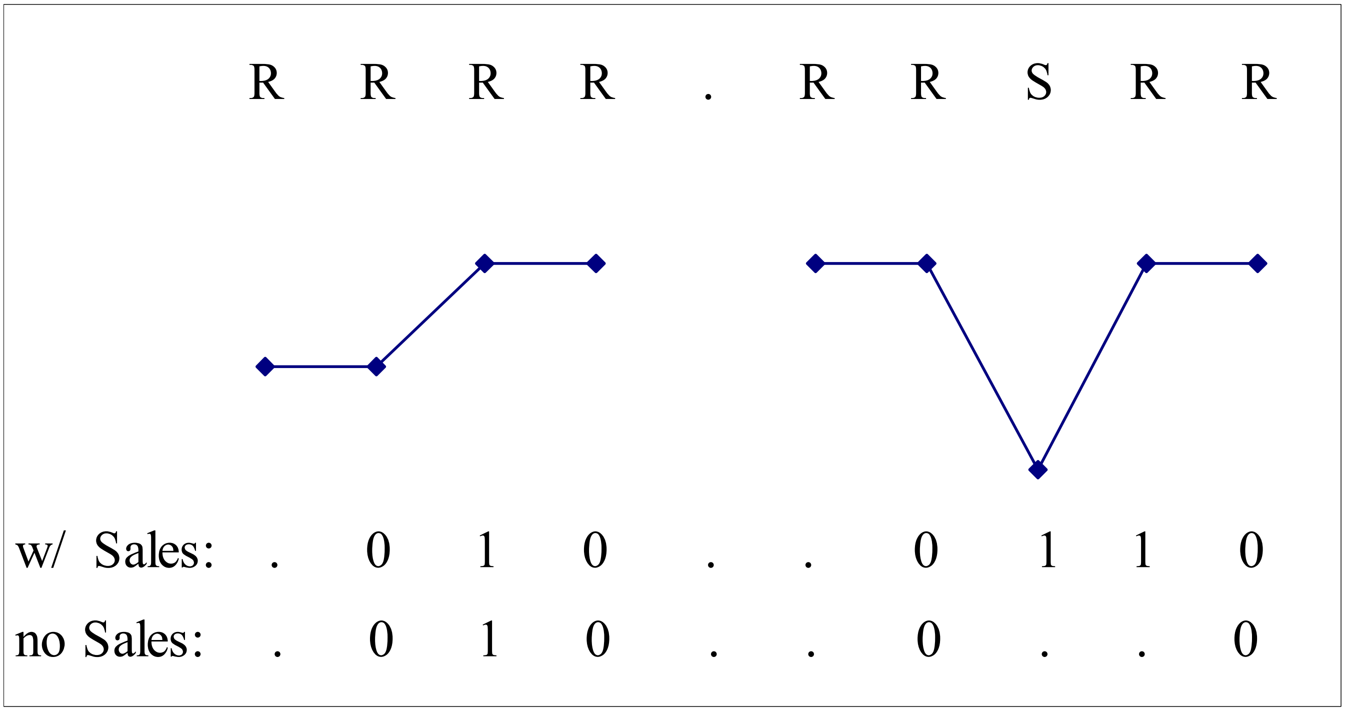
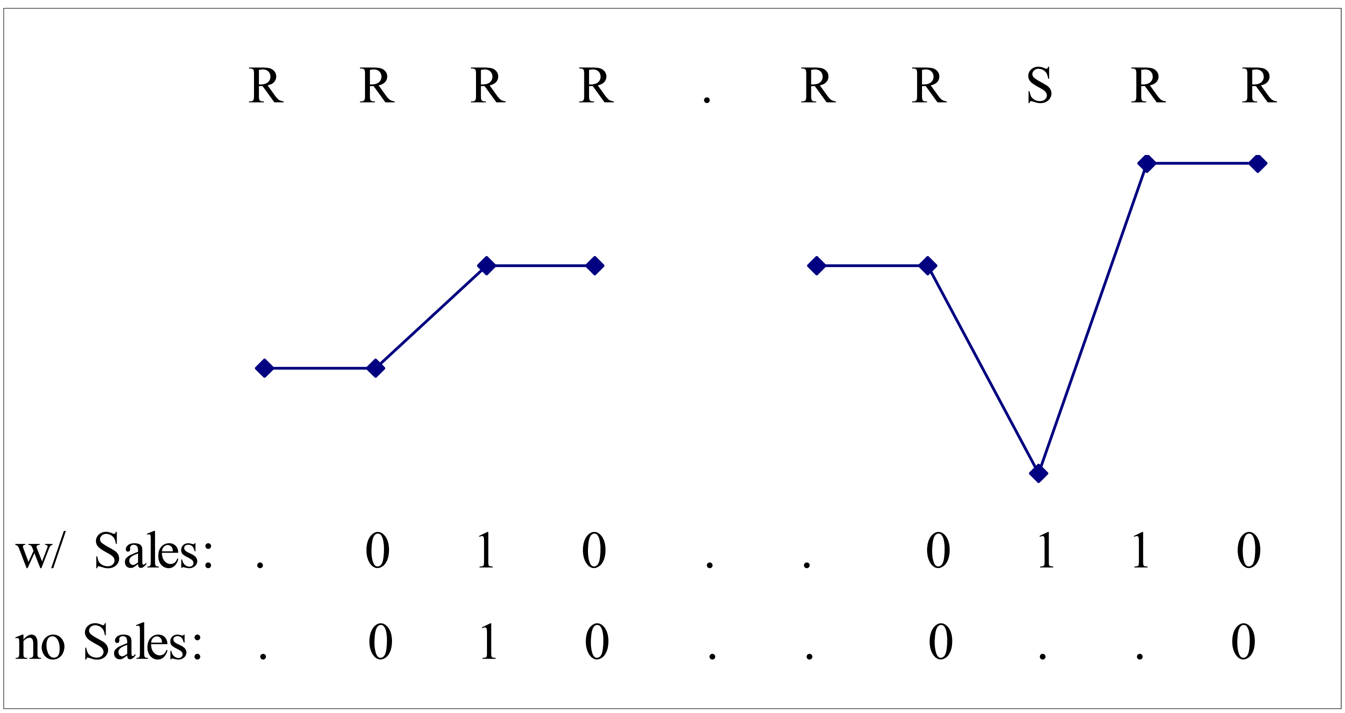


Panel A



Panel B

Figure 1 : Construction of Price Change Variables With and Without Sales

Each panel reports the first 10 observations for a hypothetical price series. The top row of each panel records the values of the sales flag for the 10 observations. The letter "R" denotes "regular price" while the letter "S" denotes "sales". Below the flag is a graph of the evolution of the price of the product. At the bottom of each panel are two indicator variables. The first records price changes, while the second records regular price changes.

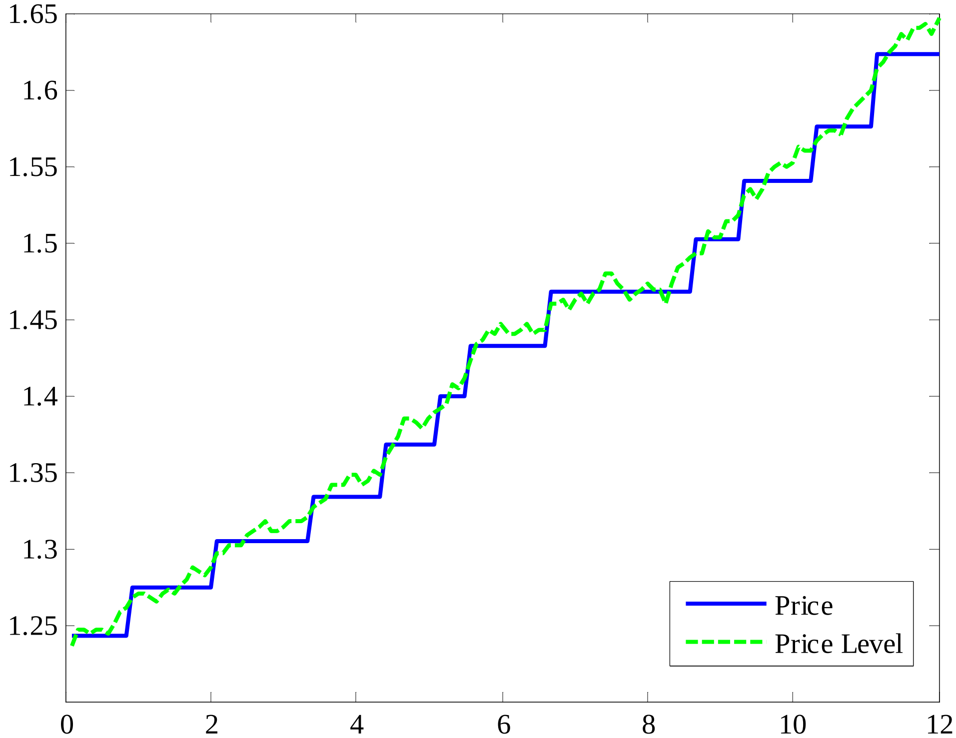


Figure 2: Sample Path from Menu Cost Model without Idiosyncratic Shocks

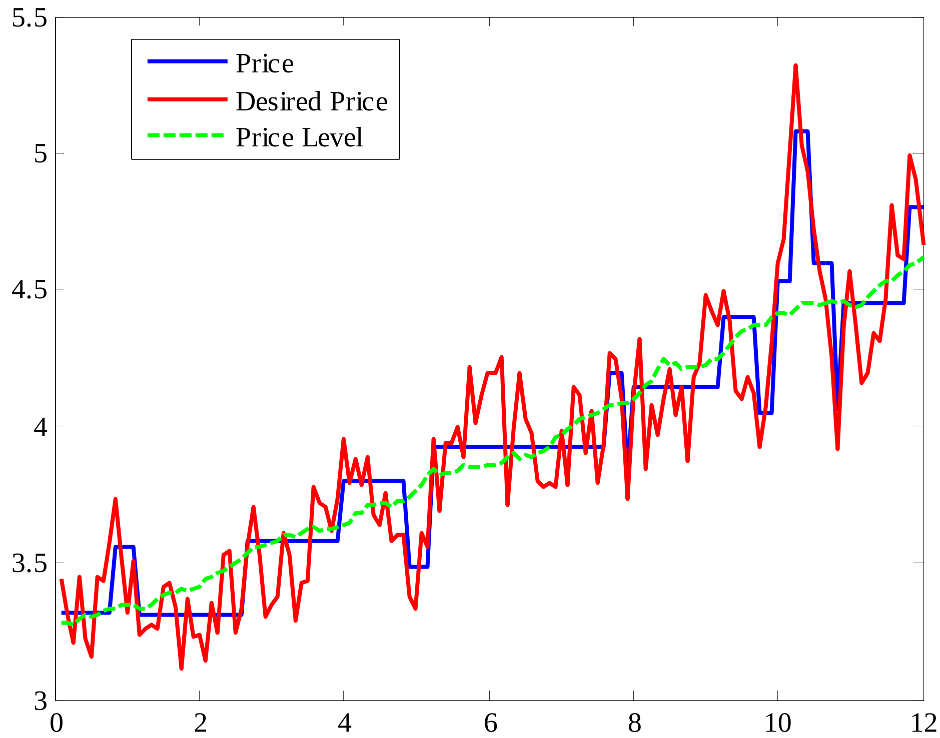
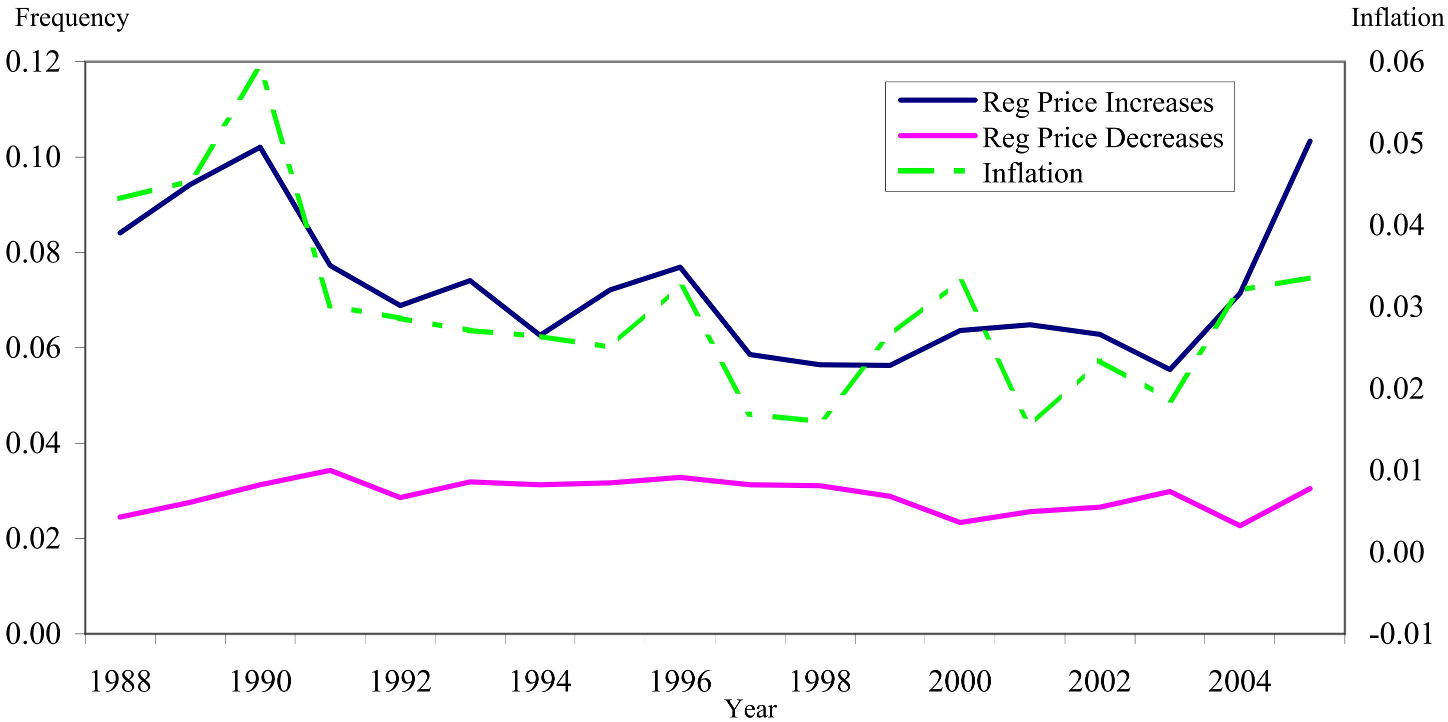


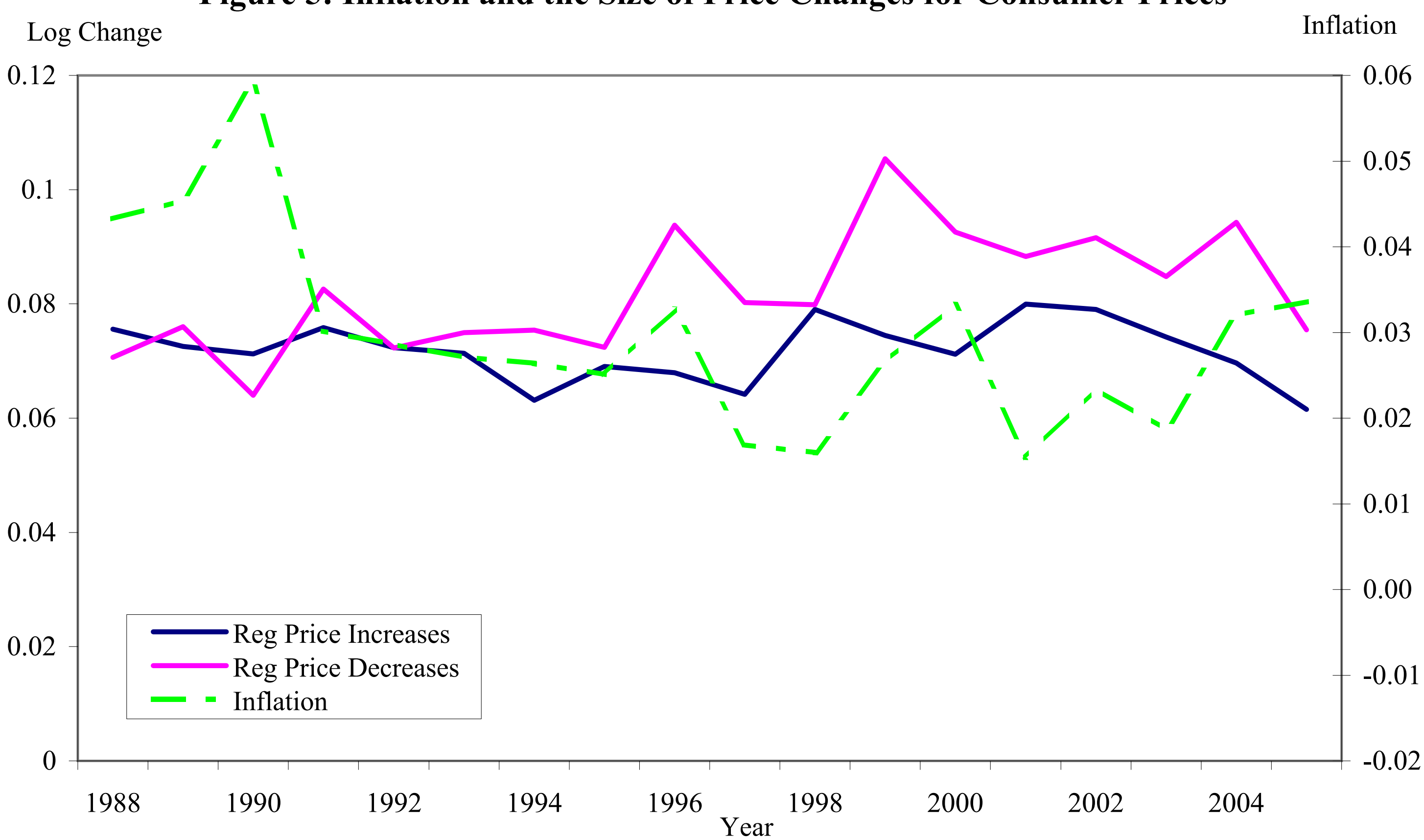
Figure 3: Sample Path from Menu Cost Model with Idiosyncratic Shocks

Figure 4: Inflation and the Frequency Price Changes for Consumer Prices



The figure plots the annual evolution of the weighted median frequency of regular price increases and decreases along with the CPI inflation rate. See section 5.1 for more details.

Figure 5: Inflation and the Size of Price Changes for Consumer Prices



The figure plots the annual evolution of the weighted median absolute size of log regular price increases and decreases along with the CPI inflation rate. See section 5.1 for more details.

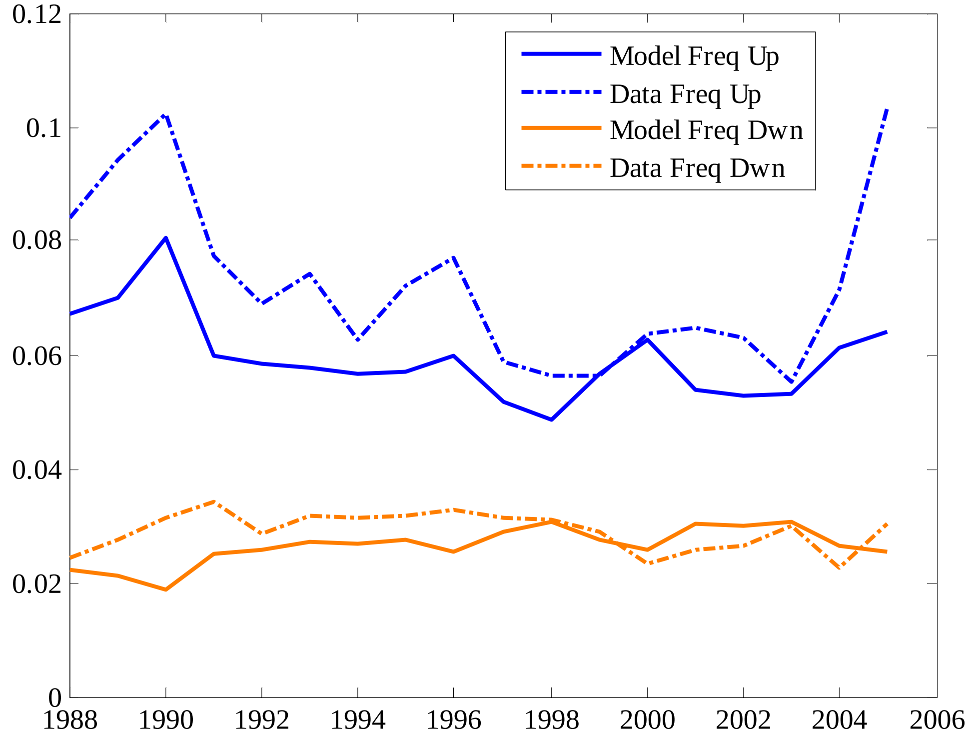


Figure 6: Frequency of price increases and price decreases in the data and in the model.

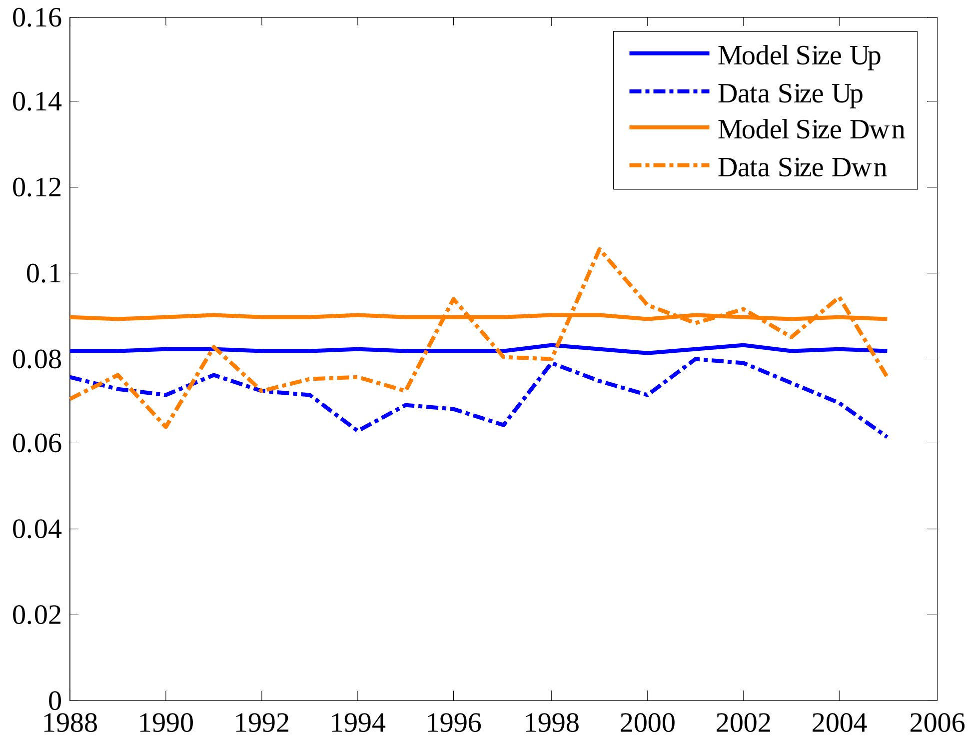
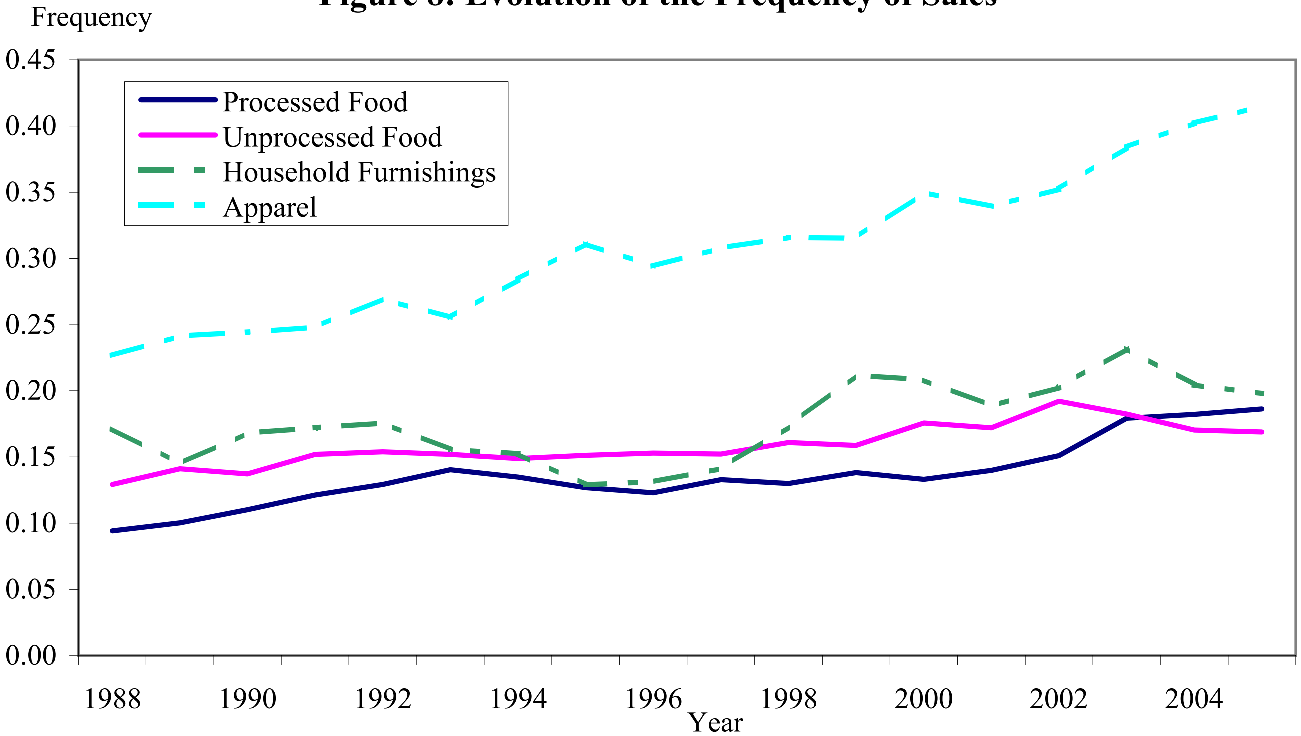


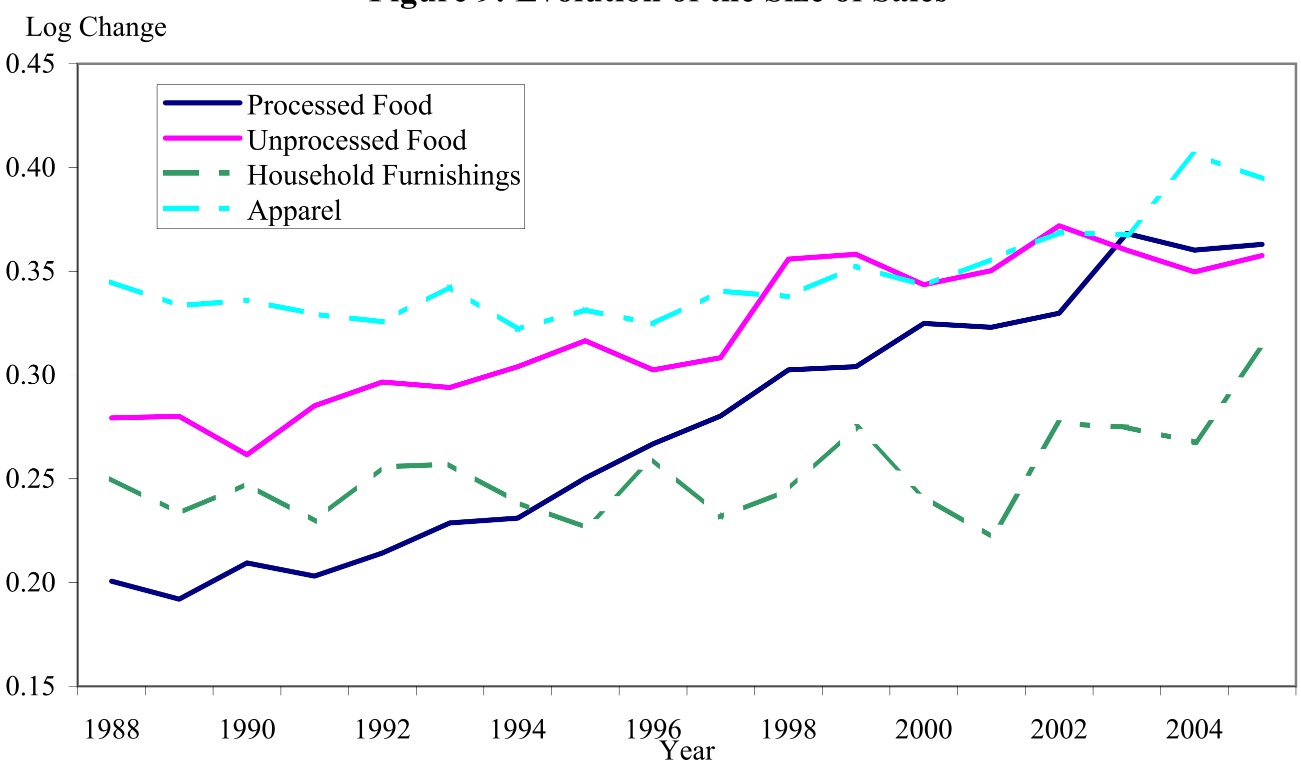
Figure 7: Size of price increases and price decreases in the data and in the model.

Figure 8: Evolution of the Frequency of Sales



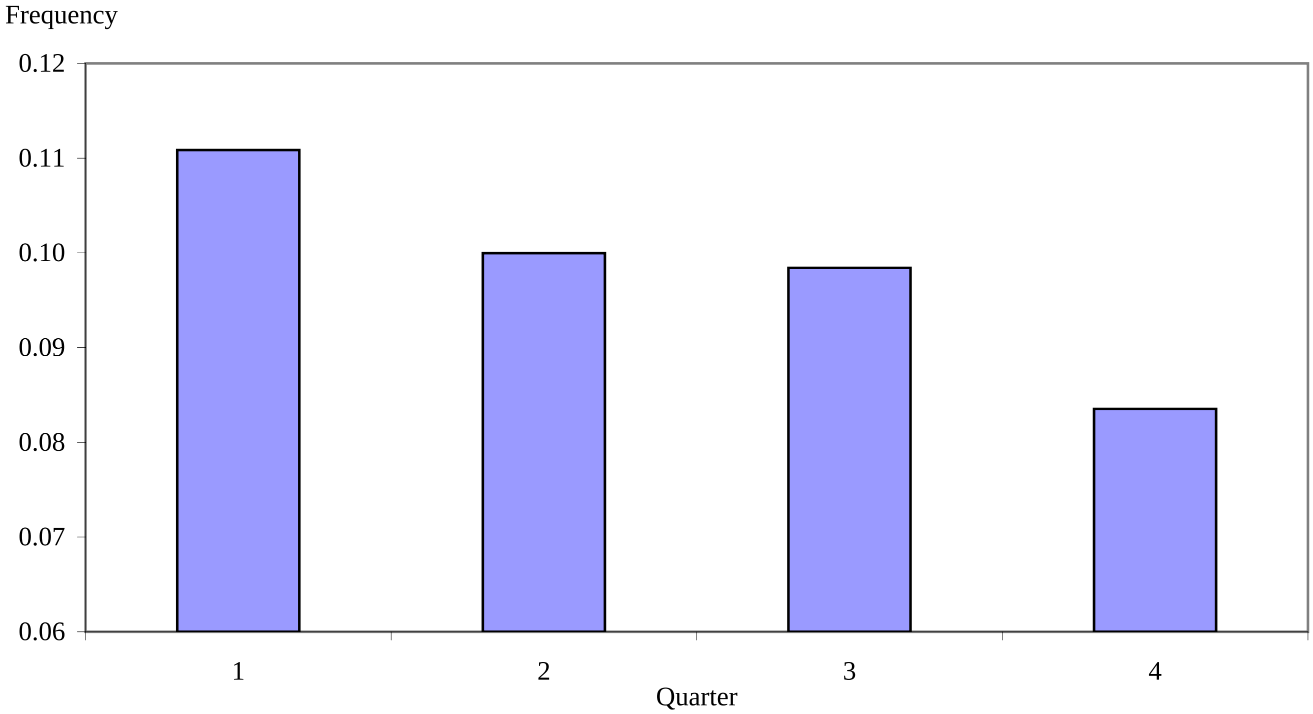
The figure plots the annual evolution of the weighted median across ELIs of the fraction of observations that are sales for the four Major Groups for which sales are most important.

Figure 9: Evolution of the Size of Sales



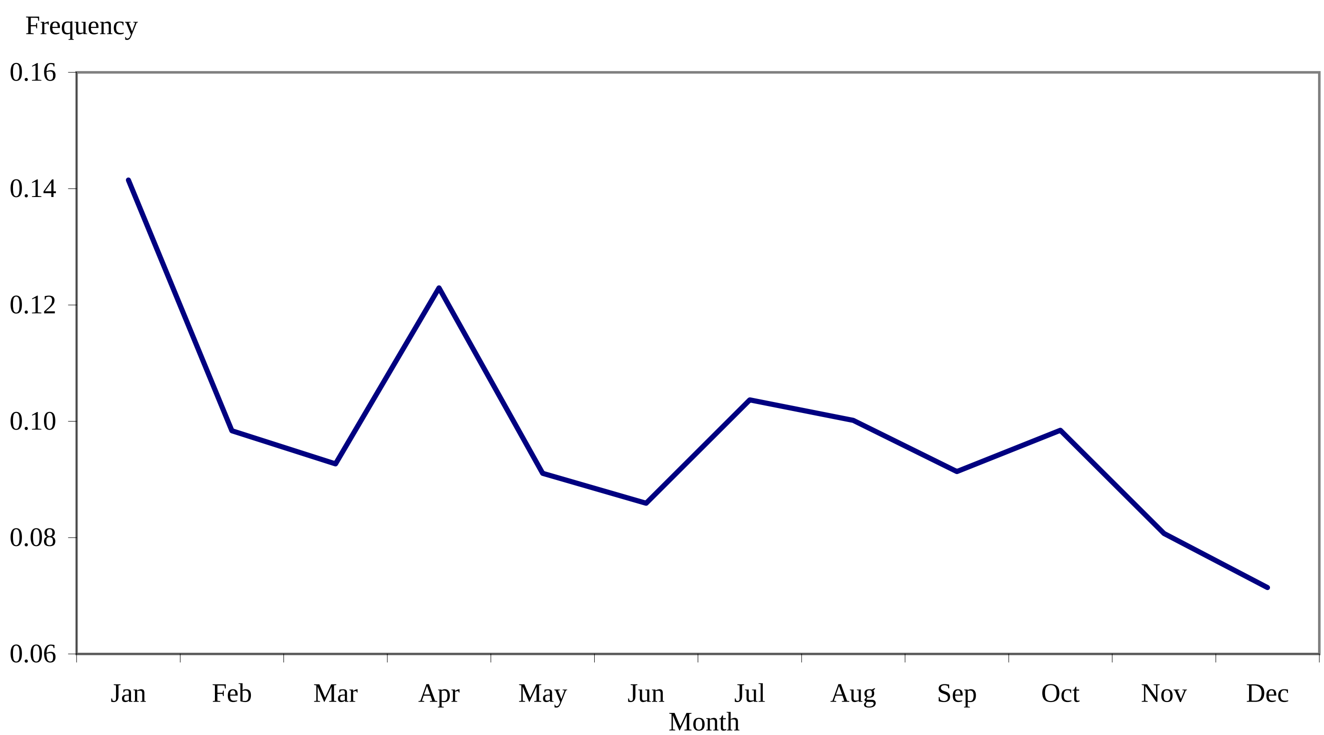
The figure plots the annual evolution of the weighted median across ELIs of the average absolute log price change at the beginning and end of sales for the four Major Groups for which sales are most important.

Figure 10: Frequency of Price Change by Quarter for Consumer Prices



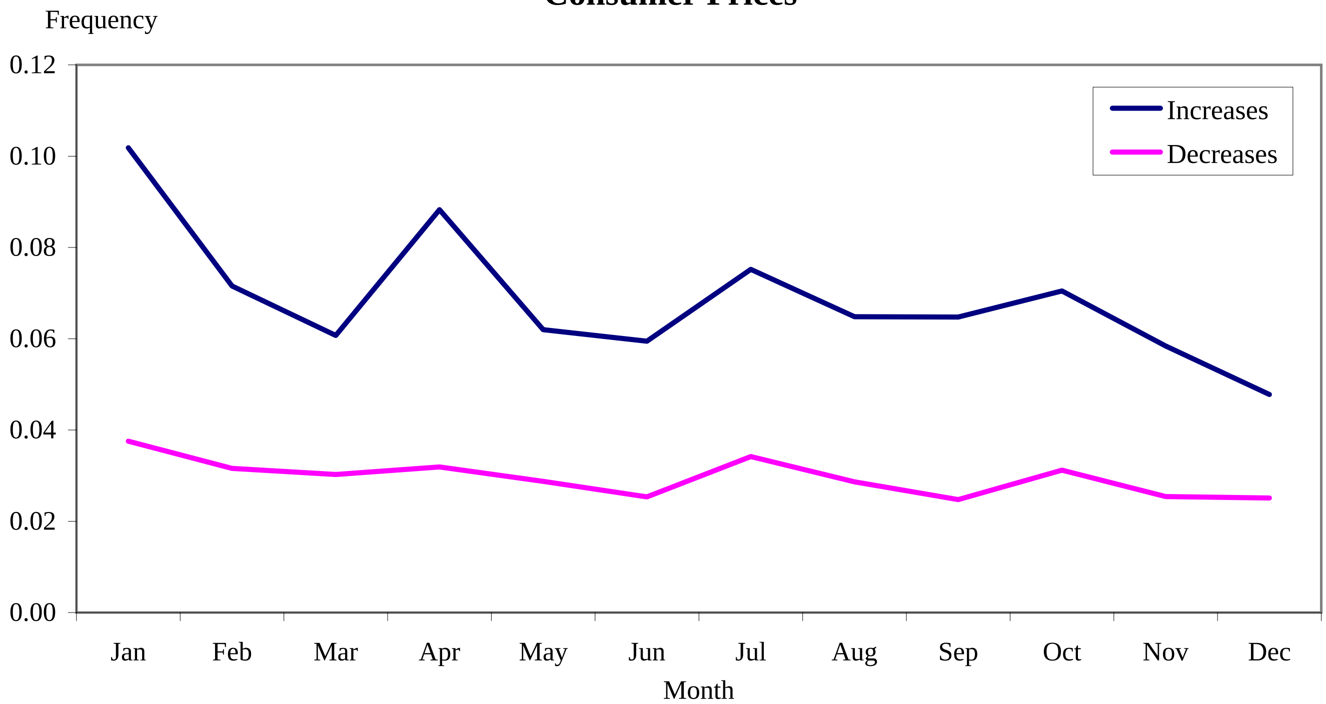
The figure plots the weighted median frequency of price change by quarter

Figure 11: Frequency of Price Change by Month for Consumer Prices



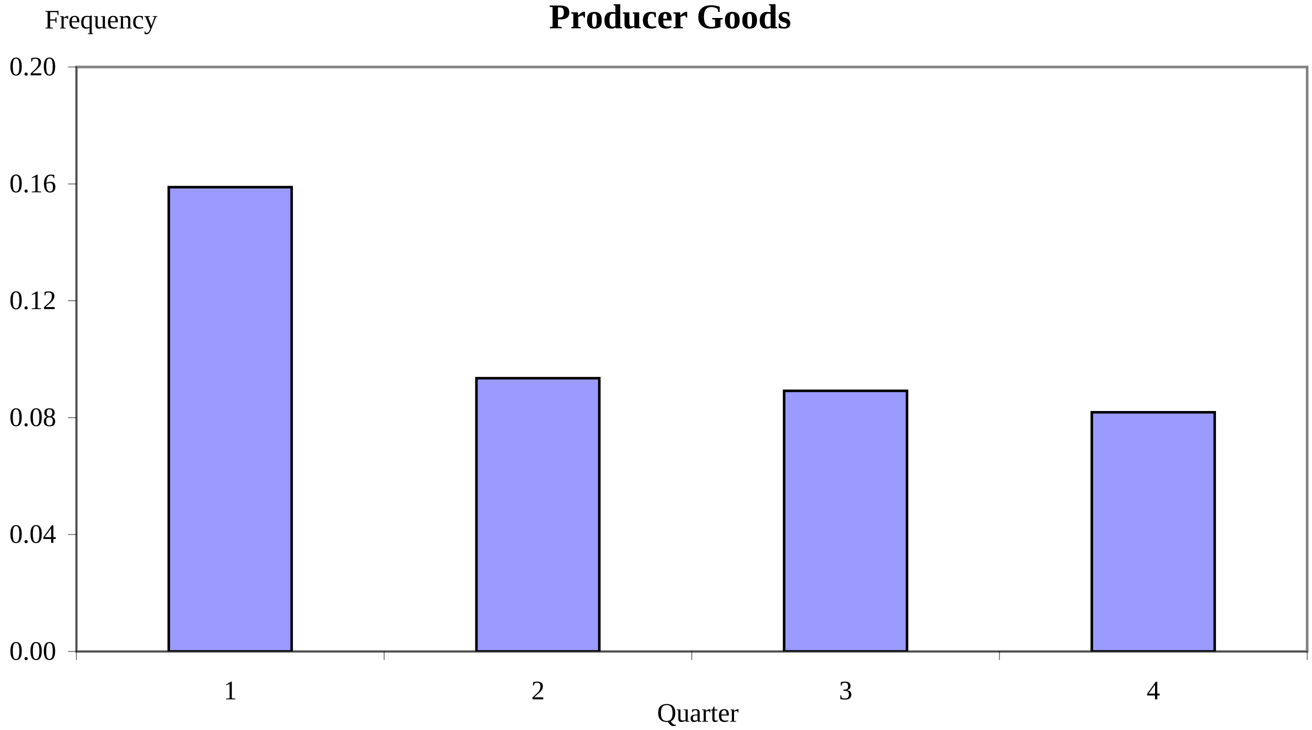
The figure plots the weighted median frequency of price change by month

Figure 12: Frequency of Price Increases and Decreases by Month for Consumer Prices



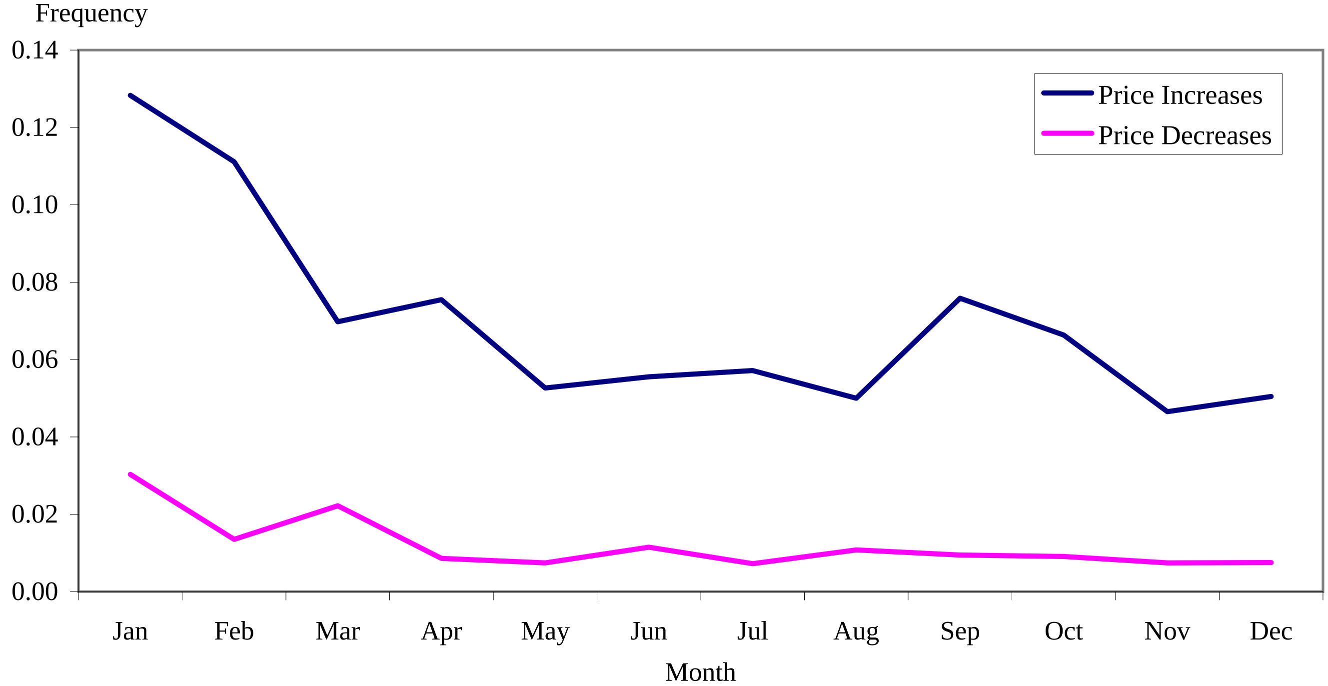
The figure plots the weighted median frequency of price increase and decrease by month

Figure 13: Frequency of Price Change by Quarter for Finished Producer Goods



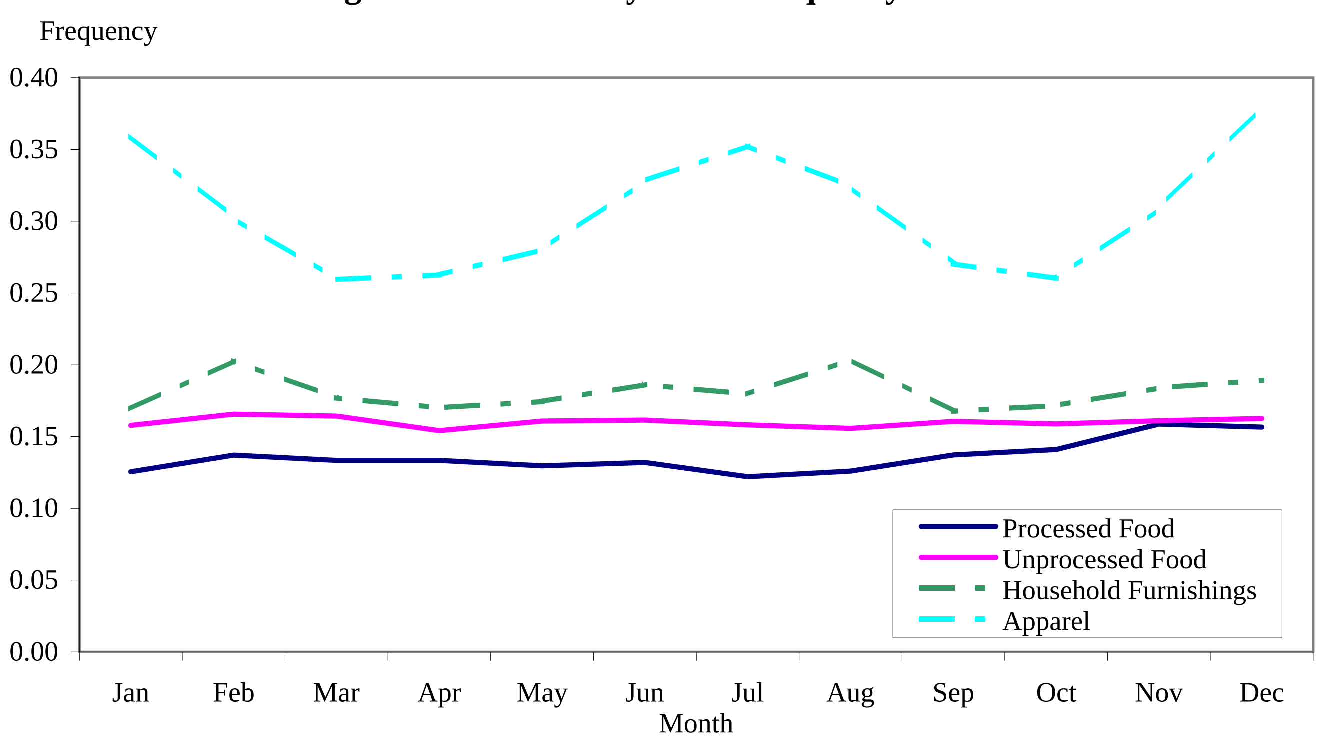
The figure plots the weighted median frequency of price change by quarter.

Figure 14: Frequency of Price Increases and Decreases for Finished Producer Goods



The figure plots the weighted median frequency of price increase and decrease by month

Figure 15: Seasonality of the Frequency of Sales



The figure plots the weighted median fraction of observations that are sales by quarter for the four Major Groups for which sales are most prevalent.

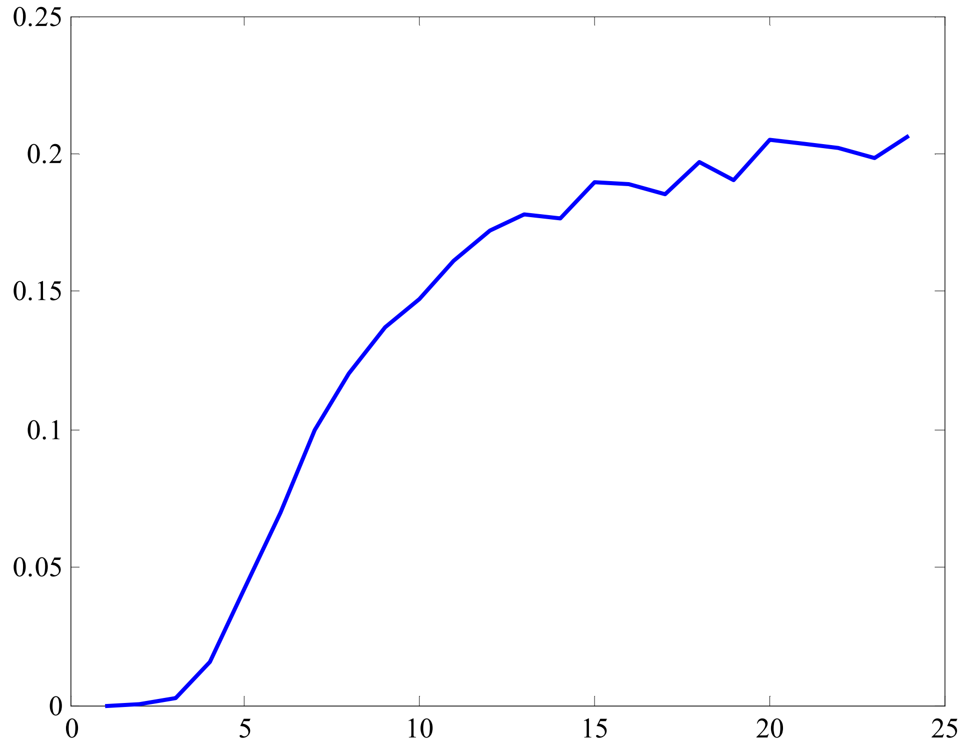


Figure 16: Hazard function when there are no idiosyncratic shocks

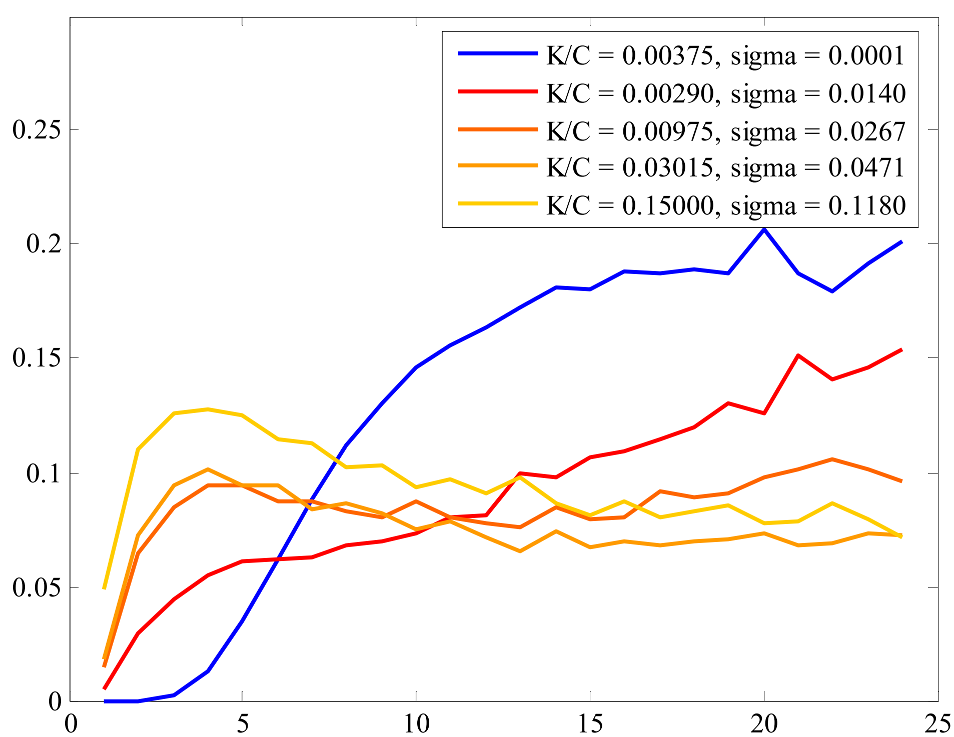
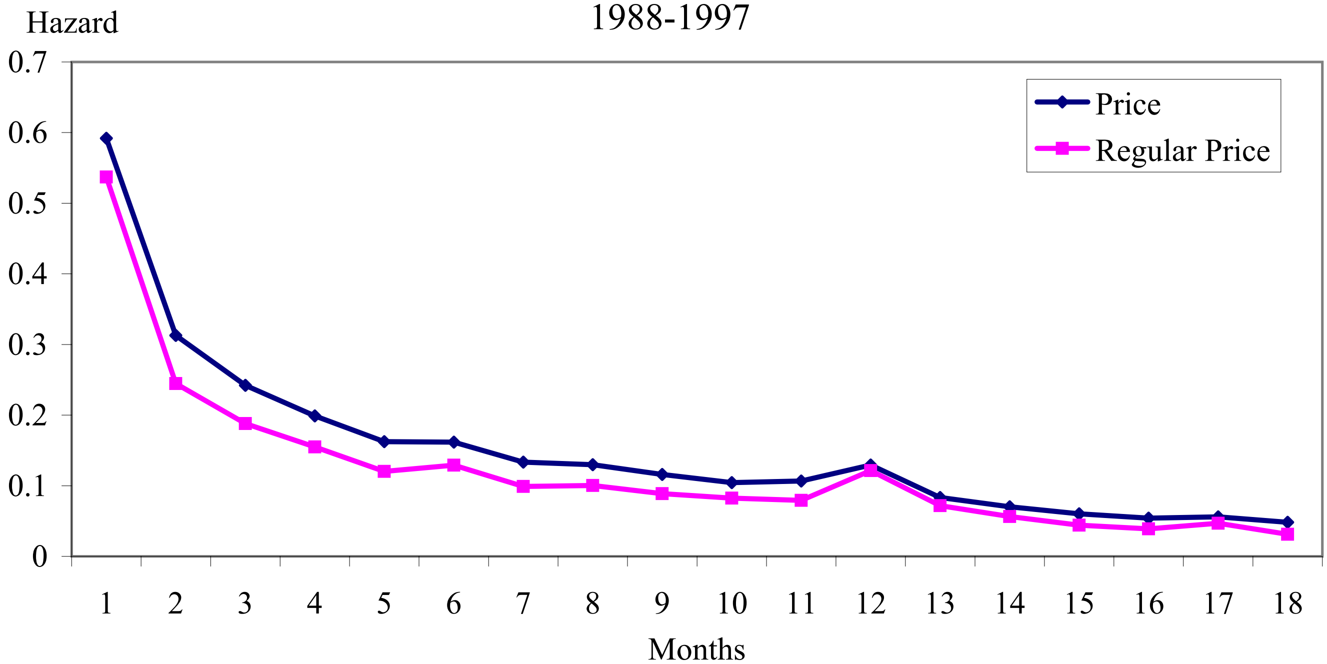


Figure 17: Hazard functions with different levels of volatility of the idiosyncratic shock
(ρ = 0.729 in all cases)

Figure 18: Kaplan-Meier Hazard Function for all Consumer Prices
1988-1997



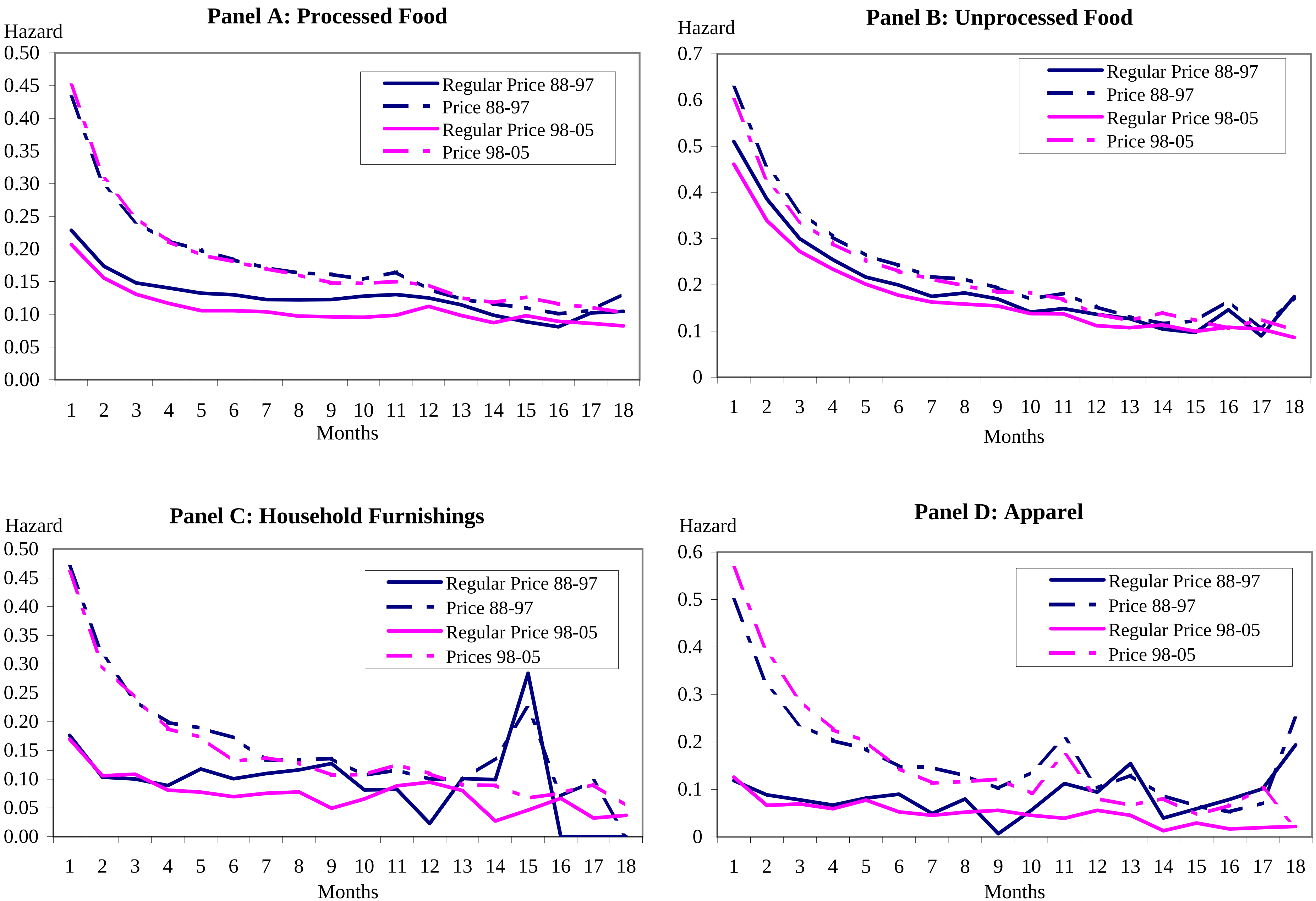


Figure 19: Hazard Functions by Major Group for Consumer Prices

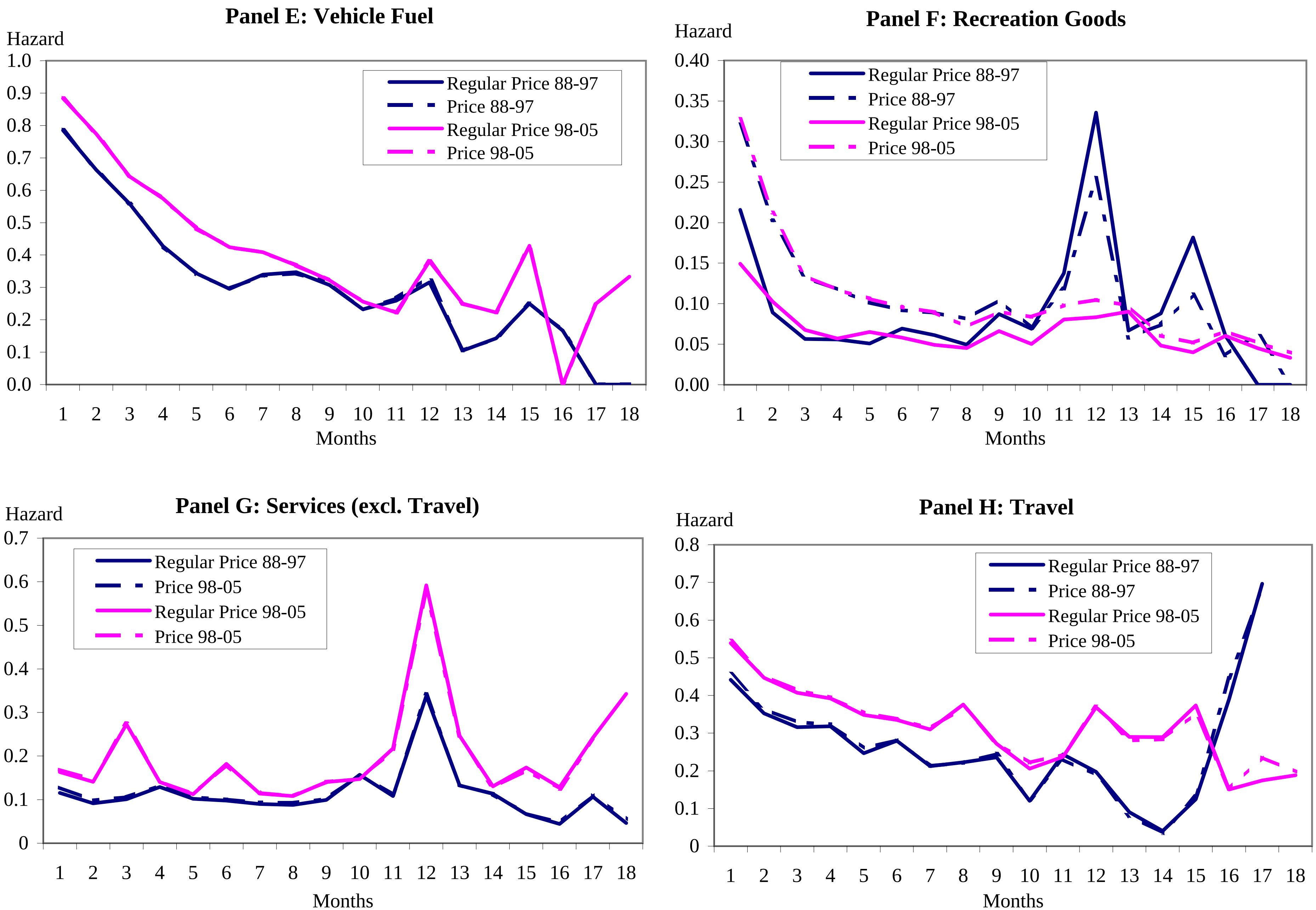
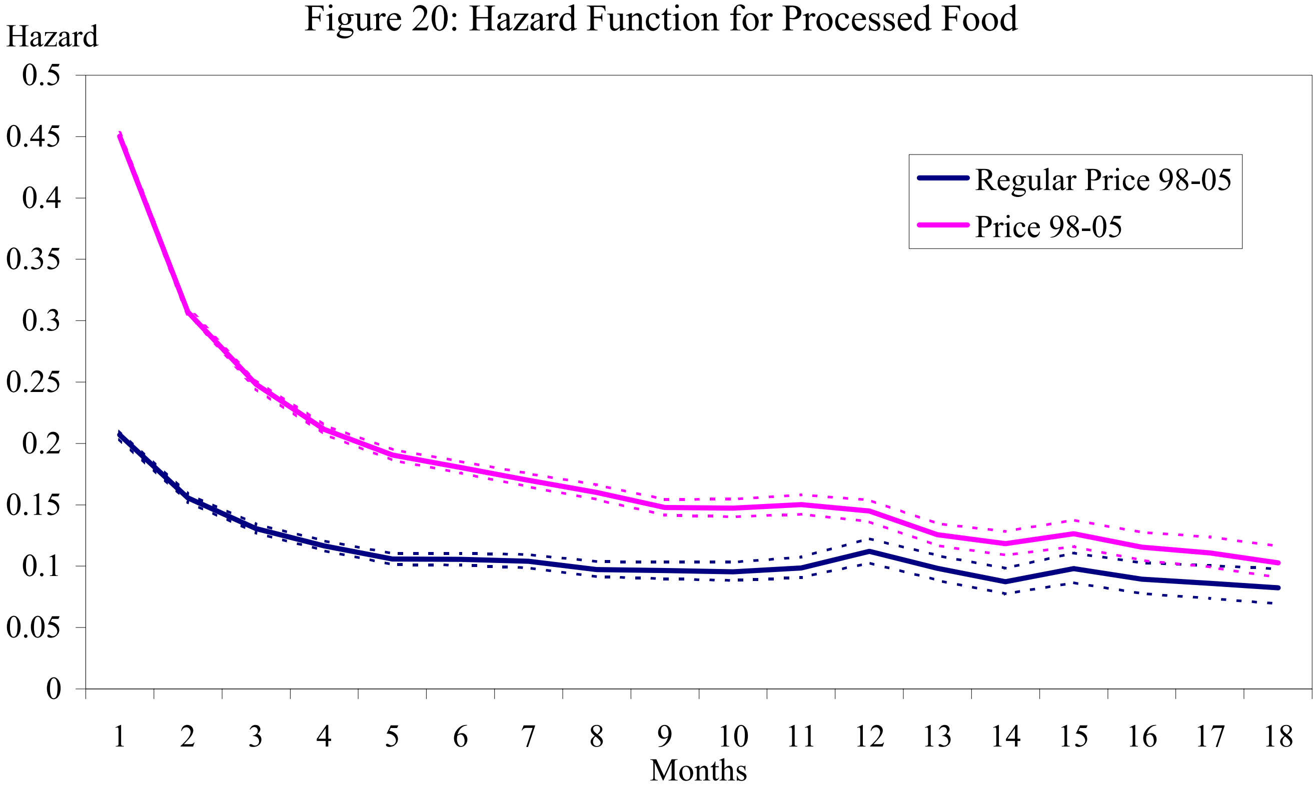


Figure 19: Hazard Functions by Major Group for Consumer Prices (contd)

Figure 20: Hazard Function for Processed Food



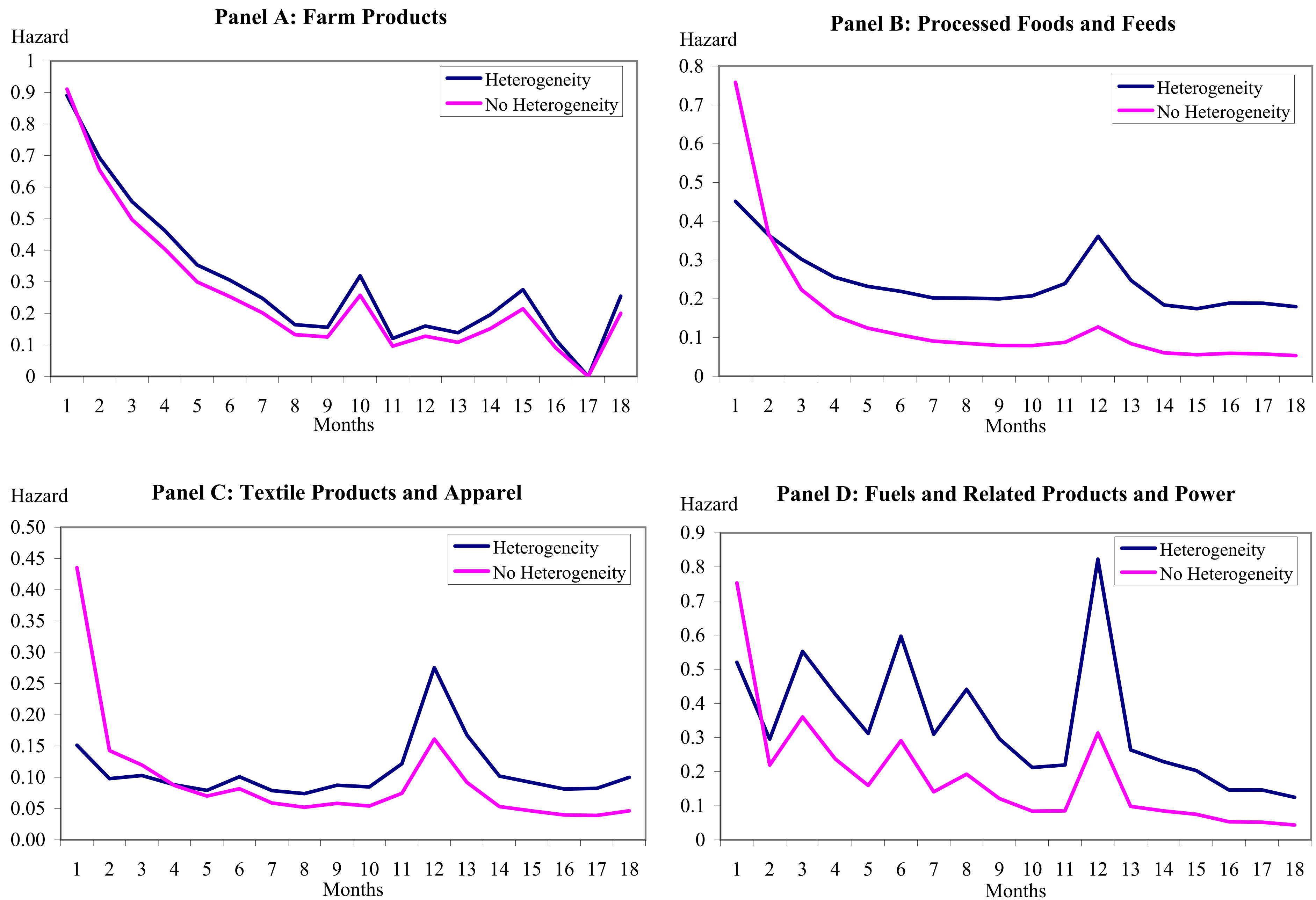


Figure 21: Hazard Functions for Major Groups of Producer Prices

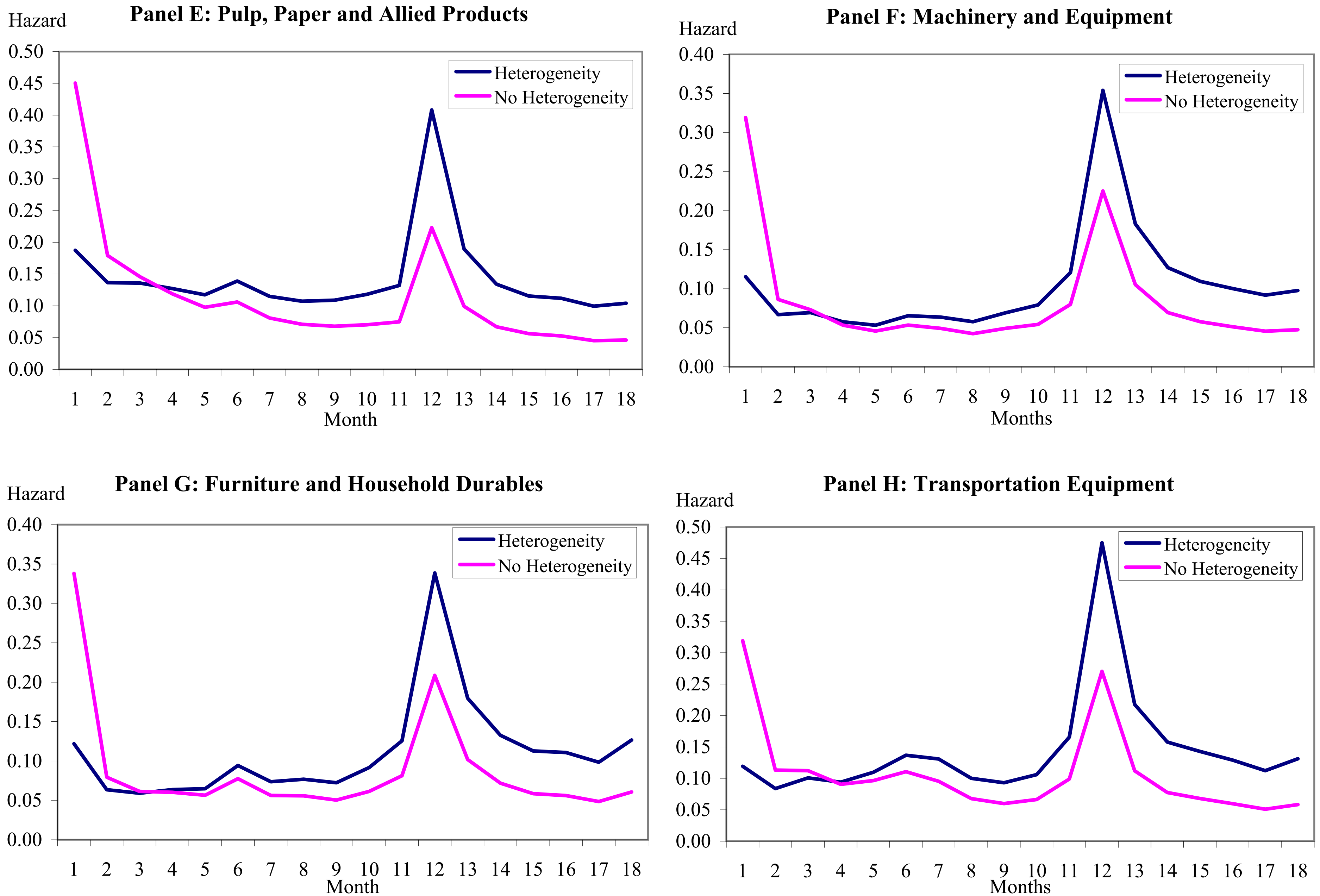


Figure 21: Hazard Functions for Major Groups of Producer Prices (contd)

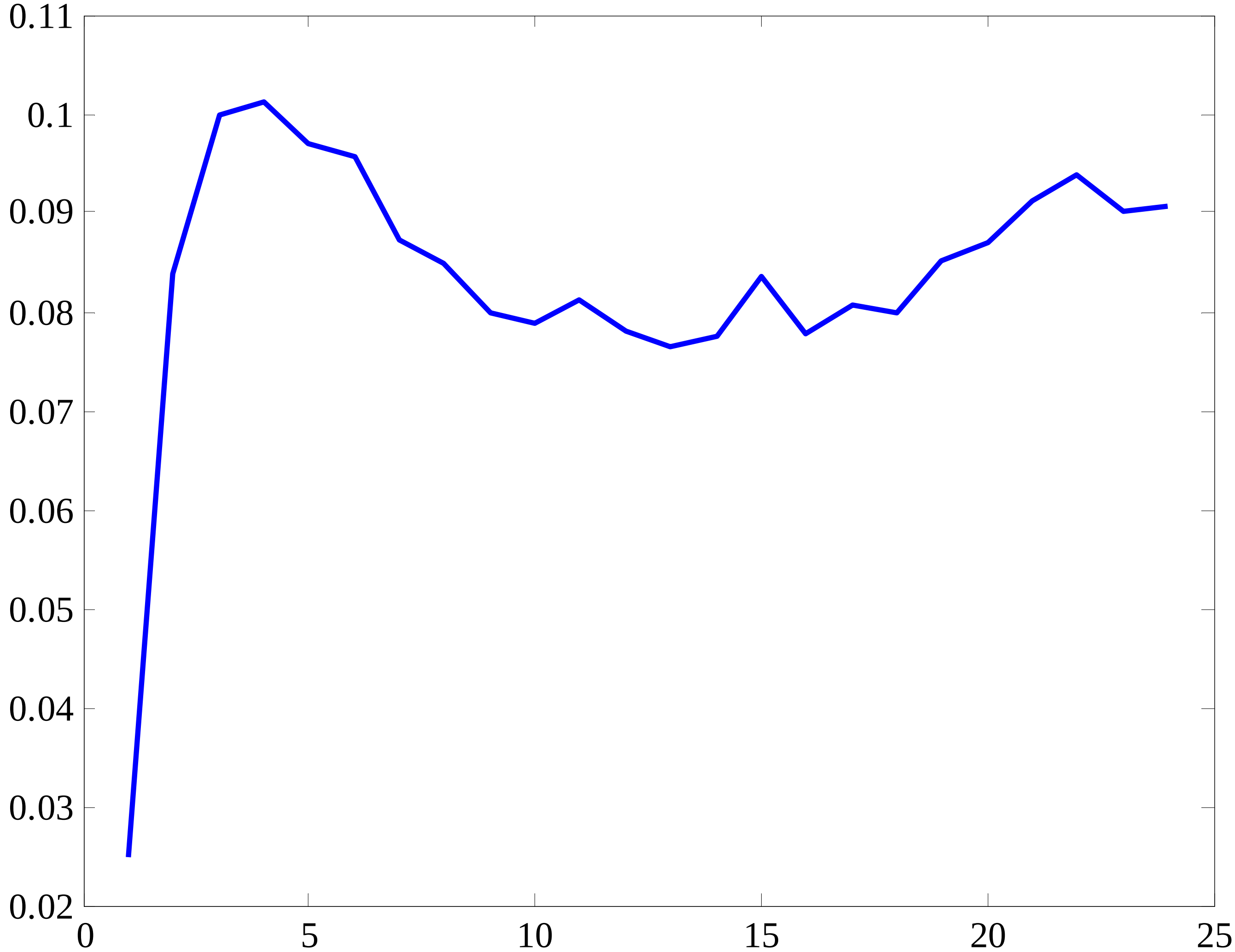


Figure 22: Hazard function for calibrated menu cost model

Table 1: Frequency of Price Change in the CPI

	1988-1997		1998-2005	
	Regular Price	Price	Regular Price	Price
Median Freq. of Change	11.1	20.3	8.7	19.4
Median Implied Duration	8.5	4.4	11.0	4.6
Median Freq. of Increase	7.9	10.8	6.1	10.0
Median Freq. of Decrease	3.2	9.1	2.8	9.2
Median Frac. of Increases	67.0	57.9	64.8	57.1
Median Freq. of Change Incl. Subs.	12.7	21.6	10.8	20.8
Mean Freq. of Change	18.5	23.8	21.1	26.5
Mean Implied Duration	11.8	8.4	13.0	9.0

All frequencies are reported in percent per month. Implied durations are reported in months. Regular prices denote prices excluding sales. The median frequency of price change is calculated by first calculating the mean frequency of price change for each ELI and then taking an expenditure-weighted median across ELI's using CPI expenditure weights. The median implied duration is -1/ln(1-f), where f is the median frequency of price change. The median frequencies of price increases and price decreases are calculated in an analogous manner to the median frequency of price change. The median fraction of price increases is calculated by first calculating the fraction of price changes that are increases for each ELI and then taking a weighted median across ELI's. The median frequency of price change including substitutions is calculated in an analogous manner, except that price changes associated with substitutions are also included as price changes. The mean frequency of price change is an expenditure weighted mean of the frequency of price change of different ELI's. The mean implied duration is calculated as the expenditure weighted mean of the implied durations across ELI's.

Table 2: Differences vs. Bils and Klenow (2004)

	1995-1997		1998-2005	
	Prices	Regular Prices	Prices	Regular Prices
Incl. Subs.	4.2 (21.0)	8.1 (11.7)	4.4 (20.8)	8.8 (10.8)
Excl. Subs.	4.3 (20.8)	8.6 (10.9)	4.6 (19.4)	11.0 (8.7)

This table presents the median implied duration of prices and the associated frequency of price change (in parentheses). Regular prices denote prices excluding sales. Frequencies are reported in percent per month, while durations are reported in months. The median frequency of price change is calculated by first calculating the mean frequency of price change for each ELI and then taking a weighted median across ELI's using CPI expenditure weights. The median implied duration is -1/ln(1-f), where f is the median frequency of price change. These statistics are presented for two time periods: the 1995-1997 time period considered by Bils and Klenow (2004) and the time period 1998-2005 that we focus on in the present analysis. The median frequency of price change including substitutions is calculated in an analogous manner to the statistics without substitutions, except that price changes associated with substitutions are also included as price changes.

Table 3: Frequency of Sales

	1988-1997	1998-2005
Expenditure weighted:		
Fraction of Price Changes Due to Sales	21.2	21.5
Fraction of Price Quotes with Sales	6.6	7.4
Weighted by Number of Observations:		
Fraction of Price Quotes with Sales	10.3	12.1

All statistics are reported as percentages. For the statistics in the first row, we first calculate the fraction of price changes due to sales for each ELI and then take an expenditure weighted mean across ELIs. The same procedure is used in the second row to calculate the expenditure weighted fraction of price quotes with sales. In the last row, we apply the same procedure as in the second row except that values for each ELI are weighted by the number of price observations for that ELI.

Table 4: Frequency of Price Change by Major Group

		Regular Price						Price				Sales	
			Median			Mean	Frac.	Median		Mean	Frac.	Frac.	Frac.
Major Group	Weight	# Obs.	Freq.	Dur.	Ch.+Sub	Freq.	Up	Freq.	Dur.	Freq.	Up	Price Ch.	Obs.
Panel A: 1988-1997													
Processed Food	7.9	1031101	12.7	7.4	13.0	13.0	66.8	25.0	3.5	24.9	56.9	47.3	13.1
Unprocessed Food	7.5	1334644	28.3	3.0	28.5	31.7	59.0	43.5	1.8	43.2	53.1	28.5	14.3
Household Furnishing	6.1	49888	6.7	14.3	10.6	7.6	67.0	24.9	3.5	23.0	50.0	65.0	20.5
Apparel	7.9	85268	4.8	20.4	10.1	4.7	61.3	27.9	3.1	28.1	37.4	82.0	26.9
Transportation Goods	8.0	94521	27.7	3.1	33.4	25.4	44.5	27.7	3.1	26.3	44.5	4.6	1.6
Recreation Goods	3.6	89713	5.7	17.1	9.0	8.0	64.4	14.7	6.3	15.8	52.1	41.4	11.7
Other Goods	5.1	63143	11.1	8.5	11.4	12.6	80.3	15.9	5.8	15.9	78.6	20.8	3.7
Utilities	5.8	252172	46.1	1.6	46.7	50.5	51.6	46.1	1.6	50.5	51.6	0.1	0.1
Vehicle Fuel	3.2	181444	71.9	0.8	70.0	65.0	52.7	72.1	0.8	65.0	52.7	0.1	0.1
Travel	4.6	130416	31.1	2.7	31.8	34.4	54.6	32.7	2.5	35.4	53.8	3.3	2.1
Services (excl. Travel)	38.8	690071	7.0	13.9	8.0	8.2	78.9	7.4	12.9	8.6	75.4	4.6	0.7
Panel B: 1998-2005													
Processed Food	8.2	918264	10.5	9.0	10.9	10.6	65.4	25.9	3.3	25.5	54.6	57.9	16.6
Unprocessed Food	5.9	929804	25.0	3.5	25.6	25.4	61.2	37.3	2.1	39.5	53.4	37.9	17.1
Household Furnishing	5.0	65281	6.0	16.1	9.2	6.5	62.9	19.4	4.6	20.6	51.0	66.8	21.2
Apparel	6.5	69416	3.6	27.3	8.1	3.6	57.1	31.0	2.7	30.1	37.6	87.1	34.5
Transportation Goods	8.3	118535	31.3	2.7	36.6	21.3	45.9	31.3	2.7	22.2	42.7	8.0	2.7
Recreation Goods	3.6	117084	6.0	16.3	7.3	6.1	62.0	11.9	7.9	13.7	52.7	49.1	10.9
Other Goods	5.4	112756	15.0	6.1	15.4	13.9	73.7	15.5	5.9	20.6	77.2	32.6	15.3
Utilities	5.3	301969	38.1	2.1	38.5	49.4	53.1	38.1	2.1	49.4	53.6	0.0	0.0
Vehicle Fuel	5.1	194269	87.6	0.5	87.6	87.4	53.5	87.6	0.5	87.5	53.3	0.0	0.3
Travel	5.5	172060	41.7	1.9	42.8	43.7	52.8	42.8	1.8	44.4	52.5	1.5	2.1
Services (excl. Travel)	38.5	506880	6.1	15.8	7.3	8.8	79.0	6.6	14.6	9.1	61.9	3.1	0.5

All frequencies are reported in percent per month. Durations are reported in months. Fractions are reported as percentages. Regular prices denote prices excluding sales. "Weight" denotes the CPI expenditure weight of the Major Group. "# Obs." denotes the number of price observations for each Major Group. "Median Freq." denotes the weighted median frequency of price change. It is calculated by first calculating the mean frequency of price change for each ELI and then taking a weighted median across ELI's within the Major Group using CPI expenditure weights. The other median statistics in this table are calculated in an analogous manner. "Median Dur." is equal to -1/ln(1-f), where f is the median frequency of price change. "Median Ch.+Sub." denotes the median of the frequency of price change including price changes associated with substitutions. "Mean Freq." denotes the expenditure weighted mean frequency of price change. "Frac. Up" denotes the median fraction of price changes that are price increases. "Frac. Price Ch." denotes the median fraction of price changes that are due to sales. while "Frac. " denotes that median fraction of observations that are sales.

Table 5: Sales Adjustment when Sales Are Concentrated in Certain Sectors

	Services	Food	Gasoline
Expenditure Weight	1/3	1/3	1/3
Frequency of Price Change	1/12	1/2	1
Implied Duration of Price Spells	12 months	2 months	1 month
Fraction of Price Changes Due to Sales	0	3/4	0
Frequency of Regular Price Change	1/12	1/8	1
Implied Duration of Regular Price Spells	12 months	8 months	1 month
Assuming a Constant Fraction of Price Changes Due to Sales:			
Frequency of Regular Price Change	1/16	3/8	9/12
Implied Duration of Regular Price Spells	16 months	2.66 months	1.33 months

In this example the expenditure weighted fraction of price changes due to sales is 3/12. Assuming that the fraction of price changes due to sales is the same across sectors, the frequency of regular price change equals the frequency of price change multiplied by 1-3/12=9/12. For simplicity, we assume that only one price change can occur per month in this example.

Table 6: Frequency of Price Change for Producer Prices

	Finished Goods		Intermediate Goods		Crude Materials	
	1988-1997	1998-2005	1988-1997	1998-2005	1988-1997	1998-2005
Median Freq. of Change	10.6	10.8	11.4	13.3	73.5	98.9
Median Implied Duration	8.9	8.7	8.3	7.0	0.8	0.2
Median Freq. of Increase	7.7	6.7	7.7	8.4	36.3	55.9
Median Freq. of Decrease	3.2	2.7	4.2	5.0	35.8	42.6
Median Frac. of Increases	65.3	60.6	61.1	58.4	48.4	56.1
Mean Freq. of Change	25.2	24.7	21.7	26.7	78.0	86.0

Frequencies are reported in percent per month. Implied durations are reported in months. Fractions are reported in percentages. The median frequency of price change is calculated by first calculating the mean frequency of price change for each cell code, then taking an unweighted median within 4-digit commodity code and then taking a value weighted median across 4-digit commodity codes. The median implied duration is -1/ln(1-f), where f is the median frequency of price change. "Frac. Up" denotes the median fraction of price changes that are price increases. The median frequency of price increases and price decreases and the median fraction of price increases are calculated in an analogous manner to the median frequency of price change. The mean frequency of price change is a value weighted mean across the 4-digit commodity code statistics discussed above.

Table 7: Frequency of Price Change by Major Group for the Finished Goods PPI

Category Name	Weight	Med. Freq. Price Ch.	Median Duration	Frac. Up
Panel A: 1988-1997				
Farm Products	1.6	82.3	0.6	45.9
Processed Foods and Feeds	22.4	11.3	8.3	60.8
Textile Products and Apparel	3.6	4.1	24.0	76.3
Hides, Skins, Leather, and Related Products	0.3	7.4	13.0	73.6
Fuels and Related Products and Power	20.8	36.0	2.2	53.3
Chemicals and Allied Products	2.8	7.4	13.0	65.8
Rubber and Plastic Products	1.8	4.6	21.3	82.2
Lumber and Wood Products	0.1	10.5	9.0	75.0
Pulp, Paper and Allied Products	3.0	5.7	17.2	87.1
Metals and Metal Products	1.1	5.0	19.7	77.5
Machinery and Equipment	13.0	4.7	21.0	85.6
Furniture and Household Durables	5.6	6.0	16.1	82.9
Nonmetallic Mineral Products	0.1	5.9	16.5	86.3
Transportation Equipment	16.8	30.4	2.8	58.2
Miscellaneous Products	6.9	10.6	8.9	85.8
Panel B: 1998-2005				
Farm Products	1.6	87.5	0.5	48.6
Processed Foods and Feeds	22.4	26.3	3.3	57.8
Textile Products and Apparel	3.6	2.3	43.2	49.7
Hides, Skins, Leather, and Related Products	0.3	3.8	25.9	80.0
Fuels and Related Products and Power	20.8	48.7	1.5	54.1
Chemicals and Allied Products	2.8	6.1	15.9	61.6
Rubber and Plastic Products	1.8	3.2	30.8	83.8
Lumber and Wood Products	0.1	1.3	78.6	86.6
Pulp, Paper and Allied Products	3.0	4.4	22.2	74.9
Metals and Metal Products	1.1	3.8	25.5	72.2
Machinery and Equipment	13.0	3.7	26.4	71.0
Furniture and Household Durables	5.6	5.1	19.1	78.6
Nonmetallic Mineral Products	0.1	4.1	23.9	67.0
Transportation Equipment	16.8	27.3	3.1	53.7
Miscellaneous Products	6.9	16.5	5.6	81.3

Frequencies are reported in percent per month. Implied durations are reported in months. Fractions are reported in percentages. "Weight" denotes the post-1997 final goods value weight of the Major Groups. "Med. Freq. Price Ch." denotes the median frequency of price change. It is calculated by first calculating the mean frequency of price change for each cell code, then taking an unweighted median within 4-digit commodity code and then taking a value weighted median across 4-digit commodity codes within the Major Group. "Med Duration" denotes the median implied duration: -1/ln(1-f), where f is the median frequency of price change. "Frac Up" denotes the median fraction of price increases. It is calculated in an analogous manner to the median frequency of price change.

Table 8: Absolute Size of Price Changes

		Regular Prices			Sales			All Prices
Major Group	Weight	Median Change	Median Increase	Median Decrease	Median Change	Median Ratio	Frac. Price Ch.	Median Change
Panel A: 1988-1997								
Processed Food	7.9	10.9	9.8	13.3	22.0	2.3	47.3	17.5
Unprocessed Food	7.5	11.1	11.2	11.3	29.9	2.5	28.5	19.3
Household Furnishings	6.1	9.3	8.5	10.2	25.9	2.5	65.0	19.1
Apparel	7.9	11.0	8.2	12.5	33.4	3.2	82.0	28.8
Transportation Goods	8.0	3.0	2.6	3.3	13.1	2.4	4.6	3.0
Recreation Goods	3.6	10.3	10.1	11.8	28.2	2.6	41.4	16.5
Other Goods	5.1	7.5	7.0	9.7	18.0	2.4	20.8	11.1
Utilities	5.8	5.5	5.4	5.7	9.7	1.6	0.1	5.5
Vehicle Fuel	3.2	4.5	4.8	4.1	7.7	2.0	0.1	4.5
Travel	4.6	19.7	18.0	21.8	30.6	1.5	3.3	20.5
Services (excl. Travel)	38.8	7.8	6.8	7.4	21.8	3.6	4.6	8.6
All Sectors	100.0	8.2	7.5	9.2	25.5	2.6	21.2	11.1
Panel B: 1998-2005								
Processed Food	8.2	13.2	11.5	17.6	33.1	2.6	57.9	26.5
Unprocessed Food	5.9	14.2	13.9	15.0	35.1	2.5	37.9	27.1
Household Furnishings	5.0	8.7	8.0	9.8	28.0	2.8	66.8	20.8
Apparel	6.5	11.5	10.0	13.3	37.1	3.1	87.1	30.2
Transportation Goods	8.3	6.1	5.9	6.2	14.1	0.9	8.0	6.1
Recreation Goods	3.6	10.1	8.7	12.0	32.9	3.1	49.1	18.9
Other Goods	5.4	7.3	7.2	9.2	26.5	2.9	32.6	10.0
Utilities	5.3	6.3	6.2	6.4	12.6	1.6	0.0	6.3
Vehicle Fuel	5.1	6.4	6.8	5.9	11.7	1.8	0.0	6.4
Travel	5.5	21.6	20.9	22.4	29.3	1.4	1.5	21.9
Services (excl. Travel)	38.5	7.1	6.5	9.5	29.5	2.9	3.1	7.3
All Sectors	100.0	8.5	7.3	10.5	29.5	2.6	21.5	10.7

"Regular prices" denote prices excluding sales. "Weight" denotes the CPI expenditure weight of the Major Group. "Median Change", "Median Increase" and "Median Decrease" refer to the weighted median absolute size of log price changes, increases and decreases, respectively. The median absolute size of log price changes is calculated by first calculating the mean absolute size of log price changes for each ELI and then taking a weighted median across ELIs using CPI expenditure weights. Other median statistics are calculated in an analogous manner. "Median Ratio" denotes the weighted median ratio of the mean absolute size of log price changes due to sales to the absolute size of log regular price changes within ELIs. For each ELI the mean size of sales is calculated for all price changes at the beginning and end of sales. "Frac. Price Ch." denotes the median fraction of price changes that are due to sales.

Table 9: Absolute Size of Changes in Finished Goods Producer Prices

Category Name	Weight	Median Change	Median Increase	Median Decrease
Panel A: 1988-1997				
Farm Products	1.6	20.6	17.8	22.1
Processed Foods and Feeds	22.4	6.4	6.1	9.0
Textile Products and Apparel	3.6	11.5	10.3	15.8
Hides, Skins, Leather, and Related Products	0.3	8.5	8.1	9.9
Fuels and Related Products and Power	20.8	5.6	5.5	5.7
Chemicals and Allied Products	2.8	12.1	10.6	18.4
Rubber and Plastic Products	1.8	8.4	7.5	12.3
Lumber and Wood Products	0.1	6.5	3.3	16.3
Pulp, Paper and Allied Products	3.0	9.8	8.9	16.6
Metals and Metal Products	1.1	8.8	6.9	10.4
Machinery and Equipment	13.0	9.3	9.0	14.1
Furniture and Household Durables	5.6	7.1	7.0	10.1
Nonmetallic Mineral Products	0.1	6.9	7.9	10.5
Transportation Equipment	16.8	6.4	3.8	13.9
Miscellaneous Products	6.9	5.8	4.3	22.1
All Goods	100.0	6.8	6.5	10.6
Panel B: 1998-2005				
Farm Products	1.6	18.3	16.4	19.5
Processed Foods and Feeds	22.4	6.5	6.4	6.8
Textile Products and Apparel	3.6	11.3	9.7	15.2
Hides, Skins, Leather, and Related Products	0.3	10.8	7.6	14.1
Fuels and Related Products and Power	20.8	8.0	8.1	7.6
Chemicals and Allied Products	2.8	17.8	10.2	19.3
Rubber and Plastic Products	1.8	10.0	9.7	7.4
Lumber and Wood Products	0.1	6.1	5.7	9.0
Pulp, Paper and Allied Products	3.0	10.6	9.2	13.1
Metals and Metal Products	1.1	8.7	7.4	9.3
Machinery and Equipment	13.0	9.3	9.2	13.2
Furniture and Household Durables	5.6	8.6	7.1	10.0
Nonmetallic Mineral Products	0.1	11.7	13.1	17.5
Transportation Equipment	16.8	4.8	4.3	4.1
Miscellaneous Products	6.9	6.8	6.9	6.2
All Goods	100.0	7.7	6.9	7.9

"Weight" denotes the post-1997 finished goods PPI value weight of the Major Group. "Median Change", "Median Increase" and "Median Decrease" refer to the weighted median absolute sizes of log price changes, increases and decreases, respectively. The median absolute size of log price changes is calculated by first calculating the mean absolute size of log price changes for each cell code, then taking an unweighted median within 4-digit commodity code and then taking a value weighted median across 4-digit commodity codes. The other median statistics are calculated in an analogous manner.

Table 10: Sales and Prices During Sales

	Freq. Reg. Price Ch.	Freq. Price Ch. During One Period Sales	Frac. Return After One Period Sales	Frac. of Sales that Last One Period
Panel A: 1988-1997				
Processed Food	12.7	14.5	73.1	65.8
Unprocessed Food	28.3	25.3	55.8	68.1
Household Furnishings	6.7	12.4	76.7	50.0
Apparel	4.8	7.4	85.7	42.0
Panel B: 1998-2005				
Processed Food	10.5	11.4	78.5	64.7
Unprocessed Food	25.0	22.5	60.0	63.2
Household Furnishings	6.0	11.6	78.2	43.3
Apparel	3.6	7.1	86.3	35.8

"Freq. Reg. Price Ch." denotes the median frequency of price changes excluding sales. "Freq. Price Ch. During One Period Sales" denotes the median monthly frequency of regular price change during sales that last one month. The monthly frequency is calculated as $1-(1-f)^{0.5}$ where f is the frequency of regular price changes during one month sales. "Frac. Return After One Period Sales" denotes the median fraction of prices that return to their original level after one period sales. "Frac. of Sales that Last One Period" denotes the median fraction of sales that last one month. In calculating this statistic we drop left censored sale spells. Medians are calculated by first calculating an average within each ELI and then calculating an expenditure weighted median across ELIs within the Major Group.

Table 11: Alternative Procedures for Accounting for Sales and Stockouts

	1988-1997		1998-2005	
	Freq. (% per month)	Impl. Dur. (months)	Freq. (% per month)	Impl. Dur. (months)
Panel A: Excluding Price Changes due to Substitutions				
1 Carry regular price forward during sales and stockouts	11.2	8.4	9.0	10.6
2 Estimate frequency of price change during sales	9.8	9.7	10.2	9.3
3 Estimate frequency of price change during sales and stockouts	11.8	8.0	9.6	9.9
Panel B: Including Price Changes due to Substitutions				
4 Estimate frequency of price change during sales	10.9	8.7	11.1	8.5
5 Estimate frequency of price change during sales and stockouts	13.0	7.2	11.8	8.0

Frequencies are reported in percent per month. Implied durations are reported in months. In all cases, the median frequency is calculated by first calculating the mean frequency of price change for each ELI and then taking an expenditure-weighted median across ELI's using CPI expenditure weights. The median implied duration is $-1/\ln(1-f)$, where f is the median frequency of price change. Row 1 gives the frequency of price change calculated for price change series where the last regular price is carried forward through sales or missing values of the price data in all cases where these spells last for 5 months or less. Row 2 is calculated by applying the implied monthly frequency of price change associated with one and two-period sales to all sale observations (see text). Row 3 is calculating by applying the implied monthly frequency of price change associated with one and two-period sales or stock-outs to both sale and stockout spells lasting 5 months or less. The statistics including substitutions are calculated in an analogous manner, except that price changes associated with substitutions are also included as price changes

Table 12: Frequency of Price Change: Comparison of CPI and PPI Categories

Category	Num. of Matches	CPI Prices Freq.	CPI Prices Duration	CPI Regular Prices Freq.	CPI Regular Prices Duration	PPI Prices Freq.	PPI Prices Duration
Processed Food	32	26.1	3.3	10.5	9.0	7.2	13.4
Unprocessed Food	24	37.3	2.1	25.9	3.3	67.9	0.9
Household Furnishings	27	23.0	3.8	6.5	14.9	5.6	17.3
Apparel	32	31.0	2.7	3.6	27.3	2.7	36.3
Recreation Goods	16	14.5	6.4	6.8	14.2	6.1	15.9
Other Goods	13	33.6	2.4	23.2	3.8	17.1	5.3

CPI regular prices denote consumer prices excluding sales. "Num. of Matches" denotes the number of ELIs matched to 4, 6 or 8-digit commodity codes within the PPI in the Major Group. "Freq." denotes the median frequency of price change. "Duration" denotes -1/ln(1-f), where f is the median frequency of price change. Medians for the consumer price data are are calculated by first calculating an average within each ELI and then calculating an expenditure weighted median across ELIs within the Major Group. Medians for the producer price data are calculated by first calculating the mean frequency of price change for each cell code, then taking an unweighted median within 4-digit commodity code and then taking a value weighted median across 4-digit commodity codes.

Table13 : Regressions of Frequency and Size of Consumer Price Changes on Inflation

Dependent Variable	Regular Prices 1988-1997	Regular Prices 1998-2005	Prices 1988-1997	Prices 1998-2005
Consumer Price ELI Level:				
Frequency of Price Increase	0.96*	0.57*	0.75*	0.70*
	(0.10)	(0.25)	(0.11)	(0.21)
Frequency of Price Decrease	-0.20*	-0.41*	-0.23	-0.44
	(0.09)	(0.11)	(0.16)	(0.14)
Size of Price Increase	0.14	-0.56	-0.05	-0.57
	(0.12)	(0.39)	(0.12)	(0.32)
Size of Price Decrease	-0.06	-0.45	0.17	0.19
	(0.28)	(0.36)	(0.13)	(0.24)
Frequency of Price Change	0.76*	0.32	0.52*	0.38
	(0.18)	(0.45)	(0.25)	(0.31)
Size of Price Change	0.45*	0.45	0.11	0.64
	(0.11)	(0.25)	(0.18)	(0.52)

The table reports the results of regressions of the median frequency and absolute size of log price increases and decreases at the ELI level on the CPI inflation rate (log changes). For example, the number in the table in the first row of numbers and first column of numbers (i.e. 0.96) refers to the regression coefficient on CPI inflation in a regression where the dependent variable is the frequency of regular price increases in 1988-1997. Each observation is for a particular ELI in a particular year. All regressions include ELI-level fixed effects and time trends. Standard errors are in parentheses. The standard errors are cluster-robust standard errors calculated according to the method described in Arellano (1987), where the standard errors are clustered by year. A star denotes significance at the 5% level.

Table 14: Regressions of Frequency and Size of Producer Price Changes on Inflation

Dependent Variable	CPI Inflation	PPI Inflation
Producer Price 4 Digit Level:		
Frequency of Price Increase	0.79*	0.40*
	(0.12)	(0.06)
Frequency of Price Decrease	-0.05	-0.08
	(0.14)	(0.05)
Size of Price Increase	0.10	0.04
	(0.07)	(0.04)
Size of Price Decrease	-0.04	-0.00
	(0.10)	(0.05)
Frequency of Price Change	0.75*	0.31*
	(0.21)	(0.09)
Size of Price Change	0.36*	0.17*
	(0.05)	(0.03)

The table reports the results of regressions of the median frequency and absolute size of log price increases and decreases at the 4 digit level on the CPI inflation rate (first column of numbers) and the PPI inflation rate (second column of numbers). In both cases the inflation rates are measured as log changes. All regressions include ELI-level fixed effects and time trends. Standard errors are in parentheses. The standard errors are cluster-robust standard errors calculated according to the method described in Arellano (1987), where the standard errors are clustered by year. A star denotes significance at the 5% level.

Table 15: Regressions of Frequency and Size of Sales on Inflation

Dependent Variable	1988-1997	1998-2005
Consumer Price ELI Level:		
Frequency of Sales	-0.36	-0.28
	(0.17)	(0.18)
Size of Sales	-0.13	0.49
	(0.72)	(0.38)

The table reports the results of regressions of the frequency and absolute size of sales at the ELI level on the CPI inflation rate (log changes). Each observation is for a particular ELI in a particular year. All regressions include ELI-level fixed effects and time trends. Standard errors are in parentheses. The standard errors are cluster-robust standard errors calculated according to the method described in Arellano (1987), where the standard errors are clustered by year. A star denotes significance at the 5% level.

Table 16: Frequency of Price Change by Category for 1998-2005

		Regular Price				Price					
Category Name	ELI	Freq.	Dur.	Up	Obs.	Freq.	Dur.	Up	Obs.	weight	CDF
GIRLS' OUTERWEAR	AD011	0.0	-	-	52	55.0	1.3	18.0	202	0.031	0.03
LEGAL SERVICES	GD011	1.6	63.1	96.2	3309	1.6	63.1	96.2	3309	0.482	0.51
CANDY/GUM/CRACKERS/PASTRIES/CHIPS/SIMILAR ITEMS	FV041	1.7	57.5	82.2	8475	1.7	57.5	82.2	8475	0.299	0.81
MEN'S PLASTIC RAINCOATS AND RAIN SETS	AA022	1.7	56.8	79.3	1662	19.4	4.6	44.5	2259	0.129	0.94
MEN'S SWEATERS AND VESTS	AA032	1.8	54.1	57.1	382	40.4	1.9	16.2	811	0.126	1.07
GIRLS' UNDERWEAR	AD016	1.8	53.7	53.5	2331	18.4	4.9	38.9	2993	0.052	1.12
SCUBA GEAR AND EQUIPMENT	RC022	1.9	52.0	50.0	105	16.9	5.4	45.5	130	0.013	1.13
PAINTINGS AND PICTURES	HL012	1.9	51.9	70.5	4087	15.4	6.0	44.0	5419	0.239	1.37
LOCAL AUTOMOBILE REGISTRATION	TF012	1.9	51.9	92.3	681	1.9	51.9	92.3	681	0.295	1.67
OTHER INFORMATION SERVICES	EE031	2.1	47.6	89.3	4041	2.2	44.2	85.9	4113	0.025	1.69
DISHCLOTHS AND DISHTOWELS	HH033	2.1	47.2	87.5	382	15.9	5.8	46.4	528	0.058	1.75
GENERAL PURPOSE AND AUTO	HM014	2.1	46.5	72.2	846	4.6	21.3	55.0	872	0.042	1.79
INTRACITY MASS TRANSIT	TG031	2.3	42.7	83.9	8028	2.3	42.7	83.9	8028	0.332	2.12
WOMEN'S SWIMSUITS	AC043	2.4	41.8	71.4	592	36.8	2.2	15.5	1159	0.191	2.31
MATERIALS FOR MAKING SLIPCOVERS,UPHOLSTERY,CURTAINS & DRAPERIES	RE021	2.4	41.6	76.9	4381	12.8	7.3	49.4	5543	0.092	2.41
ENCYCLOPEDIAS AND OTHER SETS OF REFERENCE BOOKS	EA013	2.4	41.3	33.3	502	7.4	13.1	30.0	544	0.057	2.46
WOMEN'S DRESSES	AC021	2.4	41.1	62.9	2577	37.4	2.1	17.0	5297	0.282	2.75
PHYSICAL MEDICINE	MC041	2.4	40.8	85.7	3759	2.4	40.8	85.7	3759	0.374	3.12
WOMEN'S PANTYHOSE AND STOCKINGS	AC042	2.5	39.5	70.3	2962	14.8	6.2	44.3	3566	0.198	3.32
MEN'S SWIMSUITS	AA023	2.5	39.1	53.3	594	30.5	2.7	25.9	1163	0.116	3.43
STATE VEHICLE REGISTRATION	TF011	2.6	38.5	79.5	20929	2.6	38.5	79.5	20929	0.290	3.72
CHAISE LOUNGE	HJ032	2.7	37.1	77.8	338	19.2	4.7	33.7	478	0.069	3.79
WOMEN'S BRAS, BRA SETS, GIRDLES AND CORSELETS	AC041	2.7	36.6	70.4	2633	26.0	3.3	43.6	4000	0.212	4.00
CURTAINS AND DRAPES	HH021	2.7	36.0	89.7	1059	21.8	4.1	50.7	1704	0.076	4.08
CARE OF INVALIDS, ELDERLY AND CONVALESCENTS IN THE HOME	GD061	2.8	35.7	92.3	942	2.8	35.7	92.3	942	0.151	4.23
NONELECTRIC COOKINGWARE	HL041	2.8	35.2	74.0	1784	18.0	5.0	48.8	2498	0.042	4.27
WOMEN'S OUTERWEAR	AC011	2.8	34.8	58.6	2473	30.6	2.7	23.5	5329	0.155	4.43
FOOD AT EMPLOYEE SITES AND SCHOOLS	FV031	2.9	34.5	81.2	9527	2.9	33.5	80.1	9542	0.914	5.34
PARKING FEES	TF031	2.9	34.1	81.5	43359	2.9	34.1	81.5	43359	0.226	5.57
DOLLS AND DOLL CLOTHING	RE011	2.9	33.5	70.4	4597	8.7	11.0	43.0	5192	0.362	5.93
GIRLS' SWIMSUITS	AD015	2.9	33.5	0.0	34	58.2	1.1	17.1	141	0.035	5.96
TABLEWARE AND NONELECTRIC KITCHENWARE	HL042	3.0	33.2	70.2	2830	12.6	7.4	49.8	3556	0.068	6.03
COIN-OPERATED APPAREL LAUNDRY AND DRY CLEANING	GD031	3.0	33.0	81.0	9843	3.3	29.7	76.3	9936	0.298	6.33
FLATWARE	HL032	3.0	32.8	80.0	333	23.3	3.8	51.0	631	0.031	6.36
GIRLS' DRESSES	AD012	3.0	32.6	71.4	232	44.2	1.7	17.9	581	0.069	6.43
PLASTIC DINNERWARE	HL031	3.0	32.4	70.6	2799	23.9	3.7	47.1	4655	0.073	6.50
LUGGAGE	GE012	3.1	32.2	54.5	360	25.7	3.4	41.3	734	0.116	6.62
WATCHES	AG011	3.1	32.2	65.5	2843	19.8	4.5	48.8	4045	0.094	6.71
BEAUTY PARLOR SERVICES FOR FEMALES	GC011	3.1	32.1	81.3	5060	3.1	31.3	80.5	5064	1.364	8.08
GIRLS' DRESS AND CASUAL SHOES AND BOOTS	AE022	3.1	32.1	55.6	1173	24.4	3.6	40.9	1827	0.135	8.21

Table 16: Frequency of Price Change by Category for 1998-2005 (continued)

		Regular Price				Price					
Category Name	ELI	Freq.	Dur.	Up	Obs.	Freq.	Dur.	Up	Obs.	weight	CDF
FAN	HK023	3.1	31.7	49.1	1708	13.9	6.7	37.7	2077	0.074	8.29
MEN'S DRESS AND CASUAL SHOES AND BOOTS	AE011	3.2	31.2	62.0	3171	26.4	3.3	44.2	5257	0.359	8.65
CRIB AND MATTRESS	HJ031	3.2	30.8	73.9	719	9.8	9.7	53.1	829	0.062	8.71
FEES FOR LESSONS OR INSTRUCTIONS	RF031	3.3	30.0	95.6	2778	3.6	27.3	92.1	2813	0.312	9.02
MEN'S PANTS AND SHORTS	AA041	3.3	29.4	59.0	4300	34.4	2.4	42.7	8981	0.311	9.33
EXERCISE EQUIPMENT	RC021	3.4	29.2	68.5	4806	14.5	6.4	44.2	6200	0.187	9.52
GENERAL MEDICAL PRACTICE	MC011	3.4	29.2	68.8	7801	3.4	29.2	68.8	7801	2.064	11.58
PERIODIC CHK ACT FEES, TRANS FEES, PERS CHKS	GD051	3.5	28.5	75.8	1912	3.5	28.5	75.8	1912	0.197	11.78
INFANTS' AND TODDLERS' OUTERWEAR	AF011	3.5	27.8	78.3	1698	38.0	2.1	32.0	3232	0.156	11.93
FIRST CLASS MAIL	EC011	3.5	27.8	95.0	23374	3.5	27.8	95.0	23374	0.275	12.21
WOMEN'S DRESS AND CASUAL SHOES AND BOOTS	AE031	3.5	27.7	64.6	5507	25.9	3.3	37.6	8800	0.513	12.72
WOMEN'S SWEATERS, AND SWEATER VESTS	AC031	3.6	27.3	59.8	2698	36.0	2.2	21.1	5408	0.574	13.30
BLENDERS	HK022	3.6	27.1	60.8	1408	21.0	4.2	48.2	2117	0.060	13.36
TOWELS, WASH CLOTHS, BATH MATS	HH031	3.6	27.1	68.0	690	36.9	2.2	49.0	1409	0.062	13.42
UTILITY PAIL	HN012	3.7	26.5	62.5	647	9.1	10.5	52.4	693	0.237	13.66
MEN'S SPORT COATS AND TAILORED JACKETS	AA012	3.7	26.4	65.4	700	35.4	2.3	41.1	1534	0.054	13.71
WOMEN'S SKIRTS	AC032	3.8	26.1	57.1	3532	31.0	2.7	30.1	6207	0.528	14.24
BOYS' SUITS AND VESTS	AB014	3.8	26.0	68.1	1246	26.9	3.2	44.8	1923	0.155	14.39
SHOE REPAIR AND OTHER SHOE SERVICES	GD041	3.8	26.0	80.0	530	3.8	26.0	80.0	530	0.029	14.42
WOMEN'S AND GIRLS' CLOTHING ALTERATIONS AND REPAIRS	GD042	3.8	25.5	61.2	2551	4.0	24.2	61.5	2574	0.040	14.46
BOYS' SHIRTS	AB012	3.9	25.2	66.7	1158	31.3	2.7	31.1	1848	0.095	14.56
BOOKS NOT PURCHASED THROUGH BOOK CLUBS	RG022	3.9	25.1	64.9	20803	5.4	18.1	60.2	21655	0.151	14.71
LIPSTICK, GLOSS, ROUGE	GB021	3.9	25.0	82.5	4361	9.9	9.6	59.8	4714	0.514	15.22
LIVING ROOM TABLES	HJ023	3.9	25.0	75.0	306	22.6	3.9	48.8	572	0.195	15.42
MEN'S SHIRTS	AA031	4.0	24.6	61.4	5392	34.5	2.4	40.4	9818	0.291	15.71
HAIR DRYER	GB014	4.0	24.5	66.7	225	16.1	5.7	50.0	274	0.135	15.84
MEN'S OUTERWEAR	AA013	4.0	24.4	63.3	1492	28.1	3.0	33.3	2885	0.114	15.96
STATIONERY	GE011	4.0	24.3	70.2	5090	7.2	13.3	55.5	5370	0.167	16.12
JEWELRY	AG021	4.1	23.8	62.4	4529	21.0	4.2	46.3	6929	0.437	16.56
SLEEPING BAGS, COTS, AND OTHER SLEEPING EQUIPMENT	RC023	4.1	23.6	65.8	1763	12.9	7.2	48.7	2038	0.122	16.68
DOGS	RB012	4.1	23.6	77.0	1784	7.1	13.6	66.2	1918	0.224	16.91
PORTABLE SANDING/POLISHING TOOLS	HM012	4.3	23.0	48.3	1410	16.1	5.7	46.6	1748	0.044	16.95
DOMESTIC SERVICES	HP011	4.3	22.7	79.7	1602	4.3	22.7	79.7	1602	0.450	17.40
AUTOMOBILE SERVICE CLUBS	TF032	4.3	22.7	88.8	6213	7.6	12.7	69.4	6616	0.045	17.45
BOYS' OUTERWEAR	AB011	4.3	22.6	71.4	162	34.0	2.4	24.1	329	0.041	17.49
GIRLS' PANTS AND SHORTS	AD014	4.4	22.2	61.3	1410	35.5	2.3	34.8	2674	0.100	17.59
NEWSPAPER AND MAGAZINE SUBSCRIPTIONS	RG012	4.4	22.2	76.7	35064	5.8	16.7	69.0	36335	0.399	17.99
TAXI FARE	TG032	4.4	22.2	89.2	2107	4.4	22.2	89.2	2107	0.103	18.09
MEN'S SUITS AND FORMAL WEAR	AA011	4.5	21.8	77.8	3530	33.1	2.5	47.0	6803	0.164	18.25
PROSTHODONTICS AND IMPLANTS	MC021	4.5	21.8	92.2	8615	4.5	21.8	92.2	8617	1.194	19.45
RECLINERS	HJ022	4.6	21.2	80.5	891	26.3	3.3	50.4	1614	0.208	19.65
BOYS' DRESS AND CASUAL SHOES AND BOOTS	AE021	4.6	21.1	43.1	1101	24.8	3.5	38.1	1642	0.140	19.79

Table 16: Frequency of Price Change by Category for 1998-2005 (continued)

Category Name	ELI	Regular Price Freq.	Regular Price Dur.	Regular Price Up	Regular Price Obs.	Price Freq.	Price Dur.	Price Up	Price Obs.	weight	CDF
HOUSING AT SCHOOL, EXCLUDING BOARD	HB011	4.7	20.9	91.7	1029	4.7	20.9	91.7	1029	0.331	20.13
BOYS' UNDERWEAR	AB013	5.0	19.6	67.5	806	19.6	4.6	50.2	1028	0.044	20.17
GIRLS' SWEATERS	AD013	5.0	19.6	58.6	583	36.9	2.2	28.6	1042	0.090	20.26
FERTILIZER, WEED/PEST KILLERS, LAWN/GARDEN INSECTICIDES	HM022	5.0	19.5	67.3	2145	9.0	10.7	53.1	2311	0.217	20.48
FULL SERVICE MEALS AND SNACKS	FV011	5.0	19.5	86.3	14584	5.1	19.2	85.4	14606	4.147	24.62
BEER, ALE, AND OTHER MALT BEVERAGES AWAY FROM HOME	FX011	5.0	19.5	75.8	9419	5.2	18.6	74.7	9452	0.496	25.12
BEDSPREADS	HH032	5.0	19.4	56.2	1595	34.7	2.3	48.4	3408	0.078	25.20
CEILING AND WALL LIGHTS	HL011	5.1	19.3	55.6	356	17.2	5.3	41.9	500	0.045	25.24
MEN'S UNDERWEAR	AA021	5.1	19.0	64.9	1443	25.8	3.4	50.6	1962	0.128	25.37
MATTRESSES AND SPRINGS	HJ011	5.2	18.8	77.9	1310	23.0	3.8	53.0	2100	0.184	25.56
RECORD CABINET, CURIO CABINET, BOOKCASE	HJ033	5.4	18.2	66.4	2000	18.1	5.0	50.2	2623	0.111	25.67
REPLACEMENT OF SETTING FOR WOMEN'S RINGS	GD043	5.4	18.2	59.5	1383	5.4	18.2	59.5	1383	0.021	25.69
BOARD	FV051	5.4	18.2	81.1	4446	5.5	17.8	80.3	4467	0.245	25.93
SINGLE COPY NEWSPAPERS AND MAGAZINES	RG011	5.4	18.0	67.1	12786	5.6	17.2	66.2	12834	0.149	26.08
WOMEN'S SUITS AND SUIT COMPONENTS	AC033	5.4	17.9	52.8	662	42.7	1.8	20.9	1689	0.105	26.19
TAX RETURN PREPARATION AND OTHER ACCOUNTING FEES	GD052	5.5	17.8	88.6	1283	5.5	17.8	88.6	1283	0.248	26.43
OPTOMETRISTS/OPTICIANS	MC031	5.5	17.7	76.4	5553	11.2	8.4	61.6	6180	0.386	26.82
ELEMENTARY AND HIGH SCHOOL BOOKS AND SUPPLIES	EA012	5.5	17.5	65.5	523	5.5	17.5	65.5	523	0.079	26.90
DEODORANT, ANTIPERSPIRANT	GB013	5.6	17.4	66.0	948	16.3	5.6	54.2	1089	0.119	27.02
LARGE EQUIPMENT, POWERED	HM021	5.6	17.4	61.3	1341	18.4	4.9	45.5	1911	0.211	27.23
NURSING AND CONVALESCENT HOME CARE	MD021	5.7	17.0	89.4	7263	5.7	17.0	89.4	7263	0.073	27.30
CANDY AND CHEWING GUM	FR021	5.7	16.9	68.4	30958	14.9	6.2	56.0	35773	0.312	27.61
PET SERVICES	RB021	5.8	16.9	78.3	799	5.8	16.9	78.3	799	0.158	27.77
WINE AT HOME	FW031	5.8	16.9	68.6	4531	19.3	4.7	52.9	6164	0.254	28.03
FULL COLLEGE TUITION AND FIXED FEES	EB011	5.8	16.8	85.9	1352	5.8	16.8	85.9	1352	1.584	29.61
ADMISSION TO SPORTING EVENTS	RF022	5.8	16.7	74.5	948	6.6	14.6	78.1	964	0.312	29.92
STRING INSTRUMENTS	RE031	5.8	16.6	64.5	3958	9.2	10.3	53.1	4504	0.075	30.00
CALCULATORS AND ADDING MACHINES	EE042	5.9	16.4	50.0	843	8.0	11.9	39.4	882	0.013	30.01
PRERECORDED - RECORDS, COMPACT DISCS, AND TAPES	RA061	6.0	16.3	75.7	3171	11.9	7.9	60.4	3539	0.198	30.21
BOYS' SWIMSUITS	AB015	6.0	16.2	100.0	67	56.8	1.2	19.8	222	0.033	30.24
VENETIAN BLINDS	HH022	6.0	16.1	81.3	1246	21.9	4.0	53.1	1700	0.072	30.31
DENTAL PREPARATIONS	GB012	6.1	15.9	68.5	2085	15.5	5.9	56.1	2437	0.117	30.43
SUPPORTIVE MEDICAL EQUIPMENT	MB023	6.1	15.9	80.0	901	8.7	11.0	70.7	943	0.063	30.49
SWEETROLLS, COFFEE CAKE AND DOUGHNUTS (EXCLUDING FROZEN)	FB042	6.1	15.8	75.9	11328	14.4	6.4	59.5	12923	0.110	30.60
LIMITED SERVICE MEALS AND SNACKS	FV021	6.1	15.8	81.2	16886	7.0	13.8	76.1	17153	2.304	32.91
ELEMENTARY AND HIGH SCHOOL TUITION AND FIXED FEES	EB021	6.2	15.5	85.5	995	6.2	15.5	85.5	995	0.482	33.39
HOSPITAL SERVICES	MD011	6.3	15.5	86.3	22271	6.3	15.5	86.3	22271	1.866	35.26
CAKES AND CUPCAKES (EXCLUDING FROZEN)	FB031	6.3	15.3	78.5	17134	13.1	7.1	62.0	19020	0.158	35.41

Table 16: Frequency of Price Change by Category for 1998-2005 (continued)

		Regular Price				Price					
Category Name	ELI	Freq.	Dur.	Up	Obs.	Freq.	Dur.	Up	Obs.	weight	CDF
MEDICAL EQUIPMENT FOR GENERAL USE	MB022	6.3	15.3	70.0	949	15.3	6.0	56.4	1067	0.055	35.47
ROPE	HM013	6.3	15.2	72.5	1717	9.3	10.2	62.7	1785	0.066	35.54
NEW MOTORCYCLES	TA012	6.4	15.2	45.9	959	7.5	12.9	44.0	1003	3.303	38.84
SOFAS OTHER THAN SOFA BEDS	HJ021	6.5	14.9	62.5	1234	30.3	2.8	49.6	2346	0.223	39.06
PAINT	HM011	6.5	14.9	96.0	385	16.1	5.7	65.8	454	0.065	39.13
BICYCLES AND ACCESSORIES	RC013	6.5	14.8	58.6	444	13.8	6.8	43.2	538	0.078	39.20
TOPICALS AND DRESSINGS	MB021	6.7	14.4	73.4	4251	11.9	7.9	61.3	4549	0.065	39.27
VIDEO GAME HARDWARE	RE012	6.8	14.3	25.9	399	13.2	7.1	26.7	456	0.148	39.42
DOG FOOD	RB011	6.8	14.2	68.5	2895	21.5	4.1	54.4	3580	0.355	39.77
POWDERS, CRYSTALS, TABLETS, MIXES, AND SYRUPS	FP022	6.8	14.2	68.2	16792	13.8	6.7	57.7	19550	0.111	39.88
BEDROOM CASE GOODS	HJ012	6.8	14.1	77.4	2138	18.9	4.8	57.5	2892	0.243	40.13
RADIO, PHONOGRAPHS AND TAPE RECORDERS/PLAYERS	RA051	6.9	14.1	41.4	3208	22.6	3.9	40.7	4270	0.191	40.32
COLORING	GB011	6.9	14.0	68.1	2052	19.7	4.6	53.7	2461	0.135	40.45
DAY CARE AND NURSERY SCHOOL	EB031	6.9	14.0	88.2	20666	6.9	14.0	88.2	20666	1.277	41.73
STROLLER	GE013	7.0	13.7	87.5	114	17.5	5.2	55.2	166	0.050	41.78
PREPARED SALADS	FT061	7.0	13.7	79.1	3890	16.8	5.4	60.2	4466	0.056	41.84
FRESH ROLLS, BISCUITS, AND MUFFINS	FB021	7.2	13.5	75.3	31031	15.6	5.9	60.1	35554	0.203	42.04
MISCELLANEOUS PAPER, PLASTIC, FOIL PRODUCTS	HN031	7.4	13.0	70.9	4131	19.4	4.6	56.8	5033	0.357	42.40
SALT AND OTHER SEASONINGS AND SPICES	FT041	7.4	12.9	64.5	8098	16.1	5.7	54.9	9378	0.092	42.49
KITCHEN TABLE, CHAIR AND SETS	HJ024	7.5	12.8	68.0	995	26.4	3.3	50.4	1704	0.218	42.71
FLOOR CLEANING EQUIPMENT	HK021	7.6	12.6	35.5	814	25.6	3.4	40.7	1286	0.049	42.75
DIAPERS AND DIAPER LINERS	AF012	7.6	12.6	50.5	3689	20.4	4.4	48.8	4531	0.220	42.97
POTATO CHIPS AND OTHER SNACKS	FT031	7.6	12.6	66.8	28419	26.0	3.3	53.6	40175	0.381	43.35
GARDENING OR LAWN CARE SERVICES	HP021	7.8	12.4	76.6	1813	7.8	12.4	76.6	1813	0.378	43.73
PRERECORDED - VIDEO TAPES AND DISCS	RA041	7.8	12.3	50.0	1665	11.8	8.0	49.1	1838	0.097	43.83
INTERNAL AND RESPIRATORY OVER-THE-COUNTER DRUGS	MB011	7.9	12.2	69.1	7482	15.5	5.9	57.8	8402	0.361	44.19
COMPUTER SOFTWARE	EE021	7.9	12.1	49.1	4050	10.8	8.7	46.9	4324	0.042	44.23
TENANTS' INSURANCE	HD011	7.9	12.1	77.1	13377	7.9	12.1	77.1	13377	0.510	44.74
FILM	RD011	7.9	12.1	56.3	2511	17.4	5.2	50.7	3046	0.075	44.82
PIES, TARTS, TURNOVERS (EXCLUDING FROZEN)	FB044	8.2	11.8	70.9	5434	20.5	4.4	56.4	6650	0.059	44.88
PHOTOGRAPHER'S FEES	RD021	8.2	11.8	81.3	1312	9.5	10.1	75.2	1405	0.088	44.97
MOTOR VEHICLE INSURANCE	TE011	8.2	11.8	65.8	8631	8.2	11.8	65.8	8631	3.371	48.34
OUTBOARD MOTORS GASOLINE POWERED	RC011	8.2	11.7	65.1	2030	10.8	8.7	57.2	2307	0.130	48.47
BOOKS PURCHASED THROUGH BOOK CLUBS	RG021	8.3	11.5	76.2	2025	10.3	9.2	72.1	2127	0.115	48.58
REUPHOLSTERY OF FURNITURE	HP042	8.4	11.4	81.2	822	8.4	11.4	81.2	822	0.047	48.63
OLIVES, PICKLES, RELISHES	FT042	8.4	11.3	69.3	3198	24.6	3.5	55.0	4201	0.050	48.68
INDOOR PLANTS	HL021	8.5	11.3	63.7	7032	12.9	7.3	54.2	7677	0.213	48.89
CLUB MEMBERSHIP DUES	RF011	8.6	11.2	80.8	4997	12.6	7.4	69.3	5445	0.921	49.81
VETERINARIAN SERVICES	RB022	8.7	11.0	91.0	4440	8.7	11.0	91.0	4440	0.185	50.00
AUTOMOBILE BATTERIES	TC021	8.7	10.9	68.7	34541	11.0	8.6	63.3	36130	0.188	50.19
TEA	FP021	8.9	10.8	66.3	8683	20.7	4.3	55.2	10766	0.072	50.26
FUNERAL EXPENSES	GD021	8.9	10.8	84.5	3637	8.9	10.8	84.5	3637	0.492	50.75

Table 16: Frequency of Price Change by Category for 1998-2005 (continued)

Category Name	ELI	Regular Price Freq.	Regular Price Dur.	Regular Price Up	Regular Price Obs.	Price Freq.	Price Dur.	Price Up	Price Obs.	weight	CDF
SPANISH/MEXICAN FOODS	FT062	8.9	10.7	66.9	23948	25.0	3.5	54.4	31546	0.381	51.13
ADMIS. TO MOVIES, THEATERS, CONCERTS AND OTHER RECURRING EVENTS	RF021	9.0	10.6	82.8	5707	9.1	10.5	81.9	5725	0.784	51.91
OTHER CONDIMENTS (EXCLUDING OLIVES, PICKLES, RELISHES)	FT044	9.1	10.5	70.2	5724	18.7	4.8	58.6	6748	0.070	51.98
TECHNICAL AND BUSINESS SCHOOL TUITION AND FIXED FEES	EB041	9.2	10.4	83.4	13680	9.2	10.4	83.4	13680	0.074	52.06
INSIDE HOME MAINTENANCE AND REPAIR SERVICES	HP043	9.2	10.4	70.1	729	11.5	8.2	66.7	754	0.066	52.13
JELLY, JAM, PRESERVES, MARMALADE, FRUIT BUTTER	FR031	9.3	10.2	66.2	23276	23.1	3.8	55.1	29407	0.107	52.23
GARBAGE/TRASH COLLECTION	HG021	9.4	10.2	77.2	6737	9.4	10.2	77.2	6737	0.346	52.58
SOAPS AND DETERGENTS	HN011	9.4	10.1	65.9	5674	21.7	4.1	54.9	6959	0.316	52.89
COOKIES	FB032	9.6	10.0	65.6	18116	32.1	2.6	53.5	26592	0.212	53.11
DRIED AND PROCESSED FRUIT	FM031	9.6	9.9	66.1	25658	18.6	4.9	56.9	29699	0.065	53.17
FILM PROCESSING	RD022	9.7	9.8	55.0	3161	10.7	8.9	54.9	3222	0.120	53.29
WHITE BREAD	FB011	9.8	9.7	73.9	46785	23.7	3.7	58.1	59408	0.403	53.69
SAUCES AND GRAVIES	FT043	9.9	9.6	64.3	15235	23.3	3.8	54.2	19422	0.195	53.89
RICE	FA031	9.9	9.6	62.8	27872	23.1	3.8	54.2	35286	0.210	54.10
SUGAR AND ARTIFICIAL SWEETENERS	FR011	9.9	9.6	64.6	28252	22.5	3.9	54.7	35155	0.101	54.20
OTHER VIDEO EQUIPMENT	RA031	9.9	9.5	33.8	3960	27.0	3.2	33.9	5530	0.077	54.28
RENTAL OF VIDEO TAPES AND DISCS	RA042	10.0	9.5	61.3	1940	10.0	9.5	61.0	1952	0.126	54.40
SALAD DRESSING	FS021	10.1	9.4	65.6	28674	27.9	3.1	54.1	38940	0.111	54.51
HOUSEHOLD PAPER PRODUCTS	HN021	10.1	9.4	67.9	3319	24.9	3.5	54.9	4218	0.299	54.81
LUNCHMEATS (EXC BLGNA/LVWRST/SALMI)	FE012	10.1	9.3	66.6	31565	25.0	3.5	55.1	40472	0.168	54.98
PEANUT BUTTER	FS031	10.1	9.3	59.9	10119	26.0	3.3	52.8	13387	0.053	55.03
TELEPHONES	EE041	10.3	9.2	36.9	2413	17.5	5.2	36.0	2819	0.047	55.08
FROZEN NONCARBONATED JUICES AND DRINKS	FN021	10.3	9.2	65.1	21500	27.2	3.1	54.1	30072	0.076	55.16
FROZEN FRUITS	FM021	10.4	9.1	68.3	37957	28.7	3.0	54.8	52589	0.144	55.30
MICROWAVE OVENS	HK014	10.5	9.0	43.4	725	29.4	2.9	42.9	1126	0.068	55.37
CANNED FRUIT	FM011	10.5	9.0	66.3	24619	26.2	3.3	54.6	32596	0.243	55.61
SOUP	FT011	10.5	9.0	64.2	24028	23.4	3.8	55.2	30458	0.149	55.76
STILL CAMERA	RD012	10.5	9.0	37.6	1341	19.1	4.7	33.3	1727	0.062	55.82
MOVING, STORAGE, FREIGHT EXPRESS	HP031	10.5	9.0	71.2	5244	10.7	8.8	70.7	5267	0.148	55.97
BEER, ALE, AND OTHER MALT BEVERAGES AT HOME	FW011	10.6	8.9	73.1	4888	22.6	3.9	59.1	6252	0.466	56.44
WATER AND SEWERAGE SERVICE	HG011	10.7	8.8	75.8	11155	10.7	8.8	75.8	11155	0.942	57.38
SHOCK ABSORBERS AND MACPHERSON STRUTS	TD021	10.7	8.8	72.4	5813	11.3	8.4	70.1	5959	0.708	58.09
WHISKEY AT HOME	FW021	10.8	8.8	70.8	4384	19.3	4.7	59.5	5481	0.154	58.24
UNPOWERED BOATS	RC012	11.1	8.5	65.7	316	16.6	5.5	54.7	385	0.088	58.33
ROOM SIZE RUGS	HH011	11.1	8.5	72.1	2832	17.5	5.2	61.8	3266	0.119	58.45
APPLIANCE REPAIR	HP041	11.1	8.5	83.3	539	11.1	8.5	83.3	539	0.032	58.48
CANNED FISH AND SEAFOOD	FG021	11.2	8.4	62.3	33728	26.2	3.3	53.4	44698	0.198	58.68
FLOUR	FA011	11.5	8.2	66.0	26395	25.8	3.3	55.2	33769	0.099	58.78
CIGARS	GA021	11.5	8.2	80.1	27324	13.2	7.1	75.0	29259	0.091	58.87
POWDERED/EVAPORATED/CONDENSED MILK	FJ041	11.6	8.1	66.6	32747	25.9	3.3	55.7	43064	0.219	59.09

Table 16: Frequency of Price Change by Category for 1998-2005 (continued)

Category Name	ELI	Regular Price Freq.	Dur.	Up	Obs.	Price Freq.	Dur.	Up	Obs.	weight	CDF
NONFROZEN NONCARBONATED JUICES AND DRINKS	FN031	11.7	8.1	62.6	37240	29.4	2.9	53.6	52420	0.435	59.52
MOTOR OIL	TC022	11.7	8.0	73.2	23989	15.4	6.0	66.5	25414	0.196	59.72
MULTIPLE COURSES FROZEN/FREEZE DRIED FOODS	FT021	11.8	8.0	61.7	33033	31.6	2.6	53.1	48111	0.297	60.02
CEREAL	FA021	11.8	7.9	69.3	40786	26.1	3.3	57.0	52010	0.434	60.45
LARD AND SHORTENING	FS032	11.9	7.9	66.6	23032	24.1	3.6	56.2	28981	0.108	60.56
CRACKERS	FB041	12.0	7.8	64.2	11282	35.8	2.3	53.2	17522	0.119	60.68
FROZEN BAKERY PROD & FROZEN/REFRIG DOUGHS/BATTERS	FB043	12.3	7.6	67.8	8933	28.2	3.0	55.1	11820	0.105	60.78
BABY FOOD	FT051	12.3	7.6	67.8	32212	18.9	4.8	60.0	36883	0.141	60.92
COMMUNITY ANTENNA OR CABLE TV	RA021	12.4	7.6	77.3	9408	12.8	7.3	75.3	9519	1.259	62.18
COLLEGE TEXTBOOKS	EA011	12.6	7.4	79.3	3119	12.8	7.3	78.5	3174	0.140	62.32
ICE CREAM AND RELATED PRODUCTS	FJ031	12.7	7.4	68.9	23809	32.9	2.5	54.6	34702	0.249	62.57
TELEVISIONS	RA011	12.8	7.3	37.0	3072	31.2	2.7	35.8	4728	0.245	62.82
CELLULAR TELEPHONES	ED031	13.0	7.2	46.6	9360	13.0	7.2	46.6	9360	0.068	62.88
LAMB AND MUTTON	FE013	13.0	7.2	64.7	4913	21.4	4.1	56.7	5701	0.130	63.01
COLA DRINKS	FN011	13.1	7.1	63.1	31113	38.7	2.0	52.7	57561	0.581	63.60
ROASTED COFFEE	FP011	13.5	6.9	50.7	38342	26.4	3.3	49.2	48339	0.202	63.80
BANANAS	FK021	13.5	6.9	54.3	33567	29.0	2.9	51.2	44415	0.146	63.94
FRANKFURTERS	FE011	13.8	6.7	68.8	8560	32.1	2.6	55.5	11786	0.159	64.10
TURKEY (EXCLUDING CANNED)	FF021	14.1	6.6	60.8	23067	25.9	3.3	53.4	28707	0.157	64.26
PAINTING ENTIRE MOTOR VEHICLE	TD011	14.4	6.4	70.2	3423	14.4	6.4	70.2	3424	0.164	64.42
PRESCRIPTION DRUGS	MA011	15.0	6.1	79.0	11295	15.1	6.1	78.8	11309	1.198	65.62
WASHERS	HK012	15.5	5.9	49.2	761	37.7	2.1	47.6	1872	0.070	65.69
FRESH WHOLE CHICKEN	FF011	16.6	5.5	62.2	49906	35.1	2.3	53.3	69368	0.510	66.20
CLUTCH REPAIR	TD031	16.8	5.4	73.1	6493	16.9	5.4	73.0	6498	1.353	67.55
CHEESE AND CHEESE PRODUCTS	FJ021	17.1	5.3	64.2	40825	31.9	2.6	55.1	55133	0.440	67.99
REFRIGERATOR	HK011	17.2	5.3	55.1	1023	36.4	2.2	46.6	1841	0.065	68.06
BACON AND RELATED PRODUCTS	FD011	18.4	4.9	64.1	37595	34.1	2.4	55.6	50288	0.267	68.33
HAM (EXCLUDING CANNED)	FD021	19.0	4.7	59.2	22409	35.7	2.3	51.8	31080	0.177	68.50
STOVES AND OVENS EXCLUDING MICROWAVES	HK013	19.2	4.7	50.0	271	43.0	1.8	45.9	563	0.077	68.58
FRESH FISH	FG011	20.4	4.4	59.7	29038	36.3	2.2	52.9	41256	0.274	68.85
OTHER BEEF	FC041	21.0	4.3	61.0	22684	33.1	2.5	54.9	28919	0.070	68.92
TIRES	TC011	22.3	4.0	69.0	36158	29.7	2.8	61.2	44286	0.353	69.28
CIGARETTES	GA011	23.2	3.8	74.7	26864	33.6	2.4	61.9	47034	1.714	70.99
ALTERNATIVE AUTOMOTIVE FUELS	TB022	23.4	3.8	64.8	231	23.4	3.8	64.8	231	0.016	71.01
INTERCITY TRAIN FARE	TG022	24.1	3.6	66.7	5690	24.1	3.6	66.7	5690	0.096	71.10
BUTTER	FS011	24.3	3.6	62.0	22996	38.3	2.1	55.2	30958	0.126	71.23
UNCOOKED GROUND BEEF	FC011	25.0	3.5	65.4	36487	41.6	1.9	56.3	51433	0.394	71.62
APPLES	FK011	25.6	3.4	58.6	52991	38.6	2.0	54.0	69749	0.138	71.76
PERSONAL COMPUTERS AND PERIPHERAL EQUIPMENT	EE011	25.8	3.3	31.9	2964	34.7	2.3	29.2	4047	0.136	71.90
CHUCK ROAST	FC021	25.9	3.3	62.1	37553	48.3	1.5	53.9	60096	0.186	72.08
PORK ROASTS	FD041	27.3	3.1	57.6	23810	46.6	1.6	51.8	36661	0.162	72.25
INTERCITY BUS FARE	TG021	27.8	3.1	63.3	3880	27.9	3.1	63.2	3902	0.054	72.30
ROUND STEAK	FC031	28.0	3.0	62.1	64618	47.0	1.6	54.1	96095	0.389	72.69
MAIN STATION CHARGES	ED011	28.4	3.0	64.4	45245	28.4	3.0	64.4	45245	1.501	74.19
DELIVERY SERVICES	EC021	29.3	2.9	77.5	17568	29.4	2.9	77.5	17576	0.006	74.20
POTATOES	FL011	29.6	2.9	57.1	34762	40.7	1.9	53.4	45022	0.138	74.33

Table 16: Frequency of Price Change by Category for 1998-2005 (continued)

		Regular Price				Price					
Category Name	ELI	Freq.	Dur.	Up	Obs.	Freq.	Dur.	Up	Obs.	weight	CDF
SHIP FARES	TG023	30.2	2.8	50.7	2681	29.8	2.8	49.6	3069	0.091	74.43
PORK CHOPS	FD031	30.4	2.8	58.0	24888	50.3	1.4	52.3	39053	0.172	74.60
SUBCOMPACT CARS	TA011	31.3	2.7	36.0	18587	31.3	2.7	36.0	18588	3.330	77.93
FRESH WHOLE MILK (UNFLAVORED)	FJ011	32.6	2.5	61.3	41928	37.3	2.1	58.5	47334	0.563	78.49
OTHER FRESH VEGETABLES	FL041	32.8	2.5	54.6	49876	43.5	1.8	51.9	65323	0.369	78.86
ORANGES, MANDARINS (TANGERINES) AND TANGELOS	FK031	33.3	2.5	56.5	60378	39.9	2.0	54.0	78588	0.187	79.05
BOTTLED OR TANK GAS	HE021	37.9	2.1	63.1	27483	38.0	2.1	63.1	27704	0.121	79.17
ELECTRICITY	HF011	38.1	2.1	53.6	137450	38.1	2.1	53.6	137450	3.412	82.58
LETTUCE	FL021	40.8	1.9	53.1	44153	49.6	1.5	51.0	56227	0.084	82.66
RENTAL OF LODGING AWAY FROM HOME	HB021	41.7	1.9	53.1	126572	42.8	1.8	52.6	132172	3.377	86.04
INTERSTATE TELEPHONE SERVICES	ED021	41.9	1.8	38.2	42406	41.9	1.8	38.2	42406	1.504	87.55
VEHICLE LEASING	TA031	42.4	1.8	50.3	4301	42.4	1.8	50.3	4301	0.937	88.48
EGGS IN SHELL	FH011	47.6	1.5	54.8	39066	51.9	1.4	53.5	45251	0.144	88.63
OTHER FRESH FRUITS	FK041	49.9	1.4	56.4	67032	62.2	1.0	52.4	108262	0.305	88.93
TOMATOES	FL031	50.3	1.4	55.9	30218	59.8	1.1	52.4	42741	0.118	89.05
AUTOMOBILE RENTAL	TA041	56.1	1.2	51.5	8270	56.4	1.2	51.4	8389	0.195	89.24
AIRLINE FARE	TG011	59.8	1.1	58.7	23938	59.8	1.1	58.7	23938	1.325	90.57
AUTOMOTIVE DIESEL FUEL	TB021	67.1	0.9	59.1	18087	67.1	0.9	59.1	18105	0.016	90.59
FUEL OIL	HE011	68.0	0.9	59.4	18416	68.0	0.9	59.5	18474	0.339	90.92
UTILITY NATURAL GAS SERVICE	HF021	72.4	0.8	57.0	118620	72.4	0.8	57.0	118620	1.446	92.37
PREMUIM UNLEADED GASOLINE	TB013	86.9	0.5	53.5	58745	87.0	0.5	53.5	59197	1.689	94.06
MIDGRADE UNLEADED GASOLINE	TB012	87.6	0.5	53.5	57237	87.6	0.5	53.5	57466	1.689	95.75
REGULAR UNLEADED GASOLINE	TB011	88.6	0.5	53.0	59969	88.6	0.5	53.0	60119	1.689	97.44
USED CARS	TA021	100.0	0.0	66.3	106216	100.0	0.0	66.3	106216	2.562	100.00

"Regular prices" denote prices excluding sales. "Freq." denotes the mean frequency of price change within the ELI. "Dur." denotes the median implied duration, which is defined as -1/ln(1-f) where f is the mean frequency of price change within the ELI. "Up" denotes the fraction of price changes that are price increases. "Obs." denotes the number of observations for the ELI. "Weight" denotes the expenditure weight of the ELI. "CDF" denotes the cumulative distribution function of the frequency of regular price change.