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Abstract

This paper uses a unique micro data set of price records underlying the Barbados retail price index between 1994 and 2008 to provide a detailed assessment of consumer price rigidity. The major aim is to calculate price durations and the patterns of price-setting across sectors. We also check whether price cuts are as frequent as increases, and whether there is specific downward nominal rigidity. We find that prices in Barbados tend to change relatively frequently, with between 50 and 80 percent of items in every category reporting a price change every month. While there are regular monthly price reductions as well as increases, the reductions are always smaller and fewer than the increases. The paper also reports no measurable impact of changes in the money supply or national inflation on the frequency of price changes.

***JEL Classification*:** E3; L1; C4, D400

Keywords: Price Rigidity; Consumer Prices; Inflation, Survey data

1. Introduction

Inflation is among the most heavily researched topics in Caribbean economics (Coppin, 1993; Cumberbatch, 1997; Downes et al, 1993; Hamilton, 1994; Kwon and Robinson, 2006; McClean, 1997; Sun, 2005; Worrell and Scantlebury-Maynard, 1994), but the results of this work are not often reflected in policy initiatives to combat inflation. For example, recent policies to control inflation in the Caribbean have focussed mainly on fiscal measures, whereas inflation studies have been concerned primarily with monetary policy. The policies have been typically applied at disaggregated levels, and their effects are not captured by research which deals almost exclusively with macroeconomic aggregates.

At the disaggregated or firm level, Blinder (1994) attempted to confront models of price stickiness with real world data using the responses to a series of questions on price formation by managers in charge of pricing. The survey, which solicited responses from 200 randomly selected firms in the United States (US), found that firms tend to change prices rather infrequently, at most once during an average year. In addition, most indicated that on average prices are altered only 3 months after a shock to demand or cost. Blinder also solicited views on which theories of sticky prices best explained the managers' decision-making process. Of the twelve theories tested, the coordination failure model of Ball and Romer (1991) seemed to best describe the sources of price stickiness. In a similar survey of 654 United Kingdom (UK) companies, Hall et al (1997) obtained comparable results in relation to the frequency of price changes, but in their study price stickiness was largely attributed to cost-based pricing and contracts.

In order to bridge the gap between inflation models, inflation policy and the actual practice of price formation in the Caribbean, further research is needed to illustrate and test the process of price formation, the dynamics of inflation and the scope and effectiveness of anti-inflationary policies. The present study makes a contribution to the description and testing of the practice of price formation. We extract information on the frequency and magnitude of price changes from input data for the construction of the monthly retail price index (RPI) over 8 recent years, and test for possible factors affecting the frequency and magnitude of price adjustments.

After the introduction, previous empirical studies are reviewed, followed by the empirical methodology in Section 4. Thereafter, the results are presented and in the final section, conclusions are made.

2. Previous Empirical Studies

Several authors have used data on product group trends to investigate the actual characteristics of price formation. Kashyap (1995), in a study of the evolution of prices of 12 retail goods over 35 years sourced from the mail order catalogues of three major companies in the US, found that nominal prices sometimes stayed fixed for several years before changing a number of times in a given year, by relatively small increments. Kashyap infers that the costs of price adjustment are relatively small. Levy et al (2002) compare price and cost data for 12 orange juice products, concluding that prices tend to be rigid in response to small and temporary cost shocks and in circumstances where the retailer has limited information about the nature of the shock. Herrmann and Moeser (2006) argue that, in the case of branded goods, psychological factors may also

contribute to price rigidity. The prices of branded foods remain unchanged for an average of 19 weeks and as long as 53 weeks.

Levy et al (1998) track store-level information on the prices at five large supermarkets and one drugstore chain in the US. These stores tend to change the prices of about 13-17 percent of their products every week. This relatively high frequency of price adjustment was largely attributed to the fierce competition in the supermarket industry, which counteracted the effects of the complexity and cost of altering prices as well as rigidities in the laws governing retail pricing. Weber and Anders (2007) collected weekly retail-scanner data for meat products from 207 retail outlets in Germany, capturing information on prices, discounts, promotional activities and store characteristics. On average, the prices of meat products such as beef can remain unchanged for up to 63 weeks. This high degree of price rigidity was largely attributed to the market power of firms, and their ability to absorb cost shocks by adjusting their margins, based on inferences from a conjectural variations model that yielded an estimate that market power in the retail industry tends to lead to price distortions of between 0.6 and 3 percent. Similar evidence of store level price rigidity is reported for online booksellers (Chakrabarti and Scholnick, 2007), commercial banks (Toolsema and Jacobs, 2007) and gas stations (Davis, 2007; Davis and Hamilton, 2004).

Bils and Klenow (2004), in a study covering a wider variety of goods than described in the last paragraph, use data on 350 product categories from the US retail price index on a monthly frequency from 1995 to 1997. In general, the authors find a higher frequency of adjustment than studies utilising survey data or product group information: prices tend to change every 4.3 months. Bils and Klenow also report that goods prices tend to move more often than service prices; raw goods had the highest frequency of adjustment, while medical care was least likely to

change. The persistence and volatility across goods was evaluated by fitting a first order autoregressive (AR (1)) process to the monthly inflation rate for each of the goods. The results suggested that goods with more frequent price changes tend to have more serial correlation in inflation as well as higher volatility.

Recognising the value of these studies for policy-making purposes, researchers have replicated and expanded them, using data from a wide variety of countries. Dhyne et al (2006) provide a useful summary of this literature for the euro area: prices in the euro area change less frequently than in the US, tending to remain unchanged on average for 10.6 months compared to 4.6 months in the US. The disparity was largely attributed to differences in: (1) inflation and inflation volatility; (2) market structure; (3) methodologies used by statistical agencies; (4) frequency and size of cost and demand shocks; and (5) types of goods purchased. Moreover, when prices do change, the movements are usually smaller than those for the US: 8.2 percent compared to 12.7 percent.

Price rigidity in a developing country was addressed by Kovanen (2006), who investigated the relatively higher rate of inflation and inflation volatility in Sierra Leone. The study found that the average duration of prices was 2.6 months, implying more frequent changes than in the industrial states. Kovanen attributes this finding to a relatively large number of food items included in the consumer price index (CPI) basket, the dominance of small-scale enterprises and individual sellers and the level of macroeconomic volatility and inflation uncertainty. In addition to the frequency of price changes a relatively larger proportion of the CPI basket was subject to price alterations and high volatility. By regressing the fraction of prices changing every month on a time trend, lagged inflation and an indicator of monetary policy, Kovanen shows that by

containing money growth, officials in Sierra Leone could potentially reduce the rate of inflation and inflation volatility.

More recently, Sahinoz and Saracoglu (2008) studied the price-setting behaviour of a sample of 999 firms across several Turkish industries. They found that, under normal conditions, the majority of the firms follow time-dependent pricing rules but when significant events occur, a substantial portion of them change their behaviour to state-dependent reviewing. The median Turkish firm reviews its prices every month, but changes its prices four times a year, results very similar to those of Sierra Leone discussed above by Kovanen (2006). Sahinoz and Saracoglu (2008) used probit models to show that price reviews and changes are mainly influenced by market share, price discrimination, customer type, firm size, and the existence of regulated prices.

3. Empirical Approach

This section outlines the empirical approach employed to study the issue of price rigidity in Barbados. The index measuring whether or not prices are altered during a particular month is defined as follows:

$$\begin{aligned} I_{it} &= 1 \quad if \;\; p_{it} \neq p_{it-1} \\ &= 0 \quad if \;\; p_{it} = p_{it-1} \\ for\, i &= 1,\ldots,K \;(number\; of \;\; goods) \; and \; t = 1,\ldots,T \;(number\; of \;\; periods) \end{aligned} \tag{1}$$

For each good i, the frequency of price movements F_i is calculated as the ratio of observed price changes to all valid price records. The implied duration of price spells can be calculated as the inverse of the frequency of price changes $D = \frac{1}{F}$. This computation, however, assumes that the price adjustment occurred at the end of the month and price does not move for the rest of the

month. To relax this assumption and allow for continuous timing, the implied average and median duration of price spells can be estimated as follows:

$$D_{Average} = \frac{-1}{\ln(1-F_i)}$$
$$D_{Median} = \frac{\ln(0.5)}{\ln(1-F_i)} \quad (2)$$

The rigidity of prices can be gleaned from the frequency as well as duration indicators. Prices can be considered rigid if the frequency of price changes is small and there is therefore relatively long duration of price spells.

It is also of interest to examine the synchronisation of price changes. Fisher and Konieczny (2000) provide a measure of price synchronisation based on the ratio of the empirical standard deviation of the frequency of price changes for product i to the theoretical maximum standard deviation in the case of perfect synchronisation of price movements:

$$SYNC_i = \frac{\sqrt{T^{-1}\sum_t (F_{it} - F_i)^2}}{\sqrt{F_i(1-F_i)}} \quad (3)$$

If price changes are synchronised, i.e. the prices of all goods adjust at the same time or not at all, then the ratio should be near 1. This expression is also employed to calculate the synchronisation of price increases and decreases over the sample period.

Related to the issue of price synchronisation is the correlation of monthly price changes, i.e. if prices expanded in the previous month is that change likely to lead to a rise in prices in the current month? An estimate of the correlation between monthly price changes or inflation persistence can be obtained by estimating an equation of the following form:

$$\psi_{it} = \rho_i \psi_{it-1} + \varepsilon_{it} \quad (4)$$

where ψ is the month-on-month adjustment in prices. If ρ is small then this would suggest a relatively low degree of correlation between monthly prices changes.

Menu-cost models of price adjustment suggest that inflation tends to be higher in markets where price alterations are more frequent (see Barro, 1972; Taylor, 1999). To understand the factors that have influenced price changes in Barbados over the last few years an empirical model of the frequency of price movements is estimated over the period 2000 to 2008. The model takes the following form:

$$F_t = \beta_0 + \beta_i \sum_{i=1}^{2} F_{t-i} + \delta_i \sum_{i=1}^{2} dM_{t-i} + \theta_i \sum_{i=1}^{2} \pi_{t-i} + \mu_t \quad (5)$$

where dM is the month-on-month change in M2 (money plus quasi-money) and π aggregate monthly inflation. Money is included to capture the effects that money creation can have on the demand for goods and services and therefore the frequency of price changes. Similarly, during periods of high inflation, the prices of goods and services should be expected to move relatively frequently as firms attempt to maintain profit margins. Lagged values of money and inflation are included in the regression equation, as prices cannot be instantaneously adjusted in response to demand pressures or higher input costs.

4. Results

The estimated monthly frequency of price changes for each product are given in Table 1 and plotted in Figure 1. The results indicate that between 50 to 80 percent of prices in each product group tend to move every month. The product groups with the highest frequency of price

adjustments were 'fruit' and 'vegetables and other ground provisions', with about 80 percent of items reporting price changes every month. This finding agrees with the previous literature in the area that suggests commodity prices have a higher rate of fluctuation. 'Animal feeds' have the lowest frequency of price changes, with only half of the number of goods altering prices every month. The frequency of price changes was fairly persistent over time (see Figure 2). [2]

The average duration of most goods was between 1 and 2 months, with 'animal feeds' and 'cereals, flour and bakery products' on the longer end of this spectrum. After making adjustments to reflect continuous timing of price changes, the implied average and median duration of price spells is less than 1 month for most goods, with a median duration of about 0.6 months. In the case of 'vegetables and other ground provisions' and 'fruit', prices remain fixed for less than half a month. Only animal feeds had a median duration of over 1 month.

Figure 3 also shows that the relative proportions of these changes due to price increases and decreases were relatively constant. In every month, between 40 to 50 percent of goods report higher prices while 30 to 40 percent of goods experience some decline in price. The summary statistics provided in Table 1 suggest that 'fruit', 'vegetables and other ground provisions', 'butter and other cooking fats and oils' as well as 'meat' tended to have the highest probabilities of price expansions during any given month. However, 'fruit' and 'vegetables and other ground provisions' also had the highest probabilities of price declines during a given month.

[2] The apparent rise in volatility in 2002 may be due to missing observations for some items between 2000 and 2001.

Figure 4 plots the frequency of price increases/decreases by product group. For most product groups the frequency of price expansions tended to be slightly higher than that for price contractions. The only goods that were more likely to report price cuts than price increases were 'furniture', 'glassware, cutlery and other household supplies', 'clothing' and 'footwear'.

On average the size of these expansions tended to be larger than the price reductions: mean price increases ranged from 3 to 29 percent, while average price contractions spanned between 1 and 7 percent per month (Figure 5). Nine product groups had double-digit average monthly price expansions: (1) milk, milk products and eggs; (2) sugar confectionery and preserves; (3) vegetables and other ground provisions; (4) meals bought away from home; (5) animal feeds; (6) furniture; (7) household appliances and linen; (8) clothing, and; (9) footwear. 'Household appliances', 'animal feeds', 'sugar confectionery and preserves', and 'milk, milk products and eggs', had the largest average price increases per month at 15 percent. 'Clothing, footwear and animal feeds' had the greatest average price decreases.

Figure 6, which plots the sizes of these price changes over time, reveals that during a given month price increases are likely to be associated with price reductions. It also shows evidence of five periods of high price volatility, with expansions ranging between 10 percent and over 50 percent in a month, coinciding with price contractions in double digits in the same month. Apart from these five periods, prices generally fluctuate between +10 and -5 percent.

The volatility of price changes is not markedly high for any product group. In general, the coefficient of variation for most product groups ranged between 0.2 and 0.4. The product groups with the highest degree of volatility were 'sugar, confectionery and preserves', 'animal feeds',

and ‘meals bought away from home’, with the volatility of ‘sugar confectionery and preserves’ more than twice that of the next most volatile category.

Table 2 shows only a few product groups where price changes for products within the group tended to be highly synchronised. ‘Sugar confectionery and preserves’, ‘meals bought away from home’ and ‘animal feeds’ fall into this category, in terms of both price increases and decreases, while ‘butter and other cooking fats and oils’, ‘fruit’ and ‘furniture’ seem to display a degree of synchronisation in relation to price expansions only. These results imply that while some stores do follow closely what their competitors are doing in relation to prices, most stores do not.

The estimated inflation persistence (correlation of price movements with changes in the previous month) is quite low (Figure 8).[3] Even though price alterations occur relatively frequently on the island, past price adjustments have only a small impact on current changes. In addition, virtually all correlations are negative, implying that price rises are likely to be followed by price reductions. Price changes will therefore dissipate over time. The estimated half life $\left(h = \frac{\log(0.5)}{\log(\rho)}\right)$ of movements in the prices of ‘washing soaps and detergents’ and ‘glassware, cutlery and other household appliances’ were the fastest over the period under investigation, with 1 month needed for a unit shock to prices in these product groups to disperse by half. In contrast, the estimated half life for ‘meals bought away from home’ was much longer, with the time taken for half of a unit shock to dissipate estimated at over a year.

[3] This result is similar to the conclusions of studies by Bils and Klenow (2002) and Kovenen (2006).

Estimates of an autoregressive model of the factors affecting the frequency of price change are provided in Table 3. The results suggest that most of the frequency of price adjustment tends to be due to changes over the previous two months. Lagged alterations in the money supply and past inflation had no statistically significant impact on the frequency of price.

Conclusion

Our conclusions may be summarised as follows:

- Prices in Barbados are changed quite frequently; between 50 and 80 percent of items in every category recorded a price adjustment every month on average;
- In the present decade the frequency of price movements has remained more or less constant;
- There are regular monthly price reductions as well as increases, but the reductions are always smaller and fewer than the increases;
- The magnitudes of expansions and decreases have remained largely unchanged during the current decade;
- Apart from five periods of highly volatile prices, which lasted between one and six months, price changes have fluctuated between contractions of five percent and increases of 10 percent;
- The price volatility pattern is similar for all product groups;
- However, within product groups price changes are not highly synchronised;
- Price adjustments are not highly correlated with changes in a previous period; correlations are small and negative, indicating a slight tendency for increases to be followed by decreases, and vice versa; and

- There is no measurable impact of changes in the money supply or national inflation on the frequency of price adjustments.

Further research is needed to investigate why prices are altered so frequently, why there is so much volatility (reductions as well as increases), and why prices within product groups are not synchronized. It would be instructive to design a survey of decision makers in order to explore these issues further. Also it will be necessary to revisit tests of the impact of monetary policy and notions of what really drives prices. The fact that inflation appears not to be related to the observed pattern of price changes is also puzzling and deserving of further investigation. Studies of other Caribbean countries, done in a similar vein to this one, would also serve to enlighten this discourse.

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Table 1: Frequency of Prices Changes by Product Group

	Frequency of Price Changes	Average Duration of Price Spells	Median Duration of Price Spells	Frequency of Price Increases	Frequency of Price Decreases	Average Price Increase	Average Price Decrease
Food	0.682	1.467	0.605	0.373	0.309	11.670	-3.592
Cereals, Flour and Bakery Products	0.554	1.804	0.857	0.305	0.249	3.381	-1.368
Meat	0.743	1.345	0.510	0.413	0.331	5.539	-2.354
Butter and Other Cooking Fats and Oils	0.688	1.453	0.595	0.417	0.271	5.212	-2.276
Milk, Milk Products and Eggs	0.629	1.591	0.700	0.348	0.281	21.386	-4.184
Juices and Other Non-alcoholic Beverages	0.669	1.494	0.627	0.356	0.314	5.718	-2.592
Sugar Confectionery and Preserves	0.644	1.554	0.672	0.351	0.292	29.210	-3.690
Vegetables and Other Ground Provisions	0.775	1.290	0.464	0.416	0.360	12.294	-4.450
Fruit	0.782	1.278	0.455	0.430	0.352	8.881	-4.290
Other Food	0.594	1.683	0.769	0.308	0.286	7.585	-3.695
Meals Bought Away from Home	0.673	1.485	0.620	0.376	0.297	14.247	-5.587
Animal Feeds	0.488	2.047	1.034	0.261	0.228	20.323	-6.707
Furniture	0.690	1.450	0.592	0.342	0.347	12.795	-4.514
Household Appliances & Linen	0.684	1.463	0.602	0.343	0.340	18.573	-4.849
Washing Soaps and Detergents	0.656	1.524	0.649	0.342	0.314	7.157	-3.004

Glassware, Cutlery and Other Household Supplies	0.659	1.517	0.644	0.327	0.333	8.119	-4.049
Clothing	0.573	1.744	0.814	0.286	0.287	12.932	-5.974
Footwear	0.682	1.467	0.605	0.324	0.358	13.789	-7.171

Table 2: Synchronisation Ratio by Product Group

	Synchronisation Ratio of Price Changes	Synchronisation Ratio of Price Increases	Synchronisation Ratio of Price Decreases
Food	0.610	0.345	0.295
Cereals, Flour and Bakery Products	0.523	0.398	0.348
Meat	0.691	0.394	0.324
Butter and Other Cooking Fats and Oils	0.717	0.576	0.480
Milk, Milk Products and Eggs	0.589	0.439	0.424
Juices and Other Nonalcoholic Beverages	0.648	0.461	0.416
Sugar Confectionery and Preserves	0.679	0.576	0.547
Vegetables and Other Ground Provisions	0.764	0.427	0.385
Fruit	0.798	0.532	0.497
Other Food	0.628	0.449	0.447
Meals Bought Away from Home	0.893	0.760	0.725
Animal Feeds	0.724	0.697	0.661
Furniture	0.805	0.502	0.496
Household Appliances & Linen	0.766	0.433	0.433
Washing Soaps and Detergents	0.717	0.452	0.410
Glassware, Cutlery and Other Household Supplies	0.678	0.433	0.430
Clothing	0.802	0.488	0.479
Footwear	0.775	0.451	0.453

Table 3: Determinants of the Fraction of Price Changes

	(1)	(2)	(3)
Constant	0.088 (0.039)**	0.638 (0.040)***	0.631 (0.036)***
Frequency(t-1)	0.550 (0.082)*** *	-	-
Frequency(t-2)	0.328 (0.082)*** *	-	-
Inflation(t-1)	-	-	4.454 (5.224)
Inflation(t-2)	-	-	3.184 (5.286)
Money(t-1)	-	1.645 (2.116)	-
Money(t-2)	-	0.447 (2.110)	-
R-squared	0.728	-0.014	-0.002
Sigma	0.155	0.306	0.304
LM Test for Autocorrelation	0.841 [0.359	60.792 [0.000]	60.577 [0.000]
Breusch-Pagan-Godfrey Heteroskedasticity Test	3.637 [0.030]	1.596 [0.208]	0.530 [0.591]
Observations	99	101	101

Figure 1: Frequency of Prices Changes by Product Group

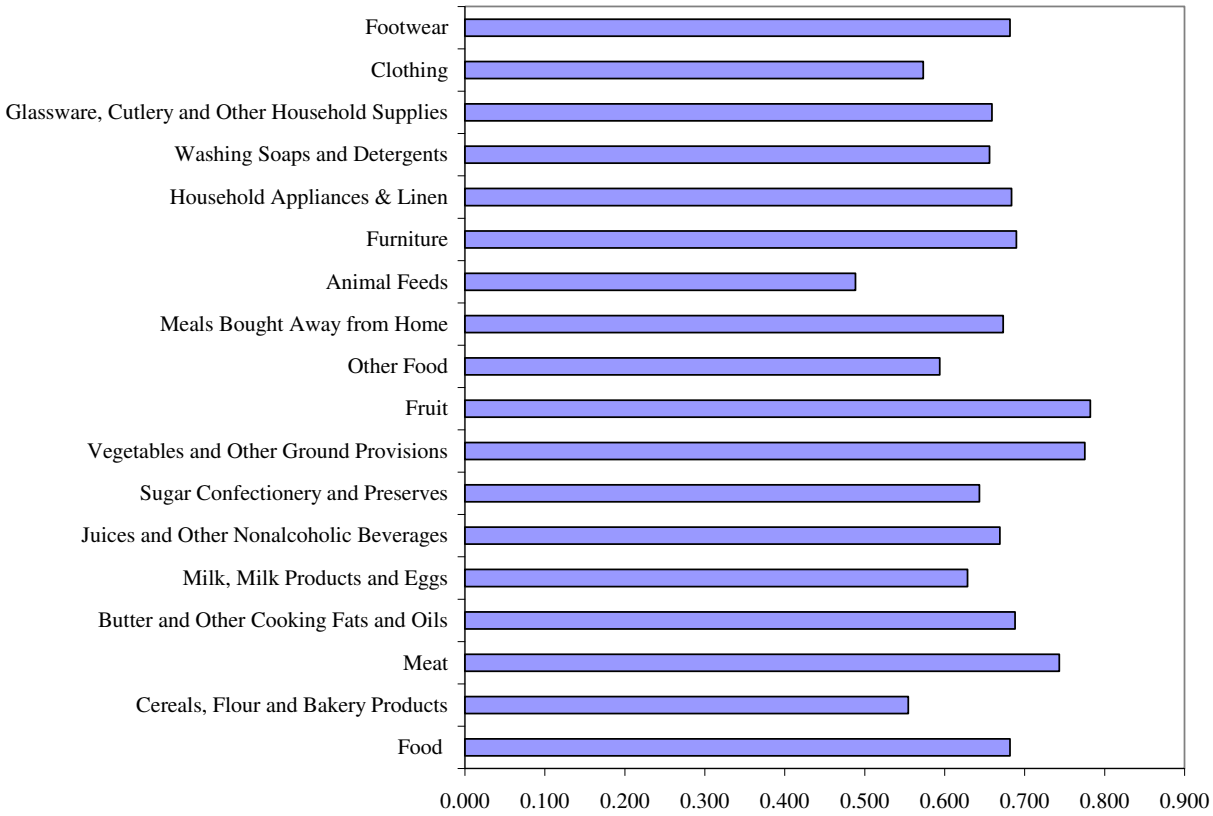

Figure 2: Frequency of Prices over Time

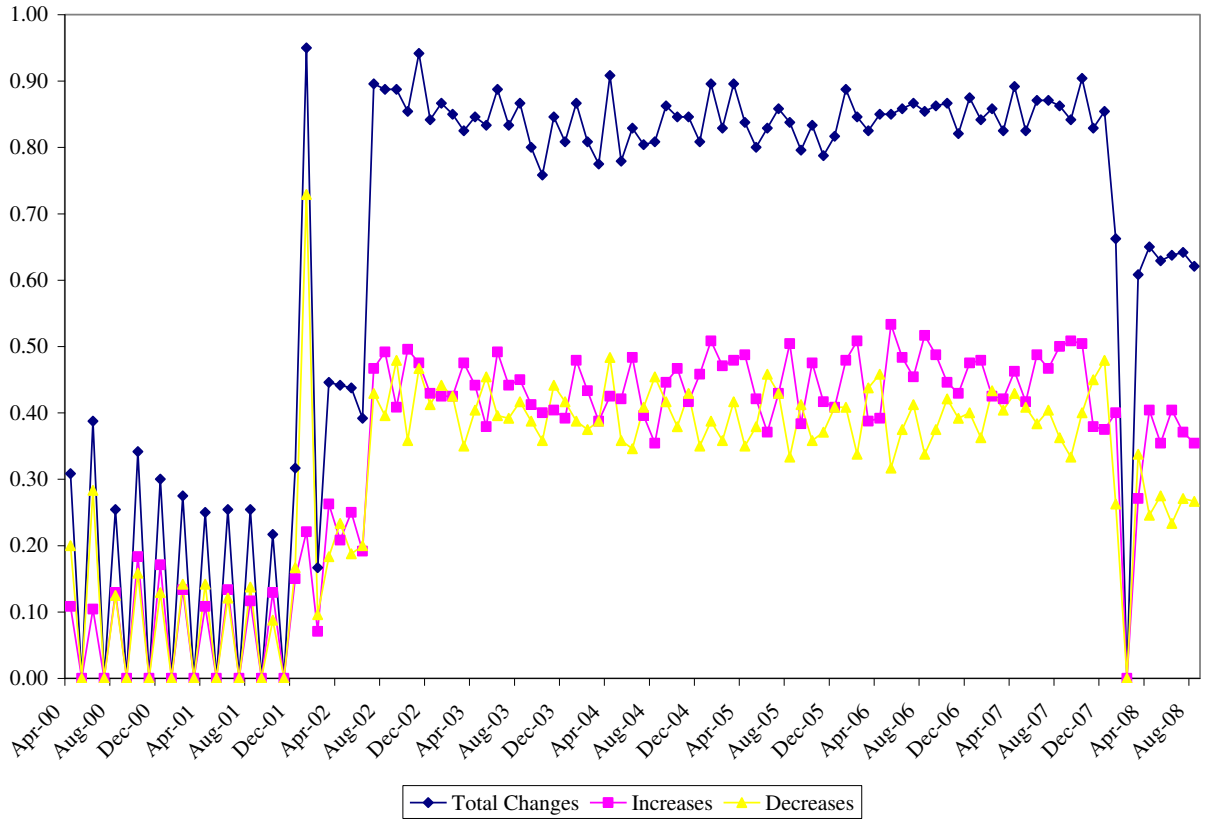

Figure 3: Duration of Prices Changes by Product Group

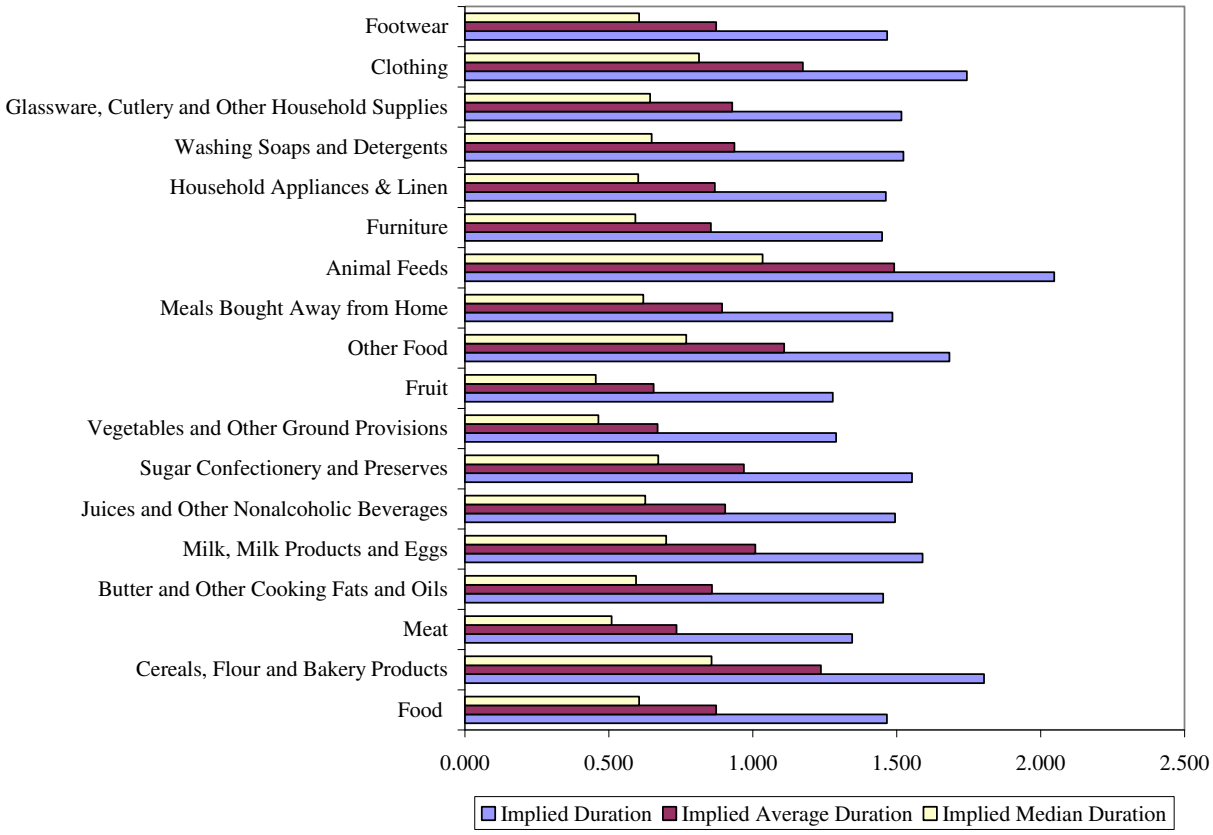

Figure 4: Frequency of Prices Increasing/Decreasing by Product Group (Per Month)

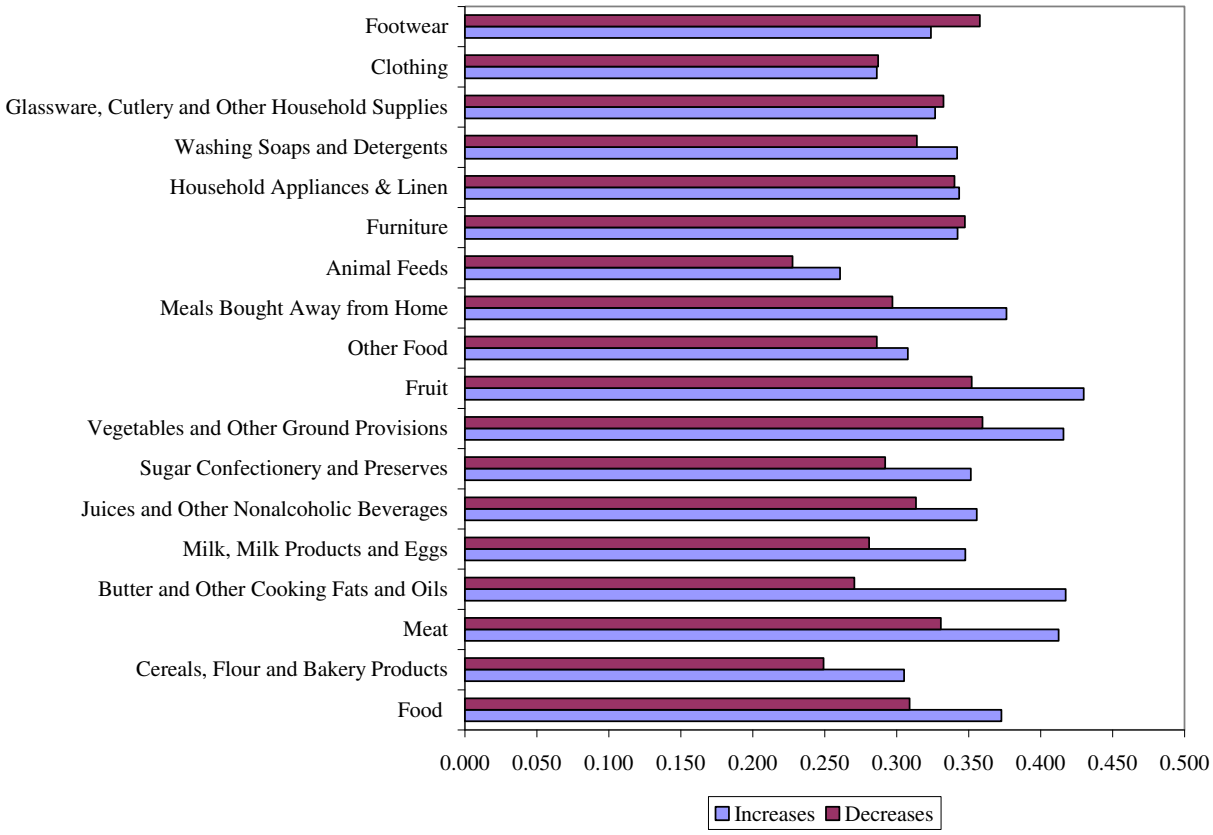

Figure 5: Average Size of Prices Increasing/Decreasing by Product Group (Per Month)

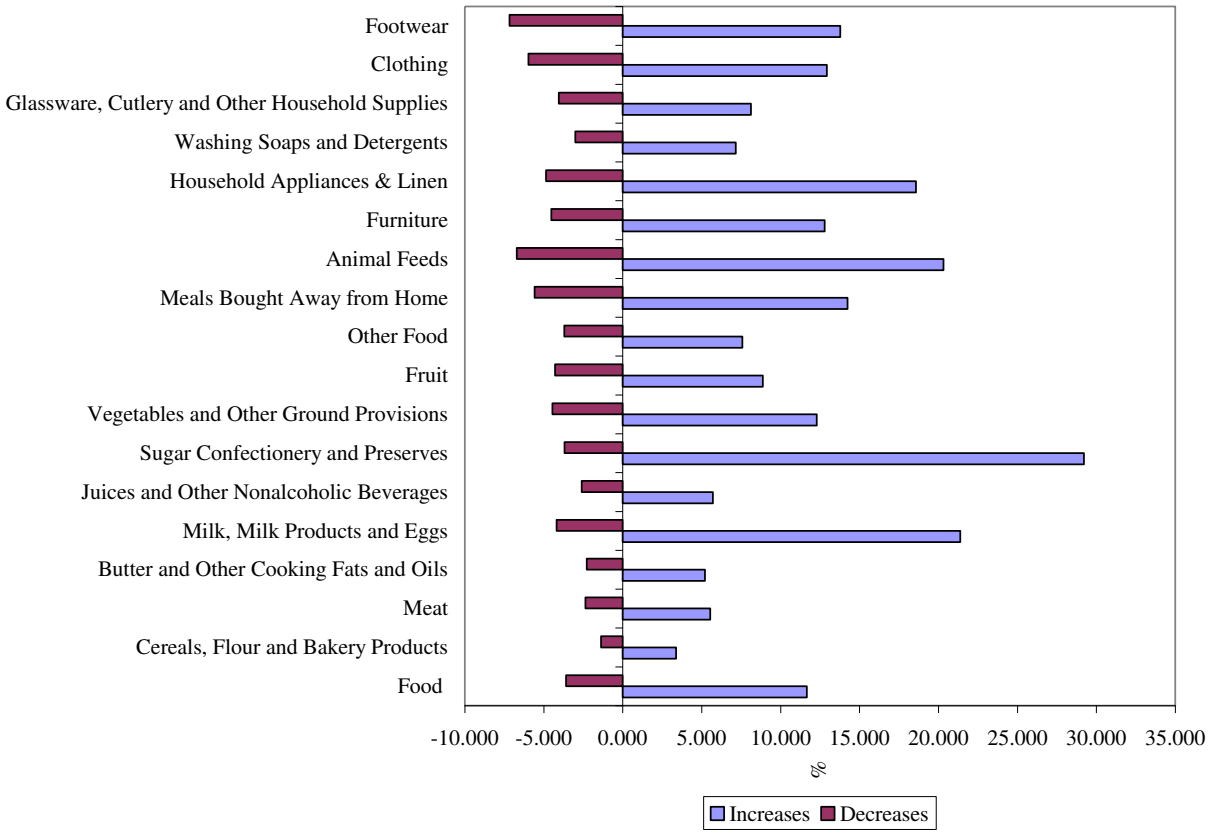

Figure 6: Average Size of Prices Increases/Decreases over Time

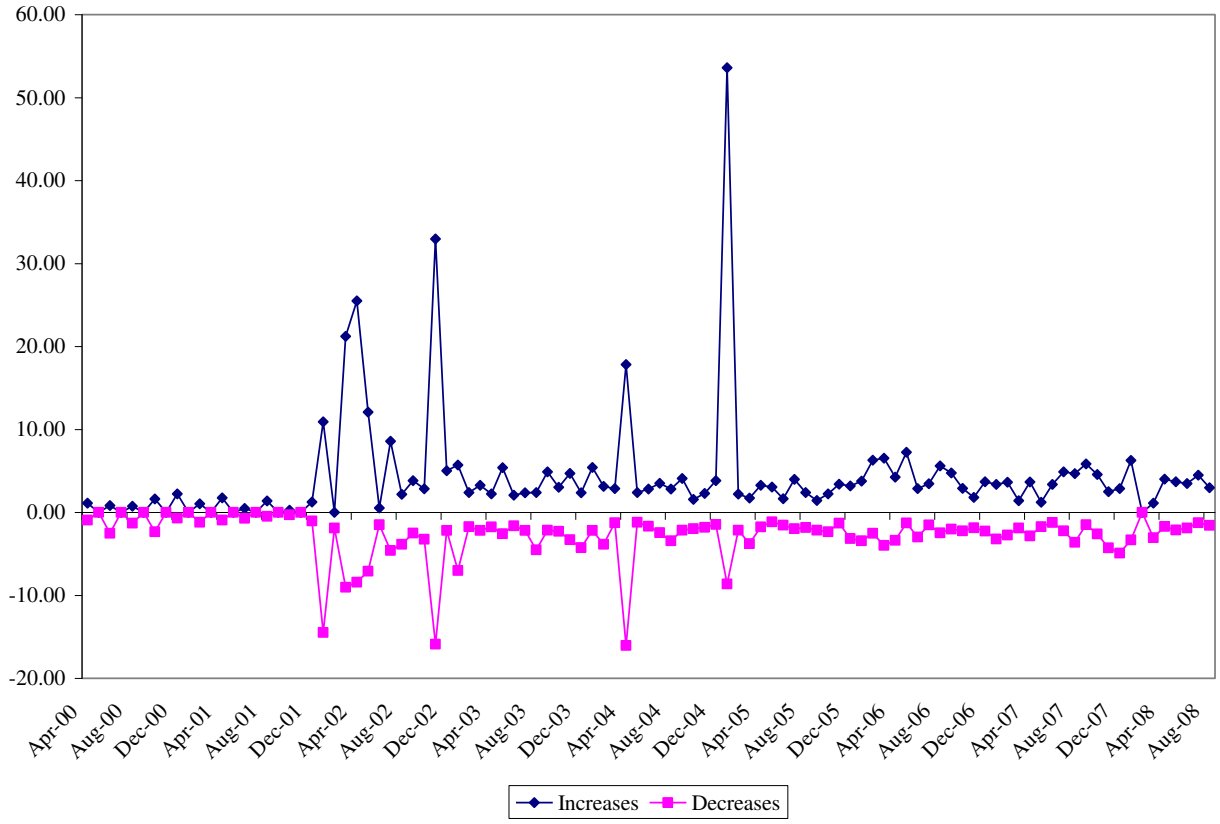

Figure 7: Estimated Volatility of Prices Changes by Product Group (Coefficient of Variation)

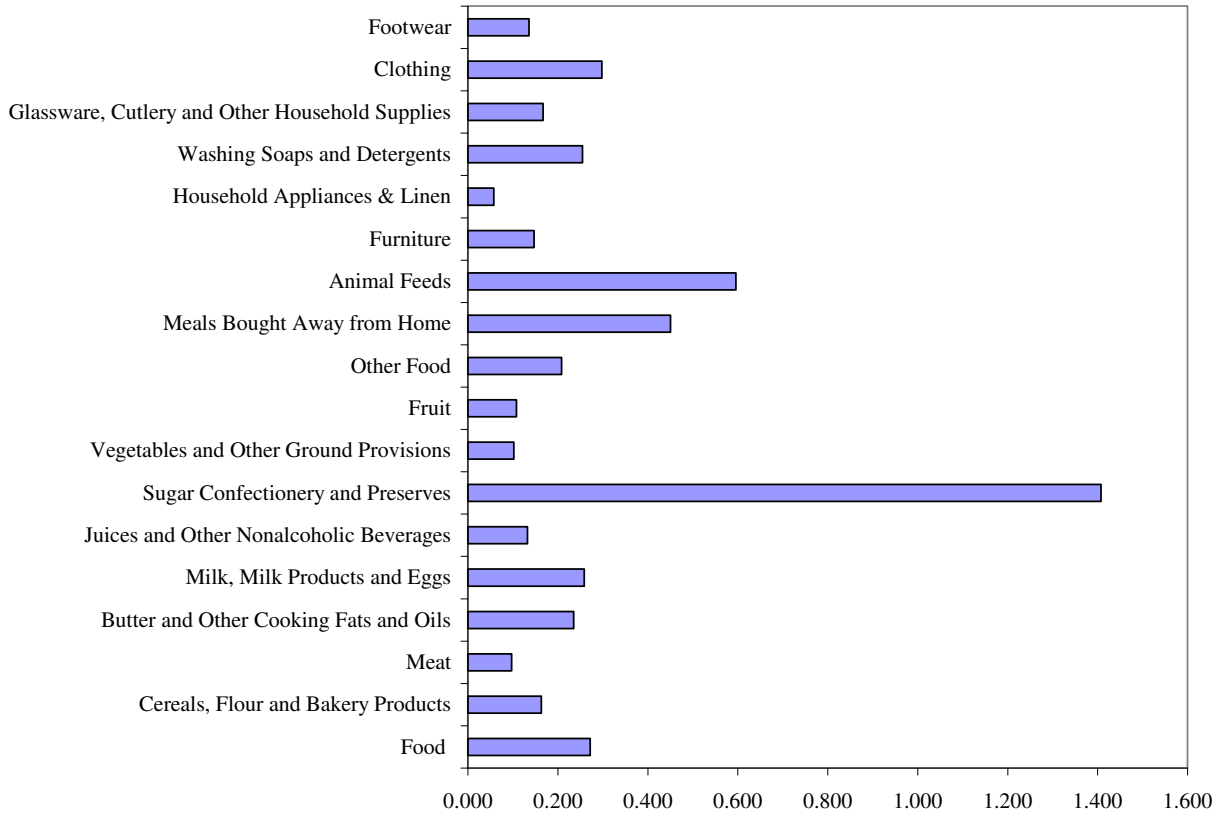

Figure 8: Estimated Inflation Persistence by Product Group

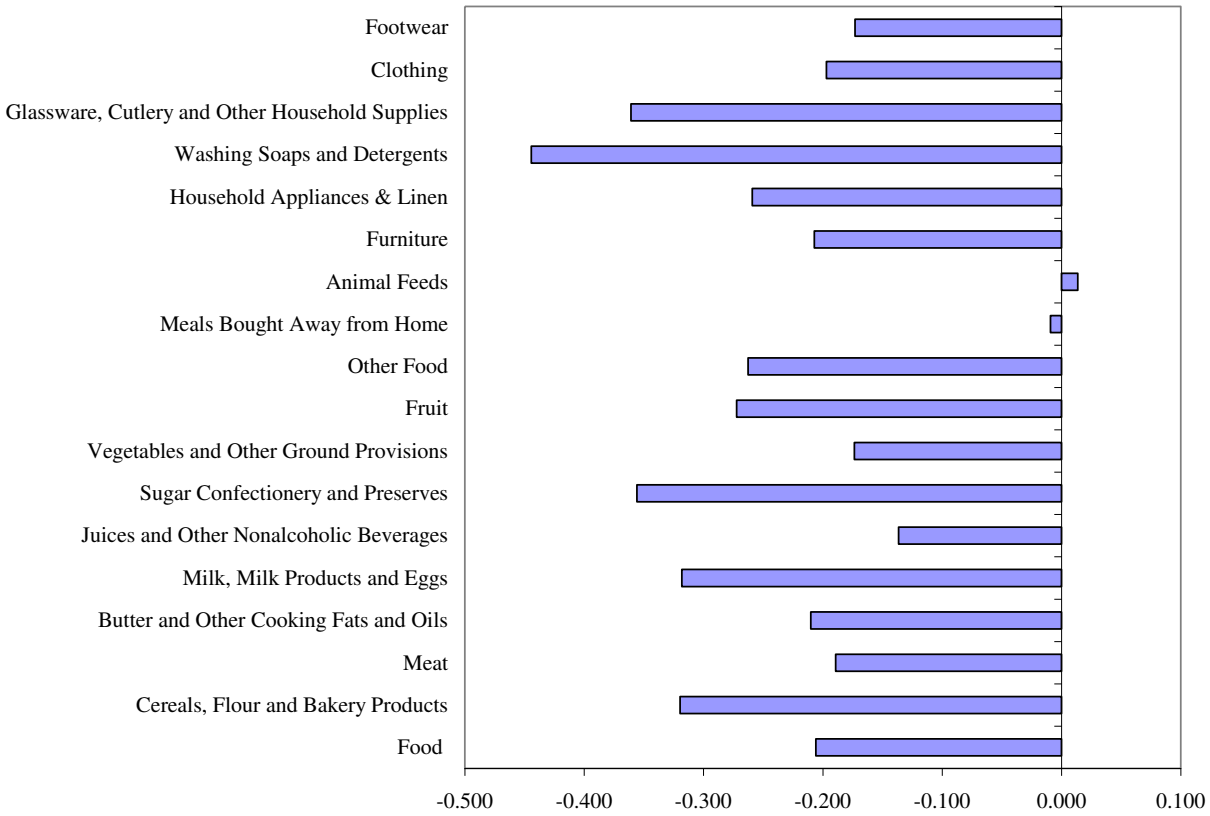

Figure 9: Empirical Survivor Functions by Product Group