Five Facts About Prices:
A Reevaluation of Menu Cost Models

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Nominal price rigidities are a key assumption in a large body of macroeconomic models that seek to:

- Understand the effects of monetary policy
- Explain the behavior of the real exchange rate
- Understand business cycles

How much price rigidity actually exists in the economy?

Literature Review: Frequency of Price Change

- Case studies of particular industries:
  - Cecchetti (1986), Carlton (1986), Kashyap (1995)
- Surveys
  - Blinder et al. (1998)
- CPI Data
  - Bils and Klenow (2004), Nakamura and Steinsson (2007), Klenow and Kryvtsov (2007)
  - Inflation Persistence Network
    - Alvarez et al., 2005, Dhyne et al., 2006

New empirical evidence on consumer and producer prices

Key questions:

- How often and how much do prices change?
- Are the predictions of macroeconomic models of price-setting consistent with the data?
  - Time series variation in size & frequency of price adjustments
  - Seasonality of price change
  - Hazard function of price change

The Data: CPI Research Database

- Approx. 70 % of consumer expenditures
- Sample Period: 1988-2005
- # obs. approx. 9 million
  - Provides average frequency of price changes, product substitutions and missing imputed prices

The Data: PPI

- New dataset on producer prices created from raw production files for the PPI
- We focus on Finished goods
- Sample Period: 1980-2005 (unbalanced panel)
- # obs. approx. 10 million
- Transaction prices: Hold fixed all "price determining" variables

CPI Data: Different Events

- Several different events lead price spells to end
  - Regular price changes
  - Sales
  - Stockouts
  - Product exit, seasonal products

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 Change Incl. Subs.	12.7	21.7	10.9	20.5
Mean Freq. of Change	18.7	23.9	21.1	26.5
Mean Implied Duration	11.6	8.3	13.0	9.0

Empirical Features of Sales

Sales are not simply short price spells

- Price usually returns to old regular price after a sale
- Sales price changes are more than twice the as large as other price changes on average
- Different relationship to aggregate variables
- Hazard function of price change including sales is very different from that excluding sales

Table 10: Sales and Prices During Sales 1998-2005

	Freq. Reg. Price Ch.	Freq. Price Ch. During One Period Sales	Frac. Return After One Period Sales	Frac. of Sales that Last One Period	Freq. Price Ch. During One Period Sales/Missing
Processed Food	10.5	11.4	78.5	64.7	11.1
Unprocessed Food	25.0	22.5	60.0	63.2	22.1
Househ. Furnish.	6.0	11.6	78.2	43.3	9.4
Apparel	3.6	7.1	86.3	35.8	5.9

Comparison to IPN

- Median frequency of price change comparable to US excluding sales
- Treatment of sales appear to make a much larger difference in US data
- Treatment of substitutions also makes a larger difference in US data

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

	Num. of	CPI Prices		CPI Regular Prices		PPI Prices	
Category	Matches	Freq.	Impl. Dur.	Freq.	Impl. Dur.	Freq.	Impl. Dur.
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

Fact 2: One-third of regular price changes are price decreases

Fact 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.

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

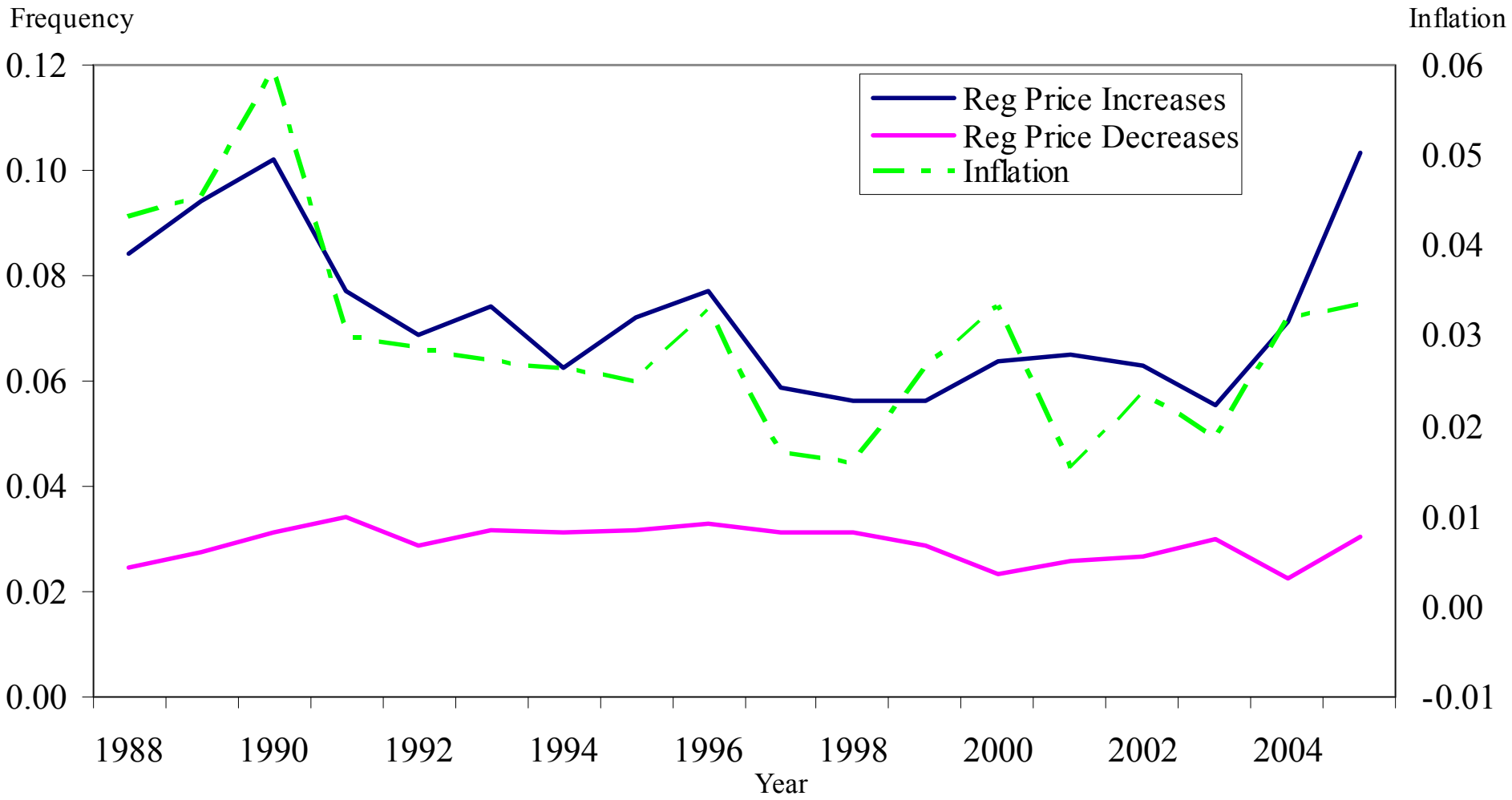


Figure 5: Inflation and the Size of Price Changes for Consumer Prices

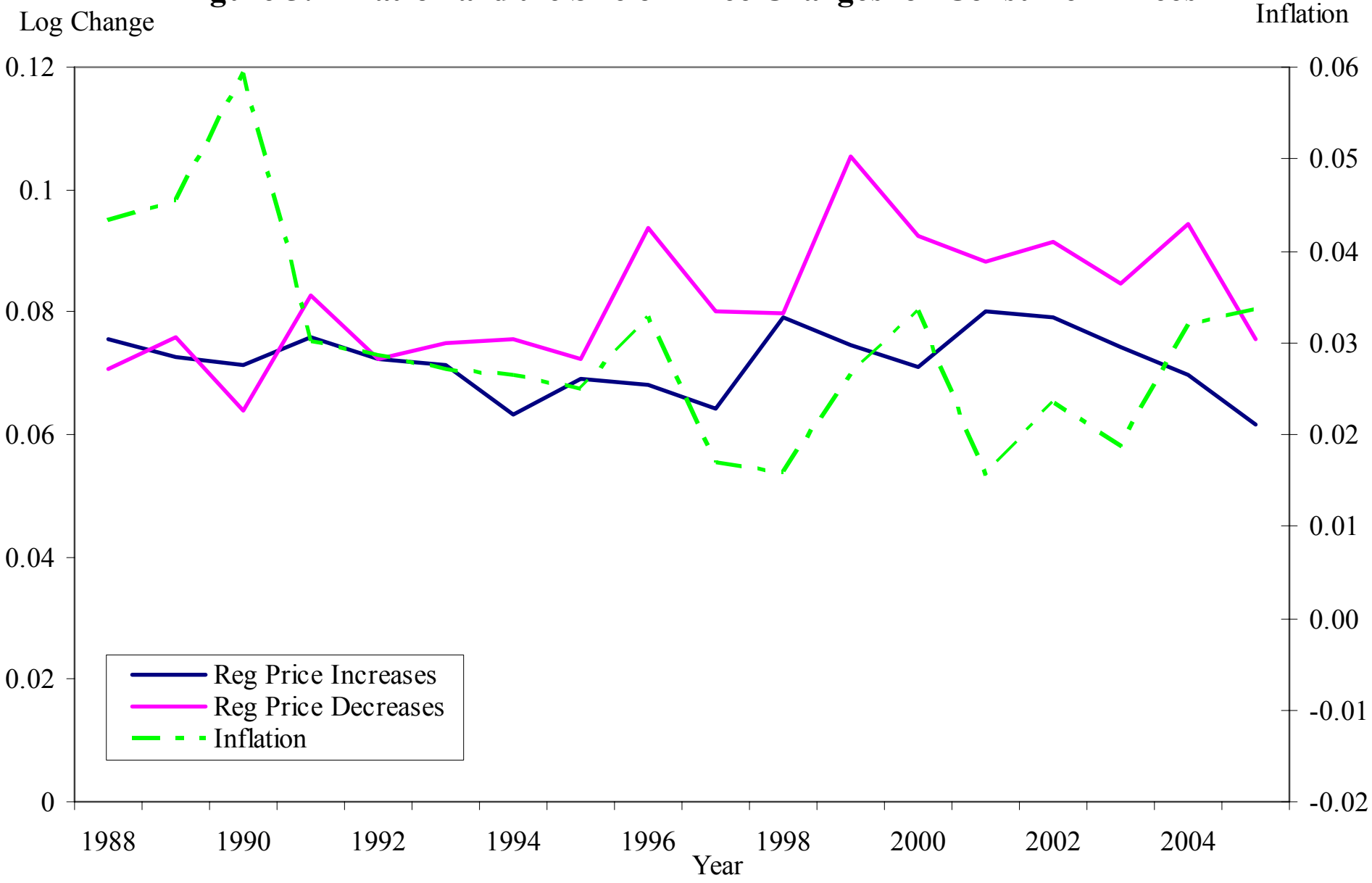


Figure 8: Evolution of the Frequency of Sales

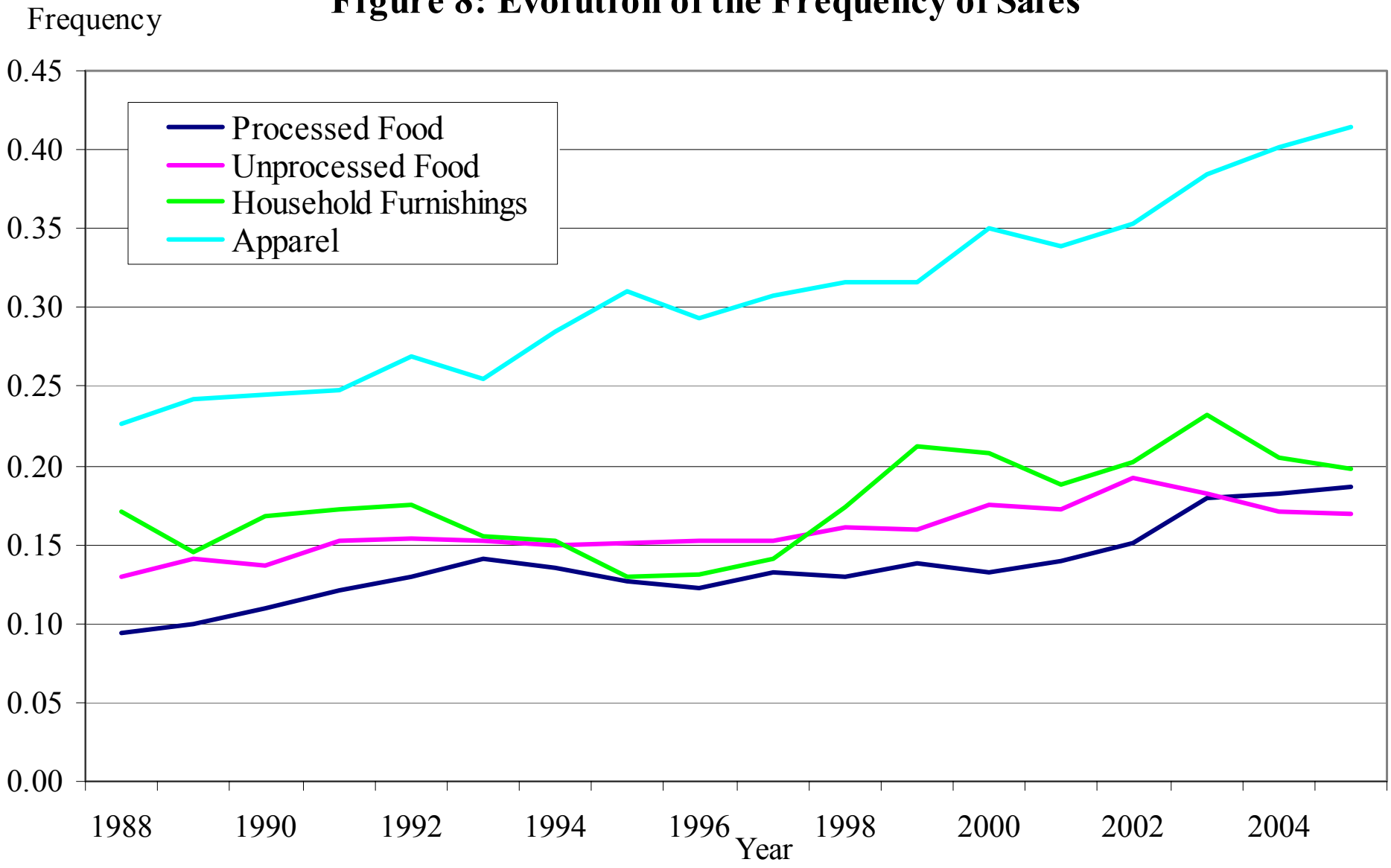
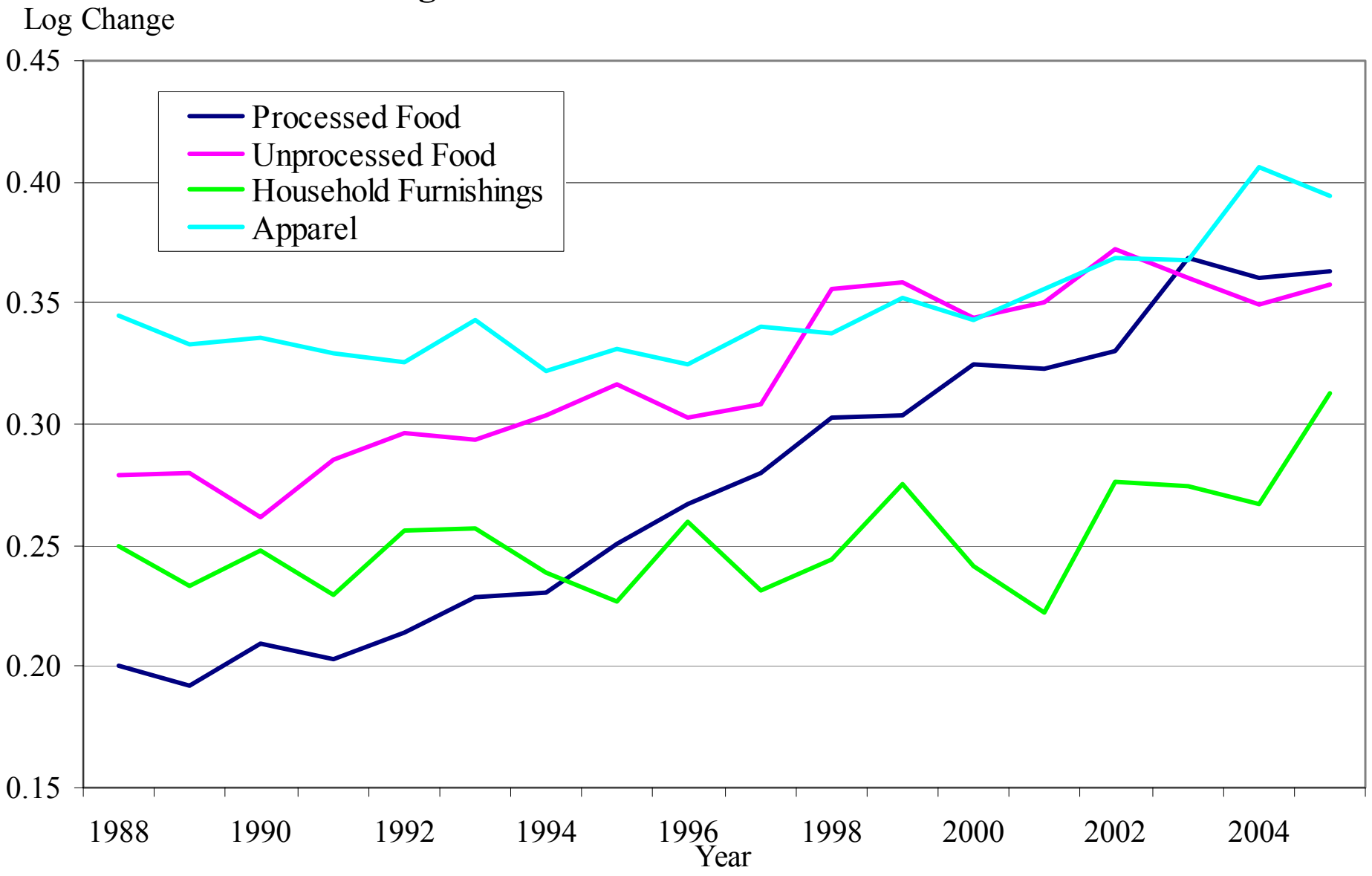


Figure 9: Evolution of the Size of Sales



Fact 4: The frequency of price change is highly seasonal

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

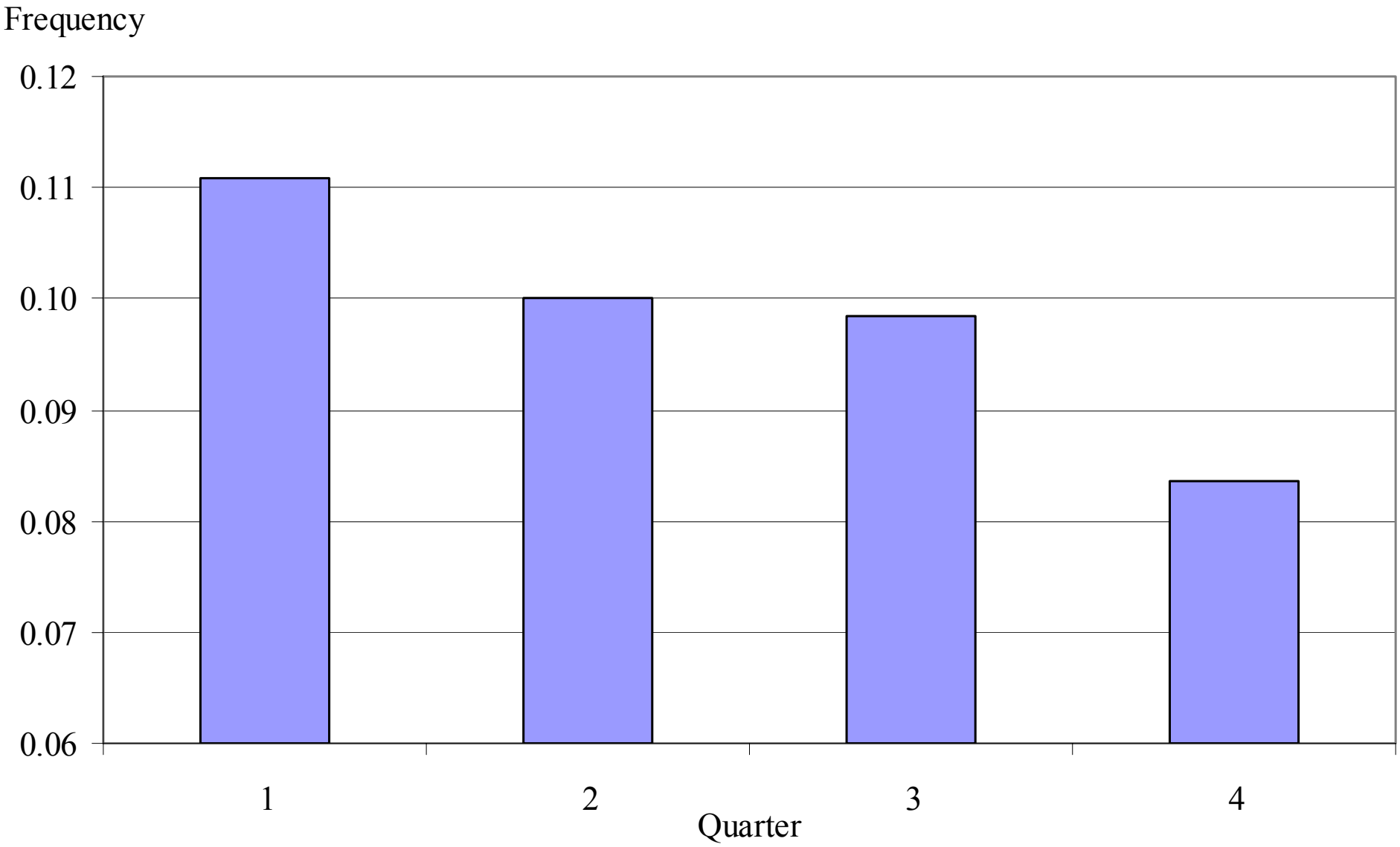
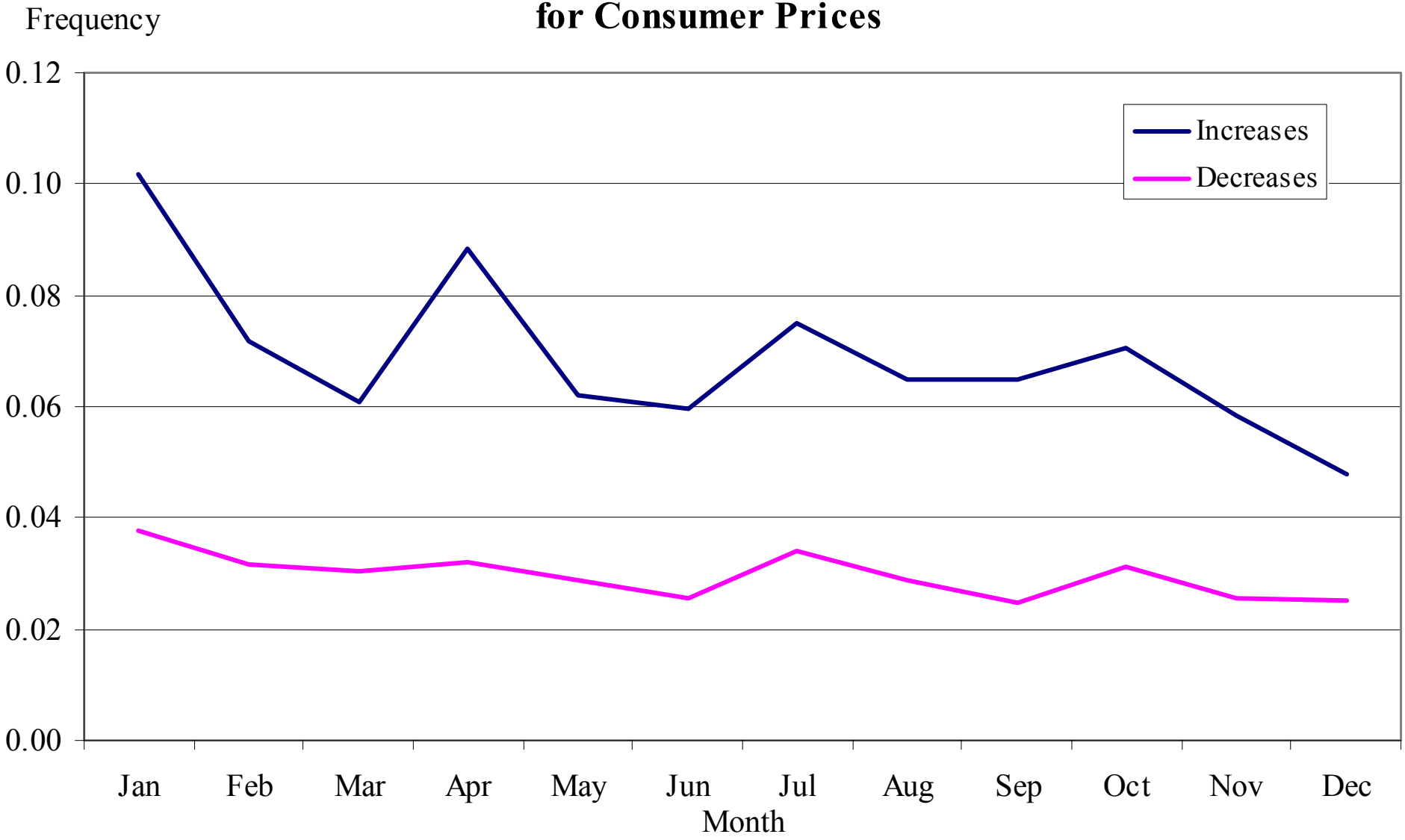


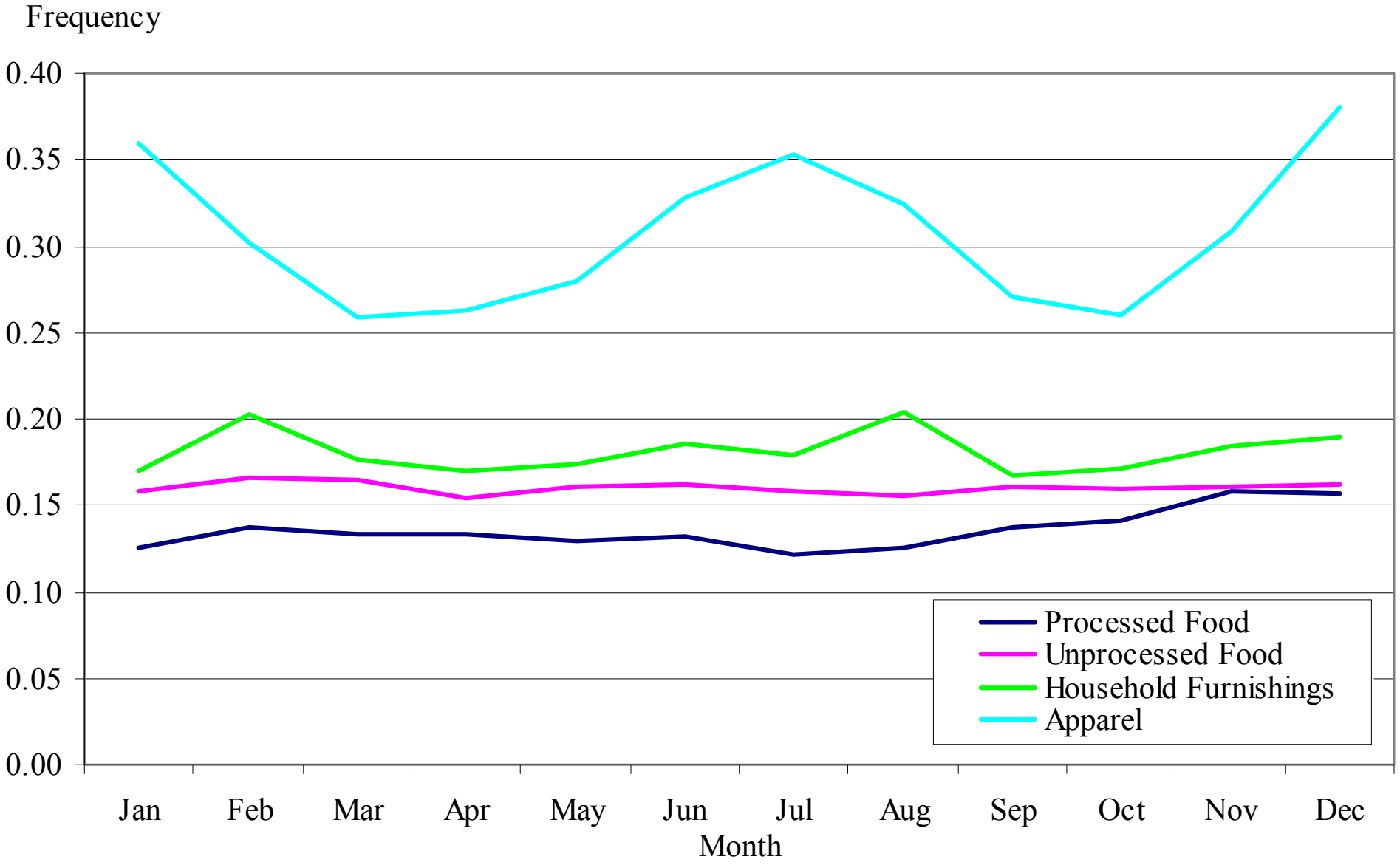
Figure 12: Frequency of Price Increases and Decreases by Month for Consumer Prices



Macroeconomic Implications:

- Seasonality in pricing is basic evidence of coordination
- Could reflect either coordinated changes in costs or pricing decisions
- Olivei and Tenreyro (2005) find that monetary non-neutrality is larger in response to monetary policy shocks that occur in certain quarters.

Figure 15: Seasonality of the Frequency of Sales



Hazard Function of Price Changes

- Key feature of interest:
  - Duration dependence (slope of the hazard function)
- Upward sloping hazard function: Older prices more likely to change.
- Traditional macroeconomic models: Flat or upward sloping hazard functions

Controlling for Unobserved Heterogeneity: CPI

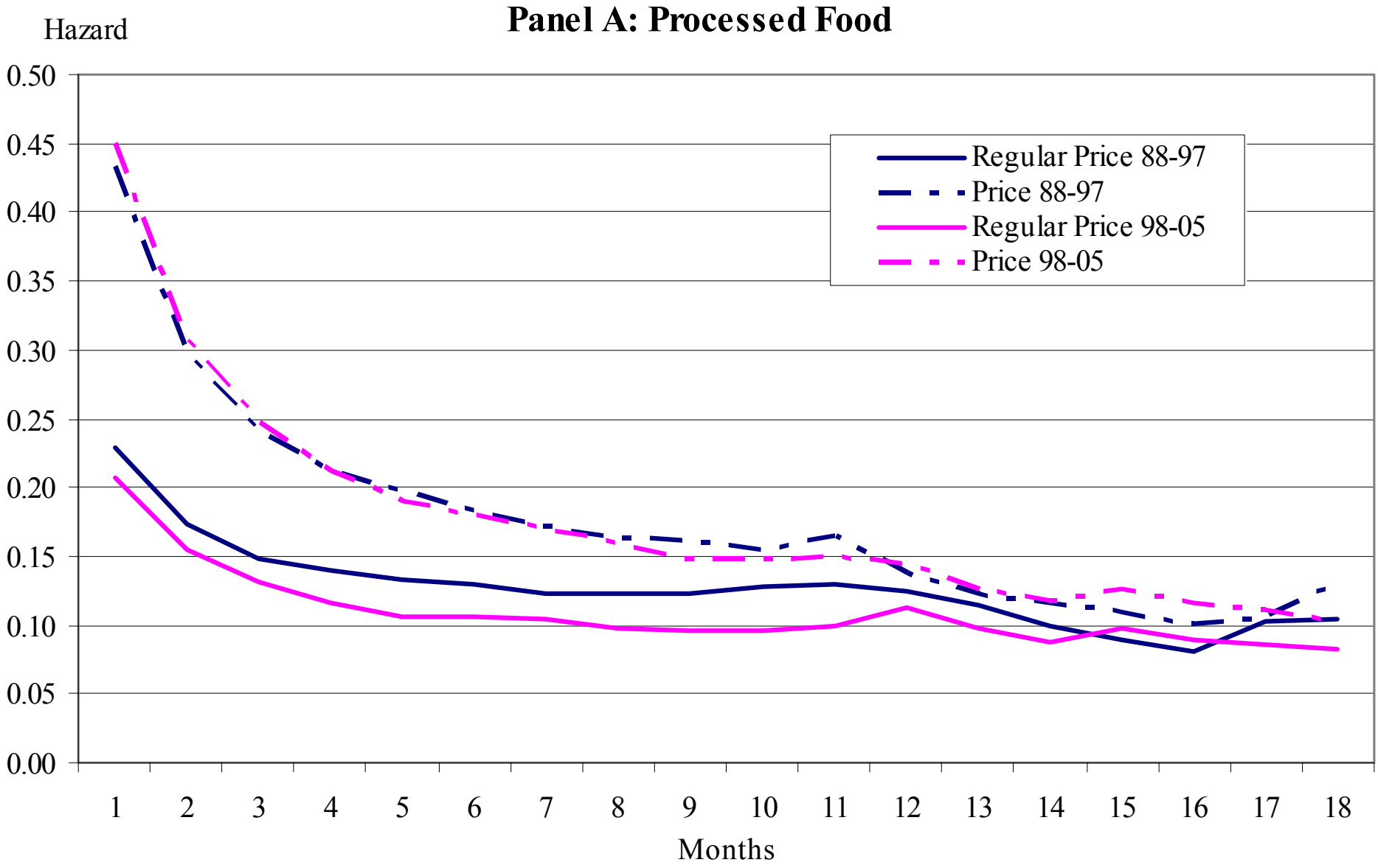
1. Divide data into groups
   - Major Groups (11)
   - Entry-Level Item (ELI) Groups (270-360)
2. Product specific unobserved heterogeneity model
   - Meyer (1990):

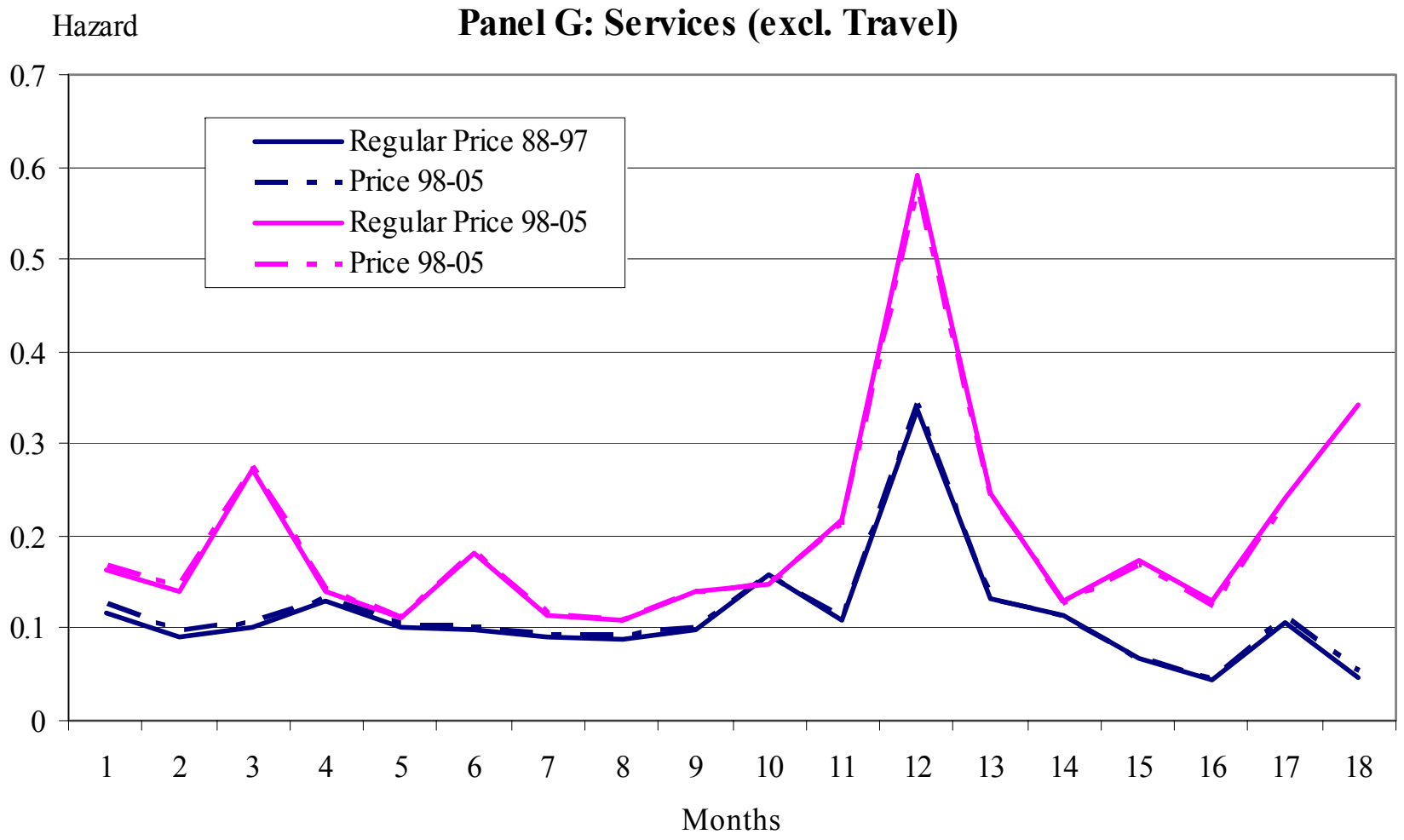
$$\lambda_{i,j}(t|\nu_i) = \nu_i \lambda_0(t) \exp(x_{i,j}\beta)$$

   - i indexes goods
   - j indexes price spells for a particular good
   - ν_i is a product specific unobserved "frailty" factor (e.g. 2 liter bottle of Diet Coke in a particular supermarket in Chicago)
   - $x_{i,j}$ is a vector of covariates
   - This model is estimated separately for each "group" (Major Group or ELI)

Main results:

- No evidence of upward sloping hazard functions
- Large difference between raw price and regular price
- Typical shape:
  - A bit downward sloping at first
  - Then mostly flat
  - For some categories: A large spike at 12 months
- Similar for PPI


Panel A: Processed Food
Hazard
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Regular Price 88-97
Price 88-97
Regular Price 98-05
Price 98-05
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Months


Panel G: Services (excl. Travel)
Hazard
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Regular Price 88-97
Price 98-05
Regular Price 98-05
Price 98-05
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Months

Comparison to IPN

- A great deal of work on this subject in IPN
- Baumgartner et al. (2005), Alvarez et al. (2005), Jenker et al. (2004), Dias et al. (2005), Fougere et al. (2005)
- Somewhat different methodologies
- Some papers conclude that it is not possible to reject a flat hazard

Conclusions

1. Temporary sales play a major role in US price flexibility
2. One-third of 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.
5. The hazard function of price changes for individual consumer and producer goods is downward sloping for the first few months and then flat, with a spike at 12 months.