# Some Evidence on the Importance of Sticky Prices

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**Abstract**

We examine the frequency of price changes for 350 categories of goods and services covering more than 70 percent of consumer spending, based on unpublished data from the BLS for 1995 to 1997. Compared with previous studies we find much more frequent price changes, with half of prices lasting less than 4.7 months. The frequency of price changes differs dramatically across goods. We exploit this variability to ask whether monthly time series for prices and consumption of goods with frequent price changes (flexible-price goods) differ markedly compared to time series for goods displaying infrequent price changes (sticky-price goods). We find that flexible-price goods display considerably more volatile inflation rates, but no more persistent inflation rates. Innovations in aggregate inflation are associated with a dramatic increase in the prices of flexible relative to sticky goods, and a persistent decline in the relative consumption of more flexibly priced goods. Popular measures of monetary shocks (e.g., innovations in the federal funds rate) also appear to have persistent effects, rather than the transitory effects one would expect from differences in price flexibility across goods. On the other hand, responses to aggregate TFP shocks are largely consistent with predictions of an explicit sticky-price model.

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## 1. Introduction

The importance of price stickiness remains a central question in economics. After a ten-year period of relative quiet, sticky-price models are again at, or near, the center of analysis of business cycle fluctuations and monetary policy. Goodfriend and King (1997), Rotemberg and Woodford (1997), Clarida, Gali, and Gertler (1999), Erceg, Henderson, and Levin (2000), Chari, Kehoe, and McGrattan (2000), Christiano, Eichenbaum, and Evans (2001), and Dotsey and King (2001) are examples of recent work built upon the assumptions that firms adjust prices slowly or infrequently and satisfy all demand at those posted prices.

The speed with which sticky-price models were first jettisoned then retrieved partly reflects the lack of conclusive evidence on the importance of sticky prices. Several papers have shown that certain wholesale and retail prices often go unchanged for many months (Carlton, 1986, Cecchetti, 1986, Kashyap, 1995, Blinder, Canetti, Lebow and Rudd, 1998, MacDonald and Aaronson, 2001). These papers do not, however, provide evidence that price rigidities have important consequences for the behavior of output. Carlton (1986, 1989) argues to the contrary, that firms have a number of tools (e.g., delivery lags) that may make price rigidities fairly unimportant. Several papers, for instance Rotemberg (1996) and Gali (1999), test implications of sticky prices for aggregate time series and find evidence consistent with an important role of price rigidities for real output fluctuations. But this time series evidence can typically be reconciled with flexible prices. For instance, as Rotemberg points out, the positive correlation he finds between unexpected movements in prices and output could raise with flexible prices if an unexpected increase in output brings about an endogenous expansion in money. King and Plosser (1984) clearly illustrated this point, while also providing a financial model that generates such a correlation under flexible prices.[1]

We try to obtain more direct evidence on the importance of price rigidities. We employ unpublished data from the U.S. Bureau of Labor Statistics (BLS) for 1995 to 1997 on

[1] Ball, Mankiw, and Romer (1988) find indirect support for real effects of price ridigities in the weaker correlation of output and inflation movements in countries with higher long-term inflation.

the monthly frequency of price changes for 350 detailed categories of consumer goods and services. We find that many prices seldom change. Prices of newspapers, men's haircuts, and taxi fares change in only 2 or 3 percent of monthly observations. By contrast, many prices change very frequently. The prices of gasoline, tomatoes, and airfares change monthly about 70 percent of the time. We exploit this diversity. We classify goods by how frequently they display monthly price changes in our detailed 1995-97 data. We then ask, if a shock occurs that drives up the aggregate rate of inflation, do goods with flexible prices respond differently than those goods for which prices rarely change. More exactly, we ask what happens to the relative prices and relative consumption of flexible- versus sticky-price goods when aggregate inflation increases. This potentially allows us to gauge the importance of sticky prices not only for the behavior of prices, but also for the behavior of output. For example, when aggregate inflation occurs unexpectedly, does a flexible-price good, such as gasoline, increase in price and fall in consumption compared to a sticky-price good, such as motor oil?[2]

The next section (section 2) presents the disaggregate data on the frequency of price changes for 1995 to 1997. The data cover a much broader set of goods than analyzed by Cecchetti (1986), Kashyap (1995), or MacDonald and Aaronson (2001). We compare our findings to theirs and to those of Blinder et al. (1998). We present a number of characteristics that predict whether a good will display a flexible price. We find that variables capturing the volatility of market supply and demand can account for most of the variation in price flexibility across categories. For example, goods that exhibit frequent model changes also typically exhibit flexible pricing.

In section 3 we briefly sketch a general equilibrium sticky-price model that follows work in Chari, Kehoe and McGrattan (2000, 2001). They model monopolistically competitive firms with staggered price setting of a fixed duration. The wrinkle we add is multiple

[2] Ahmed (1987), Card (1990), and Bils (1991) take a somewhat similar approach to examine whether fluctuations in employment are related cross-sectionally to the importance of wage stickiness. Ahmed relates wage stickiness to the importance of union contracts in an industry. Card and Bils each relate the importance of wage stickiness to how long a worker's union contract has been in effect.

consumer goods with prices fixed for different durations across the goods. We simulate this model to illustrate how flexible-price goods and sticky-price goods can differ in their responses to an aggregate shock.[3]

In section 4 we analyze monthly time series on prices and consumption for goods of varying price stickiness. We find that flexible-price goods display a sharp increase in price relative to sticky-price goods after a positive innovation in aggregate inflation. We ask whether these shifts in relative prices translate into important effects on consumption across goods. We do see that flexible-price goods fall in consumption relative to sticky-price goods in response to a positive aggregate price shock. But the relative movements in prices and quantities do not appear transitory as one would expect from differences in price flexibility across goods.

In section 4 we also estimate responses to measures of monetary policy shocks, such as federal funds rate innovations. These shocks, too, seem to generate very persistent movements in relative prices and consumption for flexible-price versus sticky-price goods. Based on this, movements in the federal funds rate do not appear to act like nominal (monetary) disturbances. These results are robust to alternative samples, alternative measures of price flexibility for the goods, and alternative measures of monetary policy shocks. Finally, in section 4 we examine responses to aggregate productivity shocks as measured by the rate of growth in TFP. The responses of relative prices and relative consumption to aggregate TFP shocks appear more consistent with the predictions of sticky-price models.

The final section (section 5) draws some tentative conclusions and discusses possible directions for further work

[3] Several papers have incorporated sticky and flexible price sectors into model economies. Examples include Ohanian, Stockman, and Kilian (1995), Aoki (2001), and Benigno (2001).

## 2. BLS Data on the Frequency of Price Changes

For calculating the CPI, the BLS collects prices for about 71,000 non-housing goods and services.[4] These are collected from around 22,000 outlets across 44 geographic areas. The BLS divides consumption into about 350 categories called "entry-level items" (ELIs). The outlets are sampled probabilistically based on household point-of-purchase surveys, and the items within each ELI are sampled according to estimates of their relative sales in the outlet.

The BLS *Commodities and Services Substitution Rate Table* gives the percentage of quotes with price changes for each ELI. For example, the 1997 Table indicates that 6,493 price quotes were collected on bananas in 1997, and that 37.8% of these quotes differed from the quote on the same type of bananas at the same outlet in the preceding month. (The Table does not contain information on the magnitude of price changes, just what share of price quotes involved *some* change in price.) The field agents who collect price quotes use a detailed checklist of item attributes to try to make sure they are pricing the same item in consecutive months. When they cannot find an item, they substitute the price of a closely-related item at the outlet. These "item substitutions" are the focus of the BLS Table, and we discuss them in detail later in this section. Item substitutions happen to be rare for bananas (only 1 in 1997) compared to other categories (3.1% of all non-housing price quotes in 1997).

The BLS has provided us with the unpublished *Commodities and Services Substitution Rate Table* for the years 1995 through 1999. The BLS revised the ELI structure in 1998, so frequencies cannot be readily compared before and after 1998. For the 168 ELI definitions which remained unchanged, however, the frequencies are quite stable on either side of the revision. The correlations for any pair of years lie between 0.96 and 0.98. In order to maximize the number of ELIs for which there is a price index before 1998, we use the 1995-1997 data and its ELI structure (350 ELIs).

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[4] The sources used for this section, unless otherwise noted, were *The Boskin Commission Report* (1986) and the *BLS Handbook of Methods* (U.S. Department of Labor, 1997, Chapter 17).

In Table 1 we list, for each ELI, the 1995-1997 average *monthly* frequency of price changes. For food and energy ELIs, in which items are priced monthly, this is the simple average of the frequencies in the 1995, 1996, and 1997 BLS Tables. For the other ELIs, the frequencies in the original BLS Tables are a mixture of one-month price change frequencies and two-month price change frequencies. In the five largest areas — New York City and suburbs, Chicago, Los Angeles and suburbs, San Francisco / Oakland / San Jose, and Philadelphia — the BLS collects quotes monthly for all goods and services. For the other 39 geographic areas, the BLS collects quotes monthly only for food and energy, and bimonthly for all other goods and services. According to the *BLS Handbook of Methods* (U.S. Department of Labor, 1997, CPI Appendix 3), the top five areas represent 25.7% of the goods and services priced in the CPI. Since goods and services are priced monthly in the top five areas, compared to bimonthly in other areas, monthly quotes represent 40.8% of the price quotes collected each month in each ELI outside food and energy.[5] Thus, in the BLS Tables, the frequency of price changes in ELIs outside food and energy is an average of monthly (weight 40.8%) and bimonthly (weight 59.2%) price change frequencies.

If the monthly probability of a price change is constant for items within an ELI (the same across areas and the same from month to month), then we can identify the monthly frequency of price changes from the mixed frequency the BLS reports and the fraction of quotes which are monthly versus bimonthly.[6] Let $y$ = the mixture of monthly and bimonthly frequencies (data from the BLS Tables), $x$ = the constant monthly frequency of price changes (not directly observed), and $z$ = the fraction of quotes which are monthly (40.8% according to

[5] If 25.7% of the items within an ELI are priced monthly and 74.3% are priced bi-monthly, then monthly quotes represent 25.7/(25.7 + 0.5*74.3) = .408, or 40.8%, of all price quotes in a given month.

[6] To do so, we assume that the probability of a price changing from $p_a$ to $p_b$ one month, then changing *back* to $p_a$ the next month, is zero. Based on scanner data for select seasonal goods at certain Chicago-area supermarkets, Chevalier, Kashyap and Rossi (2000) find that temporary sales are actually quite common. To the extent they occur, our estimated monthly frequencies understate the true monthly frequencies. Since Chevalier et al. find that temporary sales typically last one week or less, even monthly price quotes (as for the top five areas and for food and energy) understate the true frequency of price changes.

the BLS). Then $y = z*x + (1-z)*(x + (1-x)*x)$. Since $z \in (0, 1)$ and $x \in [0,1]$, the solution for $x$ is the negative root of this quadratic in $x$.

Table 1 reports estimated monthly frequencies of price changes for each of the 350 ELIs. They are simple averages of the estimated monthly frequencies for 1995, 1996 and 1997 for each ELI. The ELIs are in order of increasing frequency of price changes. The frequencies average 23.6% across the ELIs, and exhibit a standard deviation of 14.6%. Their median is 21.3% and they range from 0.9% for vehicle inspection to 71% for fresh tomatoes. Figure 1 gives the histogram of frequencies for the 350 ELIs. Not all ELIs are equally important, however, as their weights in the December 1997 CPI range from 0.001% (for playground equipment and other information processing equipment, respectively) to 3.84% (for new cars). Table 1 provides the weight of each ELI and the resulting percentile of the ELI in the cumulative distribution of price change frequencies. Weighting the ELIs by their relative importance, the monthly frequency of price changes averages 25.4% with a standard deviation of 17.3%. The weighted median is 21.1%. Thus half of the ELIs have prices that change less frequently than every 4.7 months. Figure 2 plots the cumulative percent of the non-housing CPI at each frequency.

The 350 ELIs in Table 1 cover 71.2% of the December 1997 CPI. The categories not covered are owner's equivalent rent and household insurance (20.3% weight), residential rent (5.8%), used cars (1.2%), and various unpriced items (collectively 1.5%). One question that arises is whether scanner data, which are becoming increasingly available to economists (e.g., Chevalier et al., 2000), might dominate the BLS average frequency data. Scanner data could afford weekly data on prices and quantities for thousands of consumer items. At present, however, scanner data cannot match the category coverage of the BLS data. Hawkes and Piotrowski (2000, Table 1) report that, as of December 1999, only 10.2% of consumer expenditures are scannable through AC Nielsen data for supermarkets, drugstores, and mass merchandisers. As noted, the 350 categories in the BLS Table cover 71.2% of the CPI.

*Comparison to Other Empirical Studies of Price-Stickiness*

The BLS data suggests much more frequent price adjustment than has been found in other studies.[7] Blinder et al. (1998) surveyed 200 New Jersey area firms on their price setting. Only 10% of firms reported adjusting their prices more than once a year, and 40% said they adjusted prices once per year. The balance (50%) said they adjusted prices less frequently than once per year. In contrast, the median consumer item in the BLS Table changes prices every 4.7 months. And 85% of consumer items change price more frequently than once a year, vs. only 10% in the Blinder et al. sample. One possible source of this difference in findings is that firms in the Blinder et al. survey sell mostly intermediate goods and services (79% of their sales) rather than consumer goods and services.

Even compared to other studies of *consumer* prices, the BLS data imply considerably more frequent price changes. Cecchetti (1986) studied newsstand prices of 38 American magazines over 1953 to 1979. He found the average number of years since the last price change ranged from 1.8 years to 14 years, depending on the period. In our Table 1, magazines (including subscription as well as newsstand prices) exhibit price changes 5.5% of months, implying adjustment every 1.5 years on average. More importantly, magazines are at the sticky end of the spectrum in Table 1: prices change more frequently than for magazines for 93.5% of consumption categories.[8]

Kashyap (1995) studied the monthly prices of 12 mail-order catalog goods for periods as long as 1953 to 1987. Across the goods and time, he found an average of 14.7 months between price changes. This contrasts with the 4.7 month median in the BLS data. Based on Table 1, prices change more frequently than every 14.7 months for 88% of non-housing consumption. The 12 Kashyap goods consist mostly of apparel. In the BLS data, prices actually change more frequently for clothing: the monthly hazard is 30.0% for apparel items,

[7] The BLS data also suggest much more frequent price adjustment than has typically been employed in calibrated macro models. Chari et al. (2000), for instance, consider a benchmark case in which prices are set for one year.
[8] Cecchetti states explicitly that he is interested in studying a good with greater than typical price stickiness in order to test alternative models of price rigidity.

versus 26.7% for all items. So prices for the goods in Kashyap's sample are far stickier than the typical BLS item, apparel or otherwise. Mail-order prices may tend to be stickier than prices in retail outlets. Another factor could be that Kashyap selected "well-established, popular-selling items that have undergone minimal quality changes" (Kashyap, 1995, p. 248). As we discuss below, changing product features may play an important role in price changes.

*Differences in Price Stickiness Across Consumption Categories*

Table 2 provides price change frequencies for selected broad categories of consumption. The first row shows that the frequency is 25% for all items. The next three rows provide frequencies for durable goods, nondurable goods, and services, respectively, based on U.S. National Income and Product Account (NIPA) classifications. Price changes are modestly more frequent for durable goods (32%) than for nondurable goods (29%), and are notably less frequent for services (20%). The lower frequency of price changes for services could reflect firms' response to the lower volatility of consumer demand for services.

The next six rows in Table 2 provide frequencies for each of the six CPI Expenditure Classes defined by the BLS. At the flexible end are transportation prices (e.g., new cars, airfares), 36% of which change monthly. At the sticky extreme are medical care (drugs, physicians' services) and entertainment (admission prices, newspapers, magazines, and books), 9% and 12% of whose prices change monthly.

In the final panel of Table 2 we distinguish goods with relatively little value added beyond a primary input, for instance gasoline or fresh fruits and vegetables. Such goods are presumably subject to greater volatility of cost shocks. This component of goods resembles the broader set of food and energy goods excluded by the BLS in its core rate of CPI inflation. We refer to these goods as raw goods, and to the complement set of goods as processed goods.[9] As expected, products closely linked with primary inputs (raw products) display

[9] The set of goods consists of gasoline, motor oil, fuel oils, natural gas, meats, fresh fruits, fresh and frozen vegetables, dairy products, and frozen fruit juices.

frequent price changes, with the frequency of their price changes averaging 50.2%. Even excluding the raw goods, we find that the remaining goods display an average frequency of price changes of 20.4%. This frequency remains considerably higher than values typically cited in the literature, based on narrower sets of goods.

Menu-costs models of price adjustment (e.g., Barro, 1972, or Caplin and Spulber, 1987) predict that price changes are more frequent in markets with high trend inflation (or low trend deflation). Related to this, Ball, Mankiw, and Romer (1988) exploit the prediction that the frequency of price changes should be greater in an economy with high average inflation. We examined whether the frequency of price changes (as always, based on the 1995 to 1997 panel of observations) is greater for goods that display a higher absolute level of price inflation. The average rate of inflation is based on the good's NIPA price deflator over 1959 to 2000. Observations are weighted by the good's expenditure share for 1997. Surprisingly, we observe a significant negative correlation of (-0.30, p-value 0.0006) between a good's absolute average inflation rate and the frequency of its price changes. If we also control for whether a good is a durable, nondurable, or service the correlation falls in magnitude to -0.18, but remains statistically significant (p-value 0.039).

*Market Structure and Price Flexibility*

Models of price adjustment (e.g., Barro, 1972) predict greater frequency of price changes in markets with more competition because firms then face more elastic product demands. The four-firm concentration ratio is often used as an inverse measure of market competition, with a higher value expected to correlate with less elastic demand. Several papers have found an inverse relation between the concentration ratio and the frequency of price changes or price volatility in producer prices (e.g., Carlton, 1986, Caucutt, Gosh and Kelton, 1999). We examine the relationship between the share of the largest four firms in manufacturing shipments and the frequency of price change for our goods. The concentration ratio is taken from the 1997 Census of Manufactures. To exploit this measure we match the

350 consumer goods categories to manufacturing industries as classified by the North American Industrial Classification System (NAICS). This matching can be done for 232 of the goods. The categories we were unable to match are largely services.

Table 3, column 1, gives the result of regressing the frequency of price changes on the four-firm concentration ratio. (This is a weighted least squares regression with weights given by the goods' importance in the 1997 CPI.) There is an economically and statistically strong negative relation. The coefficient of -.26 implies that raising the concentration ration from 23% (the value for pet food) to 99% (the value for cigarettes) tends to decrease the monthly frequency of price changes by about 20 percentage points.

We consider two other variables related to market competitiveness. One is the wholesale sector's markup, defined as (wholesale sales revenue minus cost of goods sold)/(wholesale sales revenue). The data for wholesale markups are reported in the 1997 Census of Wholesale Trade. We can match 251 of the 350 consumer goods to a corresponding wholesale industry in the NAICS.

Another factor potentially related to market competition is the rate that new, possibly superior, substitute products are introduced. As mentioned above, the BLS *Commodities and Services Substitution Rate Table* actually focuses on item substitutions. When an outlet discontinues an item, the field agent collecting price quotes searches for the closest substitute at the outlet. Afterwards, the BLS compares the attributes of the selected item to those of the discontinued item, and classifies the substitute as either comparable or noncomparable to the discontinued item.[10] We expect markets with greater product turnover, as measured by the rate of noncomparable substitutions, to price more flexibly. In these markets firms should face a more elastic product demand, as consumers have an option of delaying a purchase, knowing a newer model will soon arrive. Furthermore, frequent introduction of new products may proxy for ease of market entry more generally.

[10] Item substitutions occur in 3.1% of monthly price quotes in our sample. Substitutions were deemed comparable 54% of the time on average across the 350 ELIs over 1995-1997.

Table 3, column 2 provides results relating the frequency of price changes to the three measures of market structure (concentration ratio, wholesale markup, and rate of noncomparable substitutions). The coefficient on each of the three variables is of the sign anticipated and is economically and statistically important. The coefficient on the concentration ratio is actually larger than in column 1. The coefficient of -0.92 on the wholesale margin implies that increasing the margin from 12 percent (the value for meat products) to 35 percent (the value for toys and games) tends to decrease the monthly frequency of price changes by more than 20 percentage points. The coefficient on the arrival rate of new product varieties implies that ELIs with a 1% higher noncomparable item-substitution rate tend to have a 1.8 percentage point higher frequency of price changes (with a standard error of 0.36 percentage points). The fact that the coefficient significantly exceeds unity means that price changes are more frequent in the presence of greater product turnover even aside from the price changes mechanically associated with the item substitutions.[11]

As presented in Table 2, products closely linked with primary inputs (raw products) display much more frequent price changes. The regression in Table 3, column 3 again examines how the frequency of price changes responds to the three measures of market power, but now controlling for whether each good is a raw product. The coefficient implies that the frequency of price changes is 28 percentage points higher for raw products (with a standard error of 2.4 percentage points). The four-firm concentration ratio and wholesale markup, both of which appear very important in the column 2 regression, become quite unimportant when controlling for whether a good is raw or processed. The rate of product turnover robustly predicts more frequent price changes. Its coefficient actually increases, with a 1% higher

[11] The price of comparable substitutes enters the CPI without adjustment, so comparable substitutions are associated with price changes only if the substitute's price differs from the previous month's price for the discontinued item. In contrast, the prices of noncomparable substitutes enter the CPI with quality adjustments, so noncomparable substitutions are almost always associated with price changes. See Shapiro and Wilcox (1996) for an explanation of BLS quality adjustments.

monthly rate of substitutions associated with a 2.5% higher monthly frequency of price changes (standard error of 0.22%).[12]

Given the insignificance of the four-firm concentration and the wholesale margin controlling for whether a good is a raw good, in the last column of Table 3 we relate the frequency of price changes simply to the rate of noncomparable substitutions and the raw good dummy. These variables are available for the full set of 350 goods. The two variables explain a large fraction of the variation in frequency of price change across the 350 goods (adjusted $R^2$ of 0.56). A one percent higher rate of product substitutions is associated with a 2.9% higher rate of price changes (standard error of 0.27%). Thus each product turnover is associated with nearly 3 additional price changes.

## 3. A General Equilibrium Model with Goods of Varying Price-Stickiness

In this section we briefly describe the implications of a general equilibrium model with staggered price setting. The critical feature is that individual firms set their prices for different durations across two consumer good sectors. Our purpose is to illustrate how the flexible-price sector versus the sticky-price sector respond to aggregate shocks. Our model borrows heavily from the work of Chari, Kehoe and McGrattan (2000, 2001). Our sole substantive deviation from their closed economy paper (CKM 2000) is in having two consumer good sectors. Their open economy version (CKM 2001) features distinct foreign and domestic consumer goods, so our model is a hybrid of their two models: two consumer goods as in

[12] We examined several other variables aimed at capturing market structure. A higher import market share might be expected to raise competition and the frequency of price changes. (We obtained data on imports from the U.S. Department of Commerce.) We do find a statistically significant correlation of 0.18 between import share and the frequency of price changes. But import share does not help predict price flexibility after controlling for the raw dummy. We expect higher inventory holdings in industries with market power and higher markups. Therefore greater inventory holdings might be associated with less frequent price changes. The frequency of price changes is indeed very negatively correlated, -0.51, with the ratio of *wholesale* inventories to sales. But, again, this effect is not robust to controlling for the raw-good dummy. The frequency of price changes is also typically lower for goods with a high ratio of *manufacturers* inventories to shipments (correlation -0.18). This variable is modestly significant in explaining less frequent price changes even controlling for whether a good is a raw good. (The data for manufacturing and wholesale inventories are taken, respectively, from the 1997 Censuses of Manufacturing and Wholesale Trade.)

CKM 2001, but a closed economy as in CKM 2000. Within each consumer good sector, price setting is staggered evenly across monopolistically competitive firms.

Consumers have momentary utility given by

$$U(c, m, l) = [(\omega c^{1-1/\eta} + (1-\omega)m^{1-1/\eta})^{\frac{\eta}{\eta-1}}(1-l)^{\psi}]^{1-\sigma}/(1-\sigma) ,$$

where $c$ = a CES consumption aggregate, $m$ = real money balances, $l$ = labor supply, and 1 = the period time endowment. Time subscripts are implicit. Following CKM, we set $\omega = 0.94$ based on the empirical ratio of $m/c$ (M1 to nominal consumption), $\eta = 0.39$ based on the interest elasticity of money demand (from regressing log $m/c$ on the nominal three-month Treasury bill rate), $\psi = 1.5$ so that steady state $l$ is 1/4, and $\sigma = 1$ (unit intertemporal elasticities).

Aggregate consumption, in turn, is given by

$$c = [\omega_f \left(\int_0^1 c_f(i)^{\theta} di\right)^{\rho/\theta} + \omega_s \left(\int_0^1 c_s(j)^{\theta} dj\right)^{\rho/\theta}]^{1/\rho} ,$$

where $c_f(i)$ = production of flexible-price good $i$ (by a monopolistic competitor), $c_s(j)$ = production of sticky-price good $j$ (by a monopolistic competitor). As shown, there are a continuum of firms of measure 1 in each sector. We set $\omega_f = \omega_s = 0.5$ so that the sticky and flexible sectors have equal weight in $c$. We assume $\theta = 0.9$ so that the elasticity of substitution between varieties within each sector is 10. This implies that firms will desire a price markup of 10% above marginal cost, in line with the evidence of Basu and Fernald (1997). We set $\rho$ = 0 (Cobb-Douglas) so that the nominal shares of the flexible and sticky sectors are constant.

Firm production technologies are linear in labor:

$$c_f(i) = a\, l_f(i) \;\; \forall i, \;\; c_s(j) = a\, l_s(j) \;\; \forall j .$$

Aggregate productivity shocks are entertained through the parameter $a$. For simulations, we treat disturbances to $a$ as a random walk, examining responses to a 1% innovation in productivity.

Labor is mobile across firms and sectors, so the labor market clearing condition is

$$\int_0^1 l_f(i)di \; + \; \int_0^1 l_s(i)di \; = \; l \; .$$

The exogenous money growth process is

$$\log \mu_t \; = \; \rho_m \log \mu_{t\text{-}1} + \epsilon_t \; ,$$

where $\mu_t = \frac{m_t}{m_{t\text{-}1}}$ is the gross growth rate of the money supply. For our simulation we use $\rho_m$ = 0 (random walk $m$), but we obtain the same qualitative results if we use $\rho_m$ = 0.83 (estimated from an AR1 on monthly M1 growth). We prefer the random walk case because the ultimate price change is the same size as the money innovation. We examine responses to a 1% money impulse ($\sigma_\epsilon$ = .01).

For both sectors, any firm adjusting price in period $t$ sets its price before observing the current period money shock ($\epsilon_t$). Then the shock is realized and all firms hire labor (equivalently, set output) to satisfy the quantity demanded of their variety at their preset price. In the flexible-sector prices are preset for 2 periods (the 90th percentile of frequencies in our Table 1). In the sticky-price sector prices are preset for 16 periods (the 10th percentile of frequencies in Table 1). In each sector, price-setting is staggered evenly (1/2 the flexible sector firms set their prices before a period, the other half before the next period; 1/16th of the sticky sector firms set their prices before a period, 1/16th before the next period, and so on).

Firms preset their prices to maximize their expected discounted profits over the period the price will be fixed. Their information set includes the entire distribution of preset prices of other cohorts of firms in their own sector and in the other sector. As an example, if prices were preset for only one period, then firms would set price equal to its steady state markup over expected nominal marginal cost. The latter is the expected wage (divided by the marginal product of labor). In all cases the wage is determined in general equilibrium to equate household labor supply (given the preset aggregate price) to labor demand that is realized at the prices firms post. An Appendix with further details (the budget constraint, first order conditions, numerical computation of a solution to the log-linearized system of equilibrium equations) is available upon request.

Figure 3 presents equilibrium responses to a permanent 1% jump in the money supply. Aggregate consumption and labor supply both jump 1% in the month of the shock, then decline monotonically towards zero over the next 16 months. The decline is sharpest in the first two months as the two cohorts of firms in the flexible-price sector get a chance to respond: output declines sharply and prices rise sharply in the flexible sector over the first two months after the shock. As shown, the price rises and output falls gradually over the 16 months following the shock in the sticky-price sector. Thus both price growth and output growth are more persistent in the sticky sector than in the flexible sector. The bottom panel in Figure 3 summarizes the implications for relative prices and quantities: consumers shift away from the flexible-price goods as their relative price rises in the first two months after the shock, then slowly revert back to zero as more and more cohorts raise prices in the sticky-price sector. With this in mind, we now examine time series evidence on how flexible-price vs. sticky-price sectors respond to aggregate shocks.

Figure 4 shows model responses to a 1% permanent increase in the technology parameter $a$. In the first period, before prices respond, labor hours contract, with no impact on aggregate consumption. Beginning in the second period, consumption rises, gradually continuing its rise until the higher productivity is passed entirely into increased consumption,

with no permanent impact on labor hours. More interesting are the relative movements in prices and consumption between the flexible-price and sticky-price goods. Over the first several months there is a sharp fall in relative prices of the flexible-price goods. The (relatively) flexible price has fallen by a full percent compared to the sticky price two periods after the shock. It gradually rebounds over the subsequent 12 months. Given the Cobb-Douglas specification of preferences, relative consumptions display precisely the opposite pattern. As a result, the increase in real consumption falls predominantly on the flexibly-priced goods for the first 6 or so months.

## 4. Time-Series Patterns for Flexible-Price Goods vs. Sticky-Price Goods

We now describe how the monthly time-series behavior of prices and consumption relate to the frequency of price changes for the good. We look at how prices of flexible goods vary relative to those for sticky goods in response to disturbances to aggregate inflation or to disturbances that influence aggregate inflation, such as monetary policy shocks. We also ask whether any movement in relative prices is mirrored in relative consumption of the goods.

We first examine whether the variability and persistence of time series for prices and consumption differ importantly between goods with frequent price changes and those without. For instance, are inflation rates more persistent for less flexibly priced goods, as anticipated by many models of price stickiness employed in the literature?

### *The Persistence and Volatility of Prices and Consumption*

We match our 350 categories of consumer goods to available NIPA time series on prices and consumption (from the Bureau of Economic Analysis personal consumption expenditures data by detailed product class). The price deflator is a chain-type index. Real consumption is constructed from the chain-index price deflators and data on nominal expenditures. The data run from January 1959 to June 2000. Although we can match most of our 350 ELI categories to NIPA time-series, in many cases the NIPA categories are broader.

The matching results in 123 categories covering 67.3% of overall consumer spending and most of our 350 ELIs (which comprised 71.2% of the CPI).

We first ask how inflation rates differ in volatility and persistence according to the price flexibility of the good. Table 4 reports correlations of volatility and persistence with the frequency of the good's price change measured from the BLS panel for 1995 to 1997. Looking at the first two rows of the first column, we see that goods with more frequent price changes exhibit much higher volatility of inflation. The correlation between the frequency of price changes and the standard deviation of monthly price changes equals 0.50; for annual price changes it equals 0.45. For each of the 123 time series for inflation we fit an AR(1) process. The next two rows of the table report correlations of a good's frequency of price changes with the AR(1) coefficient and innovation standard error from its fitted AR(1) process. Persistence is not significantly correlated with the frequency of price changes (correlation -0.11), whereas goods with more frequent price changes display more volatile innovations (correlation 0.52).

In recent years the workhorse model for analyzing implications of sticky prices has been the Calvo (1983) model, in which firms follow probabilistic time-dependent rules for changing prices. One clear prediction of these models is that if individual sellers' prices change more frequently then we should see less persistence in a good's inflation rate and more volatility in the innovation to its inflation rate. The previous section showed that a staggered time-dependent rule shares these implications. These predictions are not well supported by the results in Table 4, as persistence of price change appears little related to frequency of price change. But we saw in Table 3 (section 2) that the frequency of price changes is well-predicted by the volatility of demand and supply as proxied by the rate of product arrivals and being a raw product. This might explain why we see greater volatility of innovations to inflation for the more flexibly priced goods. If goods that are subject to more volatile shocks also face more persistent shocks (though there is no obvious reason to expect this), then this could mask the true negative impact of price flexibility on the persistence of a good's inflation rate.

For this reason, in the second column of Table 4 we repeat the exercise controlling for the rawness of the product and the rate of noncomparable substitutions, variables found in Table 3 to predict around 60 percent of the variation in the frequency of price changes. In this second column of Table 4 the correlations are between the *residual* frequency of price changes, not predicted by these factors, and volatility and persistence. The correlations are surprisingly little affected. The correlation between frequency of price changes and persistence increases modestly in magnitude from -0.11 to -0.17, but remains borderline statistically insignificant (p-value of 0.06). Therefore, we do not see much support in Table 4 for time-dependent models of price stickiness. More promising, we believe, would be state-dependent models of price stickiness, such as Willis (2000), in which the frequency of price changes is endogenously greater in the presence of more volatile shocks.

The bottom panel of Table 4 looks at monthly growth rates of real consumption spending. Here the predictions of sticky-price models are less clear. The models are typically written assuming that output is demand-determined in the presence of a predetermined price. Therefore, price rigidity tends to exaggerate sales responses to product demand shocks, but mute the impact of cost disturbances (e.g., Gali, 1999). In the first column, without controls, goods that exhibit more frequent price changes display more volatile, but less persistent, growth rates. But controlling for a good's rawness and rate of noncomparable substitutions eliminates any significant differences in volatility or persistence by frequency of price changes.

*Relative Movement in Prices and Consumptions in Response to Aggregate Shocks*

Do flexible versus sticky-priced goods respond differently to a neutral aggregate shock? By neutral shock we mean a shock that, in the absence of any price rigidities, would have an equal impact on the prices of all goods (for example a pure monetary shock). It is not clear how to empirically identify a purely neutral shock. We start by simply considering innovations to the aggregate inflation rate, or some variant such as the median inflation rate. We then consider innovations to variables that have been suggested as measures of monetary

policy, such as the federal funds rate, as well as shifts in aggregate productivity measured by the rate of growth in total factor productivity (TFP).

Let $p_{it}$ equal the natural log of the price of good $i$ in period $t$. We look for the effect of an aggregate shock on relative values of $p_{it}$ by estimating:

$$p_{it} = \lambda_i \sum_{j=0}^{n} \beta_j x_{t\text{-}j} + \phi_{it} \tag{1}$$

where

$$\phi_{it} = \alpha_i + \gamma_i t + \mu_t + \epsilon_{it}. \tag{2}$$

$\lambda_i$ denotes the frequency of price changes for good $i$ as measured in the 1995 to 1997 BLS panel. The variable $x_t$ and its $n$ lagged values denote innovations to a variable designed to capture neutral aggregate shocks, such as overall inflation or the federal funds rate. The good specific error $\phi_{it}$ has several components. $\alpha_i$ and $\gamma_i t$ represent, respectively, good-specific levels and trends for good $i$'s price.[13] $\mu_t$ is an error term for all goods specific to time period $t$. $\epsilon_{it}$ denotes the error specific to good $i$ in time $t$.

We specify $\epsilon_{it}$ as the autoregressive process

$$\epsilon_{it} = (\rho_1 + \omega_1 \lambda_i)\epsilon_{it\text{-}1} + (\rho_2 + \omega_2 \lambda_i)\epsilon_{it\text{-}2}\,, \tag{3}$$

so that the degree of persistence in $\epsilon_{it}$ can also vary with the observed frequency of price changes $\lambda_i$. Estimation is by Cochrane-Orcutt methods, iterating on the $\beta$, $\rho$, and $\omega$ parameters. Observations are weighted by the share of the good in the CPI. To estimate the effects of an $x_t$ impulse on good $i$'s consumption ($c_{it}$), we replace $p_{it}$ in equation (1) with $c_{it}$.

We consider several different variables for the shocks $x_t$ in equation (1). We first consider innovations to the aggregate CPI, where the log CPI is represented as an AR(12)

[13] We also allow for monthly seasonals specific to each good.

process. This is estimated for the same period, January 1959 to June 2000, for which we data on prices and consumptions for the 123 goods. Figure 5 shows how the CPI responds to its own innovation: it rises 1% on impact, then rises steadily up to 7.4% after 6 years. To gauge how relative prices of flexible vs. sticky goods respond, we include CPI innovations from the current and prior 20 months (that is, $n = 20$ in equation (1) above). Figure 6 shows how relative prices respond to a CPI innovation. The figure graphs the implied response for goods with 90th percentile price flexibility relative to the response for goods at the 10th percentile of price flexibility. This is calculated by multiplying the difference in frequencies of price changes at the 90th percentile (48.6%) compared to that at the 10th percentile (6%) by the relevant value for $\beta_j x_{t-j}$ estimated from equation (1). The figure includes dashed lines depicting 95% confidence bounds for the impulse response.[14]

Looking at Figure 6, a 1% innovation in aggregate inflation is associated initially with a 2% rise in the price of flexible (90th percentile) goods relative to the price of inflexible (10th percentile) goods. After 6 months, when the impact on the aggregate CPI has accumulated to nearly 2%, the impact on flexible versus sticky prices remains at about 2%. After 20 months, when the impulse on the aggregate CPI has built to about 4%, the impact on relative prices is also about 4%.[15] Figure 7 presents the response of relative consumption to the aggregate CPI impulse. After an initial fall of about 1% for the first several months, relative consumption falls further and is down about 4% after 20 months. Figures 8 and 9 provide the implied *levels* of price and consumption responses for the 90th and 10th percentiles of price flexibility.

Our aim is to identify the impact of a neutral aggregate inflationary shock on relative prices and consumption. The persistent movements we see in relative prices and consumption in Figures 6 and 7 are difficult to justify on the basis of a neutral shock. (Compare Figures 6 through 9 to the impulse response functions from the sticky price model in Figure 3.) We infer

[14] These confidence intervals do not reflect the fact that the innovations to the aggregate CPI are generated as a residual to an estimated regression.

[15] If we look out 30 months, when the aggregate CPI is up 5 percent, the impact on relative prices is still about 4 percent. All of our subsequent results are similarly robust to looking out 30 months instead of just 20.

that the innovations to aggregate inflation are likely correlated with persistent shocks affecting the underlying costs or demands for flexible versus sticky-priced goods.

We made four attempts to control for possible correlation of sectoral shocks with aggregate inflation. First, we tried conditioning on movements in commodity prices in constructing innovations to aggregate inflation, but this had very little impact on the measured innovations. Second, we considered innovations to the median CPI, rather than the overall CPI. The median CPI downweights extreme price changes in measuring general price level movements. Results employing innovations in the median CPI, however, also revealed very persistent responses of relative prices and consumption. Third, we constructed aggregate innovations to inflation based on weighting each good by the inverse of the standard deviation of its monthly inflation rate (as well as the good's share in expenditure). In principle this should purge the aggregate shock from any mechanical correlation with relative price increases for goods with more volatile prices. But this too produced persistent responses of relative prices and consumption to aggregate inflation shocks. Fourth, we defined price flexibility by the *residual* frequency of price changes after controlling for durability, rawness of the product, and rate of noncomparable substitutions. That is, we defined $\lambda_i$ in this way in equations (1) through (3). Still, persistent effects on relative prices and consumptions remain, suggesting an inflation shock is not neutral even to residual price flexibility of the goods.

We next examine responses to innovations in the federal funds rate, the ratio of nonborrowed to total reserves, and the nonborrowed reserves of the Federal Reserve System. These have been proposed as measures of monetary policy, with a positive innovation in the federal funds rate suggesting less expansionary monetary policy and a positive innovation in nonborrowed/total reserves or nonborrowed reserves suggesting more expansionary policy (Christiano, Eichenbaum, and Evans, 1999, hereafter CEE). We take the innovations to these

series estimated by CEE from a seven variable VAR.[16] Figure 10 shows the responses of the fed funds rate, employment and the personal consumption deflator to a fed funds rate impulse. These are taken straight from the CEE estimates. A fed funds rate shock is associated with lower prices over time, and a U-shaped response of employment.

Responses of relative prices and consumption to a federal funds rate impulse appear in Figures 11 and 12. For ease of comparison with inflation and monetary shocks, the impulse here is a one percentage point *drop* in the fed funds rate. If a drop is a signal of expansionary monetary policy, we should anticipate an initial rise in relatively flexible prices. This does not occur in Figure 11. The prices for goods with frequent price changes actually decrease relative to those with less frequent price changes in the first 8 months after the innovation. After about a year and a half the flexible prices do rise relative to the stickiest ones, but at this point the effects on relative prices should be fading rather than building (see Figure 3 from the sticky price model). In Figure 12 we see no impact of a drop in the federal funds rate on relative consumption for the first year, followed by in fall in flexible-price goods relative to sticky-price goods. Neither the initial nor subsequent responses match those predicted by the model (again, see Figure 3). Figures 13 and 14 show that the level responses likewise do not match those predicted for flexible vs. sticky goods. We find very similar effects of a fed funds rate shock when we order flexible vs. sticky goods based on *residual* price flexibility (variation in $\lambda_i$ controlling for rawness and rate of product turnover).

It is argued that the Fed did not target the fed funds rate over 1979-1982, and may have been less accommodative of inflation shocks after 1982. For this reason, we also examined responses to a fed funds rate innovation estimated only over the post-1982 sample. We find that, for the first 10 months after a fed funds rate shock, more flexible prices actually respond in a manner opposite that predicted by the sticky price model. Furthermore, this effect lingers

[16] Innovations to the federal funds rate are estimated from a VAR with nonfarm employment, the consumption deflator, commodity prices, the nominal federal funds rate, nonborrowed reserves, total reserves, and M1. This is the ordering of the variables used in the Cholesky decomposition of residuals to obtain orthogonal innovations.

for 20 (or even 30) months, whereas the model predicts purely transitory effects. Relative consumption also fails to respond, contrary to model predictions.

We obtained similar patterns when we defined monetary policy shocks in terms of the other two measures employed by CEE, namely innovations to nonborrowed reserves and to the ratio of nonborrowed to total reserves. Our results are also robust to defining monetary policy shocks as in Leeper and Zha (2001). We implemented a monthly version of their four-variable VAR (real GDP, the consumption deflator, the fed funds rate, and M2) with employment in place of real GDP. Identifying monetary policy shocks in this way, we found price and consumption responses no more consistent with the predictions of the sticky price model.

There are at least two interpretations of these results. One is that the sticky price model in section 3 is not a good description of how price stickiness mediates responses to exogenous monetary policy shocks. Another interpretation is that the measures of monetary policy shocks we are using are not orthogonal to persistent shocks to flexible vs. sticky price goods. In this latter interpretation, the responses we are estimating are a mixture of the effects of real shocks and the effects of monetary policy shocks.

Lastly, we examine how relative prices and consumptions across the 123 goods respond to an aggregate supply shock as measured by the rate of growth in TFP. Data are available to construct the quarterly growth rate for aggregate TFP.[17] We constructed a monthly series for TFP growth by interpolating monthly growth rates within each quarter, conditioning on monthly data on industrial production and hours.[18] Our series for TFP growth extends from April 1964 to June 2000. Consistent with prior work, the growth rate in TFP shows no statistically significant serial correlation. For this reason, we treat TFP's growth rate as a permanent innovation to productivity ($a$).

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[17] We construct quarterly TFP growth based on data on real GDP (from National Income and Products Accounts) aggregate hours (from various BLS measures of hours and employment) and the physical capital stock (Bureau of Economic Analysis data).

[18] More exactly, we require that relative growth rates of TFP within a quarter exhibit the same relation between growth rates in TFP and growth rates in industrial production and hours that we observe across quarterly data.

The estimated responses to a 1% TFP shock for relative prices and consumptions of flexible and sticky-price goods are presented in Figures 15 and 16. These estimated responses are extremely similar to those predicted by the model (Figure 4). The price of the flexibly priced good decreases by nearly 2% over the first several months, compared to about 1% for the model. Very similarly to the model prediction, this relative price effect gradually erodes in a little over a year. The shift in relative consumptions is smaller (on the order of 1%) and less statistically clear than that in prices. But it does qualitatively mirror the movement in relative prices as predicted by the model. Consistent with the model impulses, depicted in Figure 4, we also find a general drop in prices and increase in consumptions across goods in response to a favorable TFP shock. Unlike the model responses, these effects dissipate after about one year, with aggregate price and consumption returning to trend. This could reflect that the growth rate of TFP does not correspond well to the modeled notion of a permanent shock, at least at longer horizons. These longer-term responses might also reflect delayed responses in monetary or other policies to innovations in TFP.

## 4. Conclusions

We have exploited unpublished data from the BLS for 1995 to 1997 on the monthly frequency of price changes for 350 detailed categories of consumer goods and services. We find considerably more frequent price changes, and implicitly greater price flexibility, than found in previous studies of producer prices or consumer prices for a much narrower set of goods. More than half of the goods display expected durations of prices less than 5 months, and the mean duration is less than 4 months. In contrast, Taylor (1999, p.1020) summarized the prior literature as saying that price changes have an average frequency of about one year.

Although we find that factors related to market structure and competitiveness are highly correlated with a good's frequency of price changes, these variables become much less relevant if we control for factors related to market volatility, such as being an energy or raw food product or a good where new models are frequently introduced. This raises the question

of whether the finding in previous studies that less competitive markets display less frequent price changes, or less volatile prices, is robust to these factors.

We explored whether flexible-price goods and sticky-price goods differ in how they respond to aggregate inflation shocks. Goods with more frequent price changes displayed a sharp increase in price relative to sticky price goods after a positive innovation in the aggregate inflation rate, and a sharp fall in real consumption. The persistence of the responses made us question whether inflation impulses were divorced from important real relative shocks. We considered measures of monetary shocks based on movements in the federal funds rate, as well as nonborrowed reserves and the ratio of nonborrowed to total reserves. Relative prices and quantities responded very persistently to these monetary policy variables, in contrast to the transitory effects predicted by typical sticky-price models. We also examined how relative prices and consumptions across flexible and sticky-price goods respond to aggregate TFP shocks. These responses more closely resemble the predictions of sticky-price models.

We hope to clarify our results with additional work. First, we would like to obtain and exploit more detailed information on the distribution of price changes, beyond just the frequency of price changes. This would help to separate the importance of costs of price adjustment from market volatility in explaining the differences in price variability across goods. Second, in studying responses of prices and quantities across sectors, we hope to better isolate shocks that hit sectors equally in terms of long run desired price changes.

# Table 1

## The Frequency of Price Changes by Category

| Name | ELI | FREQ | MO. | WGT. | CDF |
|---|---|---|---|---|---|
| Weighted Statistics: Mean | | 25.4 | 3.9 | | |
| Median | | 21.1 | 4.7 | | |
| Standard Deviation | | 17.3 | 5.8 | | |
| Vehicle inspection | 52014 | 0.9 | 111.0 | 0.01 | 0.0 |
| Driver's license | 52013 | 1.1 | 89.9 | 0.05 | 0.1 |
| Coin-operated apparel laundry and drycleaning | 44012 | 1.3 | 75.9 | 0.17 | 0.3 |
| Coin-operated household laundry and drycleaning | 34045 | 1.3 | 74.2 | 0.02 | 0.3 |
| Local automobile registration | 52012 | 1.8 | 55.8 | 0.05 | 0.4 |
| Vehicle tolls | 52054 | 2.0 | 50.0 | 0.04 | 0.5 |
| Newspapers | 59011 | 2.1 | 47.9 | 0.38 | 1.0 |
| Automobile towing charges | 52055 | 2.2 | 45.8 | 0.01 | 1.0 |
| Parking fees | 52053 | 2.3 | 43.1 | 0.07 | 1.1 |
| Haircuts and other barber shop services for males | 65021 | 2.4 | 41.0 | 0.12 | 1.3 |
| Intracity mass transit | 53031 | 2.5 | 39.8 | 0.30 | 1.7 |
| Beauty parlor services for females | 65011 | 2.7 | 36.9 | 0.45 | 2.3 |
| State automobile registration | 52011 | 2.7 | 36.5 | 0.27 | 2.6 |
| Legal fees | 68011 | 3.1 | 31.9 | 0.50 | 3.3 |
| Safe deposit box rental | 68021 | 3.2 | 31.6 | 0.04 | 3.4 |
| Care of invalids, elderly and convalescents in the home | 34071 | 3.3 | 30.8 | 0.05 | 3.5 |
| Household laundry and drycleaning, excl coin-operated | 34044 | 3.3 | 30.6 | 0.10 | 3.7 |
| Water softening service | 34042 | 3.6 | 27.7 | 0.01 | 3.7 |
| Alterations and repairs | 44013 | 3.6 | 27.6 | 0.03 | 3.7 |
| Postage | 34011 | 3.6 | 27.5 | 0.25 | 4.1 |
| Repair of television, radio and sound equipment | 34061 | 3.9 | 25.8 | 0.09 | 4.2 |
| Domestic services | 34031 | 4.2 | 24.1 | 0.24 | 4.5 |
| Intrastate telephone services | 27061 | 4.4 | 22.6 | 0.23 | 4.8 |
| Services by other medical professionals | 56041 | 4.7 | 21.4 | 0.17 | 5.1 |
| Encyclopedias and other sets of reference books | 66022 | 4.8 | 21.0 | 0.05 | 5.2 |
| Shoe repair and other shoe services | 44011 | 4.8 | 20.8 | 0.03 | 5.2 |
| Garbage and trash collection | 27041 | 5.1 | 19.6 | 0.22 | 5.5 |
| Taxi fare | 53032 | 5.2 | 19.4 | 0.08 | 5.6 |
| Pet services | 62053 | 5.2 | 19.2 | 0.06 | 5.7 |
| Day care and nursery school | 67031 | 5.5 | 18.3 | 0.39 | 6.2 |
| Magazines | 59021 | 5.5 | 18.2 | 0.17 | 6.5 |
| Hearing aids | 55034 | 5.6 | 18.0 | 0.03 | 6.5 |
| Film processing | 62052 | 5.7 | 17.6 | 0.13 | 6.7 |
| Physicians' services | 56011 | 5.7 | 17.5 | 1.90 | 9.4 |
| Moving, storage, freight expense | 34043 | 6.0 | 16.6 | 0.10 | 9.5 |
| Technical and business school tuition and fixed fees | 67041 | 6.0 | 16.6 | 0.16 | 9.7 |
| Apparel laundry and drycleaning, excl coin-operated | 44021 | 6.1 | 16.5 | 0.29 | 10.1 |
| Tenants' insurance | 35011 | 6.1 | 16.5 | 0.03 | 10.2 |
| Other information processing equipment | 69015 | 6.1 | 16.3 | 0.001 | 10.2 |
| Watch and jewelry repair | 44015 | 6.2 | 16.1 | 0.01 | 10.2 |
| Dental services | 56021 | 6.5 | 15.4 | 1.11 | 11.8 |
| Photographic and darkroom supplies | 61022 | 6.6 | 15.1 | 0.002 | 11.8 |

# Table 1

## The Frequency of Price Changes by Category

| Name | ELI | FREQ | MO. | WGT. | CDF |
|---|---|---|---|---|---|
| Other entertainment services | 62055 | 6.7 | 14.8 | 0.23 | 12.1 |
| Veterinarian services | 62054 | 6.9 | 14.5 | 0.21 | 12.4 |
| Reupholstery of furniture | 34063 | 6.9 | 14.5 | 0.04 | 12.4 |
| Checking accounts and special check services | 68022 | 6.9 | 14.4 | 0.15 | 12.6 |
| Club membership dues and fees | 62011 | 7.1 | 14.0 | 0.35 | 13.1 |
| Plumbing supplies and equipment | 24015 | 7.3 | 13.7 | 0.00 | 13.1 |
| Gardening and lawn care services | 34041 | 7.4 | 13.5 | 0.15 | 13.4 |
| Fees for lessons or instructions | 62041 | 7.5 | 13.4 | 0.26 | 13.7 |
| Miscellaneous supplies and equipment | 24041 | 7.5 | 13.4 | 0.03 | 13.8 |
| Cemetery lots and cripts | 68032 | 7.5 | 13.3 | 0.11 | 13.9 |
| Residential water and sewer service | 27021 | 8.0 | 12.5 | 0.80 | 15.0 |
| Books not purchased through book clubs | 59023 | 8.0 | 12.4 | 0.16 | 15.2 |
| Coolant, brake fluid, transmission fluid, and additives | 47022 | 8.6 | 11.6 | 0.02 | 15.3 |
| Interstate telephone services | 27051 | 8.7 | 11.5 | 0.31 | 15.0 |
| Tax return preparation and other accounting fees | 68023 | 8.8 | 11.3 | 0.21 | 16.0 |
| Telephone services, local charges | 27011 | 8.9 | 11.3 | 1.12 | 17.6 |
| Eyeglasses and eyecare | 56031 | 9.3 | 10.7 | 0.34 | 18.0 |
| Admission to movies, theaters, and concerts | 62031 | 9.3 | 10.7 | 0.60 | 18.9 |
| Nursing and convalescent home care | 57022 | 9.5 | 10.5 | 0.15 | 19.1 |
| Plastic dinnerware | 32031 | 9.6 | 10.4 | 0.003 | 19.1 |
| Nonelectric articles for the hair | 64012 | 9.6 | 10.4 | 0.01 | 19.1 |
| Wine away from home | 20052 | 9.6 | 10.4 | 0.19 | 19.4 |
| Intercity train fare | 53022 | 9.7 | 10.3 | 0.07 | 19.5 |
| Beer, ale, and other alcoholic malt beverages away from home | 20051 | 10.0 | 10.0 | 0.31 | 19.9 |
| Photographer fees | 62051 | 10.2 | 9.8 | 0.04 | 19.9 |
| Vehicle parts and equipment other than tires | 48021 | 10.3 | 9.7 | 0.26 | 20.3 |
| Medical equipment for general use | 55032 | 10.4 | 9.6 | 0.01 | 20.3 |
| Power tools | 32042 | 10.6 | 9.4 | 0.04 | 20.4 |
| Clothing rental | 44014 | 10.7 | 9.4 | 0.02 | 20.4 |
| Inside home maintenance and repair services | 23011 | 10.9 | 9.2 | 0.11 | 20.5 |
| Tobacco products other than cigarettes | 63012 | 10.9 | 9.2 | 0.15 | 20.8 |
| Supportive and convalescent medical equipment | 55033 | 11.0 | 9.1 | 0.01 | 20.8 |
| Electrical supplies, heating and cooling equipment | 24016 | 11.1 | 9.0 | 0.004 | 20.8 |
| Tools and equipment for painting | 24012 | 11.1 | 9.0 | 0.003 | 20.8 |
| Repair of household appliances | 34062 | 11.1 | 9.0 | 0.05 | 20.9 |
| Fees for participant sports | 62021 | 11.3 | 8.9 | 0.40 | 21.4 |
| Nonpowered hand tools | 32044 | 11.4 | 8.7 | 0.03 | 21.5 |
| Distilled spirits away from home | 20053 | 11.5 | 8.7 | 0.26 | 21.8 |
| Cosmetics, bath/nail/make-up preparations and implements | 64031 | 11.6 | 8.6 | 0.26 | 22.2 |
| Books purchased through book clubs | 59022 | 11.8 | 8.5 | 0.03 | 22.2 |
| Hospital services | 57041 | 12.1 | 8.3 | 2.16 | 25.3 |
| Other hardware | 32043 | 12.1 | 8.3 | 0.03 | 25.3 |
| Automotive maintenance and servicing | 49031 | 12.1 | 8.3 | 0.49 | 26.0 |
| Kitchen and dining room linens | 28013 | 12.2 | 8.2 | 0.02 | 26.0 |
| Stationery, stationery supplies, giftwrap | 33032 | 12.2 | 8.2 | 0.18 | 26.3 |
| Records and tapes, prerecorded and blank | 31033 | 12.3 | 8.1 | 0.10 | 26.4 |
| Laundry and cleaning equipment | 32014 | 12.4 | 8.1 | 0.03 | 26.4 |

# Table 1

## The Frequency of Price Changes by Category

| Name | ELI | FREQ | MO. | WGT. | CDF |
|---|---|---|---|---|---|
| Videocassettes and discs, blank and prerecorded | 31022 | 12.4 | 8.0 | 0.02 | 26.5 |
| Film | 61021 | 12.6 | 7.9 | 0.06 | 26.6 |
| Purchase of pets, pet supplies, and accessories | 61032 | 12.8 | 7.8 | 0.11 | 26.7 |
| Breakfast or brunch | 19032 | 12.8 | 7.8 | 0.27 | 27.1 |
| Tableware and nonelectric kitchenware | 32038 | 12.9 | 7.7 | 0.07 | 27.2 |
| Electric personal care appliances | 64017 | 13.0 | 7.7 | 0.01 | 27.2 |
| Coal | 25022 | 13.4 | 7.5 | 0.03 | 27.2 |
| Deodorant/suntan preparations, sanitary/footcare products | 64016 | 13.4 | 7.4 | 0.08 | 27.4 |
| Calculators, adding machines, and typewriters | 69014 | 13.5 | 7.4 | 0.00 | 27.4 |
| Women's hosiery | 38043 | 13.6 | 7.4 | 0.10 | 27.5 |
| Sewing notions and patterns | 42012 | 13.7 | 7.3 | 0.01 | 27.5 |
| Topicals and dressings | 55031 | 13.8 | 7.3 | 0.08 | 27.6 |
| Lunch | 19011 | 13.8 | 7.2 | 2.10 | 30.6 |
| Paint, wallpaper and supplies | 24011 | 13.9 | 7.2 | 0.02 | 30.6 |
| Blacktop and masonry materials | 24014 | 14.0 | 7.1 | 0.001 | 30.6 |
| Dinner | 19021 | 14.1 | 7.1 | 2.51 | 34.1 |
| Internal and respiratory over-the-counter drugs | 55021 | 14.1 | 7.1 | 0.25 | 34.5 |
| Shaving products, nonelectric shaving articles | 64015 | 14.3 | 7.0 | 0.02 | 34.5 |
| Cigarettes | 63011 | 14.4 | 7.0 | 1.52 | 36.6 |
| Smoking accessories | 63013 | 14.7 | 6.8 | 0.02 | 36.7 |
| Toys, games and hobbies | 61011 | 14.7 | 6.8 | 0.30 | 37.1 |
| Snacks and nonalcoholic beverages | 19031 | 14.7 | 6.8 | 0.74 | 38.1 |
| Dental products, nonelectric dental articles | 64014 | 14.8 | 6.8 | 0.07 | 38.2 |
| Clocks | 32021 | 14.9 | 6.7 | 0.01 | 38.2 |
| Landscaping items | 24043 | 15.0 | 6.7 | 0.003 | 38.2 |
| Hard surface floor covering | 24042 | 15.0 | 6.7 | 0.01 | 38.2 |
| Infants' and toddlers' underwear | 41013 | 15.1 | 6.6 | 0.13 | 38.4 |
| Funeral expenses | 68031 | 15.2 | 6.6 | 0.29 | 38.8 |
| Unpowered boats and trailers | 60012 | 15.4 | 6.5 | 0.02 | 38.9 |
| Products for the hair | 64011 | 15.7 | 6.4 | 0.14 | 39.1 |
| Slipcovers and decorative pillows | 28015 | 15.7 | 6.4 | 0.01 | 39.1 |
| Floor coverings | 32011 | 16.0 | 6.2 | 0.06 | 39.2 |
| Automobile insurance | 50011 | 16.1 | 6.2 | 2.65 | 42.9 |
| Replacement of installed wall to wall carpet | 23013 | 16.3 | 6.1 | 0.02 | 42.9 |
| Candy and chewing gum | 15011 | 16.4 | 6.1 | 0.19 | 43.2 |
| Lawn and garden supplies | 33052 | 16.6 | 6.0 | 0.09 | 43.3 |
| Other laundry and cleaning products | 33012 | 16.8 | 6.0 | 0.15 | 43.5 |
| Infants' furniture | 29042 | 16.8 | 5.9 | 0.03 | 43.5 |
| Nonelectric cookingware | 32037 | 17.0 | 5.9 | 0.03 | 43.6 |
| Photographic equipment | 61023 | 17.1 | 5.8 | 0.05 | 43.7 |
| Truck rental | 52052 | 17.3 | 5.8 | 0.05 | 43.7 |
| Glassware | 32034 | 17.5 | 5.7 | 0.03 | 43.8 |
| Indoor, warm weather and winter sports equipment | 60021 | 17.5 | 5.7 | 0.16 | 44.0 |
| Miscellaneous household products | 33051 | 17.5 | 5.7 | 0.26 | 44.3 |
| Salt and other seasonings and spices | 18041 | 17.6 | 5.7 | 0.06 | 44.4 |
| Men's nightwear | 36032 | 17.8 | 5.6 | 0.02 | 44.5 |
| Prescription drugs and medical supplies | 54011 | 17.8 | 5.6 | 0.90 | 45.7 |

# Table 1

## The Frequency of Price Changes by Category

| Name | ELI | FREQ | MO. | WGT. | CDF |
|---|---|---|---|---|---|
| Hunting, fishing, and camping equipment | 60022 | 17.9 | 5.6 | 0.05 | 45.8 |
| Household decorative items | 32023 | 18.0 | 5.6 | 0.16 | 46.0 |
| Infants' equipment | 32013 | 18.0 | 5.6 | 0.01 | 46.0 |
| Fabric for making clothes | 42011 | 18.1 | 5.5 | 0.04 | 46.1 |
| Computer software and accessories | 69012 | 18.2 | 5.5 | 0.01 | 46.1 |
| Boys' underwear, nightwear and hosiery | 37014 | 18.2 | 5.5 | 0.02 | 46.1 |
| Pet food | 61031 | 18.4 | 5.4 | 0.21 | 46.4 |
| Music instruments and accessories | 61013 | 18.4 | 5.4 | 0.06 | 46.5 |
| Indoor plants and fresh cut flowers | 32061 | 18.6 | 5.4 | 0.15 | 46.7 |
| Lamps and lighting fixtures | 32022 | 18.7 | 5.3 | 0.05 | 46.8 |
| Men's underwear and hosiery | 36031 | 18.8 | 5.3 | 0.08 | 46.9 |
| Sewing materials for household items | 28016 | 19.0 | 5.3 | 0.05 | 47.0 |
| Automotive brake work | 49022 | 19.0 | 5.3 | 0.12 | 47.1 |
| Boys' accessories | 37015 | 19.3 | 5.2 | 0.02 | 47.2 |
| Repair to steering, front end, cooling system and air conditioning | 49023 | 19.4 | 5.1 | 0.15 | 47.4 |
| Elementary and high school books and supplies | 66021 | 19.7 | 5.1 | 0.02 | 47.4 |
| Men's accessories | 36033 | 19.7 | 5.1 | 0.08 | 47.5 |
| Community antenna or cable TV | 27031 | 19.9 | 5.0 | 0.58 | 48.3 |
| Soaps and detergents | 33011 | 20.0 | 5.0 | 0.23 | 48.6 |
| Other condiments (excl olives, pickles, relishes) | 18044 | 20.1 | 5.0 | 0.05 | 48.7 |
| Rolls, biscuits, muffins (excl frozen) | 2022 | 20.1 | 5.0 | 0.10 | 48.9 |
| Telephone, peripheral equipment and accessories | 69013 | 20.1 | 5.0 | 0.01 | 48.9 |
| Automotive drive train repair | 49021 | 20.2 | 5.0 | 0.18 | 49.1 |
| Portable cool/heat equipment, small electric kitchen appliances | 32052 | 20.2 | 5.0 | 0.07 | 49.2 |
| Bicycles | 60013 | 20.3 | 4.9 | 0.04 | 49.3 |
| Watches | 43011 | 20.3 | 4.9 | 0.08 | 49.4 |
| Sweet rolls, coffee cake and doughnuts (excl frozen) | 2063 | 20.6 | 4.9 | 0.07 | 49.5 |
| Living room tables | 29032 | 20.7 | 4.8 | 0.06 | 49.6 |
| Flatware | 32033 | 20.7 | 4.8 | 0.03 | 49.6 |
| Canned ham | 4032 | 20.7 | 4.8 | 0.01 | 49.6 |
| Tires | 48011 | 20.8 | 4.8 | 0.26 | 50.0 |
| Automotive body work | 49011 | 20.8 | 4.8 | 0.17 | 50.2 |
| Distilled spirits at home (excl whiskey) | 20022 | 20.8 | 4.8 | 0.12 | 50.4 |
| Baby food | 18062 | 20.9 | 4.8 | 0.06 | 50.5 |
| Cakes and cupcakes (excl frozen) | 2041 | 21.0 | 4.8 | 0.10 | 50.6 |
| Window coverings | 32012 | 21.0 | 4.8 | 0.06 | 50.7 |
| Nondairy cream substitutes | 16013 | 21.0 | 4.8 | 0.03 | 50.7 |
| Tea | 17052 | 21.0 | 4.8 | 0.04 | 50.8 |
| Other noncarbonated drinks | 17053 | 21.1 | 4.7 | 0.05 | 50.9 |
| China and other dinnerware | 32032 | 21.4 | 4.7 | 0.04 | 50.9 |
| Serving pieces other than silver or glass | 32036 | 21.5 | 4.6 | 0.01 | 50.9 |
| Nuts | 18032 | 21.6 | 4.6 | 0.04 | 51.0 |
| Automotive power plant repair | 49041 | 21.9 | 4.6 | 0.41 | 51.6 |
| Outboard motors and powered sports vehicles | 60011 | 22.1 | 4.5 | 0.13 | 51.7 |
| Intercity bus fare | 53021 | 22.4 | 4.5 | 0.02 | 51.8 |
| Other sweets (excl candy and gum) | 15012 | 22.5 | 4.4 | 0.06 | 51.9 |
| Occasional furniture | 29044 | 22.6 | 4.4 | 0.12 | 52.0 |

# Table 1

## The Frequency of Price Changes by Category

| Name | ELI | FREQ | MO. | WGT. | CDF |
|---|---|---|---|---|---|
| Bedroom furniture other than mattress and springs | 29012 | 22.6 | 4.4 | 0.20 | 52.3 |
| Girls' hosiery and accessories | 39017 | 22.7 | 4.4 | 0.05 | 52.4 |
| Sugar and artificial sweeteners | 15021 | 22.9 | 4.4 | 0.09 | 52.5 |
| Men's footwear | 40011 | 23.4 | 4.3 | 0.22 | 52.8 |
| Mattress and springs | 29011 | 23.5 | 4.3 | 0.16 | 53.0 |
| Women's underwear | 38042 | 23.6 | 4.2 | 0.09 | 53.2 |
| Portable dishwashers | 30033 | 23.8 | 4.2 | 0.002 | 53.2 |
| Bathroom linens | 28011 | 23.8 | 4.2 | 0.06 | 53.2 |
| Lumber, paneling, wall and ceiling tile, awnings, glass | 24013 | 23.9 | 4.2 | 0.01 | 53.3 |
| Admission to sporting events | 62032 | 24.0 | 4.2 | 0.13 | 53.4 |
| Girls' underwear and nightwear | 39016 | 24.2 | 4.1 | 0.04 | 53.5 |
| Instant and freeze dried coffee | 17032 | 24.3 | 4.1 | 0.11 | 53.6 |
| New motorcycles | 45031 | 24.3 | 4.1 | 0.09 | 53.8 |
| College textbooks | 66011 | 24.3 | 4.1 | 0.19 | 54.0 |
| Girls' footwear | 40022 | 24.5 | 4.1 | 0.08 | 54.2 |
| Other processed vegetables | 14023 | 24.6 | 4.1 | 0.13 | 54.3 |
| Motor oil | 47021 | 24.7 | 4.0 | 0.04 | 54.4 |
| Lawn and garden equipment | 32041 | 24.8 | 4.0 | 0.09 | 54.5 |
| Outdoor equipment | 32015 | 24.8 | 4.0 | 0.01 | 54.5 |
| Canned and dried fruits | 13031 | 24.9 | 4.0 | 0.08 | 54.6 |
| Whiskey at home | 20021 | 24.9 | 4.0 | 0.09 | 54.7 |
| Noncarbonated fruit flavored drinks | 17051 | 25.0 | 4.0 | 0.05 | 54.8 |
| Cleansing and toilet tissue, paper towels, napkins | 33031 | 25.0 | 4.0 | 0.19 | 55.1 |
| Jewelry | 43021 | 25.2 | 4.0 | 0.32 | 55.5 |
| Other fats and oils | 16012 | 25.3 | 4.0 | 0.14 | 55.7 |
| Macaroni and cornmeal | 1032 | 25.5 | 3.9 | 0.05 | 55.8 |
| Cereal | 1021 | 25.5 | 3.9 | 0.27 | 56.2 |
| Curtains and drapes | 28014 | 25.6 | 3.9 | 0.05 | 56.3 |
| Pies, tarts, turnovers (excl frozen) | 2065 | 25.6 | 3.9 | 0.04 | 56.3 |
| White bread | 2011 | 25.7 | 3.9 | 0.26 | 56.7 |
| Kitchen and dining room furniture | 29041 | 25.8 | 3.9 | 0.15 | 56.9 |
| Canned beans other than lima beans | 14021 | 25.8 | 3.9 | 0.02 | 56.9 |
| Sofas | 29021 | 26.2 | 3.8 | 0.23 | 57.2 |
| Canned and packaged soup | 18011 | 26.3 | 3.8 | 0.10 | 57.4 |
| Lamb, organ meats, and game | 5014 | 26.4 | 3.8 | 0.03 | 57.4 |
| Rice | 1031 | 26.5 | 3.8 | 0.05 | 57.5 |
| Lodging while out of town | 21021 | 26.6 | 3.8 | 2.09 | 60.4 |
| Canned or packaged salads and desserts | 18061 | 26.6 | 3.8 | 0.03 | 60.4 |
| Other dairy products | 10012 | 26.9 | 3.7 | 0.07 | 60.5 |
| Radio, phonographs and taperecorders/players | 31031 | 26.9 | 3.7 | 0.02 | 60.6 |
| Prepared Flour Mixes | 1012 | 27.1 | 3.7 | 0.05 | 60.7 |
| Other frozen fruits and fruit juices | 13012 | 27.1 | 3.7 | 0.02 | 60.7 |
| Canned fish or seafood | 7011 | 27.4 | 3.7 | 0.07 | 60.8 |
| Women's accessories | 38044 | 27.4 | 3.7 | 0.07 | 60.9 |
| Boys' suits, sportcoats, and pants | 37016 | 27.6 | 3.6 | 0.08 | 61.0 |
| Sauces and gravies | 18043 | 27.6 | 3.6 | 0.14 | 61.2 |
| Margarine | 16011 | 27.9 | 3.6 | 0.04 | 61.2 |

# Table 1

## The Frequency of Price Changes by Category

| Name | ELI | FREQ | MO. | WGT. | CDF |
|---|---|---|---|---|---|
| Men's suits | 36011 | 27.9 | 3.6 | 0.19 | 61.5 |
| Bologna, liverwurst, salami | 5012 | 28.0 | 3.6 | 0.09 | 61.6 |
| Housing at school, excl board | 21031 | 28.0 | 3.6 | 0.24 | 62.0 |
| Bedroom linens | 28012 | 28.0 | 3.6 | 0.13 | 62.2 |
| Men's pants and shorts | 36051 | 28.0 | 3.6 | 0.21 | 62.5 |
| Video game hardware, software and accessories | 31023 | 28.1 | 3.6 | 0.01 | 62.5 |
| Other canned or packaged foods | 18063 | 28.1 | 3.6 | 0.18 | 62.7 |
| Olives, pickles, relishes | 18042 | 28.1 | 3.6 | 0.03 | 62.8 |
| Living room chairs | 29031 | 28.4 | 3.5 | 0.12 | 62.9 |
| Lunchmeats | 5013 | 28.7 | 3.5 | 0.18 | 63.2 |
| Wine at home | 20031 | 29.1 | 3.4 | 0.19 | 63.4 |
| Potato chips and other snacks | 18031 | 29.1 | 3.4 | 0.17 | 63.7 |
| Dryers | 30022 | 29.3 | 3.4 | 0.04 | 63.7 |
| Ship fares | 53023 | 29.4 | 3.4 | 0.05 | 63.8 |
| Bread other than white | 2021 | 29.7 | 3.4 | 0.14 | 64.0 |
| Women's footwear | 40031 | 29.7 | 3.4 | 0.34 | 64.5 |
| Automobile finance charges | 51011 | 29.8 | 3.4 | 0.57 | 65.3 |
| Infants' and toddlers' sleepwear | 41014 | 29.8 | 3.4 | 0.02 | 65.3 |
| Elementary and high school tuition and fixed fees | 67021 | 30.0 | 3.3 | 0.52 | 66.0 |
| Frozen bakery products & frozen/refrigerated doughs & batters | 2064 | 30.3 | 3.3 | 0.06 | 66.1 |
| Microwave ovens | 30032 | 30.4 | 3.3 | 0.04 | 66.2 |
| Frozen vegetables | 14011 | 31.0 | 3.2 | 0.09 | 66.3 |
| Peanut butter | 16014 | 31.0 | 3.2 | 0.04 | 66.3 |
| Floor covering equipment and sewing machines | 32051 | 31.2 | 3.2 | 0.04 | 66.4 |
| Beer, ale, and other alcoholic malt | 20011 | 31.3 | 3.2 | 0.42 | 67.0 |
| College tuition and fixed fees | 67011 | 31.3 | 3.2 | 1.69 | 69.3 |
| Ice cream and related products | 10041 | 31.4 | 3.2 | 0.16 | 69.6 |
| Bread and cracker products | 2062 | 31.5 | 3.2 | 0.01 | 69.6 |
| Boys' footwear | 40021 | 31.6 | 3.2 | 0.08 | 69.7 |
| Other fresh milk and cream | 9021 | 31.6 | 3.2 | 0.26 | 70.0 |
| Flour | 1011 | 31.7 | 3.2 | 0.02 | 70.1 |
| Bottled or tank gas | 25021 | 31.7 | 3.2 | 0.08 | 70.2 |
| Canned cut corn | 14022 | 31.9 | 3.1 | 0.02 | 70.2 |
| Window air conditioners | 30034 | 31.9 | 3.1 | 0.02 | 70.2 |
| Men's sportcoats and tailored jackets | 36012 | 32.1 | 3.1 | 0.03 | 70.3 |
| Outdoor furniture | 29043 | 32.2 | 3.1 | 0.03 | 70.3 |
| Videocassette recorders, disc players, cameras and accessories | 31021 | 32.3 | 3.1 | 0.04 | 70.4 |
| Carbonated drinks other than cola | 17012 | 32.4 | 3.1 | 0.14 | 70.6 |
| Men's coats and jackets | 36013 | 32.4 | 3.1 | 0.09 | 70.7 |
| Televisions | 31011 | 32.8 | 3.1 | 0.13 | 70.9 |
| Cheese | 10021 | 32.9 | 3.0 | 0.34 | 71.3 |
| Women's pants and shorts | 38033 | 33.0 | 3.0 | 0.35 | 71.8 |
| Luggage | 42013 | 33.3 | 3.0 | 0.04 | 71.9 |
| Stoves and ovens excluding microwave ovens | 30031 | 33.6 | 3.0 | 0.04 | 71.9 |
| Men's shirts | 36041 | 33.6 | 3.0 | 0.27 | 72.3 |
| Cookies | 2042 | 33.7 | 3.0 | 0.15 | 72.5 |
| Fresh, canned, or bottled fruit juices | 13013 | 33.7 | 3.0 | 0.20 | 72.8 |

# Table 1

## The Frequency of Price Changes by Category

| Name | ELI | FREQ | MO. | WGT. | CDF |
|---|---|---|---|---|---|
| Girls' skirts and pants | 39014 | 34.1 | 2.9 | 0.09 | 72.9 |
| Frozen orange juice | 13011 | 34.4 | 2.9 | 0.05 | 73.0 |
| Fresh whole milk | 9011 | 34.4 | 2.9 | 0.35 | 73.5 |
| Diesel | 47017 | 34.5 | 2.9 | 0.23 | 73.8 |
| Refrigerators and home freezers | 30011 | 34.9 | 2.9 | 0.08 | 73.9 |
| Components and other sound equipment | 31032 | 35.4 | 2.8 | 0.08 | 74.0 |
| Other poultry | 6031 | 36.0 | 2.8 | 0.09 | 74.1 |
| Frankfurters | 5011 | 36.1 | 2.8 | 0.09 | 74.3 |
| Other beef | 3043 | 36.4 | 2.8 | 0.08 | 74.4 |
| Frozen prepared foods other than meals | 18022 | 36.5 | 2.7 | 0.11 | 74.5 |
| Infants' and toddlers' play and dresswear | 41012 | 36.8 | 2.7 | 0.04 | 74.6 |
| Shellfish (excl canned) | 7021 | 37.0 | 2.7 | 0.09 | 74.7 |
| Roasted coffee | 17031 | 37.1 | 2.7 | 0.15 | 74.9 |
| Washers | 30021 | 37.1 | 2.7 | 0.06 | 75.0 |
| Frozen prepared meals | 18021 | 37.4 | 2.7 | 0.06 | 75.1 |
| Boys' shirts | 37013 | 37.5 | 2.7 | 0.07 | 75.2 |
| Pork sausage | 4042 | 37.9 | 2.6 | 0.09 | 75.3 |
| Playground equipment | 61012 | 37.9 | 2.6 | 0.001 | 75.3 |
| Infants' and toddlers' outerwear | 41011 | 38.3 | 2.6 | 0.004 | 75.3 |
| Cola drinks | 17011 | 38.8 | 2.6 | 0.21 | 75.6 |
| New trucks | 45021 | 39.3 | 2.5 | 0.89 | 76.9 |
| Fresh whole chicken | 6011 | 39.4 | 2.5 | 0.15 | 77.1 |
| Men's active sportswear | 36035 | 39.8 | 2.5 | 0.04 | 77.1 |
| Personal computers and peripheral equipment | 69011 | 40.6 | 2.5 | 0.04 | 77.2 |
| Fresh or frozen chicken parts | 6021 | 40.7 | 2.5 | 0.21 | 77.5 |
| New cars | 45011 | 41.0 | 2.4 | 3.84 | 82.9 |
| Apples | 11011 | 41.4 | 2.4 | 0.12 | 83.0 |
| Women's coats and jackets | 38011 | 41.5 | 2.4 | 0.18 | 83.3 |
| Women's nightwear | 38041 | 42.1 | 2.4 | 0.07 | 83.4 |
| Other roast (excl chuck and round) | 3041 | 42.2 | 2.4 | 0.05 | 83.4 |
| Automobile rental | 52051 | 42.3 | 2.4 | 0.21 | 83.7 |
| Fish (excl canned) | 7022 | 42.4 | 2.4 | 0.21 | 84.0 |
| Crackers | 2061 | 42.5 | 2.4 | 0.11 | 84.2 |
| Bananas | 11021 | 43.0 | 2.3 | 0.07 | 84.3 |
| Electricity | 26011 | 43.4 | 2.3 | 2.27 | 87.5 |
| Bacon | 4011 | 43.5 | 2.3 | 0.11 | 87.6 |
| Women's active sportswear | 38034 | 44.6 | 2.2 | 0.07 | 87.7 |
| Girls' tops | 39013 | 45.2 | 2.2 | 0.06 | 87.8 |
| Butter | 10011 | 45.5 | 2.2 | 0.04 | 87.8 |
| Ground beef | 3011 | 46.1 | 2.2 | 0.31 | 88.3 |
| Men's sweaters | 36034 | 46.7 | 2.1 | 0.04 | 88.3 |
| Pork roast, picnics, other pork | 4041 | 46.8 | 2.1 | 0.12 | 88.5 |
| Other steak (excl round and sirloin) | 3042 | 46.8 | 2.1 | 0.22 | 88.8 |
| Other motor fuel | 47018 | 47.1 | 2.1 | 0.02 | 88.8 |
| Boys' coats and jackets | 37011 | 47.2 | 2.1 | 0.02 | 88.8 |
| Potatoes | 12011 | 47.3 | 2.1 | 0.10 | 89.0 |
| Women's tops | 38031 | 47.3 | 2.1 | 0.36 | 89.5 |

# Table 1

## The Frequency of Price Changes by Category

| Name | ELI | FREQ | MO. | WGT. | CDF |
|---|---|---|---|---|---|
| Boys' sweaters | 37012 | 47.6 | 2.1 | 0.01 | 89.5 |
| Pork chops | 4021 | 47.9 | 2.1 | 0.14 | 89.7 |
| Round steak | 3051 | 48.2 | 2.1 | 0.08 | 89.8 |
| Sirloin steak | 3061 | 48.4 | 2.1 | 0.07 | 89.9 |
| Girls' active sportswear | 39015 | 48.5 | 2.1 | 0.02 | 89.9 |
| Women's suits | 38051 | 49.0 | 2.0 | 0.17 | 90.2 |
| Girls' coats and jackets | 39011 | 49.2 | 2.0 | 0.01 | 90.2 |
| Women's skirts | 38032 | 50.1 | 2.0 | 0.05 | 90.2 |
| Boys' active sportswear | 37017 | 50.4 | 2.0 | 0.02 | 90.3 |
| Ham (excl canned) | 4031 | 50.4 | 2.0 | 0.13 | 90.5 |
| Women's dresses | 38021 | 50.8 | 2.0 | 0.25 | 90.8 |
| Fuel oil | 25011 | 52.5 | 1.9 | 0.25 | 91.2 |
| Other fresh vegetables | 12041 | 52.8 | 1.9 | 0.34 | 91.6 |
| Round roast | 3031 | 53.1 | 1.9 | 0.05 | 91.7 |
| Chuck roast | 3021 | 54.3 | 1.8 | 0.08 | 91.8 |
| Oranges | 11031 | 54.7 | 1.8 | 0.08 | 91.9 |
| Girls' dresses and suits | 39012 | 58.4 | 1.7 | 0.04 | 92.0 |
| Other fresh fruits | 11041 | 59.7 | 1.7 | 0.47 | 92.7 |
| Eggs | 8011 | 61.8 | 1.6 | 0.19 | 92.9 |
| Premium unleaded gasoline | 47016 | 62.3 | 1.6 | 0.91 | 94.2 |
| Lettuce | 12021 | 62.4 | 1.6 | 0.08 | 94.3 |
| Mid-grade unleaded gasoline | 47015 | 63.9 | 1.6 | 0.83 | 95.5 |
| Utility natural gas service | 26021 | 64.2 | 1.6 | 1.14 | 97.1 |
| Regular unleaded gasoline | 47014 | 65.6 | 1.5 | 0.94 | 98.4 |
| Airline fares | 53011 | 70.4 | 1.4 | 1.04 | 99.8 |
| Tomatoes | 12031 | 71.0 | 1.4 | 0.12 | 100.0 |

**ELI** = Entry Level Item in the CPI (each of which contains 4-5 items priced in each geographic area).

**FREQ** = the estimated average monthly frequency of price changes over 1995-1997.

**MO.** = mean duration between price changes implied by FREQ = 1/FREQ.

**WGT.** = Relative importance in the December 1997 CPI (these sum to 71.2).

**CDF** = cumulative distribution function of FREQ within the share of the CPI covered.

Data Source: U.S. Department of Labor (1997).

# Table 2

Monthly Frequency of Price Changes for Selected Categories

| | % of Price Quotes with Price Changes | % of Price Quotes with Price Changes *Net* of the Item Substitution % |
|---|---|---|
| **All goods and services** | 25.4 (0.9) | 22.3 (0.9) |
| **Durable Goods** | 31.5 (2.5) | 23.1 (2.5) |
| **Nondurable Goods** | 29.0 (1.3) | 25.9 (1.3) |
| **Services** | 19.8 (1.4) | 18.2 (1.4) |
| **Food** | 27.8 (1.7) | 25.8 (1.7) |
| **Home Furnishings** | 25.8 (1.8) | 23.6 (1.8) |
| **Apparel** | 30.0 (3.0) | 20.8 (3.0) |
| **Transportation** | 36.3 (1.8) | 31.1 (1.8) |
| **Medical Care** | 8.8 (2.8) | 7.6 (2.8) |
| **Entertainment** | 11.7 (3.6) | 8.9 (3.7) |
| **Other** | 16.7 (2.6) | 15.1 (2.6) |
| **Raw Goods** | 50.2 (1.7) | 49.1 (1.5) |
| **Processed Goods** | 20.4 (0.8) | 16.8 (0.7) |

Notes: Frequencies are weighted means of category components. Standard errors are in parentheses. Durables, Nondurables and Services coincide with U.S. National Income and Product Account classifications. Housing (reduced to home furnishings in our data), apparel, transportation, medical care, entertainment, and other are BLS Expenditure Classes for the CPI. Raw goods gasoline, motor oil, fuel oils, natural gas, meats, fresh fruits, fresh and frozen vegetables, dairy products and frozen fruit juices.

Data Source: U.S. Department of Labor (1997).

# Table 3

## Predicting Price Changes Across Goods

Dependent Variable = Frequency of Price Changes across ELIs

| **Regressors** ↓ | **(1)** | **(2)** | **(3)** | **(4)** |
|---|---|---|---|---|
| 4-firm Concentration Ratio | -0.26<br>(.036) | -0.32<br>(.033) | -0.03<br>(.036) | |
| Wholesale Markup | | -0.92<br>(.105) | 0.02<br>(.116) | |
| Noncomparable Substitution Rate | | 1.83<br>(.273) | 2.52<br>(.223) | 2.92<br>(.270) |
| Raw Good | | | 28.3<br>(2.43) | 33.9<br>(1.68) |
| Adjusted $R^2$ | 0.18 | 0.40 | 0.63 | 0.56 |
| Number of goods (ELIs) | 232 | 222 | 222 | 350 |

Notes: Each regression is weighted by the importance of the ELI in the December 1997 CPI. Standard errors are in parentheses.

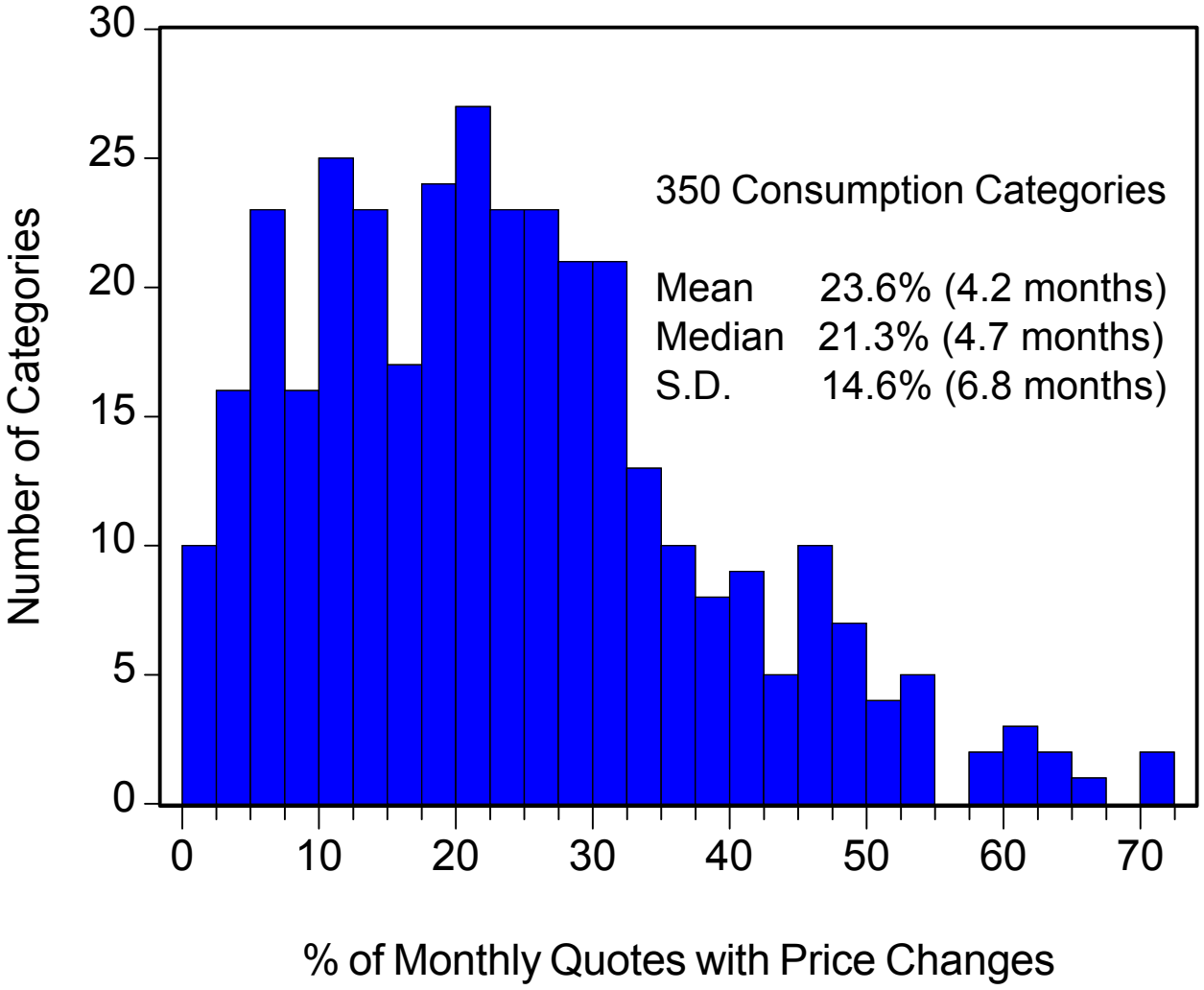
# Table 4

## Correlations (across goods) between the Frequency of Price Changes and the Persistence and Volatility of Prices and Consumption

| Variable ↓ | Without Controls for Market Volatility | With Controls for: Raw vs. Processed, Product Turnover |
|---|---|---|
| **Prices** | | |
| Std. Dev. of Monthly Growth Rate | .50 (.00) | .40 (.00) |
| Std. Dev. of Annual Growth Rate | .45 (.00) | .31 (.00) |
| AR(1) Coef. for the Monthly Growth Rate | −.11 (.22) | −.17 (.06) |
| Std. Dev. of Innovation to Growth Rate | .52 (.00) | .40 (.00) |
| **Consumption** | | |
| Std. Dev. of Monthly Growth Rate | .41 (.00) | .10 (.26) |
| Std. Dev. of Annual Growth Rate | .27 (.00) | .06 (.51) |
| AR(1) Coef. for the Monthly Growth Rate | −.34 (.00) | −.12 (.20) |
| Std. Dev. of Innovation to Growth Rate | .40 (.00) | .10 (.29) |

Notes: For both consumer deflators and real consumption the sample period is 1959:M1 to 2000:M6. We have price and consumption time series for 123 categories covering 67.3% of the 1997 CPI (vs. the 71.4% non-housing CPI for which we have frequencies of price changes). All statistics are conditional on 12 monthly seasonals. p-values are in parentheses.

# Figure 1


30
25
20
15
10
5
0
Number of Categories
350 Consumption Categories
Mean 23.6% (4.2 months)
Median 21.3% (4.7 months)
S.D. 14.6% (6.8 months)
0
10
20
30
40
50
60
70
% of Monthly Quotes with Price Changes

# Figure 2

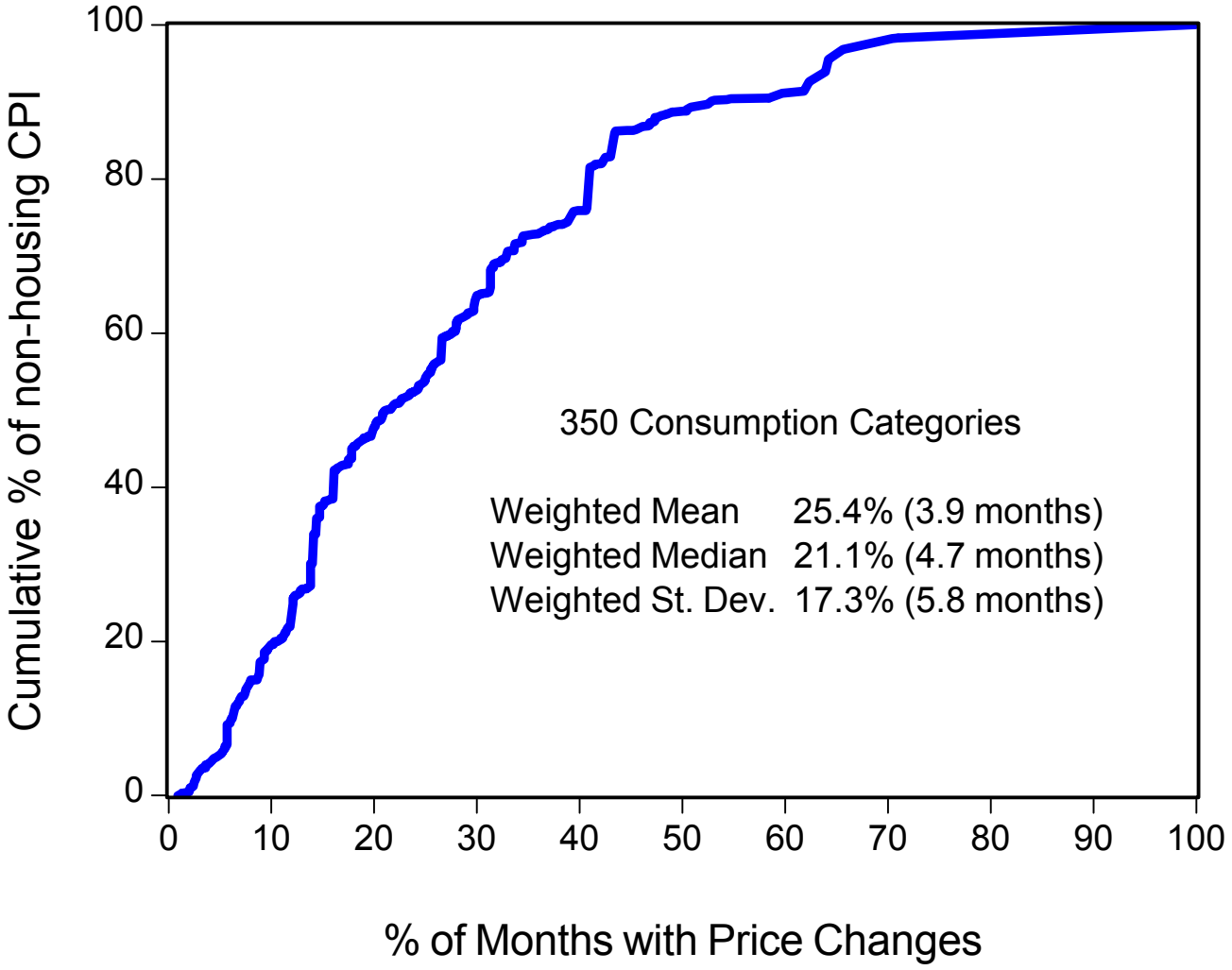

Cumulative % of non-housing CPI
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
90
100
% of Months with Price Changes
350 Consumption Categories
Weighted Mean 25.4% (3.9 months)
Weighted Median 21.1% (4.7 months)
Weighted St. Dev. 17.3% (5.8 months)

Figure 3
% responses to a 1% money supply shock (persistence of money growth is $\rho_m = 0$)

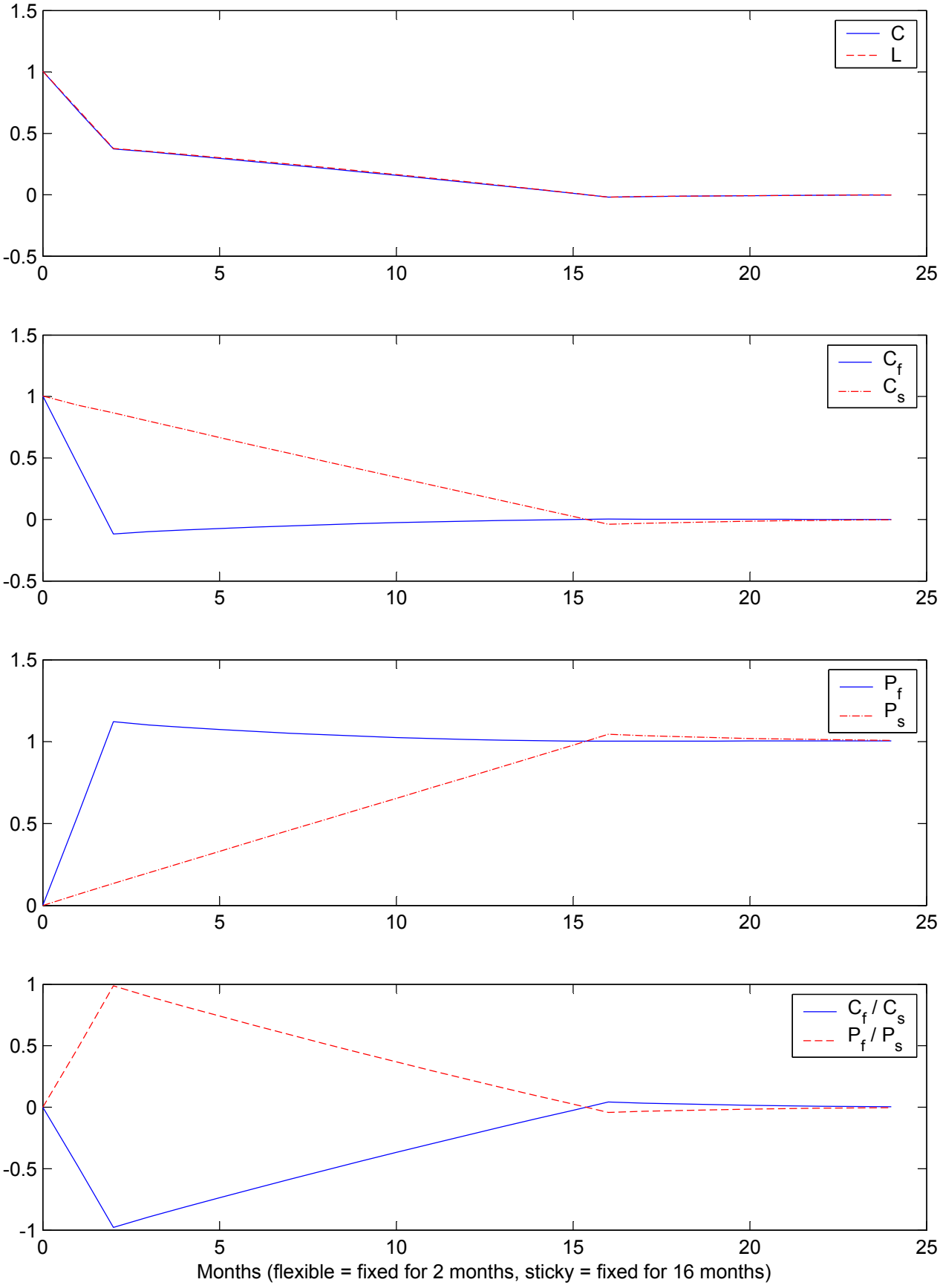


Figure 4
% responses to a 1% productivity shock (persistence is $\rho_a = 1$)

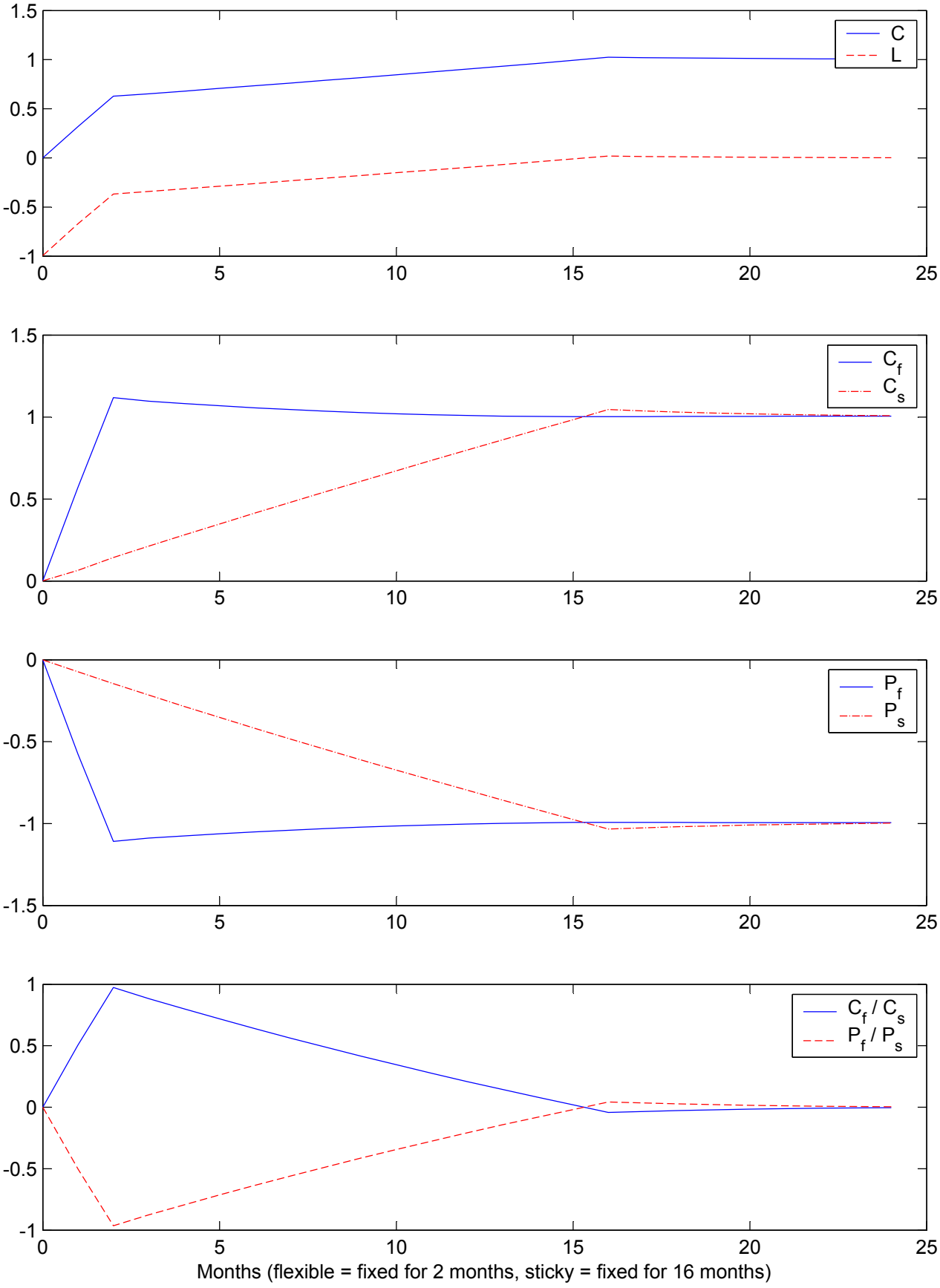


**Figure 5**
**Response of the CPI to a 1% CPI Impulse**

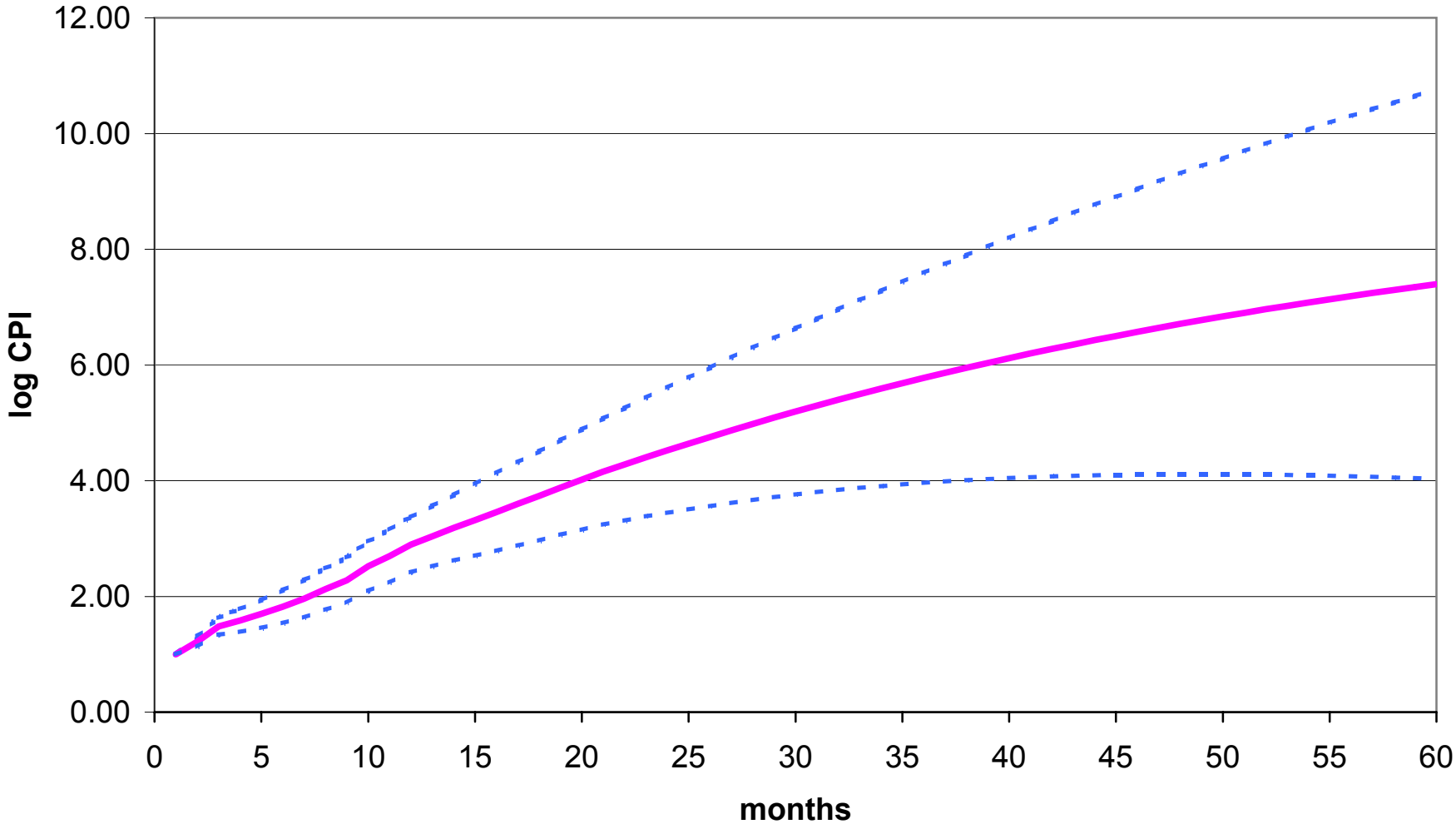


**Figure 6**
**Response of Relative Prices to a 1% CPI Impulse**

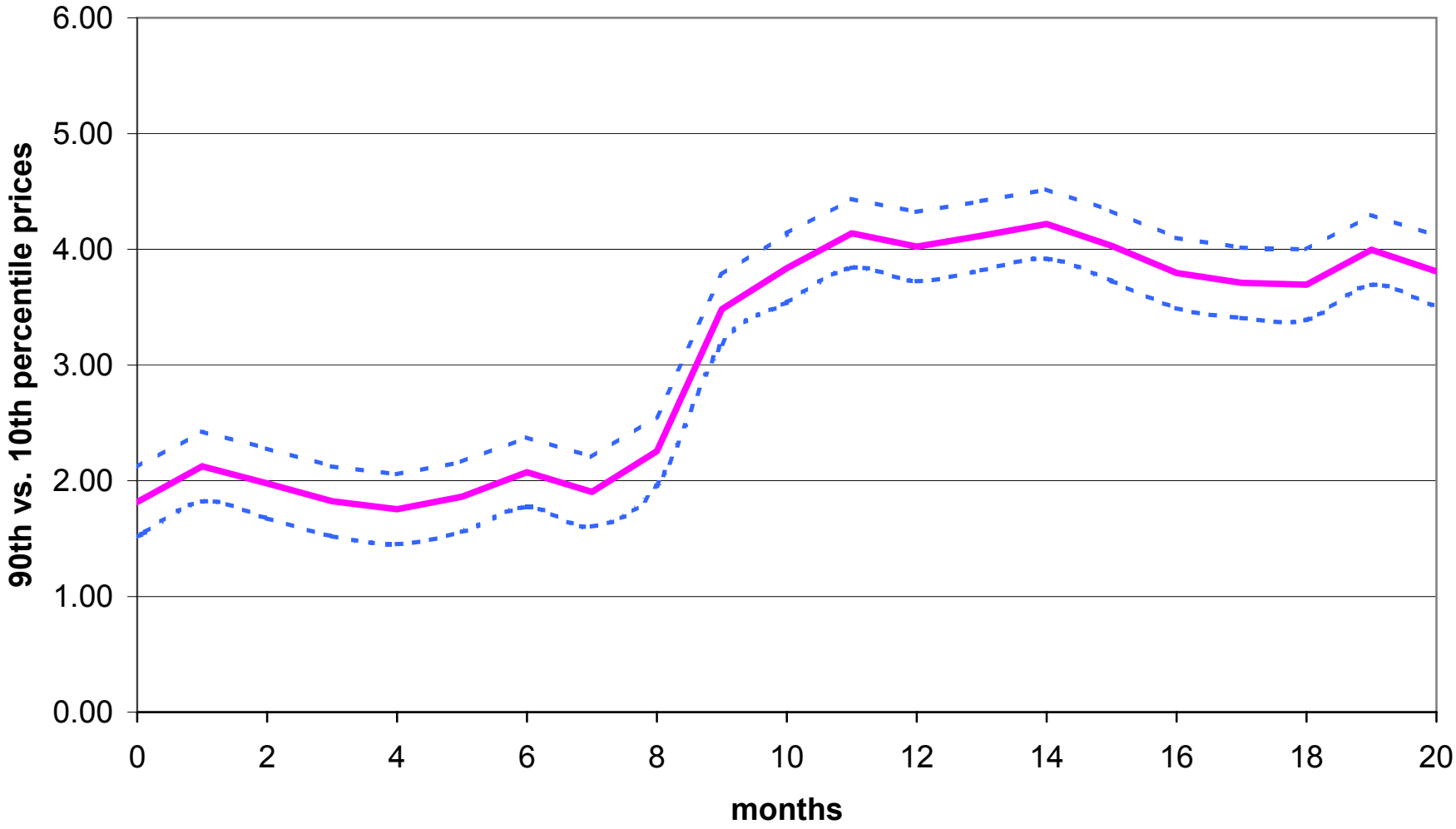


**Figure 7**

**Response of Relative Real Consumption to a 1% CPI Impulse**

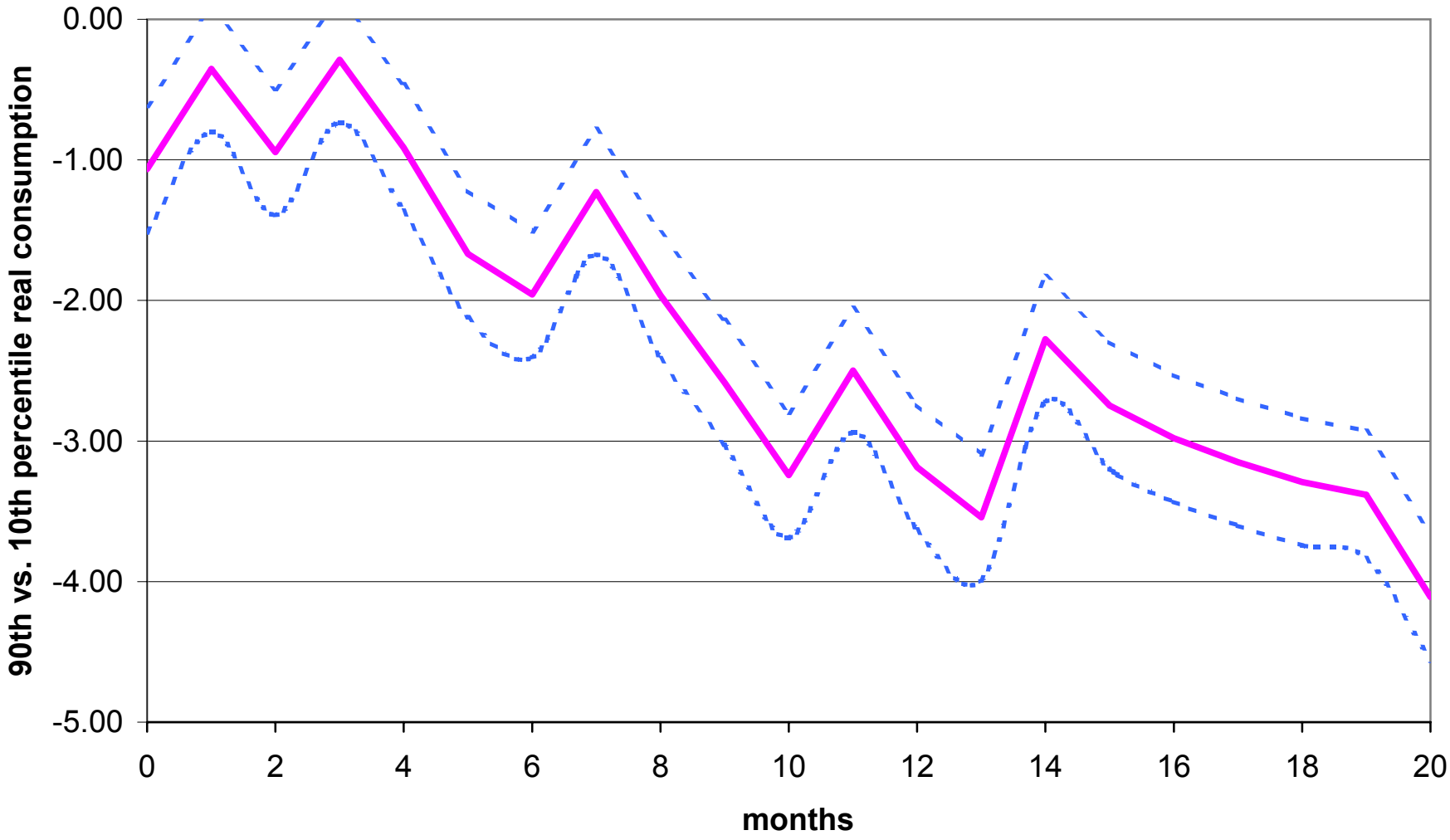


**Figure 8**

**Response of Prices to a 1% CPI Impulse**

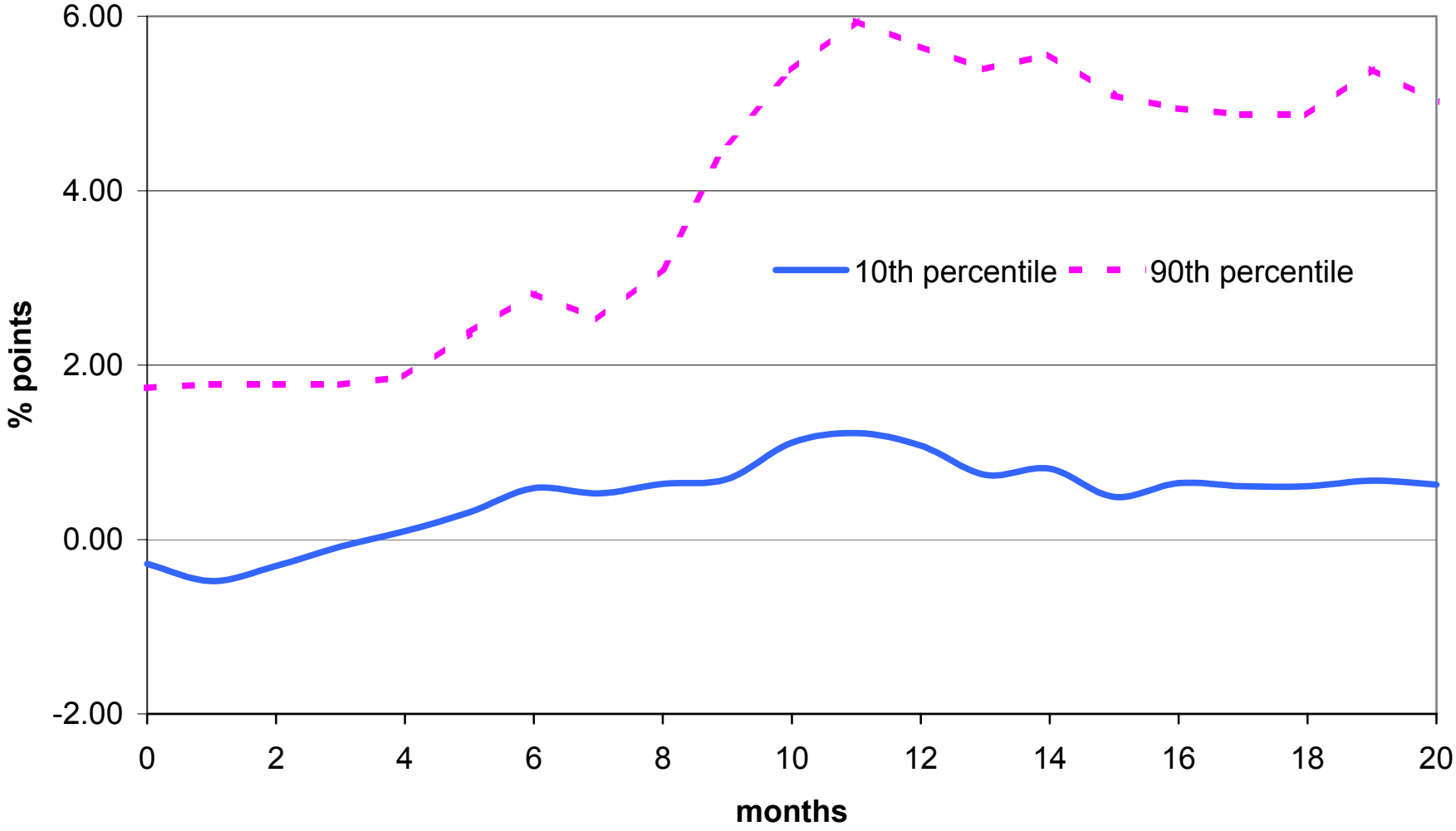


**Figure 9**

**Response of Real Consumption Levels to a 1% CPI Impulse**

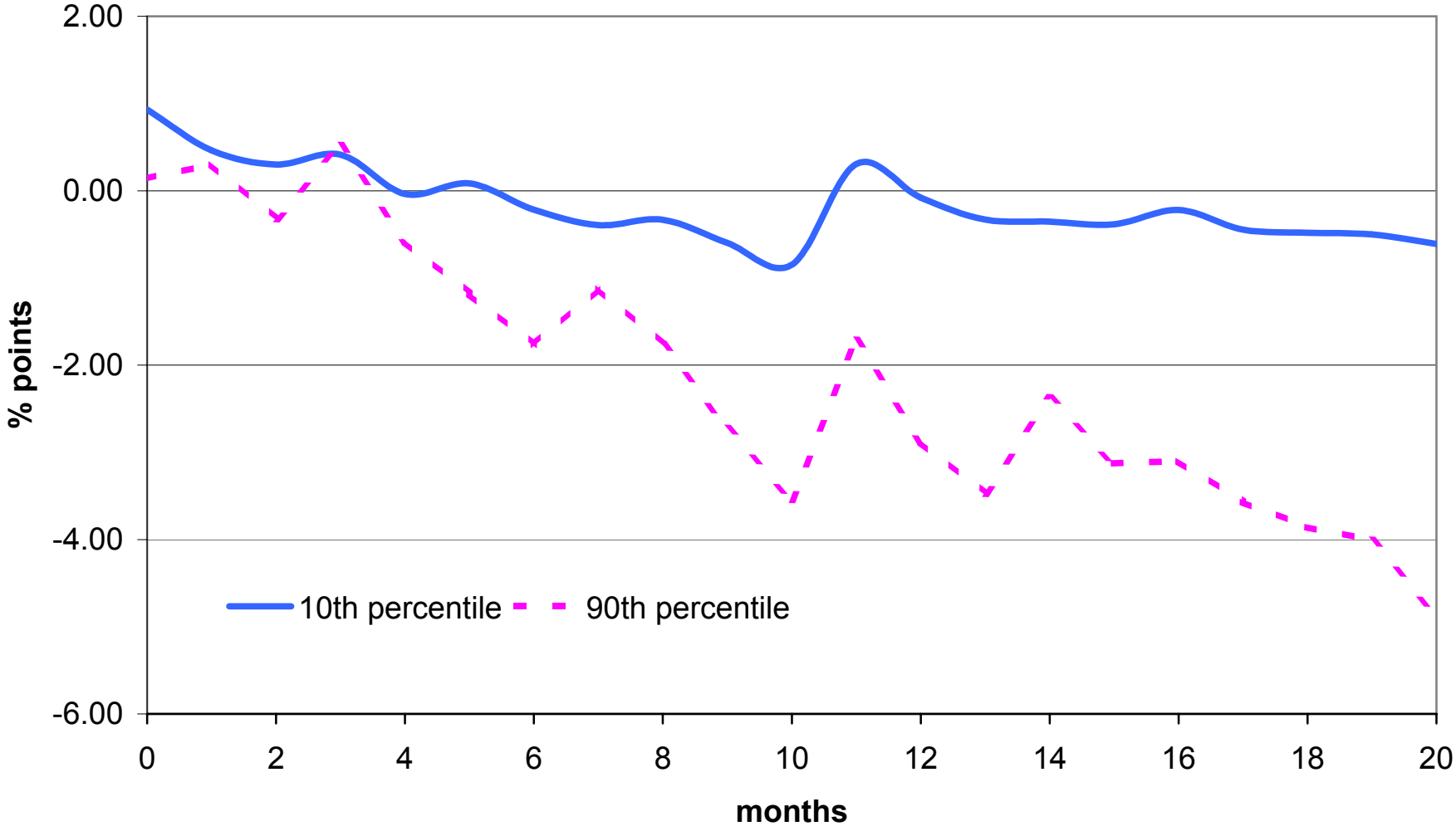
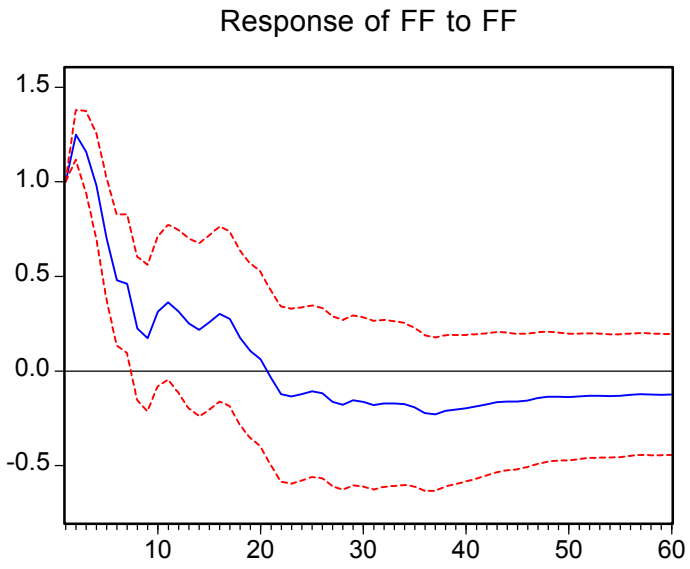
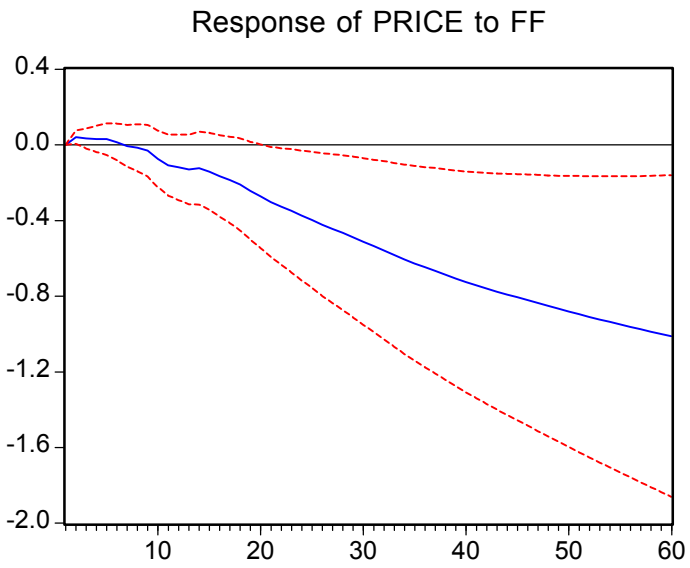


**Figure 10**


Response of FF to FF
1.5
1.0
0.5
0.0
-0.5
10
20
30
40
50
60


Response of PRICE to FF
0.4
0.0
-0.4
-0.8
-1.2
-1.6
-2.0
10
20
30
40
50
60

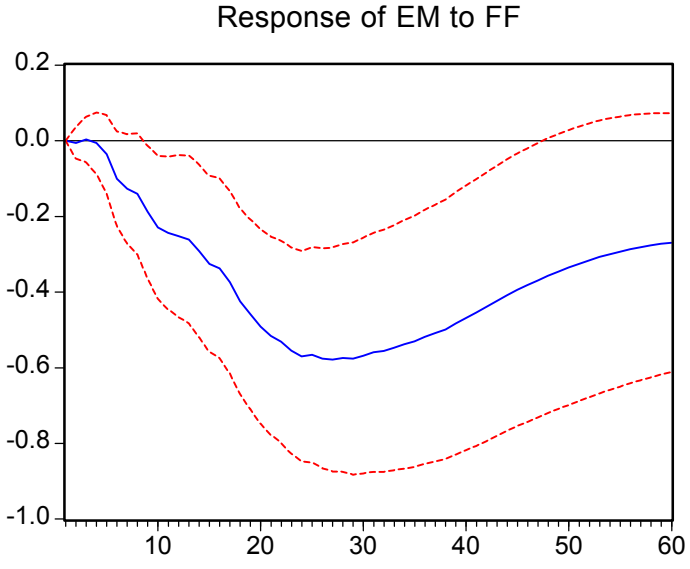

Response of EM to FF
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
10
20
30
40
50
60

**Figure 11**

**Response of Relative Prices to a 1 % point Drop in the Fed Funds Rate**

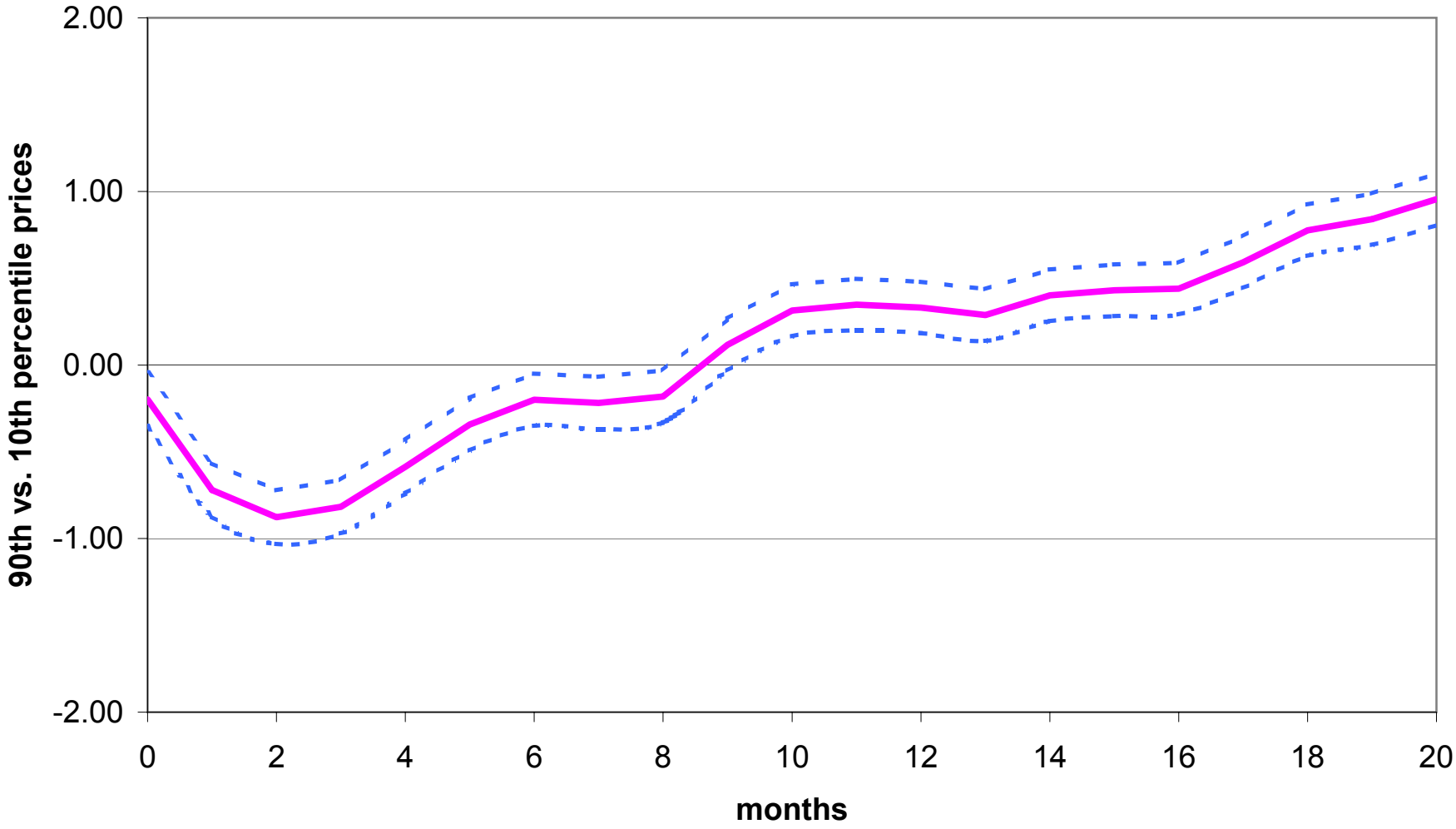


**Figure 12**

**Response of Real Consumption to a 1 % point Drop in the Fed Funds Rate**

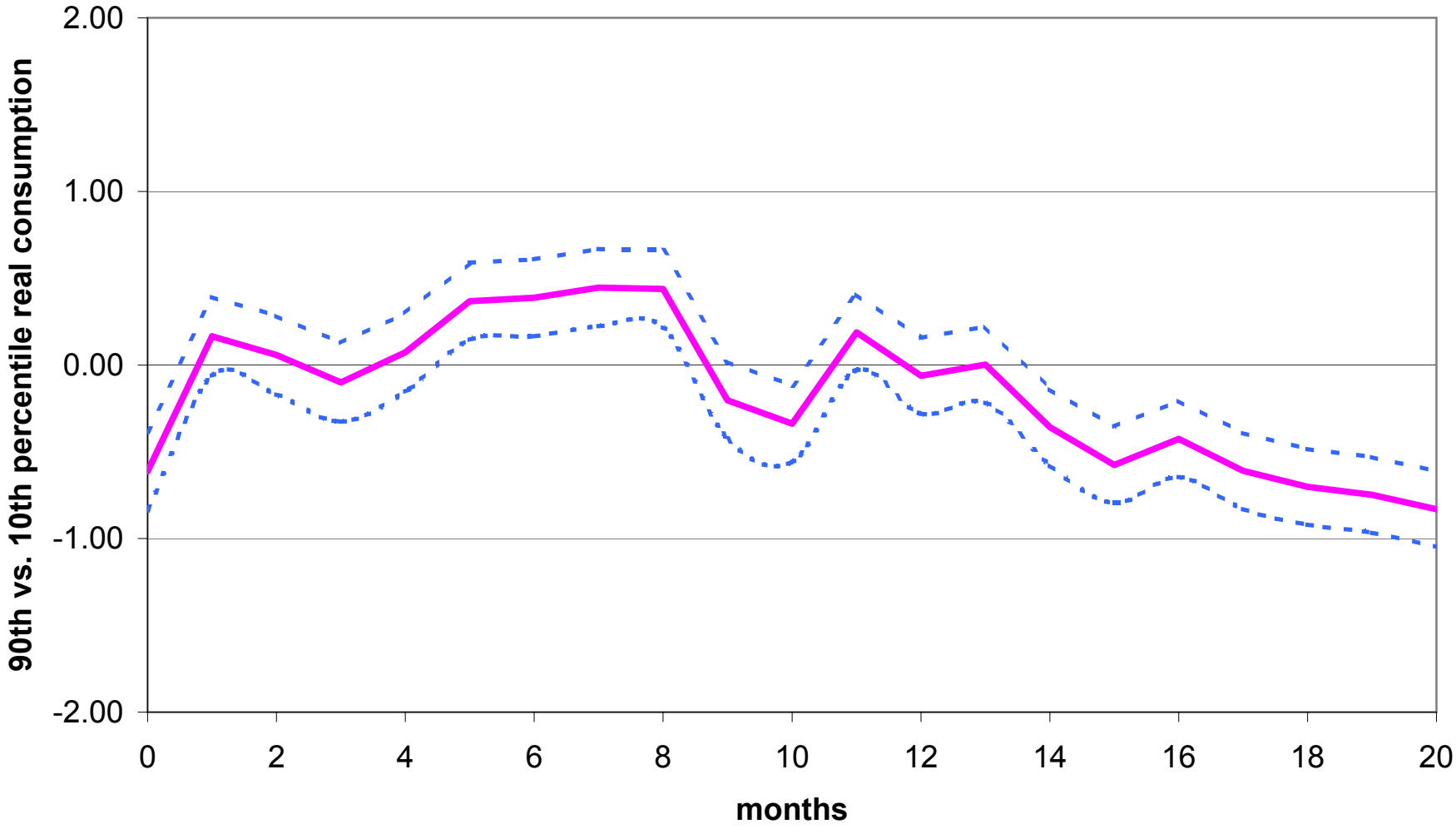


**Figure 13**

**Response of Prices to a 1 % point Drop in the Fed Funds Rate**

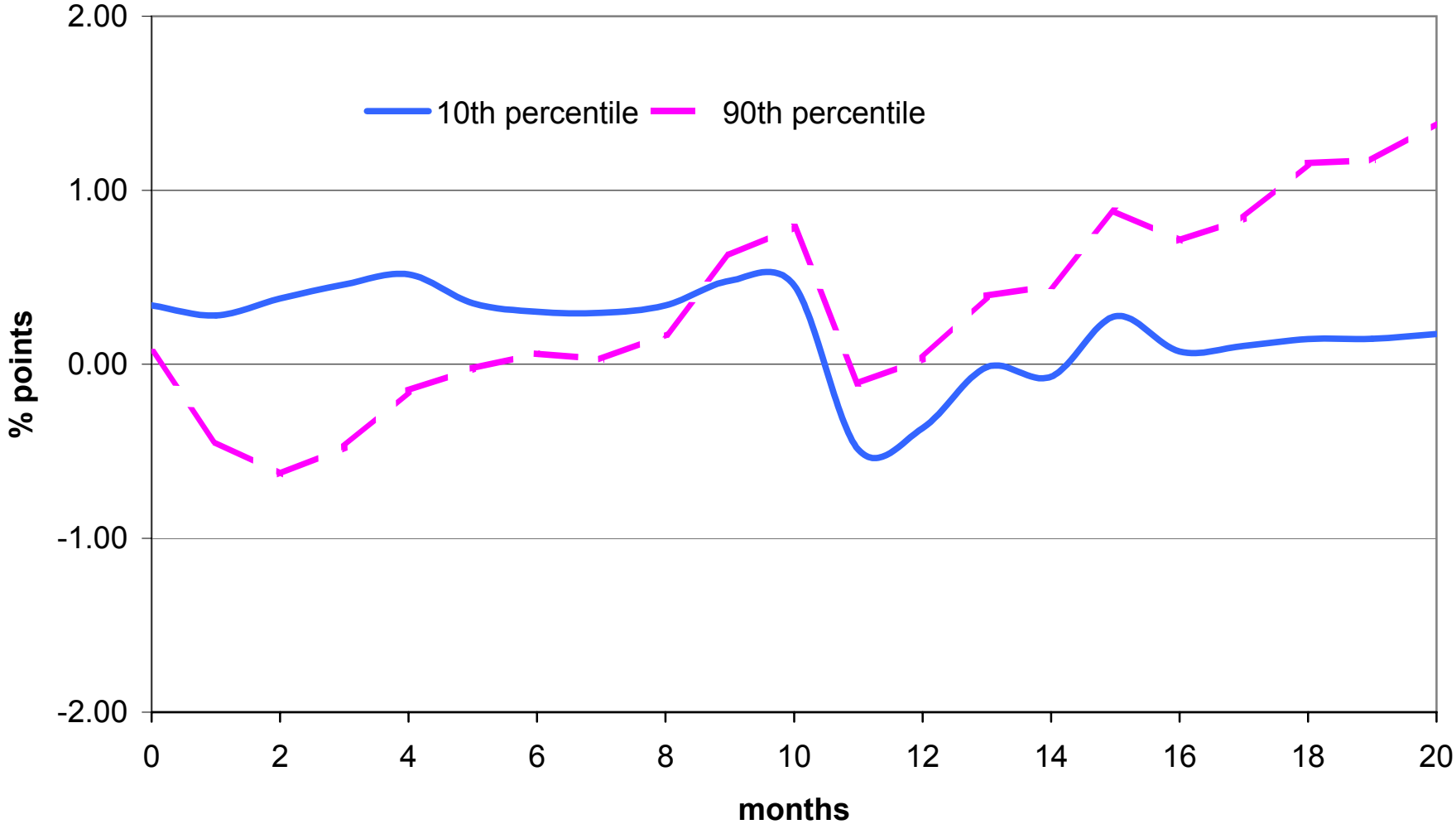


**Figure 14**

**Response of Real Consumption to a 1 % point Drop in the Fed Funds Rate**

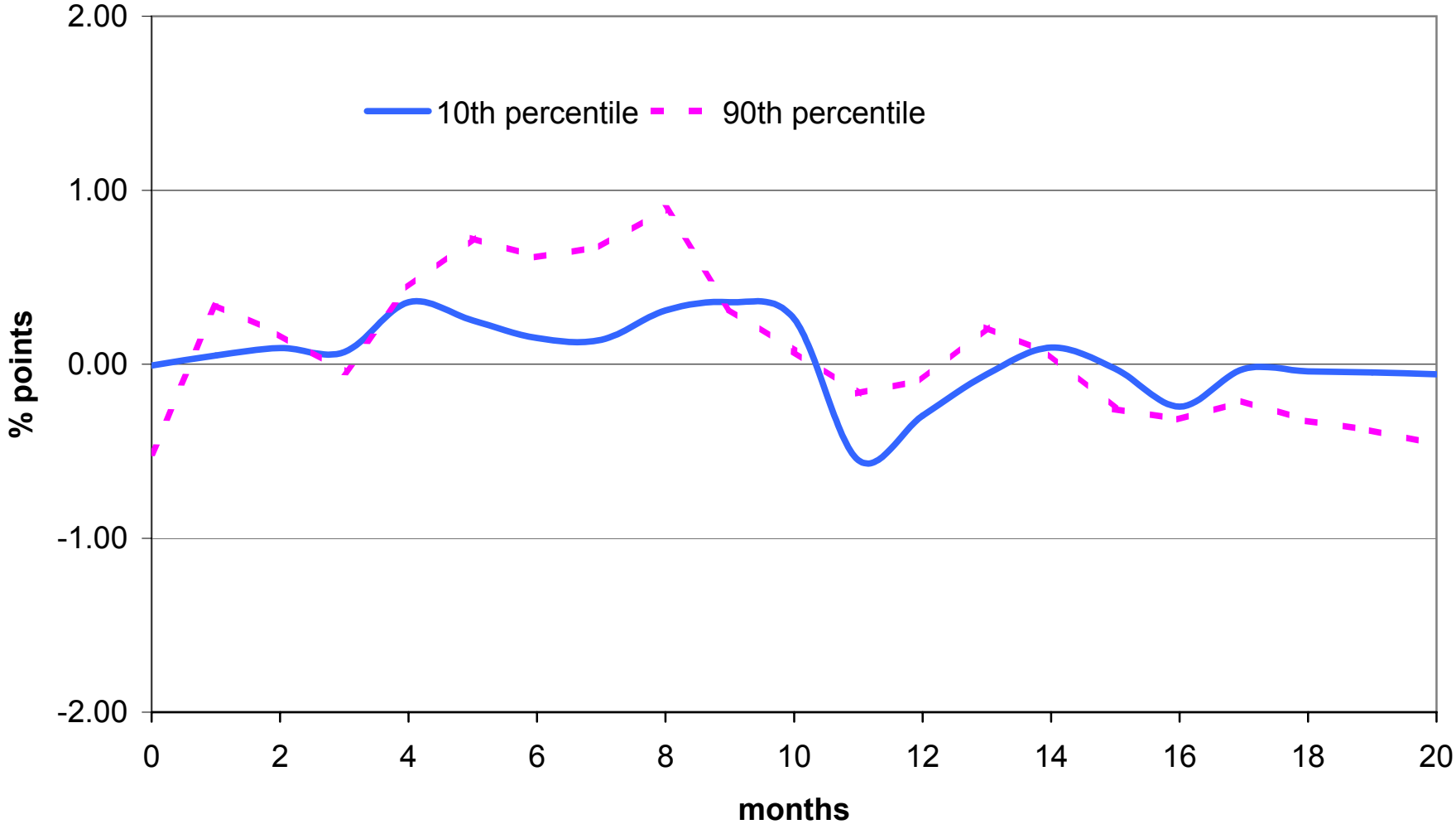


**Figure 15**
**Response of Relative Prices to a 1% TFP Impulse**

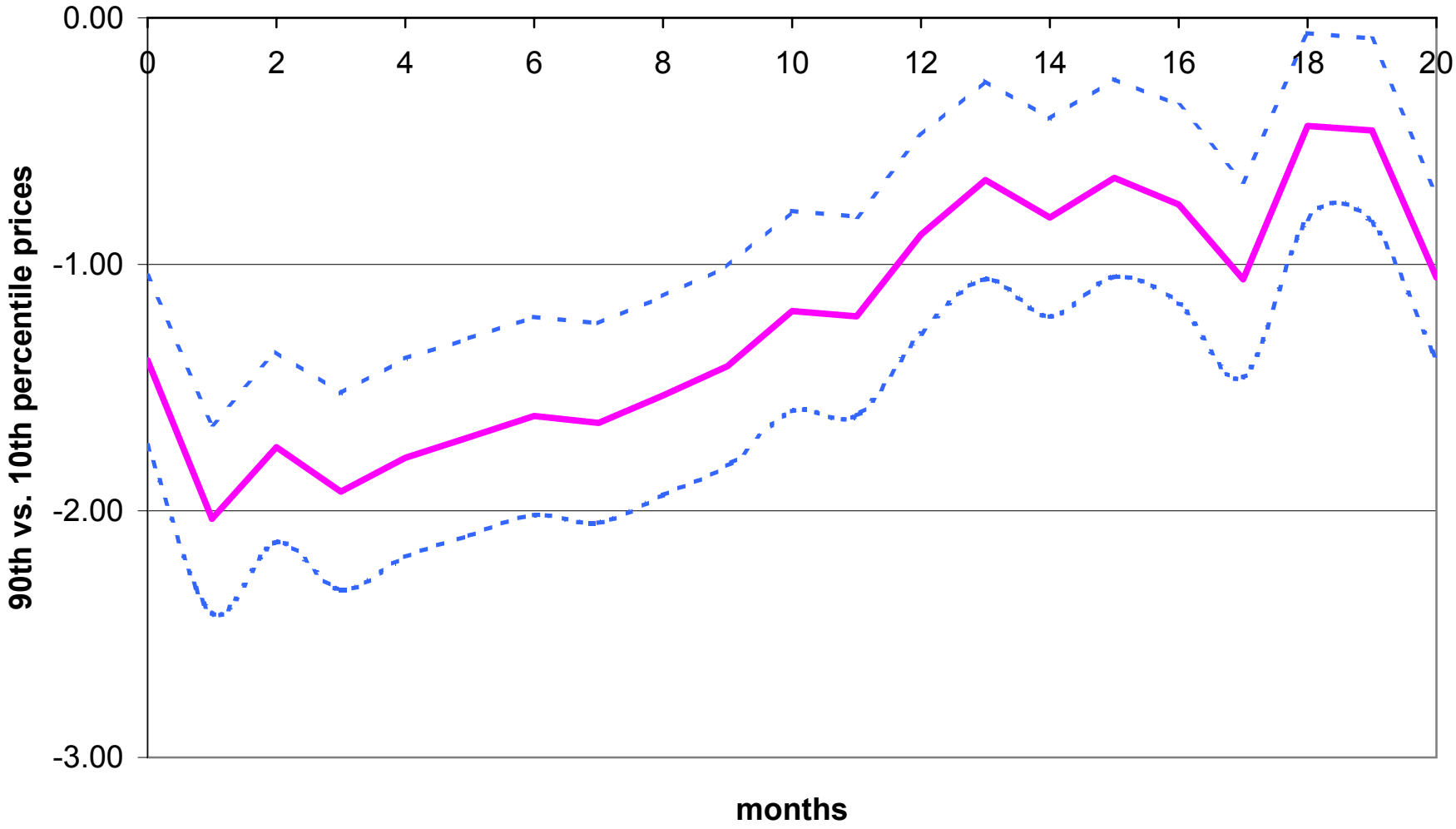
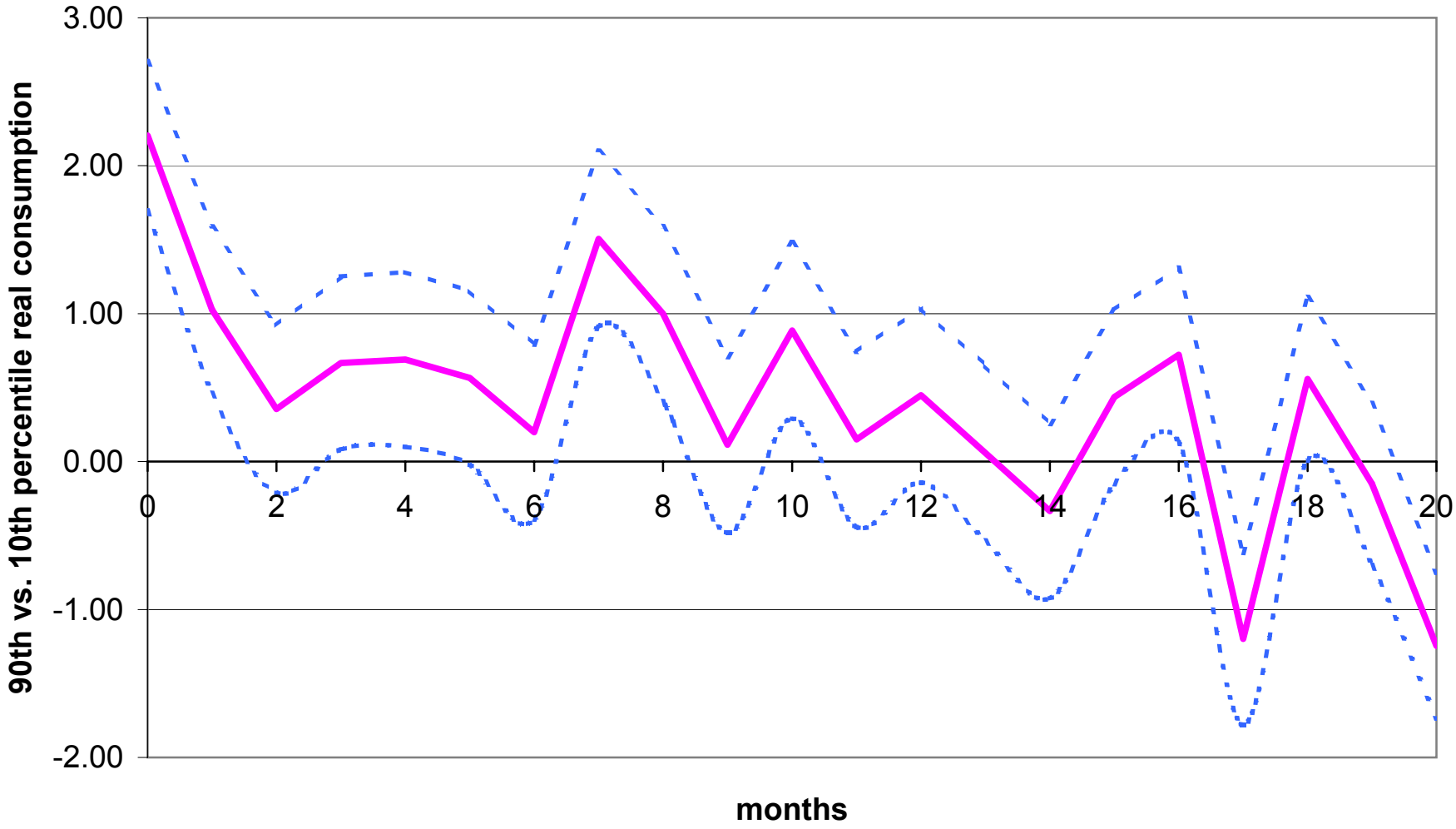


**Figure 16**
**Response of Relative Consumption to a 1% TFP Impulse**



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