Sticky Prices and Monetary Policy: Evidence from Disaggregated U.S. Data*

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Abstract

The recent empirical evidence that disaggregated prices are quite volatile has been interpreted as a challenge to the hypothesis of price rigidity used in a large class of macroeconomic models. This paper shows that this evidence does not imply that prices are flexible in the face of macroeconomic shocks. We document the effect of macroeconomic fluctuations and sectoral conditions by estimating a factor-augmented vector autoregression using a large set of macroeconomic indicators and disaggregated prices. Our main finding is that disaggregated prices appear sticky in response to macroeconomic fluctuations, and in particular to monetary policy, but flexible in response to sector-specific shocks. The observed flexibility of disaggregated prices is explained by the fact that sector-specific shocks account on average 85% of their monthly fluctuations.

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1 Introduction

Are prices flexible or sticky? The answer to this question has been for a long time the subject of considerable controversy in macroeconomics and has motivated a large empirical literature. The reason is that a proper assessment of the speed of price adjustment is crucial to understand the sources of business cycle fluctuations, as well as the effects of monetary policy on the economy.

Empirical studies based on aggregate data, such as those estimating vector autoregressions (VAR), have typically found stickiness in the aggregate price level.[1] Largely motivated by this evidence, many macroeconomic models including models used for policy analysis rest on the assumption that prices are sticky.[2] However recent evidence on the behavior of disaggregated prices suggests that prices are much more volatile than conventionally assumed in studies based on aggregate data. For instance, Bils and Klenow (2004), looking at 350 categories of consumer goods and services that cover about 70% of U.S. consumer expenditures, estimate that the median time between price changes is 4.3 months.[3] They argue that sectoral inflation rates are much more volatile and short-lived than implied by sticky-price models, thereby casting doubts on the validity of such models. Klenow and Kryvtsov (2005) document that when prices change, they change by more than 13% on average.[4]

The goal of this paper is to show empirically that once we distinguish between macroeconomic

[1] For instance, Christiano, Eichenbaum and Evans (1999) find, under a wide range of identifying assumptions, that following an unexpected monetary policy tightening, aggregate price indices remain unchanged for about a year and a half and start declining thereafter. Studies focusing on specific wholesale or retail items have also found evidence of prices maintained fixed for several months, in the U.S. See for instance Carlton (1986), Cecchetti (1986), Kashyap (1995), Levy, Bergen, Dutta and Venable (1997), MacDonald and Aaronson (2001), and Kackmeister (2001). Surveys of firms suggest that a large fraction of prices remain constant for many months (Blinder, Canetti, Lebow, and Rudd, 1998).

[2] Such models, sometimes augmented with mechanisms to increase the persistence in inflation, have been argued to replicate many features of aggregate data (e.g., Rotemberg and Woodford, 1997; Christiano, Eichenbaum and Evans, 2005; Smets and Wouters 2007), and in particular the delayed and persistent effects of monetary policy shocks on prices.

[3] The median duration remains less than 5 months when they account for temporary sales. More recently, however, Nakamura and Steinsson (2006), analyzing CPI microdata, argue that the median duration is between 8 and 11 months when they exclude sales and price changes due to product substitutions. The upper bound is similar to the median duration found in Euro area data (see, e.g., Dhyne et al., 2005, and several other studies which are part of the Eurosystem Inflation Persistence Network).

The duration between price changes varies however considerably across sectors. According to Bils and Klenow (2004), it ranges from less than a month (for gasoline prices) to more than 80 months (coin-operated apparel laundry and dry-cleaning).

[4] They estimate this change to be 8.5% when adjusting for temporary sales. Golosov and Lucas (2007), in turn, calibrate a menu-cost model with both aggregate and idiosyncratic shocks to match these facts, and find that monetary policy shocks have large and rapid effects on aggregate prices but only very little effect on economic activity.

and sector-specific fluctuations, the fact that prices change frequently at the disaggregate level does not imply that prices are flexible in the face of macroeconomic shocks. In fact, we argue that the flexibility of disaggregate prices is perfectly compatible with stickiness of aggregate price indices.

One limitation of the existing evidence such as that of Bils and Klenow (2004) or Klenow and Kryvtsov (2005) is that while they provide a careful description of individual prices movements, they do not distinguish between sector-specific and aggregate sources of fluctuations. It is thus not possible to infer from these studies whether sectoral prices respond rapidly or slowly, strongly or moderately to macroeconomic shocks. To reconcile the evidence on disaggregate and aggregate prices, it is crucial to properly assess the relative importance of the sector-specific and macroeconomic fluctuations in prices series.

In addition, while aggregate inflation is often argued to be persistent over long samples,[5] disaggregated series reveal much more transient fluctuations. The apparent persistence of aggregate inflation may reflect heterogeneity across sectors or a structural break in the mean inflation during the sample.[6] Yet, as another possible explanation, the differences in inflation persistence at the aggregate and disaggregate level may also be due to different responses to macroeconomic and sector-specific shocks.

In this paper, we disentangle the fluctuations in disaggregated U.S. consumer and producer prices which are due to aggregate macroeconomic factors from those due to sectoral conditions. We do so by estimating a factor-augmented vector autoregression (FAVAR) that relates a large panel of monthly economic indicators and individual price series to a relatively small number of estimated common factors summarizing macroeconomic forces. This framework allows us to assess the relative importance of macroeconomic and sectoral factors in explaining disaggregate price fluctuations and inflation persistence. Using this, we can analyze the typical response of disaggregate prices to macroeconomic shocks and to sector-specific shocks.

We also estimate the effects of U.S. monetary policy on disaggregated prices after identifying

[5] See, e.g., Fuhrer and Moore (1995), Galí and Gertler (1999), Cogley and Sargent (2001, 2005), Sims (2001), Stock (2001), Pivetta and Reis (2003), Levin and Piger (2003), Clark (2003).

[6] Granger (1980), Pesaran and Smith (1995) and Imbs, Mumtaz, Ravn and Rey (2005) point out that the persistence of aggregate series should not be interpreted as the average persistence of individual series in the presence of heterogenous dynamics. Cogley and Sargent (2001, 2005), Levin and Piger (2003) and Clark (2003) find that inflation persistence drops when they allow for changes in mean inflation over time.

monetary policy shocks using the information from the entire data set. We study the magnitude of the price responses to monetary policy shocks, and whether monetary policy has delayed effects on prices. While extensive research has attempted to characterize the effects of monetary policy on macroeconomic indicators, little research has analyzed its effects on disaggregated prices. Two exceptions are Bils, Klenow and Kryvtsov (2003), and Balke and Wynne (2003). These authors estimate the responses of individual prices to a monetary policy shock by appending individual price series to a separately-estimated VAR. However, their estimated price responses display a considerable "price puzzle", i.e., a price increase following an unexpected monetary policy tightening, which stands in sharp contrast to predictions of conventional models. As argued in Sims (1992) and Bernanke, Boivin and Eliasz (2005), such evidence of a price puzzle may be indicative of VAR misspecification due, e.g., to the lack of information considered in the VAR estimation. In the context of our data-rich FAVAR, this risk of misspecification is reduced, as we make an attempt to use all of the available information in the estimation.

Our main finding is that disaggregated prices appear sticky in response to macroeconomic fluctuations, and to monetary policy in particular, but flexible in response to sector-specific shocks. Importantly, we show that, although the implication for macroeconomic modeling are drastically different, these findings are consistent with the evidence reported in Bils and Klenow (2004). The reason is that macroeconomic fluctuations explain on average only 15% of the variation in monthly individual prices. So most of the fluctuations in disaggregated prices reflect sector-specific shocks to which prices are adjusting quickly, and possibly in part sampling error in measured disaggregated prices. Consistent with the evidence on disaggregated price series, we also find considerable disparities in the magnitude of price changes and in the persistence of inflation across price categories, both for consumer and producer prices. These disparities are due to a large extent to differences in the volatility of sector-specific components, and only little to different responses to macroeconomic factors.

The picture that emerges is thus one in which many prices fluctuate considerably in response to sector-specific shocks, but they respond only sluggishly to aggregate macroeconomic shocks such as monetary policy shocks. The relative importance of sector specific shocks can explain why, at the disaggregated level, individual prices are found to be adjusted relatively frequently, while estimates of the degree of price rigidity are much higher when based on aggregate data. The sluggishness in price responses to macroeconomic shocks explains why models that assume considerable price stickiness have often been successful at replicating the effects of monetary policy shocks.

After documenting the responses of prices to a monetary policy shock, we attempt to provide an explanation for the cross-sectional dispersion of price responses. To this end, we collect data on industry characteristics that are related to various theories of price stickiness. We find that the observed dispersion in the reaction of producer prices is significantly explained by the degree of market power, that prices in sectors with volatile idiosyncratic shocks react relatively more rapidly to aggregate monetary policy shocks, and that PCE categories in which prices fall the most following a monetary policy shock tend to be those in which quantities consumed fall the least. Finally, we find that the idiosyncratic components of prices and quantities move mostly in opposite directions suggesting that idiosyncratic shocks may be largely supply-type shocks.

The rest of the paper is organized as follows. Section 2 reviews the econometric framework, by discussing the formulation and estimation of the FAVAR. In Section 3, we discuss various data sets used in our estimation. Section 4 presents empirical results about the sources of fluctuations in disaggregated prices. It includes a description of the price responses to sector-specific shocks and to macroeconomic fluctuations. Section 5 investigates the effects of monetary policy shocks and relates the responses of producer prices in various sectors to industry characteristics. Section 6 reports some robustness results including results for the post-1984 period. Section 7 concludes by discussing various potential avenues to reconcile these results with existing theories.

2 Econometric Framework: FAVAR

The empirical framework that we consider is based on the factor-augmented vector autoregression model (FAVAR) described in Bernanke, Boivin and Eliasz (2005) (BBE). One of its key features is to provide estimates of macroeconomic factors that affect the data of interest by systematically and consistently exploiting all information from a large set of economic indicators. In our application, we estimate the empirical model by exploiting information from a large number of macroeconomic indicators, as well as from disaggregated data. This framework is particularly well suited to decompose the fluctuations of each series into a common and a series-specific component. It also allows us to characterize the response of all data series to macroeconomic disturbances, such as monetary policy shocks. As BBE argue, this framework should lead to a better identification of the policy shock than standard VARs, because it explicitly recognizes the large information set that the Federal Reserve and financial market participants exploit in practice, and also because it does not require to take a stand on the appropriate measures of prices and real activity which can simply be treated as latent common components. A natural by-product of the estimation is to obtain impulse response functions for any variables included in the data set. In particular, this allows us to document the effect of monetary policy on disaggregated prices.

We only provide here a general description of our implementation of the empirical framework and refer the interested reader to BBE for additional details. We assume that the economy is affected by a vector C_t of common components to all variables entering the data set. Since we will be interested in characterizing the effects of monetary policy, this vector of common components includes a measure of the stance of monetary policy. As in most related VAR applications, we assume that the Federal funds rate, R_t, is the policy instrument. It will be allowed to have pervasive effect throughout the economy and will thus be considered as a common component of all variables entering the data set. The rest of the common dynamics are captured by a $K \times 1$ vector of unobserved factors F_t, where K is relatively small. These unobserved factors may reflect general economic conditions such as "economic activity," the "general level of prices," the level of "productivity," which are not easily captured by a few time series, but rather by a wide range of economic variables. We assume that the joint dynamics of F_t and R_t are given by

$$C_t = \Phi(L)C_{t-1} + v_t \tag{1}$$

where

$$C_t = \begin{bmatrix} F_t \\ R_t \end{bmatrix},$$

and $\Phi(L)$ is a conformable lag polynomial of finite order which may contain a priori restrictions, as in standard structural VARs. The error term v_t is i.i.d. with mean zero and covariance matrix Q.

The system (1) is a VAR in C_t. The additional difficulty, with respect to standard VARs, however, is that the factors F_t are unobservable. We assume that the factors summarize the information contained in a large number of economic variables. We denote by X_t this $N \times 1$ vector of "informational" variables, where N is assumed to be "large," i.e., $N > K + 1$. We assume furthermore that the large set of observable "informational" series X_t is related to the common factors according to

$$X_t = \Lambda C_t + e_t \tag{2}$$

where Λ is an $N \times (K+1)$ matrix of factor loadings, and the $N \times 1$ vector e_t contains (mean-zero) series-specific components that are uncorrelated with the common components C_t. These series-specific components are allowed to be serially correlated and weakly correlated across indicators. Equation (2) reflects the fact that the elements of C_t, which in general are correlated, represent pervasive forces that drive the common dynamics of X_t. Conditional on the observed Federal funds rate R_t, the variables in X_t are thus noisy measures of the underlying unobserved factors F_t. Note that it is in principle not restrictive to assume that X_t depends only on the current values of the factors, as F_t can always capture arbitrary lags of some fundamental factors.[7]

As in BBE, we estimate our empirical model using a variant of a two-step principal component approach. In the first step, we extract principal components from the large date set X_t to obtain consistent estimates of the common factors. Stock and Watson (2002) show that the principal components consistently recover the space spanned by the factors when N is large and the number of principal components used is at least as large as the true number of factors. In the second step, we add the Federal funds rate to the estimated factors, and estimate the structural VAR (1). Our implementation differs slightly from that of BBE as we impose the constraint that Federal funds rate is one of the factors in the first-step estimation.[8] This guarantees that the estimated latent factors recover dimensions of the common dynamics not captured by the Federal funds rate.[9]

[7] This is why Stock and Watson (1999) refer to (2) as a dynamic factor model.

[8] We thank Olivier Blanchard for pointing us in this direction. In contrast to the approach adopted here, BBE do not impose the constraint that the Federal funds rate is one of the common components in the first step. They instead remove the Federal funds rate from the space covered by the principal components, by peforming a transformation of the principal components exploiting the different behavior of what they call "slow-moving" and "fast-moving" variables, in the second step. Our approach and that of BBE provide however very similar results (see the NBER working paper version of this paper for an application of the BBE estimation approach).

[9] More specifically, we adopt the following procedure in the first step of the estimation. Starting from an initial

This procedure has the advantages of being computationally simple and easy to implement. As discussed by Stock and Watson (2002), it also imposes few distributional assumptions and allows for some degree of cross-correlation in the idiosyncratic error term e_t. Boivin and Ng (2005) document the good forecasting performance of this estimation approach compared to some alternatives.[10]

3 Data

The data set used in the estimation of our FAVAR is a balanced panel of 653 monthly series, for the period running from 1976:1 to 2005:6. The choice of the starting date reflects our desire to maximize the sample length while considering as large a number of disaggregated price series as possible. Indeed a significant number of the disaggregated producer price indices start in 1976:1. All data have been transformed to induce stationarity. The details for this data set as well as the transformation applied to each particular series are in Appendix A. The data set includes 111 updated macroeconomic indicators used by BBE (see Appendix A.1 for details), which involve several measures of industrial production, various price indices, interest rates, employment as well as other key macroeconomic and financial variables. These indicators have been found to collectively contain useful information about the state of the economy for the appropriate identification of monetary policy. We expanded the data set of BBE in two directions.

First, we appended disaggregated data published by the Bureau of Economic Analysis on personal consumption expenditure (PCE). Specifically, we collected 335 series on PCE prices and an equal number of series on real consumption. Among these series, 35 price series and 35 real consumption series were removed because of missing observations. In order to capture data for all expenditures reported, we removed the other series in the same categories and retained the series at the immediately higher level of aggregation. However, we removed from our data set aggregate

estimate of F_t, denoted by $F_t^{(0)}$ and obtained as the first K principal components of X_t, we iterate through the following steps: (1) we regress X_t on $F_t^{(0)}$ and R_t to obtain $\hat{\lambda}_R^{(0)}$; (2) we compute $\tilde{X}_t^{(0)} = X_t - \hat{\lambda}_R^{(0)} R_t$; (3) we estimate $F_t^{(1)}$ as the first K principal components of $\tilde{X}_t^{(0)}$; (4) we repeat steps (1)-(3) multiple times.

[10] Note that this two-step approach implies the presence of "generated regressors" in the second step. According to the results of Bai (2003), the uncertainty in the factor estimates should be negligible when N is large relative to T. Still, the confidence intervals on the impulse response functions used below are based on a bootstrap procedure that accounts for the uncertainty in the factor estimation. As in BBE, the bootstrap procedure is such that 1) the factors can be re-sampled based on the observation equation, and 2) conditional on the estimated factors, the VAR coefficients in the transition equation are bootstrapped as in Kilian (1998).

price and real consumption series (except for overall aggregates), so as to count only once each category in the disaggregated data. We thus ended up with 190 disaggregated PCE price series and the 190 corresponding consumption series. At the level of disaggregation considered, we have for instance data on new domestic autos, bicycles, shoes, cereals, fresh fruit, taxicabs, and so on. In addition, we also included 4 price indices and 4 consumption aggregates (overall PCE, durable goods, nondurable goods, and services), so that we can report some results for these aggregates.[11] Further details on these series are provided in Appendix A.2.

Second, in order to obtain a more detailed picture of the characteristics of price responses, we also collected over 600 series for producer prices at the 6-digit level of NAICS codes (corresponding to 4-digit SIC codes). Because of changes in definitions and data coverage, we managed to obtain only 154 series for the period starting in January 1976 and ending in June 2005. The number of disaggregated producer price series available diminishes markedly if we start the sample prior to 1976. Appendix A.3 provides a brief description of these series.

Besides the series just described, which we used to estimate the FAVAR, we also collected data on industry characteristics, which could help us validate or reject assumptions underlying models of price determination. The C4 ratio, provided by the Bureau of the Census, reports the percentage of total sales attributable to the four largest firms in the industry. As another measure of competition, we use also data on average gross profit rates from the Annual Survey of Manufacturing. This data is available on an annual basis from 1997 to 2001. The cross-sectional industry data is described in Appendix A.4.

4 Fluctuations in Disaggregated Prices: Macroeconomic Factors and Sector-Specific Shocks

The estimated system (1) – (2) allows us to analyze the sources of fluctuations in sectoral inflation rates. Note that for all of the price series considered, (2) implies that

$$\pi_{it} = \lambda_i' C_t + e_{it}, \tag{3}$$

[11] The inclusion of these aggregates has no noticeable impact on the estimated factors as we would expect given the large number of data series used in the estimation.

where π_{it} contains the monthly log change in the respective price series. This formulation allows us to disentangle the fluctuations in sectoral inflation rates due to the macroeconomic factors — represented here by the common components C_t which have a diffuse effect on all data series — from those due to sector-specific conditions represented by the term e_{it}. It also allows us to study to what extent the persistence in sectoral inflation rates is due to macroeconomic or sectoral shocks. Note that since C_t is a vector which may contain elements with very different dynamics and the vectors of loadings λ_i may differ across sectors, each sector-specific inflation rate may reveal different dynamics in response to macroeconomic disturbances.[12] Recall also that the sector-specific terms e_{it} are allowed to be serially correlated and weakly correlated across sectors.

We estimated the system (1) – (2) for the period 1976:1- 2005:6, using the data described above, and assuming 5 latent factors in the vector F_t. We experimented with more factors but none of our conclusions were affected. We used 13 lags in estimating (1).

4.1 Sources of fluctuations and persistence

In this subsection we discuss some summary statistics about the volatility and the persistence of aggregate and disaggregated monthly inflation series. The next subsection proceeds with a discussion of the effects of sector-specific and macroeconomic shocks.

4.1.1 Inflation volatility

As is indicated in the first column of Table 1, the standard deviation of monthly aggregate inflation amounts to 0.24% for the overall PCE series, and ranges between 0.24% and 0.42% for the inflation rates of durable goods, nondurable goods and services. Most of the volatility in aggregate inflation is due to fluctuations in common macroeconomic factors. In fact, the R^2 statistic, which measures the fraction of the variance in inflation explained by the common component $\lambda_i' C_t$ lies above 0.5 for all of the aggregate measures.

The picture is however quite different for more disaggregated inflation series which are much

[12] In a recent paper, Reis and Watson (2007) estimate an equation of the form (3) using only disaggregate consumer price data, and decompose the term due to macroeconomic conditions, $\lambda_i' C_t$, into a component that involves a common change in all price categories and a component that involves relative price changes.

more volatile than aggregate series with a standard deviation of 1.15% on average (across sectors).[13] Most of this volatility is however due to sector-specific disturbances. In fact, as the lower panel of Table 1 reveals, while the mean volatility of the common component of inflation lies at 0.33%, the volatility of the sector specific component is more than three times as large. In addition, the R^2 statistic amounts to 0.15 on average for these series, suggesting that 85% of the monthly disaggregated inflation fluctuations are attributable to sector-specific disturbances. The results are roughly similar for PCE and PPI inflation rates.

Table 1 also reveals considerable heterogeneity across sectors in inflation volatility. This is mainly due to differences in the volatility of sector-specific conditions, and much less so to differences in the response to macroeconomic fluctuations. As the sector-specific components tend to cancel each other out, inflation in the aggregate price indices end up being less volatile than most sector-specific inflation rates.

Interestingly, the volatility of the common and the sector-specific components of inflation are strongly positively correlated across sectors, as indicated in Figure 1. The correlation between the volatility of idiosyncratic shocks ($Sd(e_i)$) and the volatility of the common component ($Sd\big(\lambda_i' C\big)$) is high both for PCE deflators (0.74) and for PPI data (0.81) (See Table 2).[14] Note that the inflation variance explained by the macroeconomic factors depends on the loadings represented by the matrix Λ. One interpretation is that these loadings reflect the price-setting behavior of firms in various industries. Under this interpretation, Figure 1 reveals that firms in industries with volatile idiosyncratic shocks do also respond strongly to macroeconomic shocks. This may be the case if frequent price adjustments necessitated by idiosyncratic volatility are also used as an opportunity to adjust to changes in the macroeconomic environment. That would be consistent, for instance, with a sticky price-model à la Calvo with heterogeneity in the frequency of price adjustment across sectors, as in Carvalho (2006).

The sector-specific fluctuations e_{it} should however be interpreted with care as they may not

[13] The average volatility of disaggregated PCE inflation series, weighted with expenditure shares, is somewhat lower than the unweighted average, but the overall picture remains the same for the volatility as well as for other statistics described below.

[14] From a statistical point of view, there is no reason a priori to expect that the portion of inflation volatility explained by the regression (common component) and the portion of inflation volatility explained by the error terms should be correlated across industries (or samples). Therefore, Figure 1 presents an interesting result that requires structural interpretation.

only reflect structural disturbances but also measurement error in sectoral price indices. As Shoemaker (2006) and Broda and Weinstein (2007) point out, the components of the consumer price index (which underlie most disaggregated PCE indices) may involve a relatively large amount of sampling error due to the fact that the Bureau of Labor Statistics collects each month prices from a subsample of all retail prices, and not from all retail prices. It is important to note, though, that the empirical framework adopted here is particularly well suited to characterize the effects of aggregate disturbances on disaggregated price series in the presence of measurement error, to the extent that such errors are series-specific. In this case, measurement error does generally not distort the estimates of the common components and the estimated effects of aggregate disturbances, even in the extreme situation in which the sector-specific components of inflation are entirely driven by measurement error.

While it is difficult to clean up the individual price series for sampling error, we do have some indirect evidence suggesting that the idiosyncratic components are not driven entirely by sampling error, but that they do reflect actual price changes. Figure 2 shows a clear positive correlation (of 0.37) between the volatility of our estimated idiosyncratic shocks and the frequency of price changes in consumption categories reported by Bils and Klenow (2004). A similar picture emerges when using the frequency of price changes computed by Nakamura and Steinsson (2006).[15] The prices analyzed by Bils and Klenow (2004) and Nakamura and Steinsson (2006) are also based on a limited sample, and thus may also reflect sampling issues, however these authors do actually compute the frequencies of price adjustment by following prices of individual products at particular outlets over time. As these authors account for goods substitutions, the frequencies of price changes obtained should thus mainly reflect actual prices changes, and not changes in the basket of goods considered. The positive correlation between the volatility of our sector-specific components and their statistics indicates that we do capture some of the actual price changes in these categories, rather than only substitution. In addition, if the sector-specific components of inflation were mostly reflecting sampling error, it would be difficult to see why their volatility is so strongly correlated with the volatility of the common component of inflation across sectors, as shown in Figure 1.

[15] We are grateful to Andrea Tambalotti for sharing with us the mapping between our PCE categories and the categories considered by Bils and Klenow (2004) and Nakamura and Steinsson (2006). Out of the 190 disaggregated PCE categories, we could map 108 of them with Bils and Klenow's statistics.

4.1.2 Inflation persistence

One characteristic of aggregate inflation often discussed is its persistence. To assess the degree of persistence, we fit for each inflation series π_{it} and each of its components, $\lambda_i' C_t$ and e_{it} an autoregressive process with 13 lags of the form

$$w_t = \rho(L)\, w_{t-1} + \varepsilon_t,$$

and we measure the degree of persistence by the sum of the coefficients on all lags, $\rho(1)$. Not surprisingly, as we report in Table 1, fluctuations in aggregate inflation are persistent with a measure $\rho(1)$ of 0.93 for the PCE inflation rate, and ranging between 0.76 and 0.94 for the three main components of PCE inflation.

However, the sectoral inflation series display much less persistence than the aggregated series, as Clark (2003) noted. Similarly, Altissimo, Mojon and Zaffaroni (2004) who estimated a factor model on disaggregated CPI inflation series in Europe also found that inflation rates of individual categories are on average more volatile and less persistent than the aggregate inflation rate, and display widespread heterogeneity across categories. In our data set, the persistence is 0.49 on average over all sectors, and varies importantly across sectors. While it is negative for some producer and consumer prices, it lies above 0.95 for categories such as hospital fees, physician fees, and "tenant group room and board." Interestingly, the inflation persistence is in most cases due to fluctuations in common macroeconomic factors, and the individual components display on average almost no persistence. The persistence of the aggregate inflation rates thus inherits the persistence of the common component in disaggregated inflation, as the idiosyncratic components tend to average out across sectors.

4.1.3 Persistence and volatility

Bils and Klenow (2004) emphasize that, for a particular process for marginal costs, the Calvo model predicts that a higher degree of price stickiness reduces the impact of exogenous shocks on current inflation, but that it increases the inflation persistence.[16] Thus everything else equal, in sectors

[16] As they mention, under the simplifying assumption that nominal marginal costs follow a random walk for each good, the Calvo model implies an inflation process for the good i of the form $\pi_{it} = (1 - \delta_i)\, \pi_{it-1} + \delta_i \varepsilon_{it}$, where π_{it}

with high price stickiness, the inflation rate should display a relatively low volatility and a relatively high persistence. Bils and Klenow (2004) argue that models such as the Calvo model are rejected by the data as they predict a strong negative correlation across sectors between the frequency of price adjustment and the persistence in sectoral inflation, while this correlation is positive in their data covering 123 consumer goods over the period 1995-2000, and only mildly negative in their longer data set.

Looking at all PCE and PPI prices, we find, in line with the results of Bils and Klenow (2004) a relatively weak negative correlation (-0.19) between volatility and persistence in the sector-specific component of inflation, as Table 2A indicates. However, once we look at the common component of inflation, the persistence and the volatility of inflation are much more negatively correlated (-0.45). Focusing on the PCE prices which we can map with the Bils and Klenow (2004) statistics, we also note from Table 2B that the persistence in the sector-specific component of inflation and the frequency of price adjustments are almost uncorrelated across categories, in contrast to the implications of the Calvo model. However, this correlation is -0.43 for the component of inflation driven by common macroeconomic shocks. This explains in part why the Calvo model is more successful in describing the volatility and persistence of inflation fluctuations generated by macroeconomic disturbances, than those generated by sector-specific shocks.

4.2 Effects of macroeconomic shocks and sector-specific shocks

Prices may change for all sorts of reasons, including changes in costs, in productivity, or changes in demand for goods. While Bils and Klenow (2004) and Klenow and Kryvtsov (2005) provide very valuable evidence that most prices are changed relatively frequently, and on average by large amounts, they do not identify the source of these changes. It is therefore not clear from these studies whether prices which tend to change frequently and by large amounts — e.g., due to large and frequent changes in sector specific conditions — also change readily to macroeconomic shocks. Clarifying this issue is particularly relevant to understand the effects of monetary policy. In fact, if prices were adjusting rapidly to monetary shocks, monetary policy would have little and only short-

is the change in the log price of good i, δ_i is the frequency of price adjustment or the probability that the price of good i changes in any given period, and ε_{it} is the iid growth rate of the good i's marginal cost.

lived effects on economic activity, as in the model of Golosov and Lucas (2007). Our paper thus complements Bils and Klenow's (2004) study by documenting how prices respond to sector-specific shocks and macroeconomic disturbances.

The left panels of Figure 3 report the response of each of the sectoral (log) *price level* to an adverse shock to its own sector-specific component. It is the response to a drop in e_{it} by one standard deviation. The solid lines represent the (unweighted) average responses. These prices typically respond sharply and very promptly to sector-specific disturbances, and tend to reach their new equilibrium level shortly after the shock. *Inflation rates* show thus no persistence in response to the sector-specific shock. For PCE categories, we report in Figure 4 the responses of the corresponding quantities to an adverse sector-specific shock in consumption. Similarly to prices, quantities fall once-and-for-all to such a shock. They don't seem to revert to the initial value.

To understand better the shocks that underlie sector-specific disturbances, we plot in Figure 5 the correlation between the sector-specific component of PCE inflation rates and the corresponding sector-specific component of PCE quantities (in growth rates). Figure 5 reports the histogram of the correlations over all sectors. As is clear from the figure, all correlations except for one are negative.[17] One possible explanation is that sector-specific shocks are overwhelmingly supply-type disturbances. This finding is consistent with Franco and Philippon (2004) which by looking at a large panel of firms find that permanent shocks to productivity, largely uncorrelated across firms, explain a large fraction of the firms' dynamics. Another possibility is that disaggregated prices contain significant sampling errors, which, for given estimates of nominal expenditures lead mechanically to inversely related estimates of real PCE. However, as argued earlier, while sampling errors are likely to affect the disaggregated PCE price indices, they are not likely to explain most of the fluctuations, given the magnitude of the sector-specific price fluctuations.

While sector-specific shocks tend to shift prices and quantities permanently to a new level, the responses to macroeconomic disturbances are very different. The middle panels of Figure 3 show the responses of each sectoral price to an innovation (of minus one standard deviation) to its common component $\lambda_i' C_t$.[18] We do the same for the PCE quantities in Figure 4. Prices and quantities fall

[17] The positive correlation refers to the category "insurance premiums for user-operated transportation."

[18] The responses are computed for an innovation to the AR processes estimated on each of the components, and discussed in section 4.1.2.

by a relatively moderate amount in the first couple of months after the shock, but then continue to fall over the subsequent months. This reveals important sluggishness in the responses of prices to macroeconomic disturbances, and persistence in inflation rates. This contrasts sharply with the responses to sector-specific shocks.

Of course, since we don't identify any structural macroeconomic shock in this exercise, we are describing the response to a combination of macroeconomic shocks. These figures do not allow us to exclude the possibility that there exist macroeconomic disturbances which cause a rapid and permanent change in prices. To address this shortcoming, we identify in the next section a particular macroeconomic shock, i.e., a monetary policy shock. To get a sense of the kind of macroeconomic shocks we are considering here, we note that they do have a permanent effect on both prices and quantities, and that for PCE categories, the correlation between the common component of prices and of the corresponding quantities are widely distributed over the -1 to $+1$ interval (Figure 5). This suggests that the disturbances that are common to our large data set involve both supply- and demand-type shocks.

Overall the results of this section suggest that changes in sector-specific conditions are the most important determinants of sectoral inflation rates. Fluctuations in the common components, however, are responsible for a significant fraction of the volatility of sectoral inflation rates, and generate most of the fluctuations in aggregate inflation. In addition, sectoral prices respond very differently to sector-specific shocks and to macroeconomic shocks. While sector-specific shocks may cause large fluctuations in sectoral inflation, these fluctuations are typically short lived so that prices tend to move immediately to their new permanent level. Aggregate macroeconomic shocks instead tend to have more persistent and sluggish effects on a wide range of sectoral inflation rates.

5 Effects of Monetary Policy Shocks

We now turn to the discussion of the effects of monetary policy shocks on disaggregated prices. One advantage of studying their responses to monetary shocks is that this can be done with minimal identifying restrictions in the FAVAR. To investigate the effects of other macroeconomic shocks would require arguably more controversial identifying assumptions. Since Bernanke and Blinder

(1992) and Sims (1992), it is common to use VARs to trace out the effects of monetary policy innovations on macroeconomic variables. VARs are particularly convenient for this as they merely require the identification of monetary policy shocks, leaving the rest of the macroeconomic model unrestricted. To maintain enough degrees of freedom, estimated VARs are typically low-dimensional, involving in general no more than six to eight variables.[19] The small size of traditional VARs has however been criticized. In fact, estimated monetary policy innovations are likely to be biased in small-sized VARs to the extent that central banks and the private sector make decisions on the basis of information not considered in these VARs. A common illustration of this problem is the "price-puzzle", i.e., the finding that the price level tends to increase slightly after a contractionary money policy shock, which contradicts most standard theories (see Sims, 1992). Another problem with small-sized VARs is that they don't allow us to understand the effects of monetary policy shocks on a large number of variables of interest.

Fortunately, as argued in BBE, the FAVAR described above allows us to address both of these shortcomings of traditional VAR. BBE provide a characterization of the effects of monetary policy on about twenty macroeconomic variables using estimated factors. In this section, we focus on the effects of monetary policy on our large panel of prices.

5.1 Identification of monetary policy shocks

To identify the monetary policy shock, we assume that the Federal funds rate may respond to contemporaneous fluctuations in estimated factors, but that none of the latent common components of the economy can respond within a month to unanticipated changes in monetary policy. This is the FAVAR extension of the standard recursive identification of monetary policy shock in conventional VARs. Note that in contrast to VARs, all of the indicators included in X_t are allowed to respond to contemporaneous monetary policy shocks, even though the latent factors F_t are assumed to remain unaffected in the current month, but this response is directly related to the Federal funds rate change.

[19] Leeper, Sims and Zha (1996), using Bayesian priors, consider slightly larger VARs containing up to about 20 variables.

5.2 Responses to monetary policy shocks

We proceed with a description of the response of our data series to a monetary policy shocks, i.e., an unexpected increase (of 25 basis points) of the Federal funds rate. Figure 6A shows the response of the Federal funds rate, the index of industrial production — as an aggregate measure of economic activity — and an aggregate price index (PCE deflator). The solid line shows the responses generated by our FAVAR and the dashed lines show the responses obtained from a standard VAR that include these three variables only.[20] Figure 6B shows similar impulse responses except that the VAR is estimated using the consumer price index (CPI) instead of the PCE deflator.

One important feature of this figure, emphasized by BBE, is that the VAR displays a price puzzle (especially for the CPI) and a large effect of monetary policy on industrial production after four years, which is inconsistent with long-run money neutrality. Instead the FAVAR displays a more conventional response of industrial production, and essentially no response of the price index for the first few months following a monetary policy shock. As discussed in BBE, since the FAVAR nests the VAR specification, this suggests that the FAVAR is able to exploit the relevant information from the data set, that Sims (1992) argued may be missing from small-sized VARs.[21]

We now turn to the responses of more disaggregated price series to the monetary policy shock. The FAVAR is perfectly suited for such an exercise as it allows us to compute directly the responses of all of the variables in the data set. The right panels of Figure 3 contain the disaggregated PCE and PPI price responses to the same identified monetary policy shock. While we observe some heterogeneity in the responses, a striking feature is that most indices respond very little for several months following the shock, and start falling only later. In addition, only very few sectors display price increases. Recall that in order to identify the monetary policy shock, we assume that individual prices do not respond within the same month to changes in the Federal funds rate. However nothing in the estimated FAVAR constrains the response of price series in the months following the monetary policy shock.

The right panels of Figure 3 also plot the unweighted average response (thick solid line) and

[20] The VAR includes 13 lags as is the case for the estimated equation (1) in the FAVAR.

[21] Note that if the additional series added to the data set were irrelevant, they should result in less precise estimates, but they should not bias the estimated responses. As a result, the fact that the responses of the price index and the industrial production are different for both specifications suggests that the FAVAR is exploiting relevant information.

the response of the overall price index (thick dashed line). It is interesting to note that the average price responses to a monetary shock and the response of the aggregate price indices are very similar. This suggests that the weights used in aggregate price indices do not play an important role in characterizing the response in the overall price indices. The figure makes it clear that most of the disaggregated prices move little in the 6 months following the monetary shock, and start decreasing thereafter. As reported in Table 3, prices fall on average (across sectors) only by 0.03% after 6 months, and by 0.07% after the first 12 months. The drop in prices is more pronounced for producer prices than for consumer prices.

In addition, when they start falling following the monetary shock, prices tend to decline fairly steadily for a couple of years. As reported in Table 3, the autocorrelation coefficients of inflation conditional on a monetary shock are all very high. These responses result in relatively persistent sectoral inflation movements which contrast sharply with the responses to sector-specific shocks.

The right panel of Figure 4 represents the impulse responses of the PCE quantities to the same monetary policy shock. While on average the real consumption responses tend to fall subsequent to the monetary shock, before reverting back to the initial level, there is considerable variation across sectors. As for the price responses, the average real consumption responses displays some persistence. Interestingly, sectors in which prices fall the most following a monetary shock tend to be sectors in which quantities fall the least, as indicated in Figure 7. This figure displays the scatter plot across PCE categories of the responses of prices and quantities 12 months after the monetary shock, and the regression line reveals a significant and negative slope.

To the extent that one is interested in characterizing the behavior of the economy in response to monetary policy actions, our results provide empirical support for features such as price rigidities and inflation persistence often embedded in monetary models. Our findings, however, contrast sharply with those of Bils, Klenow, and Kryvtsov (2003) and Balke and Wynne (2003) which call for a rejection of conventional sticky-price models. These authors found the opposite conclusion mainly because they estimate an important price puzzle.

Bils, Klenow, and Kryvtsov (2003) estimate responses of 123 components of the CPI to Federal funds rate innovations, where the latter innovations are extracted from a 7-variable monthly VAR. As the VAR is estimated independently from the disaggregated price data, the responses obtained constitute only rough estimates of the price responses. Based on frequencies of price adjustments reported in Bils and Klenow (2004), they consider two categories of price responses — the flexible price and sticky price categories — and they report the responses of the prices in both categories as well as their ratio. They argue that the movements in relative prices are inconsistent with a popular sticky-price model. Following an expansionary monetary policy shock, their estimated relative price (of flexible prices relative to sticky prices) declines initially and then increases, while in the model, the relative price increases temporarily before reverting back to zero. However, the main reason for their finding of an unconventional relative price response in the data is related to the fact that their estimate of flexible-price responses display a price puzzle: the flexible prices fall initially in response a monetary policy expansion, and increase only later. In contrast, sticky prices do not show significant dynamics in the first 20 months.

Balke and Wynne (2003), instead, focus on components of the producer price index. After estimating a small-sized VAR and the response of components of the PPI to an identified monetary policy shock, they also find a substantial price puzzle in individual series, and thus conclude similarly to Bils, Klenow and Kryvtsov (2003) that the implied estimated evolution of relative prices in inconsistent with that predicted by sticky price models.

These studies make two key assumptions about the behavior of the macro-economy: i) that the macroeconomic dynamics can be properly uncovered from a small set of macroeconomic indicators, and ii) that macroeconomic dynamics can be modeled separately from the disaggregated prices. Based on the results of BBE, and as argued above, the first assumption does not seem to be empirically valid and could be responsible for finding a price puzzle. The second assumption implies that disaggregated prices only have an effect on the macroeconomy through an observed aggregate index. The FAVAR framework that we consider in this paper relaxes these two assumptions as it allows us to incorporate more information in the estimation of the macroeconomic dynamics, and to model the disaggregated dynamics in a more flexible fashion. Interestingly, in contrast to these studies, we don't find any evidence of price puzzle in our estimated FAVAR. This implies that the ratio of flexible to sticky prices behaves as predicted by standard monetary models (including sticky price models) with flexible prices falling after a contractionary monetary policy shock.

5.2.1 Evidence of relative-price changes

One characteristic of the sectoral price and quantity responses reported in Figures 3 and 4 is that they seem to imply important degrees of monetary non-neutrality. In fact, following a monetary shock, all prices do not seem to revert to the same level, at least in the first four years following the shock.[22] It is important to realize however that the long-run responses to a monetary policy shock obtained from such analysis tend to be quite imprecisely estimated. We thus investigate whether there is in fact evidence of monetary non-neutrality once the uncertainty surrounding the estimated responses to monetary shocks is taken into account.

To document explicitly the extent of uncertainty surrounding the long-run responses of relative prices, we use the empirical distribution of each sector's impulse response functions to a monetary shock obtained by the bootstrap procedure described in footnote 10. More specifically, for each sector i and for each iteration of the bootstrap, we compute the response of the price of sector i relative to the average price response. In each sector, we compute the fraction of these relative prices that are positive, over all draws of the bootstrap. We denote by f_i^h this fraction for the sector i and horizon h.

Figure 8 plots the fraction of the sectors for which the bootstrapped impulse responses functions to a monetary policy shock are significantly different from the cross-sectional average price response at the 10% confidence level — i.e. the fraction of the sectors for which $f_i^h > 0.95$ or $f_i^h < 0.05$.[23] The figure reports these fractions at different horizons (from 0 to 120 months) and for disaggregated PCE prices (solid line) and PPI prices (dashed line). It shows that for the first couple of years following the monetary shock, a substantial number of sectors display relative price changes. For instance, two years after the shock, about 30% of the PCE sectors display price responses either above or below the average price response in 95% of the bootstrap iterations. However, 5 or 6 years after the shock, very few sectors show significant relative price changes. Under the null hypothesis that there are no long-run relative price changes, we would expect that 10% of the sectors would display significant relative price changes at the 10% confidence level. In fact, less that 5% of the PCE and PPI sectors reveal long-run relative price changes at the 10% confidence level, suggesting

[22] Lastrapes (2006) using VARs finds that productivity and money supply shocks have long-run effects on the distribution of relative commodity prices.

[23] The bootstraped impulse responses involve 1,000 iterations.

monetary neutrality 5 or 6 years after the shock. The results (not reported) are similar for PCE quantities and for other conventional confidence levels.

The results just discussed thus indicate that the long-run responses of disaggregated prices and quantities reported in Figures 3 and 4 are not inconsistent with long-run monetary neutrality. Under long-run monetary neutrality, all prices should eventually display an equiproportionate change — or "pure inflation," in the words of Reis and Watson (2007) — following a monetary shock. However, even in the face of such a shock, we observe important relative price movements in the short run, which are consistent with the presence of price rigidities. Interestingly, these results are also consistent with Reis and Watson's (2007) finding that a large fraction of aggregate inflation fluctuations reflects in fact relative price changes.

5.3 Cross-sectional variation in price responses

Having estimated impulse responses of sectoral prices to monetary policy shocks, we now attempt to explain differences in prices responses with sectoral characteristics.

5.3.1 Impulse responses and volatility of sectoral shocks

Two striking results are the strongly negative correlations of sectoral prices' responses to monetary shocks (in the columns IRF6 and IRF12 of Table 2) with the volatility ($Sd(e_i)$) and persistence of idiosyncratic shocks ($\rho(e_i)$). To interpret these correlations, we should point out that the impulse responses are calculated for a contractionary monetary policy and therefore more negative numbers imply more price flexibility, i.e., more rapid price adjustments.

As shown in Figure 9, sectors with small enough sectoral shocks see almost no price response to monetary shocks over the first 6 months. However the larger the sector-specific volatility the higher the price responses to monetary policy shocks. This result confirms the interpretation of Figure 1, that industries with high inherent volatility adjust also faster to macroeconomic disturbances. Similar pictures are found for when we consider longer horizons. Such a finding appears consistent with the prediction of the state-dependent model of Gertler and Leahy (2006). In this model, firms are affected by idiosyncratic shocks and face a cost of adjusting prices. The model predicts that the more firms are affected by idiosyncratic shocks, the more they adjust prices conditional on a monetary policy shock. Alternatively, by referring to the costs of processing information, Reis (2006) presents a model of inattentive producers in which a higher volatility of shocks requires more frequent price updating.

In addition, we note from Table 2 that the persistence of the idiosyncratic shocks is also negatively related to the responses of prices to monetary policy shocks. One possible interpretation is that in industries where we observe more persistence of the idiosyncratic component, firms adjust immediately to *any* shock because both common and idiosyncratic components are persistent. Those firms that experience rather transient idiosyncratic shocks wait to see if the current shock is persistent (macroeconomic) or not (idiosyncratic) and adjust only with a delay. Of course, these are raw correlations and it is not clear whether any of these relationships will remain significant after controlling for example for the degree of competition in the industry. Accordingly, we turn now to regression analysis.

5.3.2 Responses of producer prices and industry characteristics

For the producer price series we have collected data on industry characteristics by NAICS codes. We can match the responses of prices to these characteristics. Our goal is to provide evidence on the main explanatory factors for the dispersion in price responses observed in the right panels of Figure 3. To address this question we start with the following specification of the cross-industry price responses:

$$IRF_{i,h} = \alpha + \beta_1 \ comp_i + \beta_2 \ Sd(e_i) + \beta_3 \ \rho(e_i) + \epsilon_i \tag{4}$$

where $IRF_{i,h}$ is the percent deviation of the price level in industry i from its initial level, h periods after a monetary policy shock. We focus our results on the deviation of prices at a horizon of 12 months, but note that the results are robust changes in the horizon. $comp_i$ denotes the degree of competition. We also use two variables from the factor analysis: $Sd(e_i)$ measures the volatility of the idiosyncratic component while $\rho(e_i)$ is the persistence of this component. To check robustness we will also add other controls and deterministic components like dummy variables.

We start in Table 4 by using as a dependent variable the price response at the 12-month horizon for each of the 149 industries (6-digit level). Column (1) reports that profit rates are strongly and positively correlated with price responses. Since our price responses are on average negative and higher flexibility implies more negative cumulative deviation, the result implies that more competitive industries (lower profit rates) have higher price flexibility. The mean profit rate is about 25% and an increase in profit from the mean to 35% implies smaller (less negative) price response by almost 0.05 percentage points. This is consistent with standard sticky-price models (see e.g., Woodford, 2003), as well as with theories based on rational inattention (Reis, 2006). In column (5), we include three dummy variables to control for potentially different average price dynamics. We use three broad categories — food and textiles (NAICS codes starting with 31; dummy is coded as *d1*); paper, wood, chemicals (codes with 32; dummy is denoted by *d2*); and metallurgy, electronics and machinery (codes with 33; dummy is denoted by *d3*). In all three cases, the intercepts are negative, signifying the absence on average of a price puzzle for profit rates below 50%. Notably, the extra flexibility of the model improves the fit, but does not alter the coefficient on profit rates. In column (6), by including an interaction term we test whether the relationship between market power and price flexibility differs across major industry categories, but we find little evidence of changes across major categories (the coefficients are not significantly different from each other).

This positive relationship between price stickiness and competition within each sector contrasts with Bils and Klenow's (2004) finding that their preferred measure of market power — the C4 ratio — becomes insignificant once they control for prices of raw material goods.[24] As in Bils and Klenow, we also find that the C4 ratio is not a robust predictor of price dynamics. We use the inverse of the ratio as a measure of elasticity of demand, and we report in column (2) that the inverse of the C4 ratio is not significantly related to price dynamics. However, our results based on mean profit rates imply that for producer prices, market power is robustly related to price dynamics in response to monetary shocks.

Columns (3) and (4) confirm the observations from the correlation matrix (Table 2): both idiosyncratic volatility and persistence are negatively related to price impulse responses. This implies that firms in industries with persistent and volatile idiosyncratic shocks adjust rapidly to

[24] The C4 ratio (or four-firm concentration ratio) of an industry is defined as the market share of the four largest firms in the industry. It is used as a proxy for market power. In industries dominated by few firms, the ratio is close to 100% while in competitive industries the market share of the four largest firms is usually below 20%.

changes in the macroeconomic environment. Interestingly, the result survives once we include as controls profit rates (column (7)). We will treat the specification in column (7) as our baseline in order to explore the robustness of our findings. The last column of Table 4 shows that gross profit rates and idiosyncratic volatility are significant predictors of price flexibility also at the 6-month horizon.

To sum up, our sectoral analysis indicates that as predicted by models based on monopolistic competition, prices adjust more sluggishly in industries in which market power is higher. In addition, we uncovered two other important determinants of price responses: idiosyncratic volatility and the persistence of industry-specific shocks.

6 Robustness Results

6.1 Cross-sectional variation with long-run restrictions

As discussed in section 5.2.1, we don't find evidence of significant long-run relative price changes, following a monetary policy shock. Nonetheless, one might be concerned that the cross-sectional regressions results reported in the previous section may be affected by the apparent disparity of long-run price responses. To assess the effect of the apparent monetary non-neutrality on these results, we repeat our cross-sectional regressions imposing long-run restrictions on all relative prices. More precisely, on each of the sectoral price series, we impose the restriction that the response must be equal to the aggregate price response at a particular date in the future. Such restrictions involve only the factor loadings Λ in the observation equation (2), and for each price series, the coefficients in the observation equation are estimated via restricted OLS. Appendix B contains the technical details about this estimation and presents the least-squares estimator of the factor loadings.

We report results using our FAVAR estimated with long-run restrictions at a horizon of 4 and 10 years. As mentioned before, we impose that at these horizons all price indices have a response to the monetary policy shock that is equal to the response of the aggregate price index, to ensure that there are no effects of monetary policy on relative prices. Figure 10 plots the responses of PCE and PPI prices to a monetary shock when these long-run restrictions are imposed. Table 6 provides the statistics reported in Table 3 when the restrictions are imposed. Apart from the fact that the prices responses are by construction all meeting at some given horizon in the future, these results reveal no important difference with respect to the case discussed above. Table 5 provides further evidence that gross profit rates and idiosyncratic volatility are significant predictors of price flexibility. The results reported in columns (1)-(4) suggest that the short-term dynamics of prices are not influenced significantly by the imposition of the long-run restrictions. To the contrary, market power and idiosyncratic volatility are still significant and economically important determinants of price flexibility. The results for our persistence measure $\rho(e_i)$ are mixed — there is no statistical significance for the correlation between persistence and price responses at 6 month horizon, but at the longer horizon of 12 months the negative correlation is still present.[25] These results thus confirm that the cross-sectional distribution of price responses in the short run is not too sensitive to the long-run responses.

6.2 Post 1984

All of the results reported above are based on a sample that starts in 1976:1 and ends in 2005:6. Recent research has however provided evidence of widespread instability in many macroeconomic series[26], of changes in monetary policy behavior[27] over our sample, and of an important reduction in output volatility since around 1984. To ensure that our results are not affected by such events, we reproduce our main results for the sample 1984:1 – 2005:6.

Table 7 reproduces Table 1 for the post-1984 sample. While the persistence in inflation is lower in that sample — with the decline in persistence due to a lower persistence in the common component — all of the qualitative results discussed in Section 4 remain valid. Most notably, it remains true that most of the volatility in sectoral inflation is explained by sector-specific disturbances. In fact, only about 10% of inflation fluctuations is attributable to macroeconomic factors. Even though the persistence in disaggregate inflation is lower in the post-1984 sample than in our full sample, that persistence remains due to macroeconomic factors.

[25] We have reproduced the full set of regressions as reported in Table 4 for the specifications in Table 5. Since there is very little variation in the results we have decided not to report these estimates. The full set of tables is available from the authors.

[26] Stock and Watson (1996, 2002) have provided evidence of instability in VARs.

[27] Bernanke and Mihov (1998), Clarida, Galí and Gertler (2000), Cogley and Sargent (2001, 2005), Boivin (2006), Boivin and Giannoni (2002, 2006).

Figure 11 reproduces the responses of disaggregated prices to sector-specific shocks, to macroeconomic shocks, and to monetary policy shocks. Once again, while there are some changes,[28] the responses are qualitatively similar to the ones reported for the full sample in Figure 3. Importantly, the price responses to idiosyncratic shocks are very different from those to macroeconomic shocks, and disaggregated prices continue to respond with a significant delay to monetary policy shocks.

6.3 Alternative factor estimations

Bernanke, Boivin and Eliasz (2005) (BBE) similarly to Stock and Watson and several other authors extract factors from a bit more than a hundred macroeconomic series. In this paper, instead, we extract the factors on the basis of these series plus a large number of disaggregated price and quantity series. To the extent that disaggregated series are indeed driven in part by macroeconomic sources of fluctuations – i.e., to the extent that the factor structure that we postulate is a useful characterization of the data – expanding the data set with disaggregated prices and quantities should not "tilt" the factors in one direction at the expense of other dimensions of the economy, as long as we have included at least as many factors as their true number.

To ensure that this indeed the case in our application, we performed two robustness checks. First, we repeated our calculations with a larger number of estimated factors, and found no noticeable differences in our results. Second, we re-estimated the FAVAR, estimating the factors in the first stage only on the basis of the 111 series that were identified by Stock and Watson as the most informative series for extracting common factors. The extracted factors correspond to those used in BBE. We find that none of our conclusions are sensitive to this change in the information set. Table C.1, in Appendix C, repeats the calculations underlying the Tables 1 and 3 but this time estimating the latent factors on the smaller data set. The results are overall almost identical for both sets of latent factors. One noticeable difference however is that the Stock-Watson/BBE data yields a slightly larger price puzzle in response to monetary shocks, suggesting that there is useful information in the disaggregated price series for the estimation of monetary policy shocks. In fact

[28] One noticeable change is the fact that the price responses to the same monetary shock are overall smaller in the post-1984 period than in the larger sample. Boivin and Giannoni (2006) estimate a structural model to explain this observation and conclude that the smaller responses are well explained by a change in systematic monetary policy since the early 1980's.

the median price response is slightly positive at the 6-month horizon, though not significantly so. All figures are also similar to those reported, when we use the Stock-Watson/BBE factors.

As another robustness check, we reestimated the FAVAR again with 5 latent factors, but assuming now that the index of industrial production and the aggregate PCE price index constitute observable factors, besides the Federal funds rate. Again, none of our results change with this specification. The key statistics reported Table C.2 are very similar to those reported in Tables 1 and 3.

7 Conclusion

In this paper, we disentangle the fluctuations in disaggregated U.S. consumer and producer prices which are due to aggregate macroeconomic shocks from those due to shocks to individual price series. We do so by estimating a factor-augmented VAR that relates a large panel of economic indicators and of individual price series to a relatively small number of estimated common factors. After identifying monetary policy shocks using all of the information available, we estimate consistently the effects of U.S. monetary policy on disaggregated prices. This is important not only to get a better understanding of the nature of the fluctuations in disaggregated prices, and of how prices react to macroeconomic shocks, but also to assess the impact of monetary policy on prices in various sectors.

We obtain several empirical results that can be summarized as follows:

1. At the level of disaggregation considered, most of the monthly sectoral prices fluctuations appear to be due to sector-specific factors, and only about 15% of monthly individual sectoral price fluctuations, on average, are due to aggregate macroeconomic factors.

2. Sectoral inflation fluctuations are relatively persistent, but this persistence is essentially due to the very high degree of persistence in the components driven by common or macroeconomic shocks, and not to sector-specific disturbances. As a result, sectoral prices respond very differently to sector-specific shocks and to macroeconomic shocks: while sector-specific shocks may cause large fluctuations in sectoral inflation, these fluctuations are typically short lived so that prices tend to move immediately to their new permanent level; aggregate macroeconomic

shocks instead tend to have more persistent and sluggish effects on a wide range of sectoral inflation rates.

3. Most disaggregated prices respond with a significant delay to identified monetary policy shocks, and show little evidence of a "price puzzle," contrary to existing studies based on traditional VARs. The absence of a strong price puzzle suggests that by exploiting a large information set in the estimation of a FAVAR, we may obtain more accurate estimates of the effects of monetary policy, as emphasized by BBE.

4. PCE categories in which prices fall the most following a monetary policy shock tend to be those in which quantities consumed fall the least.

5. The observed dispersion in the reaction of producer prices to monetary policy shocks is significantly explained by the degree of market power as measured by gross profits.

6. Prices react more rapidly to monetary policy shocks in sectors with volatile idiosyncratic and persistent idiosyncratic shocks.

7. The correlations between the idiosyncratic components of prices and quantities tend to be negative, suggesting that sector-specific shocks may be driven by supply-type shocks, and/or may reflect sampling error in measured disaggregated prices.

This collection of stylized facts on the response of disaggregated U.S. prices to various shocks presents challenges to current models of price determination. An evaluation of various models on the basis of these stylized facts is beyond the scope of this paper. Nevertheless, it is worth pointing out that our finding number 2 — namely that sectoral prices respond differently to macroeconomic and sector-specific shocks — may explain why sticky-price models such as the Calvo model have been so popular in characterizing the effects of monetary policy actions on aggregate variables, while they have been sharply criticized at the same time by authors focused on disaggregated price series.

Clearly, it would be desirable to have models that can fully account for the responses of aggregate and disaggregated prices to both macroeconomic and sector-specific disturbances. Some recent papers are very promising in this respect. Carvalho (2006) generalizes the Calvo model to allow for heterogeneity in price stickiness across sectors. He finds that in the presence of strategic complementarities, firms which adjust prices infrequently have a disproportionately large effect on the decisions of other firms, and thus on the aggregate price level. Even if most sectors have relatively flexible prices, and thus respond quickly to sector-specific disturbances, they may respond sluggishly to nominal shocks. Gertler and Leahy (2006) propose a state-dependent pricing model that involves volatile prices due to idiosyncratic shocks, but that predicts sluggish price responses to a monetary shock, as reported here, due to real rigidities.[29] Given that firms are assumed to consider price adjustments only when they are hit with sector-specific shocks, the model also predicts that a high volatility of idiosyncratic shocks should be associated with more volatile prices and a more volatile response to monetary shocks, as we find in the data. In yet another direction, recent models on rational inattention such as the one proposed by Maćkowiak and Wiederholt (2006) are also able to generate different responses of sectoral prices to sector-specific shocks and aggregate shocks. In such a model, prices may respond slowly to aggregate shocks but quickly to sector-specific shocks as firms choose to pay relatively little attention to macroeconomic conditions and more attention to firm-specific conditions.[30]

Assessing the empirical success of each of these theories along the many dimensions documented in this paper is not a trivial task. Even though a strict and literal interpretation of any of these models may always be rejected on some dimension, a fair assessment requires moving beyond the strict interpretation and determining whether some enriched version of existing theories can be successful. This is in our view an important avenue for future research.

[29] In contrast, the state-dependent model of Golosov and Lucas (2007) which has idiosyncratic productivity shocks but which abstracts from strategic complementarities generates rapid and strong price responses following a monetary policy shock. Midrigan (2006), however, extends the model of Golosov and Lucas (2007) to a multi-product setting and calibrates the distribution of idiosyncratic shocks in a way that mitigates the price responses to monetary shocks.

[30] In the model of Reis (2006), firms rationally choose to be inattentive to news and occasionally update their information. This model predicts that (i) stickiness is higher in industries with low price elasticity of demand; (ii) costs of processing information are positively related with inattentiveness; (iii) volatility of shocks requires more frequent updating. While this model does not distinguish between aggregate and sector-specific conditions, one can imagine an extension which would generate different responses to such shocks.

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Table 1 — Volatility and persistence of monthly inflation series

		Standard deviation (in %)			R^2	Persistence		
		Inflation	Common comp.	Sector-specific		Inflation	Common comp.	Sector-specific
Aggregated series								
PCE	Total	0.24	0.21	0.11	0.80	0.93	0.96	0.23
	Durables	0.33	0.25	0.21	0.58	0.92	0.98	0.52
	Nondurables	0.42	0.31	0.29	0.53	0.76	0.92	0.28
	Services	0.24	0.19	0.14	0.64	0.94	0.98	-0.65
Disaggregated series								
All	Average	1.15	0.33	1.09	0.15	0.49	0.92	-0.07
	Median	0.75	0.27	0.71	0.12	0.59	0.94	-0.01
	Minimum	0.23	0.06	0.13	0.01	-3.57	0.22	-2.21
	Maximum	11.68	1.86	11.61	0.73	0.96	0.99	0.85
	Std	1.14	0.23	1.13	0.12	0.42	0.08	0.49
PCE	Average	0.98	0.30	0.92	0.17	0.50	0.93	-0.10
	Average (weighted)	0.88	0.31	0.80	0.27	0.60	0.94	0.08
	Median	0.65	0.24	0.61	0.12	0.60	0.95	-0.01
	Minimum	0.23	0.08	0.13	0.01	-3.57	0.22	-2.21
	Maximum	11.68	1.86	11.61	0.73	0.96	0.99	0.85
	Std	1.10	0.23	1.09	0.15	0.50	0.08	0.55
PPI	Average	1.36	0.38	1.30	0.12	0.48	0.91	-0.04
	Median	0.92	0.31	0.88	0.11	0.56	0.93	0.00
	Minimum	0.35	0.06	0.30	0.01	-0.58	0.29	-1.36
	Maximum	7.75	1.13	7.69	0.42	0.91	0.98	0.78
	Std	1.16	0.21	1.15	0.08	0.29	0.07	0.40

Notes: Sample is 1976:1–2005:6. Inflation is measured as $\pi_{it}= p_{it}-p_{it-1}$ where p_{it} is the log of the price series i. Common components are $\lambda_i' C_t$. Sector-specific components are e_{it}. R^2 statistics measure the fraction of the variance of π_{it} explained by $\lambda_i' C_t$. Persistence is based on estimated AR processes with 13 lags. Weighted average of statistics for disaggregated PCE series is obtained using expenditure shares in year 2005 as weights.

Table 2 — Cross-sectional correlations of various statistics

A. All prices (PCE and PPI)

	$\text{Sd}(\pi_i)$	$\text{Sd}(\lambda_i' C)$	$\text{Sd}(e_i)$	R^2	$\rho(\pi_i)$	$\rho(\lambda_i' C)$	$\rho(e_i)$	AC1	AC12	IRF6	IRF12
$\text{Sd}(\pi_i)$	1	0.79	1.00	-0.41	-0.61	-0.56	-0.17	0.29	0.23	-0.53	-0.45
$\text{Sd}(\lambda_i' C)$		1	0.77	-0.15	-0.35	-0.45	0.03	0.32	0.29	-0.59	-0.69
$\text{Sd}(e_i)$			1	-0.43	-0.62	-0.56	-0.19	0.29	0.23	-0.53	-0.44
R^2				1	0.55	0.32	0.38	-0.19	-0.11	0.18	0.12
$\rho(\pi_i)$					1	0.69	0.58	-0.01	-0.08	0.22	0.12
$\rho(\lambda_i' C)$						1	0.17	-0.14	-0.22	0.35	0.26
$\rho(e_i)$							1	0.21	0.14	-0.16	-0.21
AC1								1	0.85	-0.47	-0.54
AC12									1	-0.47	-0.57
IRF6										1	0.86
IRF12											1

B. PCE prices

	$\text{Sd}(\pi_i)$	$\text{Sd}(\lambda_i' C)$	$\text{Sd}(e_i)$	R^2	$\rho(\pi_i)$	$\rho(\lambda_i' C)$	$\rho(e_i)$	AC1	AC12	IRF6	IRF12	BK
$\text{Sd}(\pi_i)$	1	0.76	1.00	-0.36	-0.66	-0.63	-0.34	0.19	0.25	-0.34	-0.31	0.38
$\text{Sd}(\lambda_i' C)$		1	0.74	-0.10	-0.40	-0.45	-0.11	0.19	0.23	-0.50	-0.66	0.55
$\text{Sd}(e_i)$			1	-0.38	-0.67	-0.63	-0.36	0.19	0.25	-0.33	-0.28	0.37
R^2				1	0.50	0.30	0.45	-0.12	-0.08	0.07	0.01	-0.23
$\rho(\pi_i)$					1	0.79	0.65	0.00	-0.15	0.25	0.12	-0.33
$\rho(\lambda_i' C)$						1	0.34	-0.04	-0.21	0.37	0.19	-0.43
$\rho(e_i)$							1	0.10	0.01	-0.08	-0.07	-0.03
AC1								1	0.82	-0.33	-0.35	0.24
AC12									1	-0.45	-0.46	0.36
IRF6										1	0.77	-0.54
IRF12											1	-0.64
BK												1

C. PPI prices

	$\text{Sd}(\pi_i)$	$\text{Sd}(\lambda_i' C)$	$\text{Sd}(e_i)$	R^2	$\rho(\pi_i)$	$\rho(\lambda_i' C)$	$\rho(e_i)$	AC1	AC12	IRF6	IRF12
$\text{Sd}(\pi_i)$	1	0.82	1.00	-0.51	-0.59	-0.46	0.06	0.38	0.11	-0.66	-0.53
$\text{Sd}(\lambda_i' C)$		1	0.81	-0.18	-0.24	-0.41	0.29	0.49	0.30	-0.70	-0.74
$\text{Sd}(e_i)$			1	-0.53	-0.60	-0.46	0.05	0.38	0.10	-0.66	-0.52
R^2				1	0.77	0.34	0.26	-0.16	0.01	0.27	0.16
$\rho(\pi_i)$					1	0.49	0.39	-0.04	0.16	0.30	0.14
$\rho(\lambda_i' C)$						1	-0.16	-0.23	-0.16	0.36	0.29
$\rho(e_i)$							1	0.47	0.42	-0.25	-0.38
AC1								1	0.83	-0.64	-0.72
AC12									1	-0.52	-0.65
IRF6										1	0.90
IRF12											1

Notes: Sample is 1976:1–2005:6. $\text{Sd}(\pi_i)$ = standard deviation of sectoral inflation π_{it} over time; $\text{Sd}(\lambda_i' C)$ = st. dev. of the component of π_{it} driven by common factors; $\text{Sd}(e_i)$ = st. dev. of sector-specific component; $\rho()$ represents the persistence measure mentioned in Table 1. AC1 and AR12 are the first- and twelveth-order autocorrelations of the inflation response of π_{it} to a monetary policy shock. IRF6 and IRF12 are price level responses to a monetary shock,at horizons of 6 and 12 months, expressed in percent deviations from price level prior to shock. BK are the frequencies of price adjustments computed by Bils and Klenow (2004) and mapped to our PCE categories.

Table 3 — Response of price series to a monetary policy shock

		Autocorrelation of π_{it} conditional on shock				*Price responses (in %)*	
		1st-order	3rd-order	6th-order	12th-order	6 mo.	12 mo.
Aggregated series							
PCE	Total	0.97	0.91	0.81	0.62	-0.01	-0.04
	Durables	0.97	0.90	0.80	0.61	-0.01	-0.04
	Nondurables	0.97	0.92	0.84	0.66	-0.03	-0.10
	Services	0.96	0.88	0.76	0.54	0.00	-0.01
Disaggregated series							
All	Average	0.97	0.90	0.80	0.58	-0.03	-0.07
	Median	0.97	0.91	0.81	0.61	-0.01	-0.04
	Minimum	0.91	0.77	0.49	-0.02	-0.49	-0.69
	Maximum	1.00	0.98	0.92	0.79	0.18	0.20
	Std	0.01	0.04	0.07	0.13	0.08	0.11
PCE	Average	0.96	0.89	0.77	0.54	-0.01	-0.03
	Average (weighted)	0.96	0.89	0.77	0.54	-0.01	-0.04
	Median	0.96	0.89	0.79	0.58	0.00	-0.02
	Minimum	0.91	0.77	0.49	-0.02	-0.21	-0.58
	Maximum	1.00	0.98	0.92	0.79	0.11	0.20
	Std	0.01	0.04	0.08	0.14	0.05	0.08
PPI	Average	0.97	0.92	0.82	0.63	-0.05	-0.11
	Median	0.97	0.92	0.83	0.64	-0.02	-0.07
	Minimum	0.94	0.82	0.63	0.19	-0.49	-0.69
	Maximum	0.99	0.97	0.92	0.78	0.18	0.16
	Std	0.01	0.03	0.05	0.10	0.11	0.13

Notes: Sample is 1976:1–2005:6. Autocorrelations are computed on responses to monetary policy shock. Price responses at horizons of 6 and 12 months are expressed in percent deviations from price level prior to shock. Weighted average of statistics for disaggregated PCE series is obtained using expenditure shares in year 2005 as weights.

Table 4 — Cross-sectional dispersion of price responses to a monetary shock

Dependent variable: Responses of disaggregated PPI to monetary shock at horizons of 12 or 6 months

	Horizon of 12 months							6 months
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
constant	-0.226	-0.093	-0.034	-0.114			-0.128	-0.046
	(0.027)**	(0.019)**	(0.016)*	(0.010)**			(0.044)**	(0.031)
Gross profit	0.482				0.493		0.313	0.254
	(0.088)**				(0.088)**		(0.111)*	(0.101)*
invC4		-0.340						
		(0.535)						
Sd(e_i)			-5.732				-4.633	-5.274
			(1.569)**				(1.415)**	(0.985)**
$\rho\,(e_i)$				-0.119			-0.086	-0.040
				(0.018)**			(0.015)**	(0.013)**
$d1$					-0.244	-0.223		
					(0.031)**	(0.028)**		
$d2$					-0.235	-0.207		
					(0.029)**	(0.035)**		
$d3$					-0.218	-0.278		
					(0.029)**	(0.073)*		
$d1$*profits						0.417		
						(0.070)**		
$d2$*profits						0.386		
						(0.103)**		
$d3$*profits						0.735		
						(0.280)**		
Observations	149	149	151	151	149	149	149	149
R^2	0.17	0.00	0.27	0.13	0.53	0.54	0.44	0.52

Notes: Sample is 1976:1–2005:6. InvC4 is the inverse of the C4 ratio, where the C4 ratio is the market share of the 4 largest firms in the industry; Sd(e_i) = st. dev. of sector-specific component; $\rho\,(e_i)$ = persistence of sector-specific component; $d1, d2, d3$ are sectoral dummies. Robust standard errors in parentheses. (*) denotes significant at 5%; (**) denotes significant at 1%.

Table 5 — Cross-sectional dispersion of price responses to a monetary shock with long-run restrictions

Dependent variable: Responses of disaggregated PPI to monetary shock				
	Horizon of 12 months		Horizon of 6 months	
Long-run restrictions:	4 years	10 years	4 years	10 years
	(1)	(2)	(3)	(4)
constant	0.187	0.326	0.317	0.475
	(0.122)	(0.144)*	(0.114)**	(0.127)**
Gross profit	0.371	0.433	0.349	0.371
	(0.073)**	(0.076)**	(0.080)**	(0.077)**
Sd(e_i)	-0.437	-0.576	-0.494	-0.657
	(0.134)**	(0.159)**	(0.126)**	(0.145)**
$\rho\,(e_i)$	-0.008	-0.068	0.018	-0.032
	(0.021)	(0.017)**	(0.023)	(0.016)
Observations	149	149	149	149
R^2	0.18	0.26	0.18	0.24

Notes: See notes of Table 4. Robust standard errors in parentheses. (*) denotes significant at 5%; (**) denotes significant at 1%.

Table 6 — Response of price series to a monetary policy shock
Long-run restrictions imposed at horizon of 4 years

		Autocorrelation of π_{it} conditional on shock				*Price responses (in %)*	
		1st-order	3rd-order	6th-order	12th-order	6 mo.	12 mo.
Aggregated series							
PCE	Total	0.97	0.91	0.81	0.62	-0.01	-0.04
	Durables	0.97	0.90	0.81	0.62	-0.02	-0.05
	Nondurables	0.97	0.92	0.83	0.64	-0.01	-0.05
	Services	0.97	0.90	0.80	0.60	-0.02	-0.04
Disaggregated series							
All	Average	0.97	0.91	0.82	0.62	-0.04	-0.09
	Median	0.97	0.91	0.82	0.63	-0.02	-0.06
	Minimum	0.92	0.74	0.46	0.02	-0.48	-0.65
	Maximum	0.99	0.97	0.92	0.78	0.14	0.07
	Std	0.01	0.03	0.05	0.09	0.08	0.09
PCE	Average	0.97	0.90	0.80	0.59	-0.01	-0.04
	Average (weighted)	0.97	0.90	0.80	0.59	-0.01	-0.04
	Median	0.97	0.90	0.81	0.61	-0.01	-0.04
	Minimum	0.92	0.74	0.46	0.02	-0.22	-0.24
	Maximum	0.99	0.96	0.91	0.78	0.13	0.07
	Std	0.01	0.03	0.05	0.10	0.05	0.04
PPI	Average	0.98	0.92	0.84	0.66	-0.06	-0.14
	Median	0.97	0.92	0.84	0.66	-0.04	-0.11
	Minimum	0.95	0.84	0.66	0.33	-0.48	-0.65
	Maximum	0.99	0.97	0.92	0.78	0.14	0.07
	Std	0.01	0.02	0.04	0.07	0.10	0.10

Notes: Sample is 1976:1–2005:6. Autocorrelations are computed on responses to monetary policy shock. Price responses at horizons of 6 and 12 months are expressed in percent deviations from price level prior to shock. Weighted average of statistics for disaggregated PCE series is obtained using expenditure shares in year 2005 as weights.

Table 7 — Volatility and persistence of monthly inflation series
Post-1984 sample

		Standard deviation (in %)			R^2	*Persistence*		
		Inflation	Common comp.	Sector-specific		Inflation	Common comp.	Sector-specific
Aggregated series								
PCE	Total	0.16	0.13	0.09	0.70	0.74	0.83	0.34
	Durables	0.26	0.16	0.20	0.39	0.83	0.95	0.41
	Nondurables	0.40	0.33	0.22	0.71	0.28	0.70	0.49
	Services	0.16	0.09	0.13	0.30	0.73	0.96	-0.51
Disaggregated series								
All	Average	0.97	0.25	0.93	0.10	0.23	0.86	-0.16
	Median	0.64	0.16	0.62	0.07	0.30	0.88	-0.10
	Minimum	0.11	0.02	0.10	0.00	-4.33	0.34	-2.35
	Maximum	7.32	2.85	7.15	0.75	1.22	0.97	0.77
	Std	0.98	0.30	0.94	0.11	0.49	0.08	0.49
PCE	Average	0.86	0.24	0.81	0.13	0.19	0.87	-0.22
	Average (weighted)	0.75	0.28	0.68	0.20	0.37	0.89	-0.08
	Median	0.57	0.15	0.55	0.08	0.27	0.90	-0.21
	Minimum	0.11	0.04	0.10	0.01	-4.33	0.49	-2.35
	Maximum	7.32	2.85	7.15	0.75	0.95	0.97	0.77
	Std	0.93	0.34	0.88	0.14	0.57	0.08	0.51
PPI	Average	1.11	0.27	1.07	0.08	0.27	0.85	-0.10
	Median	0.75	0.17	0.72	0.06	0.34	0.87	-0.02
	Minimum	0.24	0.02	0.23	0.00	-1.32	0.34	-1.64
	Maximum	6.34	1.49	6.29	0.33	1.22	0.96	0.77
	Std	1.01	0.24	0.99	0.06	0.37	0.08	0.44

Notes: Sample is 1984:1–2005:6. Inflation is measured as $\pi_{it}= p_{it}-p_{it-1}$ where p_{it} is the log of the price series i. Common components are $\lambda_i' C_t$. Sector-specific components are e_{it}. R^2 statistics measure the fraction of the variance of π_{it} explained by $\lambda_i' C_t$. Persistence is based on estimated AR processes with 13 lags. Weighted average of statistics for disaggregated PCE series is obtained using expenditure shares in year 2005 as weights.

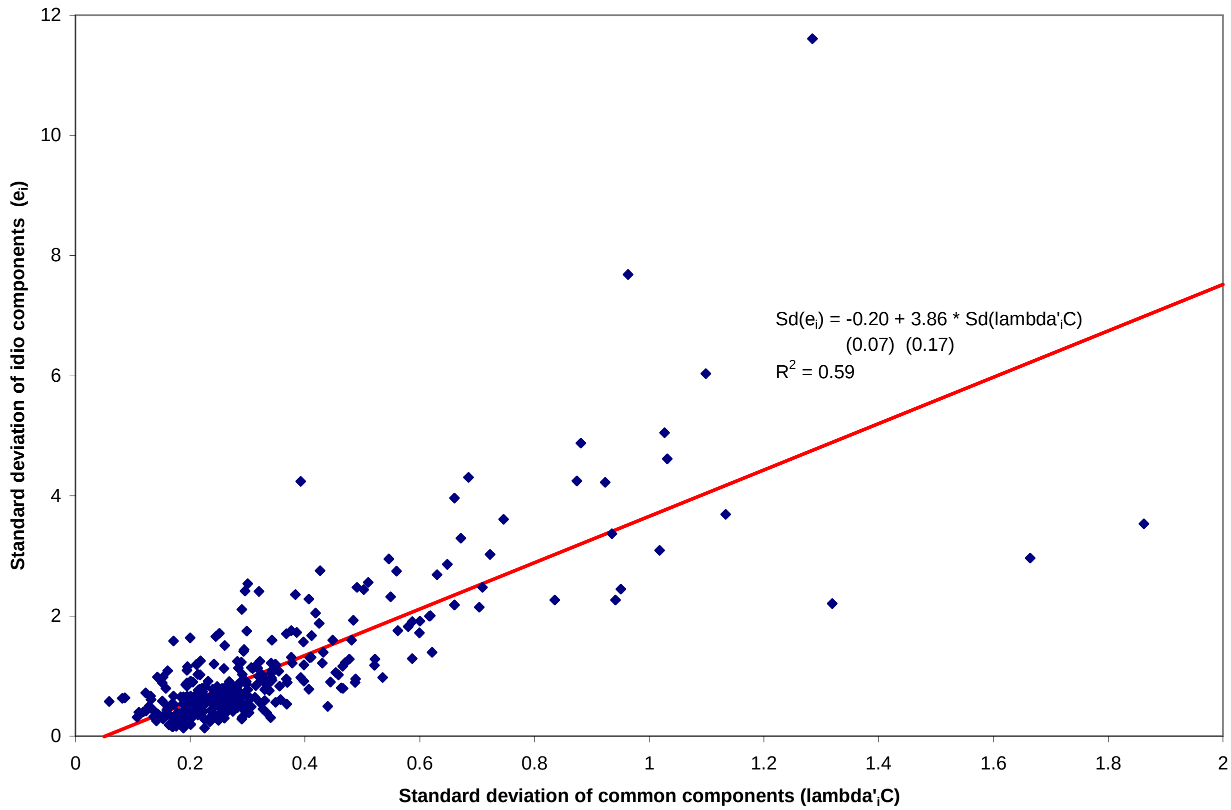

Figure 1: Volatility of common and sector-specific components of sectoral inflation rates

Notes: Standard deviations (expressed in %) refer to sector-specific and common components of sectoral inflation rates (PCE and PPI prices). Solid line represents cross-sectional regression line.

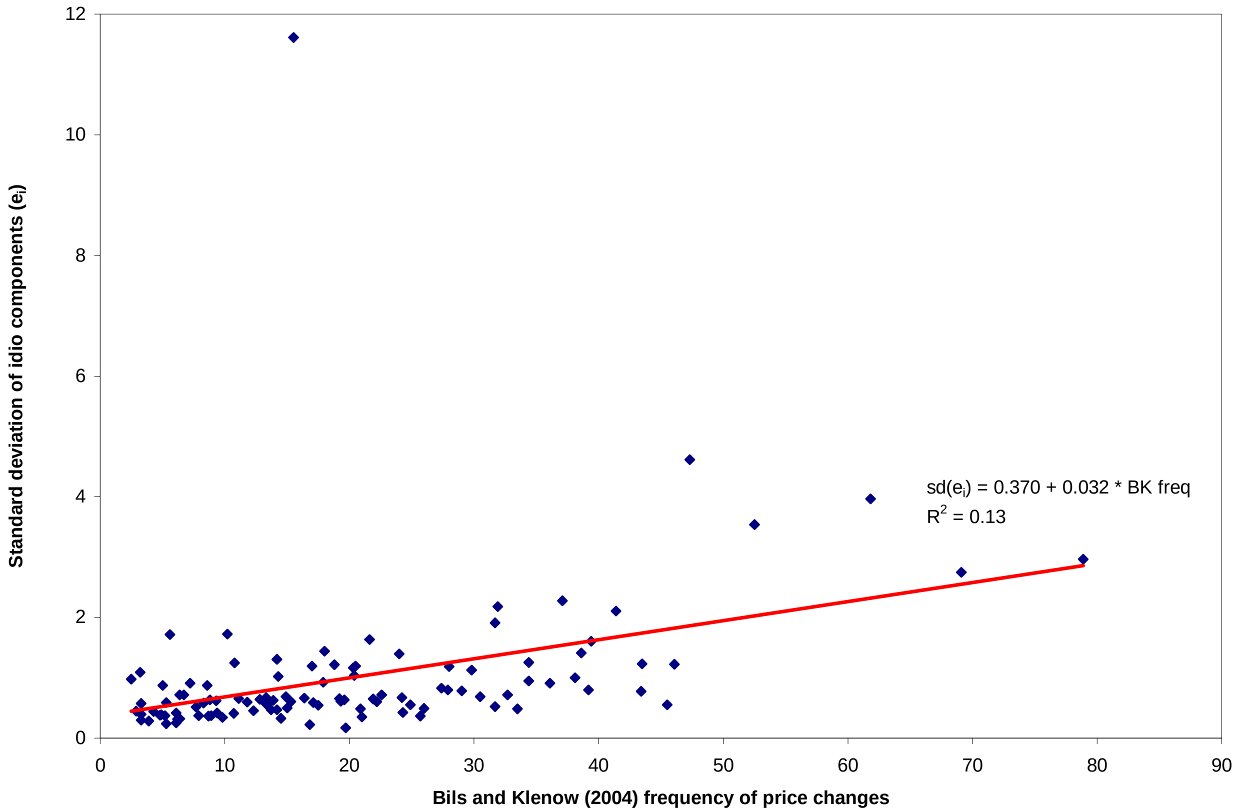

FIGURE 2: BILS-KLENOW FREQUENCY OF PRICE CHANGES AND VOLATILITY OF SECTORAL COMPONENTS

Notes: Standard deviations refer to sector-specific components of disaggregated PCE inflation series (expressed in %). Solid line represents cross-sectional regression line.

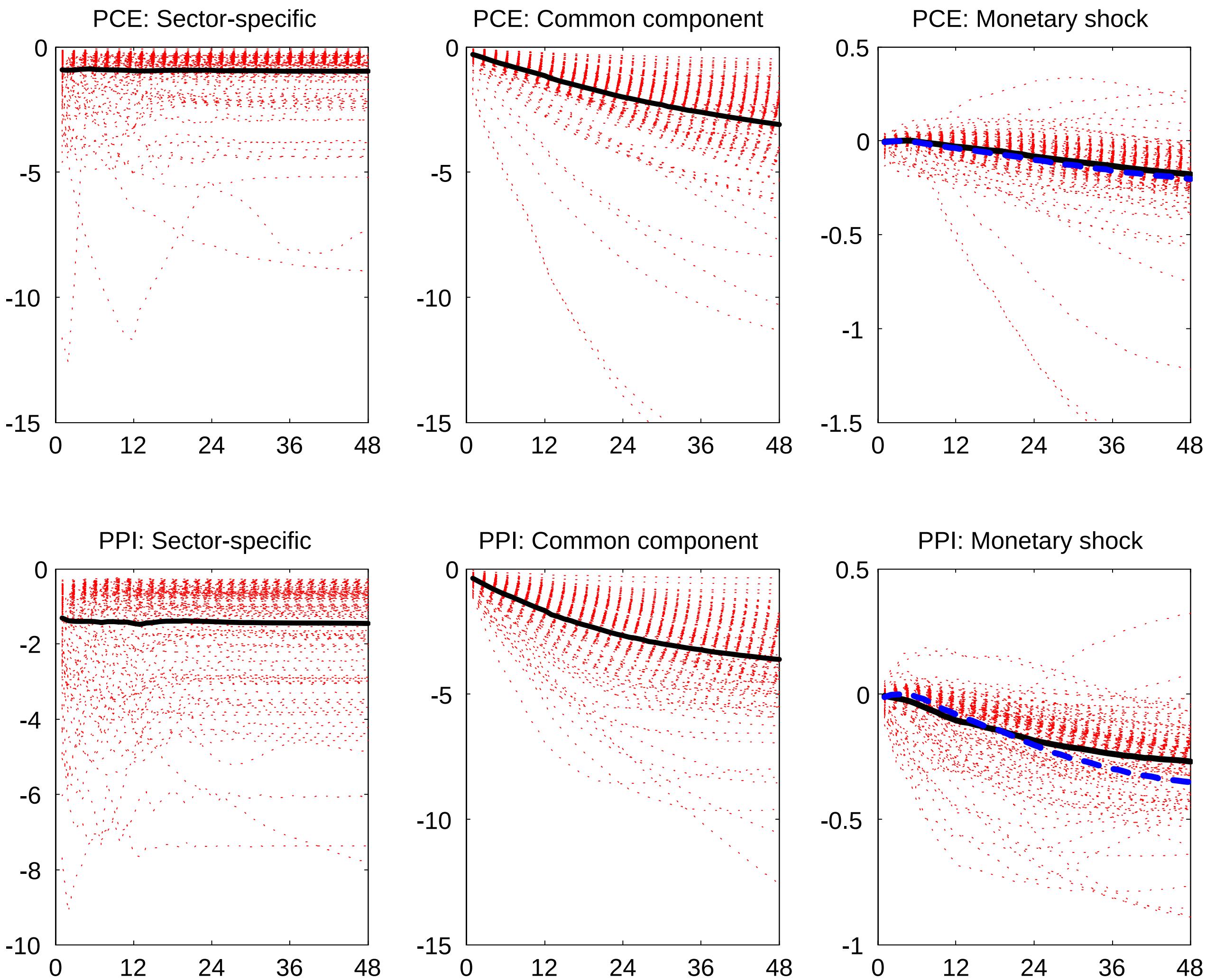

FIGURE 3. SECTORAL PRICE RESPONSES TO VARIOUS SHOCKS

Notes: Estimated impulse responses of sectoral prices (in %) to a sector-specific shock e_{it} of one standard deviation (left panels), to a shock to the common component $\lambda_i' C_t$ of one standard deviation (middle panels), and to an identified monetary policy shock (right panels). The monetary shock is a surprise increase of 25 basis points in the Federal funds rate. Thick solid lines represent unweighted average responses. Thick dashed lines represent the response of the aggregate PCE and PPI (finished) price indices to a monetary policy shock.

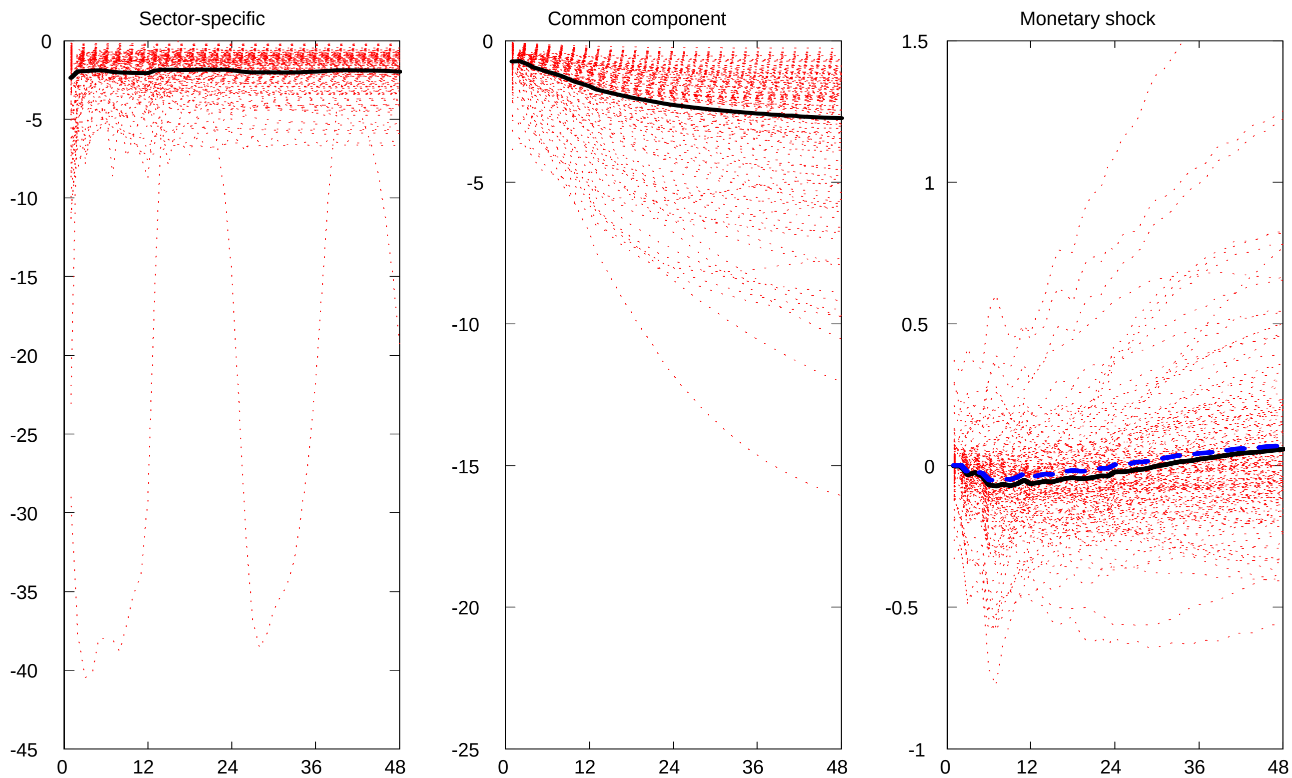

FIGURE 4: RESPONSES OF DISAGGREGATED CONSUMPTION TO VARIOUS SHOCKS

Notes: Estimated impulse responses of sectoral PCE quantities (in %) to a sector-specific shock e_{it} of one standard deviation (left panels), to a shock to the common component $\lambda_i' C_t$ of one standard deviation (middle panels), and to an identified monetary policy shock (right panels). The monetary shock is a surprise increase of 25 basis points in the Federal funds rate. Thick solid lines represent unweighted average responses. Thick dashed lines represent the response of the aggregate PCE quantity to a monetary policy shock.

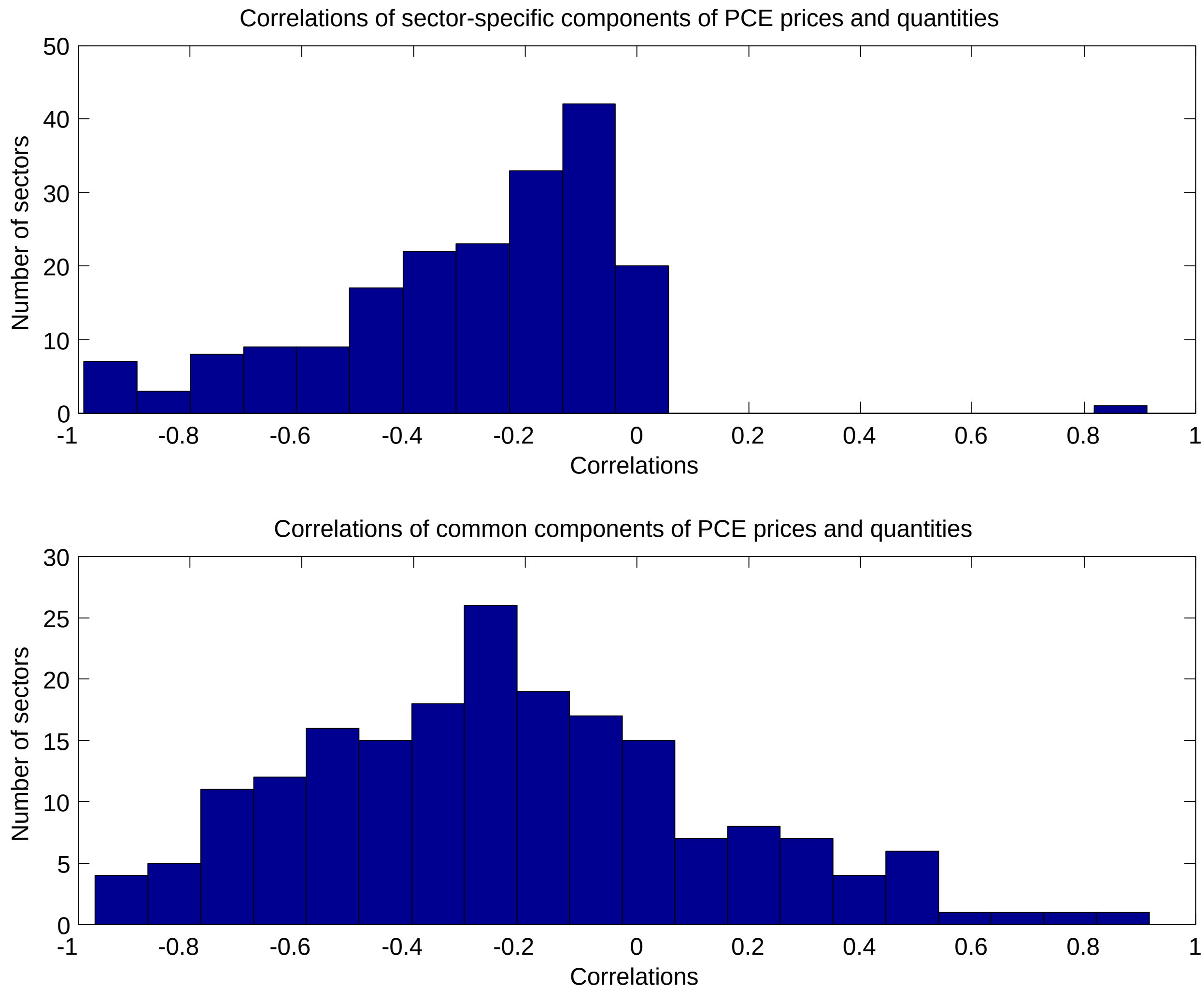

FIGURE 5: CORRELATIONS BETWEEN COMPONENTS OF PCE PRICES AND QUANTITIES

Note: Each panel represents a histogram of correlations for all PCE categories. The upper panel plots for each PCE category the correlation between the sector-specific component of PCE inflation rates and growth rates of PCE quantities. The lower panel plots the correlation between the component of PCE inflation and growth rates of PCE quantities that are driven by common macroeconomic fluctuations.

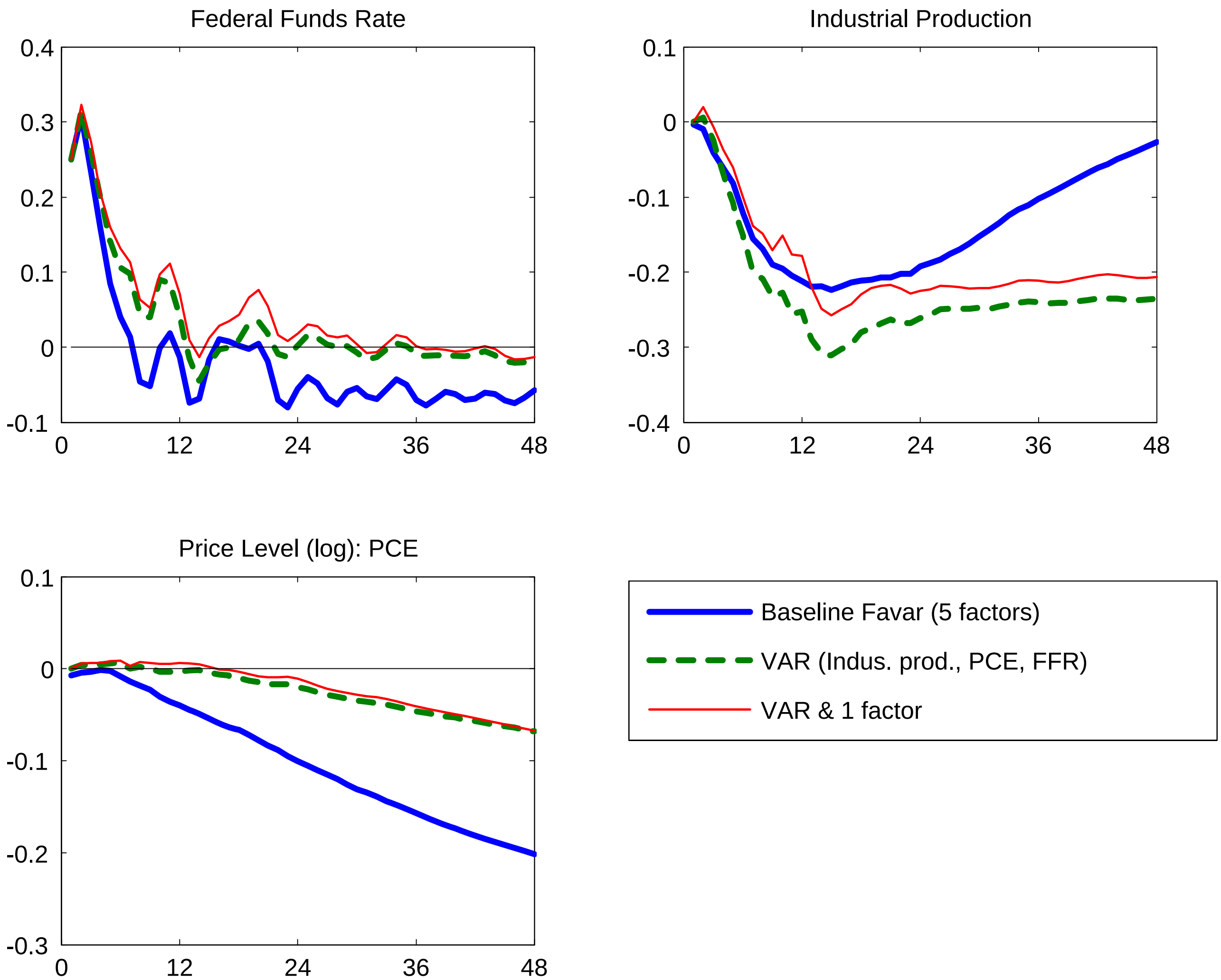

Figure 6a: Estimated impulse responses to an identified monetary policy shock (PCE)

Notes: Sample is 1976:1-2005:6. Monetary shock is an unexpected increase of 25 basis points in the Federal funds rate. Responses reported are estimated using baseline FAVAR (thick solid line), 3-variable VAR (thick dashed line) and same VAR augmented with first principal component of large data set.

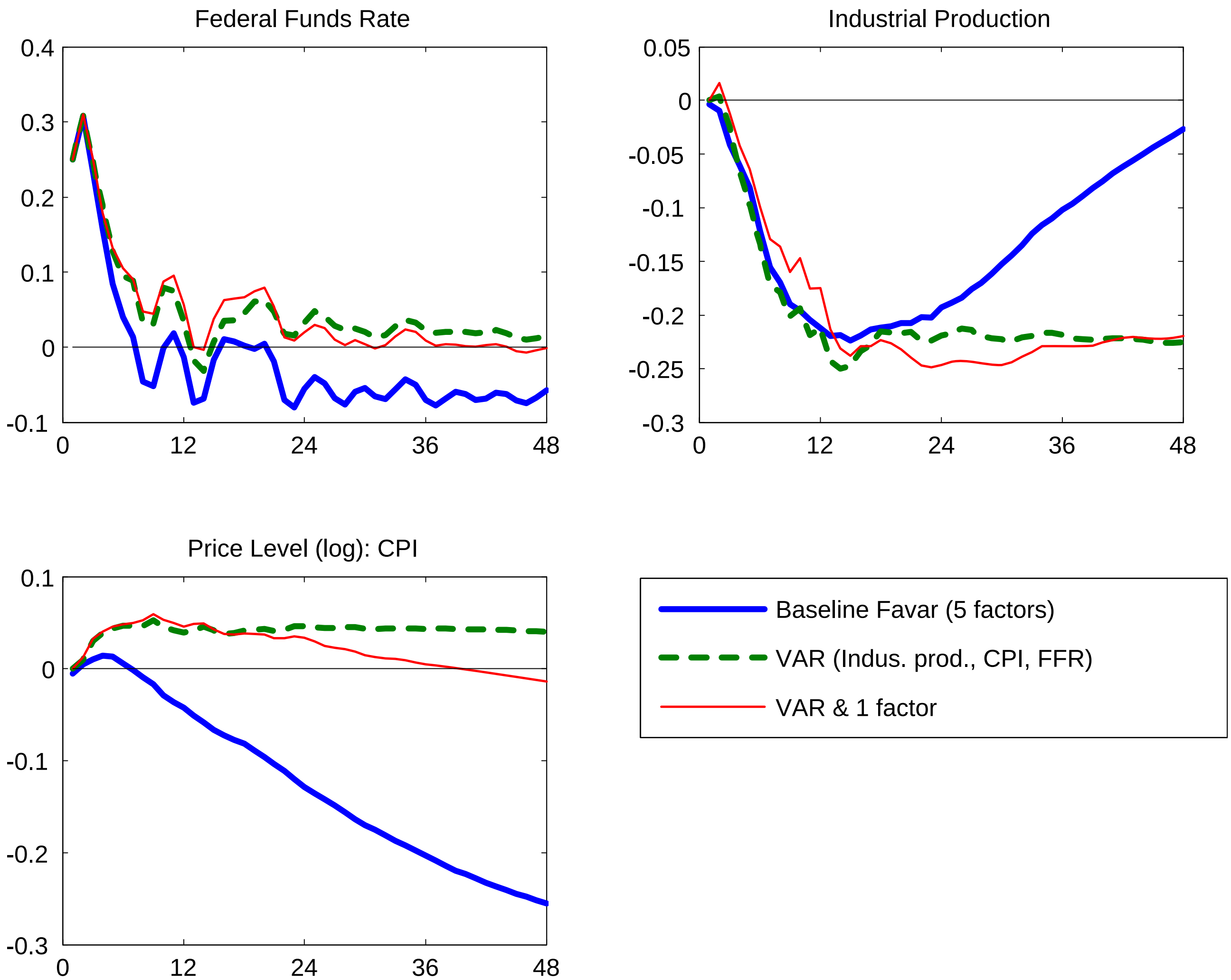

Figure 6b: Estimated impulse responses to an identified monetary policy shock (CPI)

Notes: Sample is 1976:1-2005:6. Monetary shock is an unexpected increase of 25 basis points in the Federal funds rate. Responses reported are estimated using baseline FAVAR (thick solid line), 3-variable VAR (thick dashed line) and same VAR augmented with first principal component of large data set.

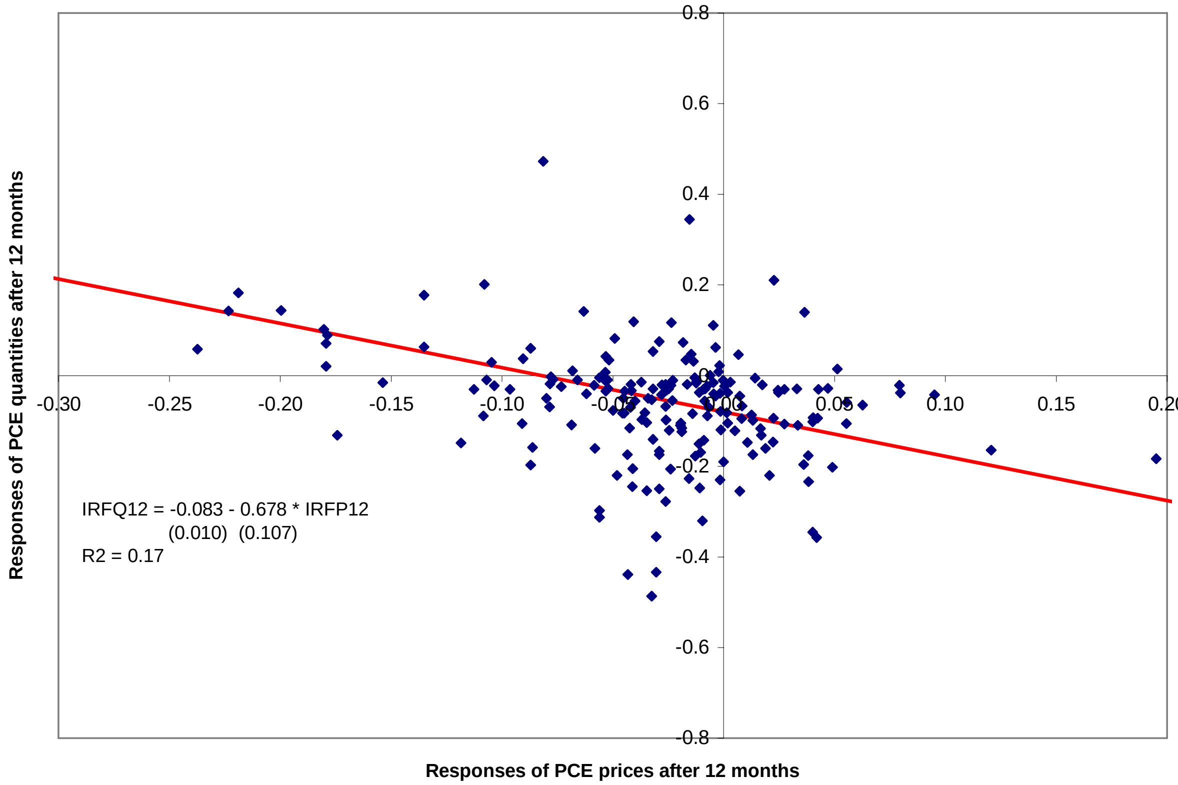

FIGURE 7: RESPONSES OF PCE PRICES AND QUANTITIES TO A MONETARY POLICY SHOCK AFTER 1 YEAR

Notes: Estimated impulse responses of sectoral prices and quantities (in %) to an identified monetary policy shock. The monetary shock is a surprise increase of 25 basis points in the Federal funds rate. Solid line represent cross-sectional regression line.

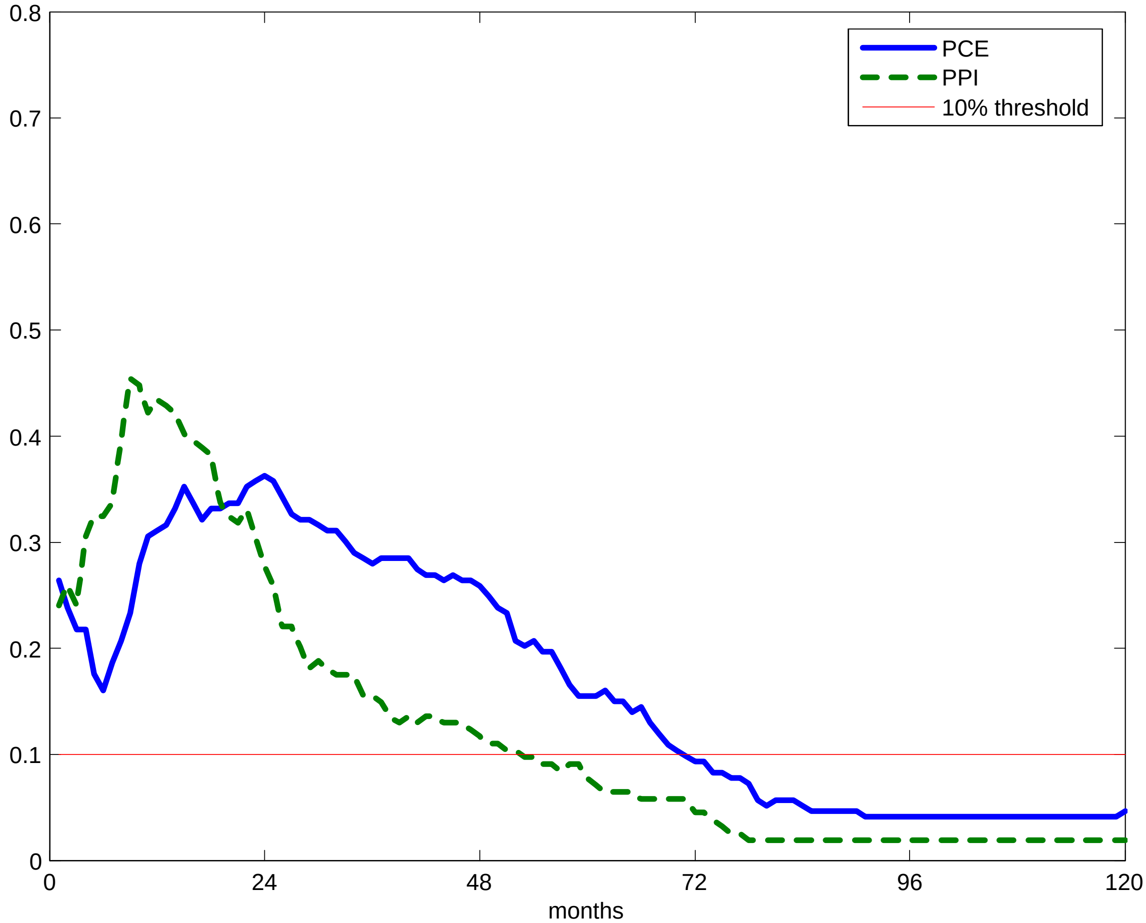

FIGURE 8: FRACTION OF RELATIVE PRICES SIGNIFICANTLY DIFFERENT FROM AVERAGE AT 10% CONFIDENCE LEVEL FOLLOWING A MONETARY SHOCK

Notes: Fraction of the sectors i for which the bootstrapped price responses to a monetary policy shock are such that $f_i^h > 0.95$ or $f_i^h < 0.05$, as a function of the horizon h. The numbers f_i^h denote for each sector i and horizon h the fraction of the bootstrapped price responses that are larger than the cross-sectional average price response. Bootstrapped impulse responses involve 1,000 iterations.

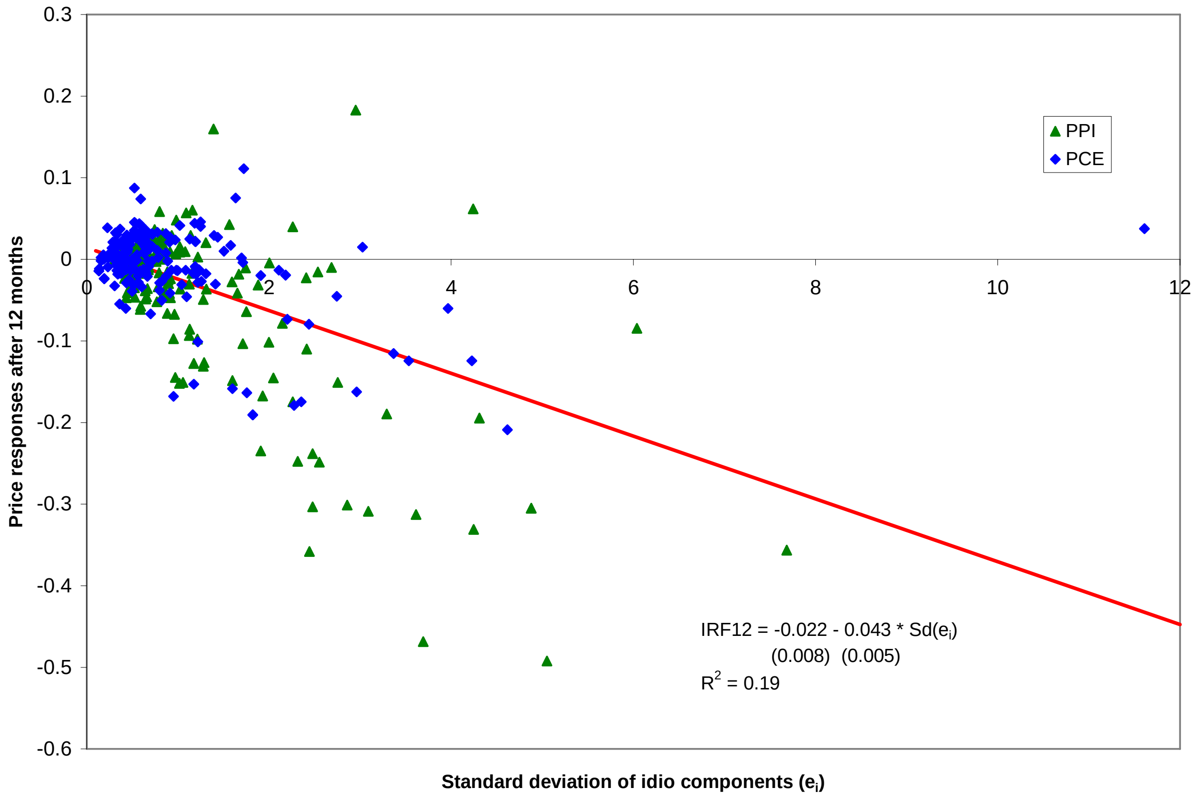

Figure 9: Price responses to monetary shocks after 1 year and volatility of sector-specific components

Notes: Estimated impulse responses of sectoral prices to identified monetary policy shock are expressed in %. The monetary shock is a surprise increase of 25 basis points in the Federal funds rate. Solid line represent cross-sectional regression line.

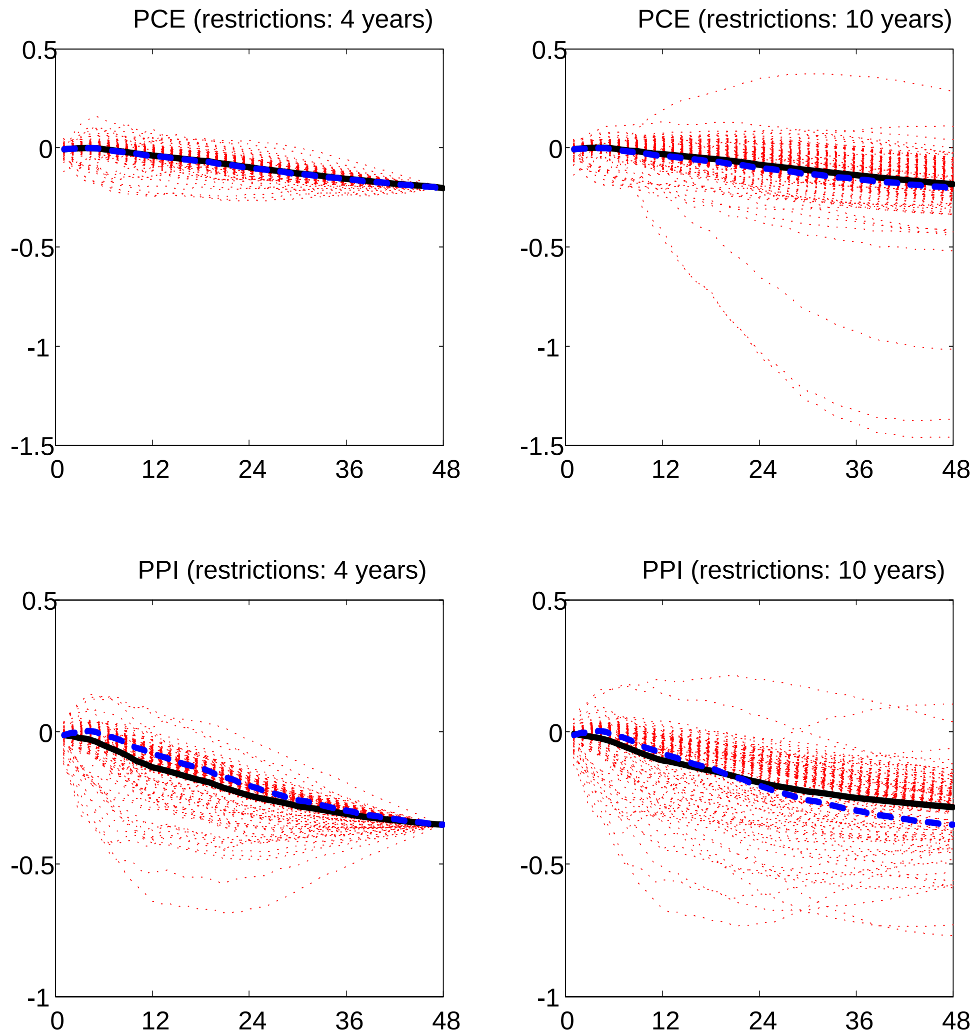

FIGURE 10. SECTORAL PRICE RESPONSES TO MONETARY SHOCKS WITH LONG-RUN RESTRICTIONS AT HORIZON OF 4 AND 10 YEARS

Notes: Estimated impulse responses of sectoral prices (in %) to an identified monetary policy shock. The monetary shock is a surprise increase of 25 basis points in the Federal funds rate. Thick solid lines represent unweighted average responses. Thick dashed lines represent the response of the aggregate PCE and PPI (finished) price indices to a monetary policy shock. In left panels, all price responses are constrained to be equal to the aggregate price response at the horizon of 4 years. In right panels, the constraints apply at the horizon of 10 years.

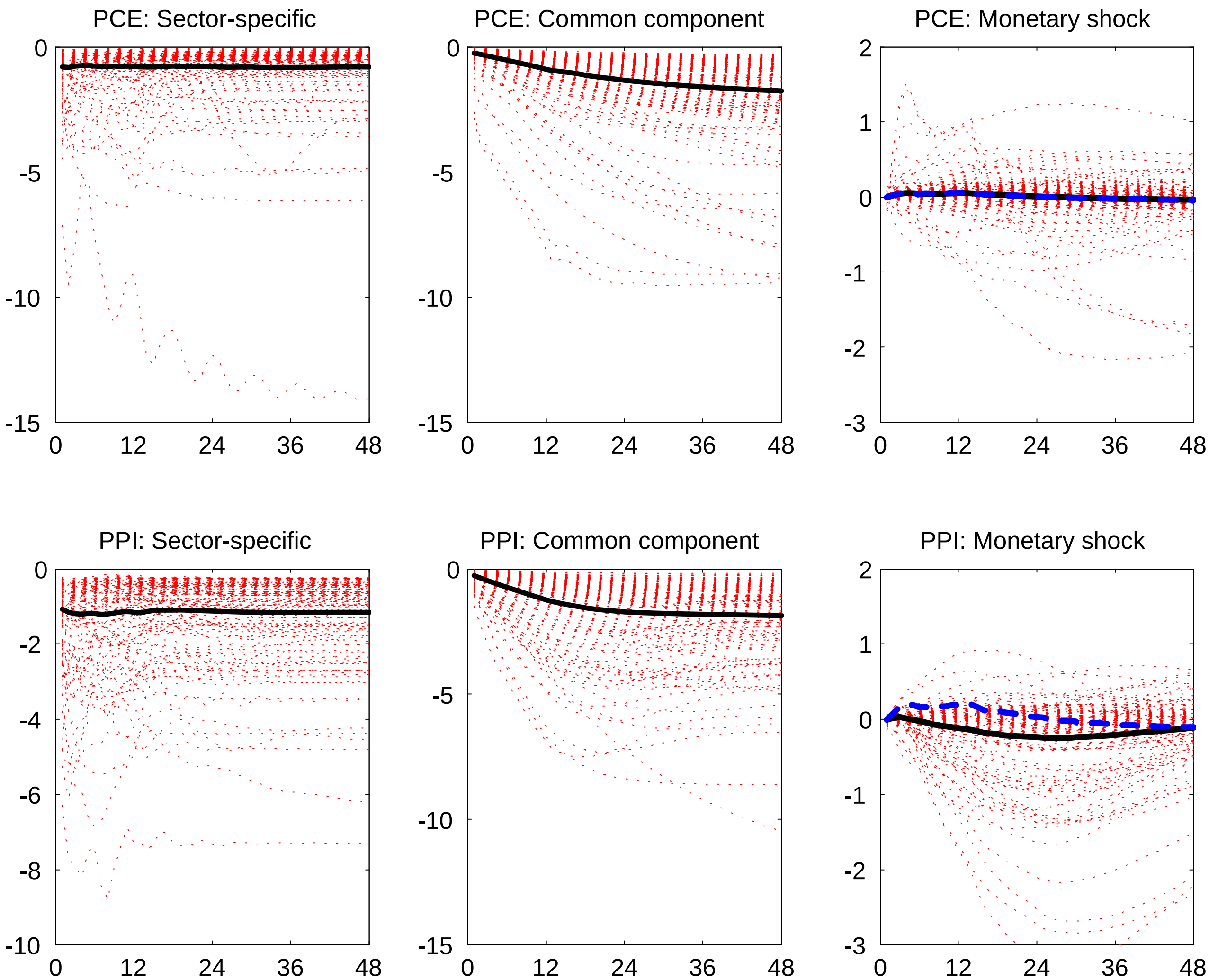

Figure 11: Sectoral price responses to various shocks in post-1984 sample

Notes: Estimated impulse responses of sectoral prices (in %) to a sector-specific shock e_{it} of one standard deviation (left panels), to a shock to the common component $\lambda_i' C_t$ of one standard deviation (middle panels), and to an identified monetary policy shock (right panels). The monetary shock is a surprise increase of 25 basis points in the Federal funds rate. Thick solid lines represent unweighted average responses. Thick dashed lines represent the response of the aggregate PCE and PPI (finished) price indices to a monetary policy shock.

APPENDIX

A. Data Descriptions

A.1 – Main Data Set

Format is as in Stock and Watson (2002) paper: series number; series mnemonic; data span; transformation code and series description as appears in the database. The transformation codes are: 1 – no transformation; 2 – first difference; 4 – logarithm; 5 – first difference of logarithm. Second differencing of logarithms was not used. Our main data set contains 230 monthly series with no missing observations. Series were directly taken from DRI/McGraw Hill Basic Economics Database.

	OUT ----------- Real Output and Income			
1	IPS11	1976:1 - 2005:6	5	Industrial Production Index - Products, Total
2	IPS299	1976:1 - 2005:6	5	Industrial Production Index - Final Products
3	IPS12	1976:1 - 2005:6	5	Industrial Production Index - Consumer Goods
4	IPS13	1976:1 - 2005:6	5	Industrial Production Index - Durable Consumer Goods
5	IPS18	1976:1 - 2005:6	5	Industrial Production Index - Nondurable Consumer Goods
6	IPS25	1976:1 - 2005:6	5	Industrial Production Index - Business Equipment
7	IPS32	1976:1 - 2005:6	5	Industrial Production Index - Materials
8	IPS34	1976:1 - 2005:6	5	Industrial Production Index - Durable Goods Materials
9	IPS38	1976:1 - 2005:6	5	Industrial Production Index - Nondurable Goods Materials
10	IPS43	1976:1 - 2005:6	5	Industrial Production Index - Manufacturing (SIC)
11	IPS67e	1976:1 - 2005:6	5	Industrial Production Index - Mining NAICS=21
12	IPS68e	1976:1 - 2005:6	5	Industrial Production Index - Electric and Gas Utilities
13	IPS10	1976:1 - 2005:6	5	Industrial Production Index - Total Index
14	PMI	1976:1 - 2005:6	5	Purchasing Managers' Index (SA)
15	PMP	1976:1 - 2005:6	5	NAPM Production Index (Percent)
16	PYQ	1976:1 - 2005:6	5	Personal Income (Chained) (Bil 2000$, SAAR)
17	MYXPQ	1976:1 - 2005:6	5	Personal Income Less Transfer Payments (Chained) (Bil 2000$,SAAR)
18	IPS307	1976:1 - 2005:6	5	Industrial Production Index - Residential Utilities
19	IPS316	1976:1 - 2005:6	5	Industrial Production Index - Basic Metals
	EMP ------------- Employment and Hours			
20	LHEL	1976:1 - 2005:6	5	Index of Help-Wanted Advertising In Newspapers (1967=100;SA)
21	LHELX	1976:1 - 2005:6	4	Employment: Ratio; Help-Wanted Ads: No. Unemployed Clf
22	LHEM	1976:1 - 2005:6	5	Civilian Labor Force: Employed, Total (Thous., SA)
23	LHNAG	1976:1 - 2005:6	5	Civilian Labor Force: Employed, Nonagric. Industries (Thous., SA)
24	LHUR	1976:1 - 2005:6	1	Unemployment Rate: All Workers, 16 Years & Over (%, SA)
25	LHU680	1976:1 - 2005:6	1	Unemploy. by Duration: Average(Mean) Duration in Weeks (SA)
26	LHU5	1976:1 - 2005:6	1	Unemploy. by Duration: Persons Unempl.Less Than 5 Wks (Thous., SA)
27	LHU14	1976:1 - 2005:6	1	Unemploy. by Duration: Persons Unempl.5 To 14 Wks (Thous., SA)
28	LHU15	1976:1 - 2005:6	1	Unemploy. by Duration: Persons Unempl.15 Wks + (Thous., SA)
29	LHU26	1976:1 - 2005:6	1	Unemploy. by Duration: Persons Unempl.15 To 26 Wks (Thous., SA)
30	BLS_LPNAG	1976:1 - 2005:6	5	Total Nonfarm Employment (SA) - CES0000000001
31	BLS_LP	1976:1 - 2005:6	5	Total Private Employment (SA) - CES0500000001
32	BLS_LPGD	1976:1 - 2005:6	5	Goods-Producing Employment (SA) - CES0600000001
33	BLS_LPMI	1976:1 - 2005:6	5	Natural Resources and Mining Employment (SA) - CES1000000001
34	BLS_LPCC	1976:1 - 2005:6	5	Construction Employment (SA) - CES2000000001
35	BLS_LPEM	1976:1 - 2005:6	5	Manufacturing Employment (SA) - CES3000000001
36	BLS_LPED	1976:1 - 2005:6	5	Durable Goods Manufacturing Employment (SA) - CES3100000001
37	BLS_LPEN	1976:1 - 2005:6	5	Nondurable Goods Manufacturing Employment (SA) - CES3200000001
38	BLS_Ser.-EMP	1976:1 - 2005:6	5	Service-Providing Employment (SA) - CES0700000001
39	BLS_Tra.EMP	1976:1 - 2005:6	5	Trade, Transportation, and Utilities Employment (SA) - CES4000000001
40	BLS_Ret.- EMP	1976:1 - 2005:6	5	Retail Trade Employment (SA) - CES4200000001
41	BLS_Whol. EMP	1976:1 - 2005:6	5	Wholesale Trade Employment (SA) - CES4142000001
42	BLS_Fin.-EMP	1976:1 - 2005:6	5	Financial Activities Employment (SA) - CES5500000001
43	BLS_P-Ser.EMP	1976:1 - 2005:6	5	Private Service-Providing Employment (SA) - CES0800000001
44	BLS_LPGOV	1976:1 - 2005:6	5	Government Employment (SA) - CES9000000001
45	BLS_LPHRM	1976:1 - 2005:6	1	Manufacturing Average Weekly Hours of Production Workers (SA) - CES3000000005
46	BLS_LPMOSA	1976:1 - 2005:6	1	Manufacturing Average Weekly Overtime of Production Workers (SA) - CES3000000007
47	PMEMP	1976:1 - 2005:6		NAPM Employment Index (Percent)
	HSS ------------- Housing Starts and Sales			
48	HSFR	1976:1 - 2005:6	4	Housing Starts: Nonfarm (1947-58); Total Farm&Nonfarm(1959-); (Thous. U., SA)
49	HSNE	1976:1 - 2005:6	4	Housing Starts: Northeast (Thous. U., SA)
50	HSMW	1976:1 - 2005:6	4	Housing Starts: Midwest (Thous. U., SA)
51	HSSOU	1976:1 - 2005:6	4	Housing Starts: South (Thous. U., SA)
52	HSWST	1976:1 - 2005:6	4	Housing Starts: West (Thous. U., SA)
53	HSBR	1976:1 - 2005:6	4	Housing Authorized: Total New Private Housing Units (Thous., SAAR)
54	HMOB	1976:1 - 2005:6	4	Mobile Homes: Manufacturers' Shipments (Thous. U., SAAR)

	INV ---------------- Real Inventories and Inventory-Sales Ratios			
55	PMNV	1976:1 - 2005:6	1	NAPM Inventories Index (Percent)
	ORD--------------- Orders and Unfilled Orders			
56	PMNO	1976:1 - 2005:6	1	NAPM New Orders Index (Percent)
57	PMDEL	1976:1 - 2005:6	1	NAPM Vendor Deliveries Index (Percent)
58	MOCMQ	1976:1 - 2005:6	5	New Orders (Net) - Consumer Goods & Materials, 1996 Dollars (BCI)
59	MSONDQ	1976:1 - 2005:6	5	New Orders, Nondefense Capital Goods, In 1996 Dollars (BCI)
	SPR --------------- Stock PriCES			
60	FSPCOM	1976:1 - 2005:6	5	S&P's Common Stock Price Index: Composite (1941-43=10)
61	FSPIN	1976:1 - 2005:6	5	S&P's Common Stock Price Index: Industrials (1941-43=10)
62	FSDXP	1976:1 - 2005:6	1	S&P's Composite Common Stock: Dividend Yield (% Per Annum)
63	FSPXE	1976:1 - 2005:6	1	S&P's Composite Common Stock: Price-Earnings Ratio (%, NSA)
64	FSDJ	1976:1 - 2005:6		Common Stock Prices: Dow Jones Industrial Average
	EXR ---------------- Exchange Rates			
65	EXRSW	1976:1 - 2005:6	5	Foreign Exchange Rate: Switzerland (Swiss Franc Per U.S.$)
66	EXRJAN	1976:1 - 2005:6	5	Foreign Exchange Rate: Japan (Yen Per U.S.$)
67	EXRUK	1976:1 - 2005:6	5	Foreign Exchange Rate: United Kingdom (Cents Per Pound)
68	EXRCAN	1976:1 - 2005:6	5	Foreign Exchange Rate: Canada (Canadian $ Per U.S.$)
	INT ---------------- Interest Rates			
69	FYFF	1976:1 - 2005:6	1	Interest Rate: Federal Funds (Effective) (% Per Annum, NSA)
70	FYGM3	1976:1 - 2005:6	1	Interest Rate: U.S.Treasury Bills,Sec Mkt,3-Mo.(% Per Ann, NSA)
71	FYGM6	1976:1 - 2005:6	1	Interest Rate: U.S.Treasury Bills,Sec Mkt,6-Mo.(% Per Ann, NSA)
72	FYGT1	1976:1 - 2005:6	1	Interest Rate: U.S.Treasury Const Maturities,1-Yr.(% Per Ann, NSA)
73	FYGT5	1976:1 - 2005:6	1	Interest Rate: U.S.Treasury Const Maturities,5-Yr.(% Per Ann, NSA)
74	FYGT10	1976:1 - 2005:6	1	Interest Rate: U.S.Treasury Const Maturities,10-Yr.(% Per Ann, NSA)
75	FYAAAC	1976:1 - 2005:6	1	Bond Yield: Moody's AAA Corporate (% Per Annum)
76	FYBAAC	1976:1 - 2005:6	1	Bond Yield: Moody's BAA Corporate (% Per Annum)
77	SFYGM3	1976:1 - 2005:6	1	Spread FYGM3 - FYFF
78	SFYGM6	1976:1 - 2005:6	1	Spread FYGM6 - FYFF
79	SFYGT1	1976:1 - 2005:6	1	Spread FYGT1 - FYFF
80	SFYGT5	1976:1 - 2005:6	1	Spread FYGT5 - FYFF
81	SFYGT10	1976:1 - 2005:6	1	Spread FYGT10 - FYFF
82	SFYAAAC	1976:1 - 2005:6	1	Spread FYAAAC - FYFF
83	SFYBAAC	1976:1 - 2005:6	1	Spread FYBAAC - FYFF
	MON ---------------- Money and Credit Quantity Aggregates			
84	FM1	1976:1 - 2005:6	5	Money Stock: M1(Curr,Trav.Cks,Dem Dep,Other Ck'able Dep) (Bil$, SA)
85	FM2	1976:1 - 2005:6	5	Money Stock:M2(M1+O'nite Rps,Euro$,G/P&B/D Mmmfs&SAv&Sm Time Dep (Bil$, SA)
86	FM3	1976:1 - 2005:6	5	Money Stock: M3(M2+Lg Time Dep,Term Rp's&Inst nnly Mmmfs) (Bil$, SA)
87	FM2DQ	1976:1 - 2005:6	5	Money Supply - M2 In 1996 Dollars (BCI)
88	FMFBA	1976:1 - 2005:6	5	Monetary Base, Adj for Reserve Requirement Changes (Mil$, SA)
89	FMRRA	1976:1 - 2005:6	5	Depository Inst Reserves: Total,Adj For Reserve Req Chgs (Mil$, SA)
90	FMRNBA	1976:1 - 2005:6	5	Depository Inst Reserves: Nonborrowed,Adj Res Req Chgs (Mil$, SA)
91	FCLBMC	1976:1 - 2005:6	1	Wkly Rp Lg Com'l Banks: Net Change Com'l & Indus Loans (Bil$, SAAR)
92	CCINRV	1976:1 - 2005:6	5	Consumer Credit Outstanding - Nonrevolving(G19)
93	IMFCLNQ	1976:1 - 2005:6		Commercial & Industrial Loans Oustanding In 1996 Dollars
	PRI --------------- Price Indexes			
94	PMCP	1976:1 - 2005:6	1	NAPM Commodity Prices Index (Percent)
95	PWFSA	1976:1 - 2005:6	5	Producer Price Index: Finished Goods (82=100,SA)
96	PWFCSA	1976:1 - 2005:6	5	Producer Price Index: Finished Consumer Goods (82=100,SA)
97	PWIMSA	1976:1 - 2005:6	5	Producer Price Index: Intermed Mat.Supplies & Components (82=100,SA)
98	PWCMSA	1976:1 - 2005:6	5	Producer Price Index: Crude Materials (82=100,SA)
99	PUNEW	1976:1 - 2005:6	5	CPI-U: All Items (82-84=100,SA)
100	PU83	1976:1 - 2005:6	5	CPI-U: Apparel & Upkeep (82-84=100,SA)
101	PU84	1976:1 - 2005:6	5	CPI-U: Transportation (82-84=100,SA)
102	PU85	1976:1 - 2005:6	5	CPI-U: Medical Care (82-84=100,SA)
103	PUC	1976:1 - 2005:6	5	CPI-U: Commodities (82-84=100,SA)
104	PUCD	1976:1 - 2005:6	5	CPI-U: Durables (82-84=100,SA)
105	PUXF	1976:1 - 2005:6	5	CPI-U: All Items Less Food (82-84=100,SA)
106	PUXHS	1976:1 - 2005:6	5	CPI-U: All Items Less Shelter (82-84=100,SA)
107	PUXM	1976:1 - 2005:6	5	CPI-U: All Items Less Medical Care (82-84=100,SA)
108	PSCCOM	1976:1 - 2005:6	5	Spot Market Price Index: BLS & CRB: All Commodities (1967=100)
	AHE ------------- Average Hourly Earnings			
109	BLS_LEHCC	1976:1 - 2005:6	5	Construction Average Hourly Earnings of Production Workers (SA) - CES2000000006
110	BLS_LEHM	1976:1 - 2005:6	5	Manufacturing Average Hourly Earnings of Production Workers (SA) - CES3000000006
	OTH ------------- Miscellaneous			
111	HHSNTN	1976:1 - 2005:6	1	U. of Michigan Index of Consumer Expectations (Bcd-83)

A.2. Personal Consumption Expenditures (price indexes and nominal expenditure)

Format is as above: series number; series; data span; transformation code and series description as appears in the database. The transformation for all data was first difference of logarithms, which is coded as 5. This data set contains 194 monthly price series on Personal Consumption Expenditures with no missing observations, and 194 monthly real consumption series on Personal Consumption Expenditures. We describe here the 194 price series. The 194 corresponding real consumption series were ordered and transformed in a similar fashion. Series were downloaded from the underlying tables of the Bureau of Economic Analysis.

1	P1NDCG3	1976:1 - 2005:6	5	New domestic autos
2	P1NFCG3	1976:1 - 2005:6	5	New foreign autos
3	P1NETG3	1976:1 - 2005:6	5	Net transactions in used autos
4	P1MARG3	1976:1 - 2005:6	5	Net purchases of used autos: Used auto margin
5	P1REEG3	1976:1 - 2005:6	5	Net purchases of used autos: Employee reimbursement
6	P1TRUG3	1976:1 - 2005:6	5	Trucks, new and net used
7	P1REVG3	1976:1 - 2005:6	5	Recreational vehicles
8	P1TATG3	1976:1 - 2005:6	5	Tires and tubes
9	P1PAAG3	1976:1 - 2005:6	5	Accessories and parts
10	P1FNRG3	1976:1 - 2005:6	5	Furniture, including mattresses and bedsprings
11	P1MHAG3	1976:1 - 2005:6	5	Major household appliances
12	P1SEAG3	1976:1 - 2005:6	5	Small electric appliances
13	P1CHNG3	1976:1 - 2005:6	5	China, glassware, tableware, and utensils
14	P1RADG3	1976:1 - 2005:6	5	Video and audio goods, including musical instruments, and computer goods
15	P1FLRG3	1976:1 - 2005:6	5	Floor coverings
16	P1CLFG3	1976:1 - 2005:6	5	Clocks, lamps, and furnishings
17	P1TEXG3	1976:1 - 2005:6	5	Blinds, rods, and other
18	P1WTRG3	1976:1 - 2005:6	5	Writing equipment
19	P1HDWG3	1976:1 - 2005:6	5	Tools, hardware, and supplies
20	P1LWNG3	1976:1 - 2005:6	5	Outdoor equipment and supplies
21	P1OPTG3	1976:1 - 2005:6	5	Ophthalmic products and orthopedic appliances
22	P1GUNG3	1976:1 - 2005:6	5	Guns
23	P1SPTG3	1976:1 - 2005:6	5	Sporting equipment
24	P1CAMG3	1976:1 - 2005:6	5	Photographic equipment
25	P1BCYG3	1976:1 - 2005:6	5	Bicycles
26	P1MCYG3	1976:1 - 2005:6	5	Motorcycles
27	P1BOAG3	1976:1 - 2005:6	5	Pleasure boats
28	P1AIRG3	1976:1 - 2005:6	5	Pleasure aircraft
29	P1JRYG3	1976:1 - 2005:6	5	Jewelry and watches
30	P1BKSG3	1976:1 - 2005:6	5	Books and maps
31	P1GRAG3	1976:1 - 2005:6	5	Cereals
32	P1BAKG3	1976:1 - 2005:6	5	Bakery products
33	P1BEEG3	1976:1 - 2005:6	5	Beef and veal
34	P1PORG3	1976:1 - 2005:6	5	Pork
35	P1MEAG3	1976:1 - 2005:6	5	Other meats
36	P1POUG3	1976:1 - 2005:6	5	Poultry
37	P1FISG3	1976:1 - 2005:6	5	Fish and seafood
38	P1GGSG3	1976:1 - 2005:6	5	Eggs
39	P1MILG3	1976:1 - 2005:6	5	Fresh milk and cream
40	P1DAIG3	1976:1 - 2005:6	5	Processed dairy products
41	P1FRUG3	1976:1 - 2005:6	5	Fresh fruits
42	P1VEGG3	1976:1 - 2005:6	5	Fresh vegetables
43	P1PFVG3	1976:1 - 2005:6	5	Processed fruits and vegetables
44	P1JNBG3	1976:1 - 2005:6	5	Juices and nonalcoholic drinks
45	P1CTMG3	1976:1 - 2005:6	5	Coffee, tea and beverage materials
46	P1FATG3	1976:1 - 2005:6	5	Fats and oils
47	P1SWEG3	1976:1 - 2005:6	5	Sugar and sweets
48	P1OFDG3	1976:1 - 2005:6	5	Other foods
49	P1PEFG3	1976:1 - 2005:6	5	Pet food
50	P1MLTG3	1976:1 - 2005:6	5	Beer and ale, at home
51	P1WING3	1976:1 - 2005:6	5	Wine and brandy, at home
52	P1LIQG3	1976:1 - 2005:6	5	Distilled spirits, at home
53	P1ESLG3	1976:1 - 2005:6	5	Elementary and secondary school lunch
54	P1HSLG3	1976:1 - 2005:6	5	Higher education school lunch
55	P1OPMG3	1976:1 - 2005:6	5	Other purchased meals
56	P1APMG3	1976:1 - 2005:6	5	Alcohol in purchased meals
57	P1CFDG3	1976:1 - 2005:6	5	Food supplied to employees: civilians
58	P1MFDG3	1976:1 - 2005:6	5	Food supplied to employees: military
59	P1FFDG3	1976:1 - 2005:6	5	Food produced and consumed on farms
60	P1SHUG3	1976:1 - 2005:6	5	Shoes
61	P1WGCG3	1976:1 - 2005:6	5	Clothing for females

62	P1WICG3	1976:1 - 2005:6	5	Clothing for infants
63	P1WSGG3	1976:1 - 2005:6	5	Sewing goods for females
64	P1WUGG3	1976:1 - 2005:6	5	Luggage for females
65	P1MBCG3	1976:1 - 2005:6	5	Clothing for males
66	P1MSGG3	1976:1 - 2005:6	5	Sewing goods for males
67	P1MUGG3	1976:1 - 2005:6	5	Luggage for males
68	P1MICG3	1976:1 - 2005:6	5	Standard clothing issued to military personnel (n.d.)
69	P1GASG3	1976:1 - 2005:6	5	Gasoline and other motor fuel
70	P1LUBG3	1976:1 - 2005:6	5	Lubricants
71	P1OILG3	1976:1 - 2005:6	5	Fuel oil
72	P1LPGG3	1976:1 - 2005:6	5	Liquefied petroleum gas and other fuel
73	P1TOBG3	1976:1 - 2005:6	5	Tobacco products
74	P1SOAG3	1976:1 - 2005:6	5	Soap
75	P1CSMG3	1976:1 - 2005:6	5	Cosmetics and perfumes
76	P1OPHG3	1976:1 - 2005:6	5	Other personal hygiene goods
77	P1SDHG3	1976:1 - 2005:6	5	Semidurable house furnishings
78	P1CLEG3	1976:1 - 2005:6	5	Cleaning preparations
79	P1LIGG3	1976:1 - 2005:6	5	Lighting supplies
80	P1PAPG3	1976:1 - 2005:6	5	Paper products
81	P1RXDG3	1976:1 - 2005:6	5	Prescription drugs
82	P1NRXG3	1976:1 - 2005:6	5	Nonprescription drugs
83	P1MDSG3	1976:1 - 2005:6	5	Medical supplies
84	P1GYNG3	1976:1 - 2005:6	5	Gynecological goods
85	P1DOLG3	1976:1 - 2005:6	5	Toys, dolls, and games
86	P1AMMG3	1976:1 - 2005:6	5	Sport supplies, including ammunition
87	P1FLMG3	1976:1 - 2005:6	5	Film and photo supplies
88	P1STSG3	1976:1 - 2005:6	5	Stationery and school supplies
89	P1GREG3	1976:1 - 2005:6	5	Greeting cards
90	P1ARTG3	1976:1 - 2005:6	5	Expenditures abroad by U.S. residents: Government expenditures abroad
91	P1ARSG3	1976:1 - 2005:6	5	Expenditures abroad by U.S. residents: Other private services
92	P1REMG3	1976:1 - 2005:6	5	Less: Personal remittances in kind to nonresidents
93	P1MGZG3	1976:1 - 2005:6	5	Magazines and sheet music
94	P1NWPG3	1976:1 - 2005:6	5	Newspapers
95	P1FLOG3	1976:1 - 2005:6	5	Flowers, seeds, and potted plants
96	P1OMHG3	1976:1 - 2005:6	5	Owner occupied mobile homes
97	P1OSTG3	1976:1 - 2005:6	5	Owner occupied stationary homes
98	P1TMHG3	1976:1 - 2005:6	5	Tenant occupied mobile homes
99	P1TSPG3	1976:1 - 2005:6	5	Tenant occupied stationary homes
100	P1TLDG3	1976:1 - 2005:6	5	Tenant landlord durables
101	P1FARG3	1976:1 - 2005:6	5	Rental value of farm dwellings
102	P1HOTG3	1976:1 - 2005:6	5	Hotels and motels
103	P1HFRG3	1976:1 - 2005:6	5	Clubs and fraternity housing
104	P1HHEG3	1976:1 - 2005:6	5	Higher education housing
105	P1HESG3	1976:1 - 2005:6	5	Elem and second education housing
106	P1TGRG3	1976:1 - 2005:6	5	Tenant group room and board
107	P1TGLG3	1976:1 - 2005:6	5	Tenant group employee lodging
108	P1ELCG3	1976:1 - 2005:6	5	Electricity
109	P1NGSG3	1976:1 - 2005:6	5	Gas
110	P1WSMG3	1976:1 - 2005:6	5	Water and sewerage maintenance
111	P1REFG3	1976:1 - 2005:6	5	Refuse collection
112	P1LOCG3	1976:1 - 2005:6	5	Local and cellular telephone
113	P1INCG3	1976:1 - 2005:6	5	Intrastate toll calls
114	P1ITCG3	1976:1 - 2005:6	5	Interstate toll calls
115	P1DMCG3	1976:1 - 2005:6	5	Domestic service, cash
116	P1DMIG3	1976:1 - 2005:6	5	Domestic service, in kind
117	P1MSEG3	1976:1 - 2005:6	5	Moving and storage
118	P1FIPG3	1976:1 - 2005:6	5	Household insurance premiums
119	P1FIBG3	1976:1 - 2005:6	5	Less: Household insurance benefits paid
120	P1RCLG3	1976:1 - 2005:6	5	Rug and furniture cleaning
121	P1EREG3	1976:1 - 2005:6	5	Electrical repair
122	P1FREG3	1976:1 - 2005:6	5	Reupholstery and furniture repair
123	P1PSTG3	1976:1 - 2005:6	5	Postage
124	P1MHOG3	1976:1 - 2005:6	5	Household operation services, n.e.c.
125	P1ARPG3	1976:1 - 2005:6	5	Motor vehicle repair
126	P1RLOG3	1976:1 - 2005:6	5	Motor vehicle rental, leasing, and other
127	P1TOLG3	1976:1 - 2005:6	5	Bridge, tunnel, ferry, and road tolls
128	P1AING3	1976:1 - 2005:6	5	Insurance premiums for user-operated transportation
129	P1IMTG3	1976:1 - 2005:6	5	Local transportation: Mass transit systems
130	P1TAXG3	1976:1 - 2005:6	5	Taxicab
131	P1IRRG3	1976:1 - 2005:6	5	Railway
132	P1IBUG3	1976:1 - 2005:6	5	Bus
133	P1IAIG3	1976:1 - 2005:6	5	Airline
134	P1TROG3	1976:1 - 2005:6	5	Other
135	P1PHYG3	1976:1 - 2005:6	5	Physicians
136	P1DENG3	1976:1 - 2005:6	5	Dentists
137	P1OPSG3	1976:1 - 2005:6	5	Other professional services
138	P1NPHG3	1976:1 - 2005:6	5	Hospitals: Nonprofit

139	P1FPHG3	1976:1 - 2005:6	5	Hospitals: Proprietary
140	P1GVHG3	1976:1 - 2005:6	5	Hospitals: Government
141	P1NRSG3	1976:1 - 2005:6	5	Nursing homes
142	P1MING3	1976:1 - 2005:6	5	Health insurance: Medical care and hospitalization
143	P1IING3	1976:1 - 2005:6	5	Health insurance: Income loss
144	P1PWCG3	1976:1 - 2005:6	5	Health insurance: Workers' compensation
145	P1MOVG3	1976:1 - 2005:6	5	Admissions to motion picture theaters
146	P1LEGG3	1976:1 - 2005:6	5	Admissions to theaters and opera, and entertainments of nonprofit instit. (except athletics)
147	P1SPEG3	1976:1 - 2005:6	5	Admissions to spectator sports
148	P1RTVG3	1976:1 - 2005:6	5	Radio and television repair
149	P1CLUG3	1976:1 - 2005:6	5	Clubs and fraternal organizations
150	P1SIGG3	1976:1 - 2005:6	5	Sightseeing
151	P1FLYG3	1976:1 - 2005:6	5	Private flying
152	P1BILG3	1976:1 - 2005:6	5	Bowling and billiards
153	P1CASG3	1976:1 - 2005:6	5	Casino gambling
154	P1OPAG3	1976:1 - 2005:6	5	Other commercial participant amusements
155	P1PARG3	1976:1 - 2005:6	5	Pari-mutuel net receipts
156	P1REOG3	1976:1 - 2005:6	5	Other recreation
157	P1SCLG3	1976:1 - 2005:6	5	Shoe repair
158	P1DRYG3	1976:1 - 2005:6	5	Drycleaning
159	P1LGRG3	1976:1 - 2005:6	5	Laundry and garment repair
160	P1BEAG3	1976:1 - 2005:6	5	Beauty shops, including combination
161	P1BARG3	1976:1 - 2005:6	5	Barber shops
162	P1WCRG3	1976:1 - 2005:6	5	Watch, clock, and jewelry repair
163	P1CRPG3	1976:1 - 2005:6	5	Miscellaneous personal services
164	P1BROG3	1976:1 - 2005:6	5	Brokerage charges and investment counseling
165	P1BNKG3	1976:1 - 2005:6	5	Bank service charges, trust services, and safe deposit box rental
166	P1IMCG3	1976:1 - 2005:6	5	Commercial banks
167	P1IMNG3	1976:1 - 2005:6	5	Other financial institutions
168	P1LIFG3	1976:1 - 2005:6	5	Expense of handling life insurance and pension plans
169	P1GALG3	1976:1 - 2005:6	5	Legal services
170	P1FUNG3	1976:1 - 2005:6	5	Funeral and burial expenses
171	P1UNSG3	1976:1 - 2005:6	5	Labor union expenses
172	P1ASSG3	1976:1 - 2005:6	5	Profession association expenses
173	P1GENG3	1976:1 - 2005:6	5	Employment agency fees
174	P1AMOG3	1976:1 - 2005:6	5	Money orders
175	P1CLAG3	1976:1 - 2005:6	5	Classified ads
176	P1ACCG3	1976:1 - 2005:6	5	Tax return preparation services
177	P1THEG3	1976:1 - 2005:6	5	Personal business services, n.e.c.
178	P1PEDG3	1976:1 - 2005:6	5	Private higher education
179	P1GEDG3	1976:1 - 2005:6	5	Public higher education
180	P1ESCG3	1976:1 - 2005:6	5	Elementary and secondary schools
181	P1NSCG3	1976:1 - 2005:6	5	Nursery schools
182	P1VEDG3	1976:1 - 2005:6	5	Commercial and vocational schools
183	P1REDG3	1976:1 - 2005:6	5	Foundations and nonprofit research
184	P1POLG3	1976:1 - 2005:6	5	Political organizations
185	P1MUSG3	1976:1 - 2005:6	5	Museums and libraries
186	P1FOUG3	1976:1 - 2005:6	5	Foundations to religion and welfare
187	P1WELG3	1976:1 - 2005:6	5	Social welfare
188	P1RELG3	1976:1 - 2005:6	5	Religion
189	P1FTRG3	1976:1 - 2005:6	5	Foreign travel by U.S. residents (110)
190	P1EXFG3	1976:1 - 2005:6	5	Less: Expenditures in the United States by nonresidents (112)
191	P1TDGG3	1976:1 - 2005:6	5	Durable goods
192	P1TNDG3	1976:1 - 2005:6	5	Nondurable goods
193	P1TSSG3	1976:1 - 2005:6	5	Services
194	PPCE	1976:1 - 2005:6	5	Personal Consumption Expenditures (all items)

A.3. Producer Price Indices

Format is as in Stock and Watson (2002) paper: series number; series mnemonic (NAICS code); data span; transformation code and series description as appears in the database. The transformation for all data was first difference of logarithms, which is coded as 5. This data set contains 154 monthly series with no missing observations. All series are downloaded from the website of BLS.

1	311119	1976:1 - 2005:6	5	Other animal food manufacturing
2	311119p	1976:1 - 2005:6	5	Other animal food manufacturing (primary products)
3	311211	1976:1 - 2005:6	5	Flour Milling
4	311212	1976:1 - 2005:6	5	Rice milling
5	311213	1976:1 - 2005:6	5	Malt mfg
6	311223a	1976:1 - 2005:6	5	Other oilseed processing (cottonseed cake and meal and other byproducts)
7	311225p	1976:1 - 2005:6	5	Fats and oils refining and blending (primary products)
8	311311	1976:1 - 2005:6	5	Sugarcane mills
9	311313	1976:1 - 2005:6	5	Beet sugar manufacturing
10	311412	1976:1 - 2005:6	5	Frozen specialty food manufacturing
11	311520	1976:1 - 2005:6	5	Ice cream and frozen dessert mfg
12	311920	1976:1 - 2005:6	5	Coffee and tea manufacturing
13	312140	1976:1 - 2005:6	5	Distilleries
14	32211-	1976:1 - 2005:6	5	Pulp mills
15	32213-	1976:1 - 2005:6	5	Paperboard mills
16	325620p	1976:1 - 2005:6	5	Toilet preparation mfg (primary products)
17	325920	1976:1 - 2005:6	5	Explosives manufacturing
18	32731-	1976:1 - 2005:6	5	Cement mfg
19	327320	1976:1 - 2005:6	5	Ready mixed concrete mfg and dist
20	327410	1976:1 - 2005:6	5	Lime
21	327420	1976:1 - 2005:6	5	Gypsum building products manufacturing
22	327910	1976:1 - 2005:6	5	Abrasive product manufacturing
23	331210	1976:1 - 2005:6	5	Iron steel pipe & tube mfg from purch steel
24	333210	1976:1 - 2005:6	5	Sawmill & woodworking machinery mfg
25	334310	1976:1 - 2005:6	5	Audio & video equipment mfg
26	335110	1976:1 - 2005:6	5	Electric lamp bulb & part mfg
27	336370	1976:1 - 2005:6	5	Motor vehicle metal stamping
28	337910	1976:1 - 2005:6	5	Mattress mfg
29	311421	1976:1 - 2005:6	5	Fruit and vegetable canning
30	311423	1976:1 - 2005:6	5	Dried and dehydrated food manufacturing
31	311513	1976:1 - 2005:6	5	Cheese manufacturing
32	311611	1976:1 - 2005:6	5	Animal except poultry slaughtering
33	311612	1976:1 - 2005:6	5	Meat processed from carcasses
34	311613	1976:1 - 2005:6	5	Rendering and meat byproduct processing
35	311711	1976:1 - 2005:6	5	Seafood canning
36	311712	1976:1 - 2005:6	5	Fresh & frozen seafood processing
37	311813p	1976:1 - 2005:6	5	Frozen cakes pies & other pastries mfg (Primary products)
38	3118233	1976:1 - 2005:6	5	Dry pasta manufacturing (macaroni spaghetti vermicelli and noodles)
39	312111p	1976:1 - 2005:6	5	Soft drinks manufacturing (primary products)
40	312221	1976:1 - 2005:6	5	Cigarettes
41	3122291	1976:1 - 2005:6	5	Other tobacco product mfg (cigars)
42	313111	1976:1 - 2005:6	5	Yarn spinning mills
43	3133111	1976:1 - 2005:6	5	Broadwoven fabric finishing mills (finished cotton broadwoven fabrics not finished in weaving mills)
44	315111	1976:1 - 2005:6	5	Sheer hosiery mills
45	315191	1976:1 - 2005:6	5	Outerwear knitting mills
46	315223	1976:1 - 2005:6	5	Men's boy's cut & sew shirt excl work mfg
47	315224	1976:1 - 2005:6	5	Men's boy's cut & sew trouser slack jean mfg
48	315993	1976:1 - 2005:6	5	Men's and boys' neckwear mfg
49	316211	1976:1 - 2005:6	5	Rubber and plastic footwear manufacturing
50	316213	1976:1 - 2005:6	5	Men's footwear excl athletic mfg
51	316214	1976:1 - 2005:6	5	Women's footwear excl athletic mfg
52	316992	1976:1 - 2005:6	5	Women's handbag & purse mfg
53	321212	1976:1 - 2005:6	5	Softwood veneer or plywood mfg
54	3212191	1976:1 - 2005:6	5	Reconstituted wood product mfg (particleboard produced at this location)
55	3219181	1976:1 - 2005:6	5	Other millwork including flooring (wood moldings except prefinished moldings made from purchased moldings)
56	321991	1976:1 - 2005:6	5	Manufactured homes mobile homes mfg
57	3221211	1976:1 - 2005:6	5	Paper except newsprint mills (clay coated printing and converting paper)
58	322214	1976:1 - 2005:6	5	Fiber can tube drum & other products mfg
59	324121	1976:1 - 2005:6	5	Asphalt paving mixture & block mfg
60	324122	1976:1 - 2005:6	5	Asphalt shingle & coating materials mfg
61	324191p	1976:1 - 2005:6	5	Petroleum lubricating oils and greases (primary products)
62	325181	1976:1 - 2005:6	5	Alkalies and chlorine
63	3251881	1976:1 - 2005:6	5	All other basic inorganic chemical manufacturing (sulfuric acid gross new and fortified)
64	3251921	1976:1 - 2005:6	5	Cyclic crude and intermediate manufacturing (cyclic coal tar intermediates)

65	325212	1976:1 - 2005:6	5	Synthetic rubber manufacturing
66	325222	1976:1 - 2005:6	5	Manufactured noncellulosic fibers
67	325314	1976:1 - 2005:6	5	Fertilizer mixing only manufacturing
68	3254111	1976:1 - 2005:6	5	Medicinal & botanical mfg (synthetic organic medicinal chemicals in bulk)
69	3261131	1976:1 - 2005:6	5	Unsupported plastics film sheet excluding packaging manufacturing
70	326192	1976:1 - 2005:6	5	Resilient floor covering manufacturing
71	326211	1976:1 - 2005:6	5	Tire manufacturing except retreading
72	327111	1976:1 - 2005:6	5	Vitreous plumbing fixtures access ftg mfg
73	327121	1976:1 - 2005:6	5	Brick and structural clay tile
74	327122	1976:1 - 2005:6	5	Ceramic wall and floor tile
75	327124	1976:1 - 2005:6	5	Clay refractories
76	327125	1976:1 - 2005:6	5	Nonclay refractory manufacturing
77	327211	1976:1 - 2005:6	5	Flat glass manufacturing
78	327213	1976:1 - 2005:6	5	Glass container manufacturing
79	327331	1976:1 - 2005:6	5	Concrete block and brick manufacturing
80	3279931	1976:1 - 2005:6	5	Mineral wool manufacturing
81	331111	1976:1 - 2005:6	5	Iron and steel mills
82	331112	1976:1 - 2005:6	5	Electrometallurgical ferroalloy product mfg
83	331221	1976:1 - 2005:6	5	Rolled steel shape manufacturing
84	331312	1976:1 - 2005:6	5	Primary aluminum production
85	331315	1976:1 - 2005:6	5	Aluminum sheet plate & foil mfg
86	331316	1976:1 - 2005:6	5	Aluminum extruded products
87	331421	1976:1 - 2005:6	5	Copper rolling drawing & extruding
88	3314913	1976:1 - 2005:6	5	Other nonferrous metal roll draw extruding (titanium and titanium base alloy mill shapes excluding wire)
89	3314923	1976:1 - 2005:6	5	Other nonferrous secondary smelt refine alloying (secondary lead)
90	331511	1976:1 - 2005:6	5	Iron foundries
91	3322121	1976:1 - 2005:6	5	Hand and edge tools except machine tools and handsaws (mechanics' hand service tools)
92	332213	1976:1 - 2005:6	5	Saw blade & handsaw mfg
93	3323111	1976:1 - 2005:6	5	Prefabricated metal building and component manufacturing (prefabricated metal building systems excluding farm service bldgs & residential buildings)
94	332321	1976:1 - 2005:6	5	Metal window and door manufacturing
95	332431	1976:1 - 2005:6	5	Metal can mfg
96	324393	1976:1 - 2005:6	5	Other metal container manufacturing (steel shipping barrels & drums excl beer barrels more than 12 gallon capacity)
97	332611	1976:1 - 2005:6	5	Spring heavy gauge mfg
98	3326122	1976:1 - 2005:6	5	Spring light gauge mfg (precision mechanical springs)
99	3327224	1976:1 - 2005:6	5	Bolt nut screw rivet & washer mfg (externally threaded metal fasteners except aircraft)
100	332913	1976:1 - 2005:6	5	Plumbing fixture fitting & trim mfg
101	332991	1976:1 - 2005:6	5	Ball and roller bearings
102	332992	1976:1 - 2005:6	5	Small arms ammunition mfg
103	332996	1976:1 - 2005:6	5	Fabricated pipe & pipe fitting mfg
104	332998	1976:1 - 2005:6	5	Enameled iron & metal sanitary ware mfg
105	333111	1976:1 - 2005:6	5	Farm machinery & equipment mfg
106	333131	1976:1 - 2005:6	5	Mining machinery & equipment mfg
107	333132	1976:1 - 2005:6	5	Oil and gas field machinery and equipment mfg
108	333292	1976:1 - 2005:6	5	Textile machinery
109	333293	1976:1 - 2005:6	5	Printing machinery & equipment mfg
110	3332941	1976:1 - 2005:6	5	Food products machinery mfg (dairy and milk products plant machinery)
111	3332981	1976:1 - 2005:6	5	All other industrial machinery mfg (chemical manufacturing machinery equip. and parts)
112	3333111	1976:1 - 2005:6	5	Automatic vending machine mfg (automatic merchandising machines coin operated excluding parts)
113	333512	1976:1 - 2005:6	5	Machine tool metal cutting types mfg
114	333513	1976:1 - 2005:6	5	Machine tool metal forming types mfg
115	3335151	1976:1 - 2005:6	5	Cutting tool & machine tool accessory mfg (small cutting tools for machine tools and metalworking machinery)
116	333612	1976:1 - 2005:6	5	Speed changer industrial high speed drive & gear mfg
117	333618	1976:1 - 2005:6	5	Other engine equipment mfg
118	3339111	1976:1 - 2005:6	5	Pump & pumping equipment mfg (indus. pumps except hydraulic fluid power pumps)
119	333922	1976:1 - 2005:6	5	Conveyor & conveying equipment mfg
120	3339233	1976:1 - 2005:6	5	Overhead crane hoist & monorail system mfg (overhead traveling cranes and monorail systems)
121	3339241	1976:1 - 2005:6	5	Industrial truck tractor trailer stacker machinery mfg (industrial trucks and tractors motorized and hand powered)
122	333992	1976:1 - 2005:6	5	Welding & soldering equipment mfg (welding & soldering equipment mfg)
123	333997	1976:1 - 2005:6	5	Scale & balance except laboratory mfg
124	334411	1976:1 - 2005:6	5	Electron tube mfg
125	334414	1976:1 - 2005:6	5	Electronic capacitor mfg
126	334415	1976:1 - 2005:6	5	Electronic resistor mfg
127	334417	1976:1 - 2005:6	5	Electronic connector mfg
128	3345153	1976:1 - 2005:6	5	Electricity measuring testing instrument mfg (test equipment for testing electrical radio & communication circuits & motors)
129	334517p	1976:1 - 2005:6	5	Irradiation apparatus manufacturing (primary products)
130	3351211	1976:1 - 2005:6	5	Residential electric lighting fixture mfg (residential electric lighting fixtures except portable & parts)
131	335122	1976:1 - 2005:6	5	Commercial electric lighting fixture mfg
132	335129	1976:1 - 2005:6	5	Other lighting equipment mfg

133	335212	1976:1 - 2005:6	5	Household vacuum cleaner mfg
134	335221	1976:1 - 2005:6	5	Household cooking appliance mfg
135	335311	1976:1 - 2005:6	5	Power distribution specialty transformer mfg
136	335312	1976:1 - 2005:6	5	Motor & generator mfg
137	335314p	1976:1 - 2005:6	5	Relay & industrial control mfg (primary products)
138	335911	1976:1 - 2005:6	5	Storage battery mfg
139	3359291	1976:1 - 2005:6	5	Other communication and energy wire mfg (power wire and cable made in plants that draw wire)
140	335932	1976:1 - 2005:6	5	Noncurrent carrying wiring device mfg
141	335991p	1976:1 - 2005:6	5	Carbon & graphite product mfg (primary products)
142	336321p	1976:1 - 2005:6	5	Vehicular lighting equipment mfg (primary products)
143	337121	1976:1 - 2005:6	5	Upholstered household furniture mfg
144	337122	1976:1 - 2005:6	5	Wood household furniture except upholstered
145	337124	1976:1 - 2005:6	5	Metal household furniture
146	337211	1976:1 - 2005:6	5	Wood office furniture mfg
147	3372141	1976:1 - 2005:6	5	Nonwood office furniture (office seating including upholstered nonwood)
148	3399111	1976:1 - 2005:6	5	Jewelry except costume mfg (jewelry made of solid platinum metals and solid karat gold)
149	3399123	1976:1 - 2005:6	5	Silverware & hollowware mfg (Flatware and carving sets made wholly of metal)
150	339931	1976:1 - 2005:6	5	Doll & stuffed toy mfg
151	339932	1976:1 - 2005:6	5	Game toy & children's vehicle mfg
152	339944	1976:1 - 2005:6	5	Carbon paper & inked ribbon mfg
153	3399931	1976:1 - 2005:6	5	Fastener button needle & pin mfg (Buttons and parts except for precious or semiprecious metals and stones)
154	3399945	1976:1 - 2005:6	5	Broom brush & mop mfg (other brushes)

A.4. Cross-Sectional Industry Characteristics

For the cross-sectional regressions we use the following data sources:

C4 - Concentration ratio. Represents the percentage of sales made by the largest 4 firms in the industry. Source. Bureau of the Census 1997.

Profit rates – average gross profit rates for 1997-2001 based on tax accounting. Source: 2001 Annual Survey of Manufacturers.

B Restrictions on long-run responses to monetary shocks

Impulse responses for the price series are calculated by using the dynamics of the common factors and the following equation:

$$X_{it} = \lambda_i' C_t + e_{it} \tag{B.1}$$

where X_{it} contains the monthly log change in the respective price series. The response of X_{it} after h periods is given by

$$\widehat{X_{i,h}} = \lambda_i' \widehat{C_h}$$

where $\widehat{C_h}$ is the vector of responses of the common factors after h periods. We want to impose the restriction that after H periods the response of the log price level in sector i is equal to a certain value denoted by a. We choose a to correpond to the response of the relevant aggregate price index. Since the price data is expressed in first differences, we cumulate the responses over the first H periods to obtain the log price level H period after the shock. We thus impose the desired restrictions of the following form on the estimation of λ_i:

$$\lambda_i' \sum_{h=0}^{H} \widehat{C_h} = a.$$

So we can estimate equation (B.1) by OLS subject to the restriction above.

If we denote by λ_i^u the unrestricted OLS estimate of the loadings, then the restricted least squares estimate of the loadings, λ_i^r, can be calculated from the standard textbook formula (see, e.g., Greene (2003, chap.6, sect. 6.3.2):

$$\lambda_i^r = \lambda_i^u - \left(C_t' C_t\right)^{-1} \left(\sum_{h=0}^{H} \widehat{C_h}\right) \left[\left(\sum_{h=0}^{H} \widehat{C_h}\right)' \left(C_t' C_t\right)^{-1} \left(\sum_{h=0}^{H} \widehat{C_h}\right)\right]^{-1} \left(\lambda_i^{u\prime} \sum_{h=0}^{H} \widehat{C_h} - a\right).$$

C Robustness results: Alternative factor estimations

TABLE C.1 — VOLATILITY, PERSISTENCE OF MONTHLY INFLATION SERIES AND RESPONSES TO MONETARY SHOCKS — SW/BBE FACTORS

		St. dev. (in %)			R^2	*Persistence*			*Monetary shock*		
		π_{it}	$\lambda_i' C_t$	e_{it}		π_{it}	$\lambda_i' C_t$	e_{it}	AC1	Price response	
										6 mo.	12 mo.
Aggregated series											
PCE	Total	0.24	0.22	0.09	0.85	0.93	0.93	0.28	0.96	0.01	-0.02
	Durables	0.33	0.23	0.24	0.48	0.92	0.95	0.54	0.94	0.05	0.02
	Nondurables	0.42	0.38	0.19	0.79	0.76	0.88	0.65	0.97	-0.03	-0.11
	Services	0.24	0.17	0.17	0.51	0.94	0.97	0.40	0.94	0.03	0.02
Disaggregated series											
All	Average	1.15	0.30	1.10	0.12	0.49	0.91	0.01	0.96	-0.00	-0.05
	Median	0.75	0.23	0.71	0.09	0.59	0.92	0.09	0.96	0.01	-0.03
	Minimum	0.23	0.06	0.10	0.01	-3.57	0.28	-1.68	0.93	-0.76	-0.77
	Maximum	11.68	2.48	11.62	0.87	0.96	0.99	0.81	1.00	1.05	1.08
	Std	1.14	0.25	1.13	0.12	0.42	0.07	0.47	0.02	0.13	0.15
PCE	Average	0.98	0.28	0.92	0.15	0.50	0.93	-0.05	0.96	0.01	-0.02
	Average (weighted)	0.88	0.32	0.79	0.24	0.60	0.94	0.15	0.96	0.02	-0.02
	Median	0.65	0.21	0.62	0.10	0.60	0.94	0.06	0.96	0.01	-0.01
	Minimum	0.23	0.09	0.10	0.01	-3.57	0.70	-1.68	0.93	-0.46	-0.66
	Maximum	11.68	2.48	11.62	0.87	0.96	0.99	0.81	1.00	1.05	1.08
	Std	1.10	0.28	1.08	0.14	0.50	0.05	0.54	0.02	0.12	0.14
PPI	Average	1.36	0.33	1.31	0.09	0.48	0.89	0.09	0.97	-0.03	-0.09
	Median	0.92	0.26	0.89	0.08	0.56	0.90	0.11	0.97	0.01	-0.06
	Minimum	0.35	0.06	0.31	0.01	-0.58	0.28	-1.16	0.93	-0.76	-0.77
	Maximum	7.75	1.12	7.66	0.30	0.91	0.98	0.81	1.00	0.20	0.18
	Std	1.16	0.20	1.14	0.06	0.29	0.07	0.35	0.01	0.14	0.15

Notes: Sample is 1976:1–2005:6. Inflation is measured as $\pi_{it} = p_{it} - p_{it-1}$ where p_{it} is the log of the price series i. Common components are $\lambda_i' C_t$. Sector-specific components are e_{it}. R^2 statistics measure the fraction of the variance of π_{it} explained by $\lambda_i' C_t$. Persistence is based on estimated AR processes with 13 lags. Weighted average of statistics for disaggregated PCE series is obtained using expenditure shares in year 2005 as weights. AC1 is first-order autocorrelation of price responses to monetary policy shock. Price responses at horizons of 6 and 12 months are expressed in percent deviations from initial price level.

Table C.2 — Volatility, Persistence of monthly inflation series and responses to monetary shocks — FFR, IP PCE as observable factors

		St. dev. (in %)				*Persistence*			*Monetary shock*		
		π_{it}	$\lambda_i' C_t$	e_{it}	R^2	π_{it}	$\lambda_i' C_t$	e_{it}	AC1	Price response	
										6 mo.	12 mo.
Aggregated series											
PCE	Total	0.24	0.24	0.00	1.00	0.93	0.00	0.00	0.97	-0.01	-0.03
	Durables	0.33	0.25	0.21	0.59	0.92	0.97	0.52	0.96	-0.01	-0.03
	Nondurables	0.42	0.37	0.20	0.77	0.76	0.83	-0.01	0.97	-0.01	-0.06
	Services	0.24	0.21	0.11	0.77	0.94	0.97	-0.26	0.96	-0.01	-0.01
Disaggregated series											
All	Average	1.15	0.36	1.08	0.16	0.49	0.91	-0.06	0.97	-0.03	-0.06
	Median	0.75	0.28	0.70	0.13	0.59	0.93	-0.01	0.97	-0.02	-0.04
	Minimum	0.23	0.05	0.11	0.01	-3.57	0.12	-2.08	0.89	-0.36	-0.48
	Maximum	11.68	3.26	11.22	0.81	0.96	0.99	0.85	1.00	0.16	0.21
	Std	1.14	0.30	1.11	0.13	0.42	0.09	0.45	0.02	0.07	0.10
									0.96	-0.01	-0.03
PCE	Average	0.98	0.33	0.90	0.19	0.50	0.91	-0.09			
	Average (weighted)	0.88	0.37	0.77	0.29	0.60	0.92	0.10	0.96	-0.01	-0.02
	Median	0.65	0.24	0.60	0.13	0.60	0.94	-0.02	0.96	-0.00	-0.02
	Minimum	0.23	0.11	0.11	0.02	-3.57	0.12	-2.08	0.89	-0.19	-0.34
	Maximum	11.68	3.26	11.22	0.81	0.96	0.99	0.85	1.00	0.10	0.21
	Std	1.10	0.35	1.06	0.15	0.50	0.11	0.50	0.02	0.05	0.07
PPI	Average	1.36	0.40	1.29	0.14	0.48	0.91	-0.03	0.97	-0.06	-0.11
	Median	0.92	0.33	0.86	0.12	0.56	0.93	-0.00	0.97	-0.03	-0.08
	Minimum	0.35	0.05	0.30	0.01	-0.58	0.41	-1.33	0.90	-0.36	-0.48
	Maximum	7.75	1.31	7.63	0.44	0.91	0.97	0.77	1.00	0.16	0.18
	Std	1.16	0.22	1.15	0.09	0.29	0.07	0.39	0.01	0.08	0.10

Notes: Sample is 1976:1–2005:6. Inflation is measured as $\pi_{it} = p_{it} - p_{it-1}$ where p_{it} is the log of the price series i. Common components are $\lambda_i' C_t$. Sector-specific components are e_{it}. R^2 statistics measure the fraction of the variance of π_{it} explained by $\lambda_i' C_t$. Persistence is based on estimated AR processes with 13 lags. Weighted average of statistics for disaggregated PCE series is obtained using expenditure shares in year 2005 as weights. AC1 is first-order autocorrelation of price responses to monetary policy shock. Price responses at horizons of 6 and 12 months are expressed in percent deviations from initial price level.