Has Fed Policy Mattered for Inflation?

Evidence from Monetary VARs

By Jai Kedia

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Introduction

There is a belief among the U.S. public and public officials that the Federal Reserve exerts significant control over inflation using monetary policy tools such as changes to the federal funds rate or money supply. In a May 2022 survey of U.S. registered voters conducted by Morning Consult/Politico, 34% of respondents claimed that the Federal Reserve had "a lot of control" over inflation while another 40% said that the Fed exercised "some control" over inflation. Extrapolated to the U.S. population, a staggering 74% of U.S. citizens believe that the Fed can manipulate inflation to some degree in its desired direction.

Politicians are also quick to blame the Federal Reserve or assert its power over the economy. Leaders on both sides of the political aisle do the same. As inflation began to grow last year, President Biden highlighted the Fed as the key institution to combat inflation, saying "the critical job of making sure that the elevated prices don't become entrenched rests with the Federal Reserve" (Irwin, 2022). Similarly, U.S. Senator Thom Tillis (R-NC), a member of the Senate Banking, Housing, and Urban Affairs Committee, in comments to Fed Chair Jerome Powell said, "[r]egarding the Fed specifically – though I am pleased you have begun taking the drastic action necessary to right the U.S. economy – these actions are long-overdue" (Tillis, 2022), indicating his belief in the Fed's control over inflationary pressure.

The empirical evidence does not support these assertions. This paper investigates the effects of unanticipated changes to monetary policy on inflation and finds that the public perception of the Fed's ability to manage inflation is overstated. Using standard monetary Vector Auto Regressions (VARs) that are fitted to various data samples from modern U.S. economic history, we show that as a result of a one standard deviation (positive) shock to the Fed's policy rate, inflation initially *increases* and only reduces after a few quarters. Not only does inflation initially move in the opposite direction the Fed would want, but the future reduction is small, with the most impact in the services sector. The goods market is the most responsive to the policy rate shock, but the effects are not as intended; in response to the policy rate change, goods prices elevate in the short term and return to normal but never reduce. In short, the desired effect (a reduction in inflation after raising the policy rate) is very small and occurs only in the services sector, but the undesired effect (an increase in inflation) happens to a greater degree on the goods market.

Additionally, our results suggest that monetary policy explains only a small fraction of the variability in inflation at all

[1] Cato Institute, Center for Monetary and Financial Alternatives, 1000 Massachusetts Ave NW, Washington, D.C. 20001; Email: jkedia@cato.org. The author thanks Jerome Famularo and Ankith Reddy for their invaluable research assistance and Norbert Michel for his guidance and feedback.

horizons studied (3-months to 5-years). The share of monetary policy shocks in determining inflation variability rarely exceeds 10% and this share is smaller in the modern macroeconomy (post-1984) than in the past. Fed policy is marginally more important for services inflation but only at longer horizons (3 years and beyond), and usually between 10 to 15% of total variability since the Great Recession. At all horizons and for all PCE metrics, supply factors are far more important in determining inflation than monetary policy. In some cases, especially at longer horizons, even demand factors outweigh monetary policy in determining inflation.

The paper proceeds as follows. Section 1 details the VAR specification used to model the key variables that govern the macroeconomy: inflation, output gap, and interest rate. It presents the identification technique used to extract structural demand, supply, and monetary policy shocks from the reduced-form VAR. This section also describes the data used to estimate the relevant parameters of the VAR and how the data ranges are stratified for deeper analysis. Section 2 presents the transition of the economy after a usual shock to monetary policy back to steady state in the form of impulse response functions. Section 3 shows the share of monetary policy in explaining inflation variance over multiple horizons. This section also includes a breakdown of inflation variance into its three components: supply, demand, and monetary policy factors, so that the reader may compare their relative importance. The final section concludes.

1. VAR Model and Data

This paper uses a monetary structural vector autoregression ("SVAR") technique to untangle the effects of monetary policy on inflation. This method has been a standard approach since the influential Sims (1980) paper and has since been used by several economists for similar purposes.[2] The structural model is as follows:

$$\boldsymbol{A}\vec{y}_t = \boldsymbol{B_0} + \sum_{i=1}^{p} \boldsymbol{B_i}\vec{y}_{t-i} + \vec{\varepsilon}_t \qquad (1)$$

where $\vec{y}_t$ captures the state of the economy in the current quarter as indicated by the annualized inflation rate, output gap, and the annualized interest rate so that: $\vec{y}_t = [\pi_t^j, x_t, i_t]'$. Matrices $\boldsymbol{A}, \boldsymbol{B_0}$, and $\boldsymbol{B_i}$ contain the coefficients that govern the autoregressive process and $\vec{\varepsilon}_t \sim N[\vec{0}, \boldsymbol{\Omega}]$ is a vector of serially uncorrelated, structural (i.e., no intratemporal covariances) innovations that capture per period supply, demand, and monetary policy shocks respectively ($\vec{\varepsilon}_t = [\varepsilon_t^s, \varepsilon_t^d, \varepsilon_t^i]'$).

Note that while the interpretation of monetary policy shocks is relatively clear as unanticipated Fed policy changes, it is difficult to exactly determine the source of demand and supply shocks within the context of a simplified VAR model. In general, supply shocks capture changes to economy-wide production costs such as rising fuel or input prices or cost-push shocks. Demand factors include fiscal spending and changes in consumer preferences, among others. The VARs exhibit demand and supply factors in the aggregate, but their exact source is

[2] See Stock and Watson (2001) for a detailed explanation of SVARs and how they are identified from reduced-form VARs. The paper also demonstrates the use of the 3-variable monetary SVAR similar to its application in this paper.

unclear;[3] several medium-scale macro DSGE models attempt to further disaggregate these shocks,[4] but such an analysis is not under the Fed-specific scope of this paper.

The inclusion of matrix A implies that the state of the economy is simultaneously determined; however, estimation can only yield the following *reduced-form* version of equation (1):

$$\vec{y}_t = \boldsymbol{C_0} + \sum_{i=1}^{p} \boldsymbol{C_i}\vec{y}_{t-i} + \vec{v}_t \qquad (2)$$

Consequently, an identification method is required to extract the structural coefficients from the estimated equation (2) by restricting $\frac{n\,(n-1)}{2}$ parameters. In the base case, $n = 3$ as we have three variables describing the state of the economy requiring 3 identifying restrictions.[5] Following the short-run ("SR") identification technique from Stock and Watson (2001), the variables are ordered from fastest to slowest with respect to contemporaneous effects (i.e. we assume that output gap and interest rate have no immediate quarter effect on inflation, only current inflation affects current output gap, and so on). This technique places the following restrictions on the contemporaneous correlation matrix:

$$\boldsymbol{A} = \begin{bmatrix} \alpha_{11} & 0 & 0 \\ \alpha_{21} & \alpha_{22} & 0 \\ \alpha_{31} & \alpha_{32} & \alpha_{33} \end{bmatrix} \qquad (3)$$

Within the estimation procedure, this identification technique is accomplished by conducting a lower triangular Cholesky decomposition of the reduced-form innovations covariance matrix.

Quarterly data for all variables are collected from Q1 1960 to Q4 2019 from the FRED website unless otherwise specified. PCE price index data for the following categories are collected: overall, core (i.e., less food and energy), goods, and services. Price indices are converted to annualized inflation rates using the formula:

$$\pi_t^j = \log \frac{PCE\ Metric_t^j}{PCE\ Metric_{t-1}^j} \times 400\ \% \qquad (4)$$

Data on Real U.S. GDP and Real Potential U.S. GDP are collected and converted to the U.S. output gap using the formula:

$$x_t = \log \frac{Real\ GDP_t}{Real\ Potential\ GDP_t} \times 100\ \% \qquad (5)$$

The Effective Federal Funds Rate ("FFR") is used as the measure for the policy tool interest rate. Note that the data sample includes the mid-2010s period which corresponds to the interest rate operating at or just marginally above the zero lower bound ("ZLB"). Owing to the ZLB, the Fed resorted to unconventional monetary policy such as quantitative easing to stimulate the economy, methods that do not appear in the official

[3] Economists usually categorize supply shocks as those which cause output and inflation to move in opposite directions and demand shocks as those which cause output and inflation to move in the same direction. The shocks in this paper act similarly.

[4] See Smets and Wouters (2007) for one such example. The paper identifies 6 different demand/supply shocks, plus a monetary policy shock, from the data and weighs their relative importance to the business cycle.

[5] During sensitivity tests, the quarterly percentage change in the S&P 500 is included in the VAR to capture the effects of the financial system on the economy and vice-versa. In this case, $n = 4$ and 6 identifying restrictions are needed. This approach also uses the SR identification technique with the stock returns placed ahead of inflation.

FFR. This may potentially distort the estimation of the model as the data does not capture the true stance of monetary policy. To account for this, the Wu and Xia (2016) FFR Shadow Rate ("WX2016 FFR") is used, when available, which appropriately adjusts the FFR. The shadow rate closely matches the FFR during periods where the FFR is significantly higher than zero but accounts for unconventional policy when the FFR is stuck at the ZLB. The interest rate is set according to:

$$i_t = \begin{cases} FFR_t \; if \; t < Q1\,1990 \\ WX2016\; FFR_t \; if \; t \geq Q1\,1990 \end{cases} \quad (6)$$

All analyses utilize a VAR ($p = 4$) structure, thereby fitting a model with 4 quarterly lags to each dataset. Of course, it is unlikely that the inherent structure of the U.S. business cycle has remained the same through the course of our entire data period. Changes to the underlying structure necessitate a re-estimation of the model under various data sub-samples to prevent biasing coefficient estimates. As such, we identify two major structural breaks in this period: the monetary policy era after the end of Paul Volcker's Fed chairmanship (see Clarida, Gali, and Gertler, 2000) starting in Q1 1984 and the post-Great Recession ZLB regime following the financial crisis which begins in Q1 2008. The VAR models are estimated for the following four datasets:

Era Label	*Date Range*
Full Period	Q1 1960 to Q4 2019
Pre-Volcker	Q1 1960 to Q4 1983
Post-Volcker	Q1 1984 to Q4 2007
ZLB Regime	Q1 2008 to Q4 2019

Table 1: Data Periods for VAR Analysis

For the purposes of sensitivity, the following models are also estimated: including returns to the S&P 500, replacing the shadow rate with the base FFR for all time periods, including PCE inflation for the energy sector, and switching the order of inflation and output gap. The results from these analyses do not substantially change the conclusions presented below and are available upon request.

2. Impulse Responses

This section presents the impulse response functions ("IRFs") of inflation as measured from a variety of PCE metrics to a one standard deviation unanticipated (positive) shock to monetary policy. In simple terms, the IRFs simulate a "business cycle", generated in response to a sudden rate hike by the Fed. We calibrate the initial shock size to one standard deviation to simulate usual Fed policy in the time period under consideration as we would expect the normally distributed shock to be within one standard deviation about 67% of the time. The responses of PCE inflation broken down by category: overall, core, goods, and services, are presented in Figure 1.

Outside of the Pre-Volcker period, the Fed has historically been unsuccessful in significantly lowering inflation. In the other three periods, unexpected tightening increases inflation instead of reducing it. Any inflation reductions are small and don't occur until roughly 3 years after the initial shock. Interestingly, the sensitivity of prices to monetary policy in the services sector has decreased, but the sensitivity of goods prices has increased; this is especially true during the ZLB regime. Over the full data period, and in the ZLB period in particular, the goods market reacts much more strongly than the services market to monetary tightening. Additionally, rate hikes only increase goods market inflation but never succeed in reducing it. The cumulative effect on the

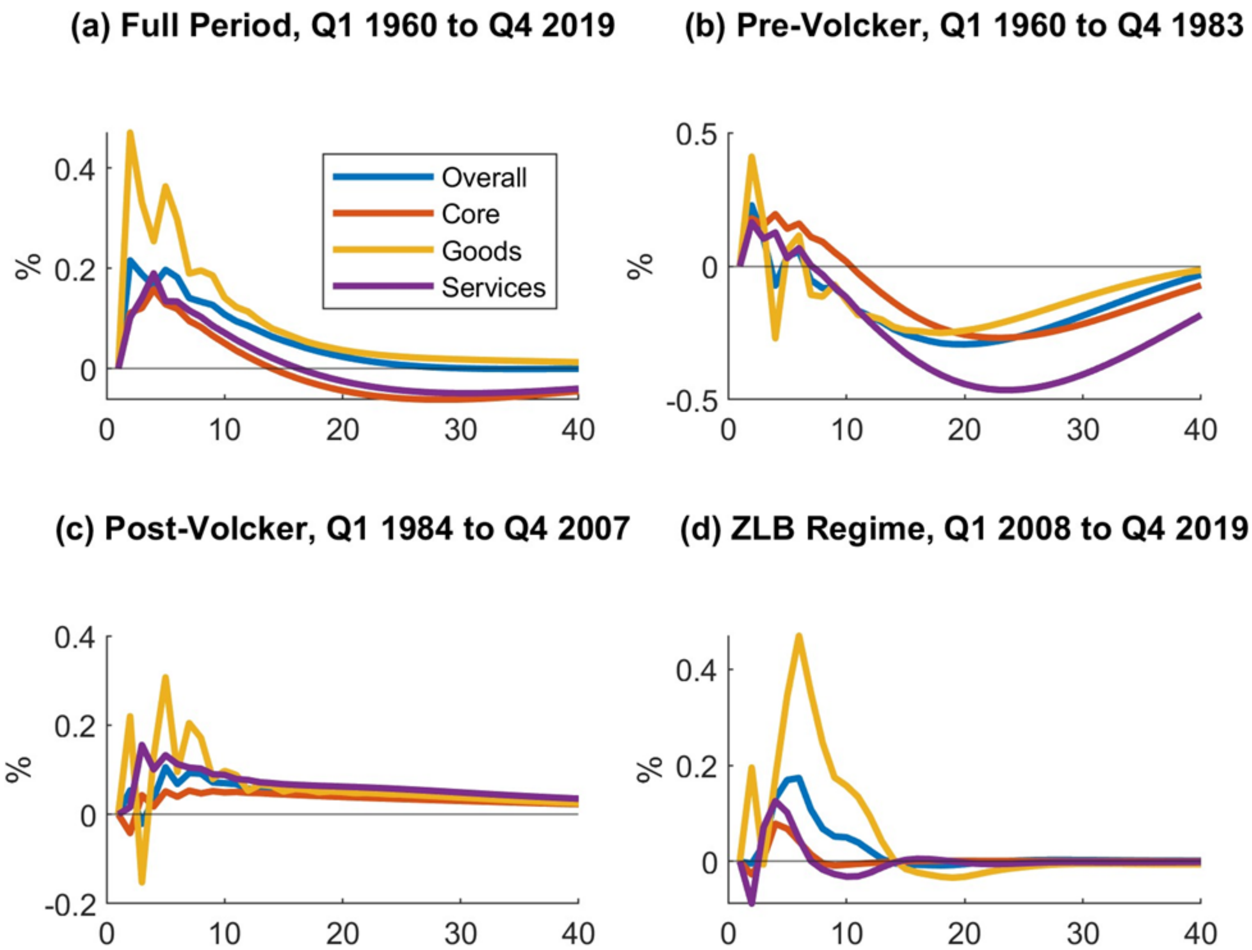

Figure 1: Impulse Responses of Inflation to 1 s.d. Tightening of Monetary Policy

goods market of Fed tightening is masked when looking at overall PCE or core PCE, both of which respond in a similar manner to services. It is concerning that during the most recent economic period, unanticipated tightening of usual magnitude raised goods inflation by over 40 basis points during its positive peak effect but could barely reduce it by even 10 points at its peak negative effect.

Policy rate changes had virtually no effect at all on core PCE during the ZLB regime. While it is hard to extract causal inference from such VAR analysis, this relationship might help explain why the Fed has been largely unsuccessful in combating the post-COVID inflationary cycle. Assuming the underlying structure of the economy has remained the same pre- and post-COVID, any unanticipated changes on the part of the Fed would have to be orders of magnitude larger than its usual standard deviation rate hikes to have even a moderate impact on inflation. The IRF analysis suggests that the Fed may not have been able to control runaway inflation as well as the public and government officials may believe it could have.

Impulse responses from sensitivity tests are not included here but do not alter the conclusions. Energy sector inflation is extremely volatile but as discussed in the next

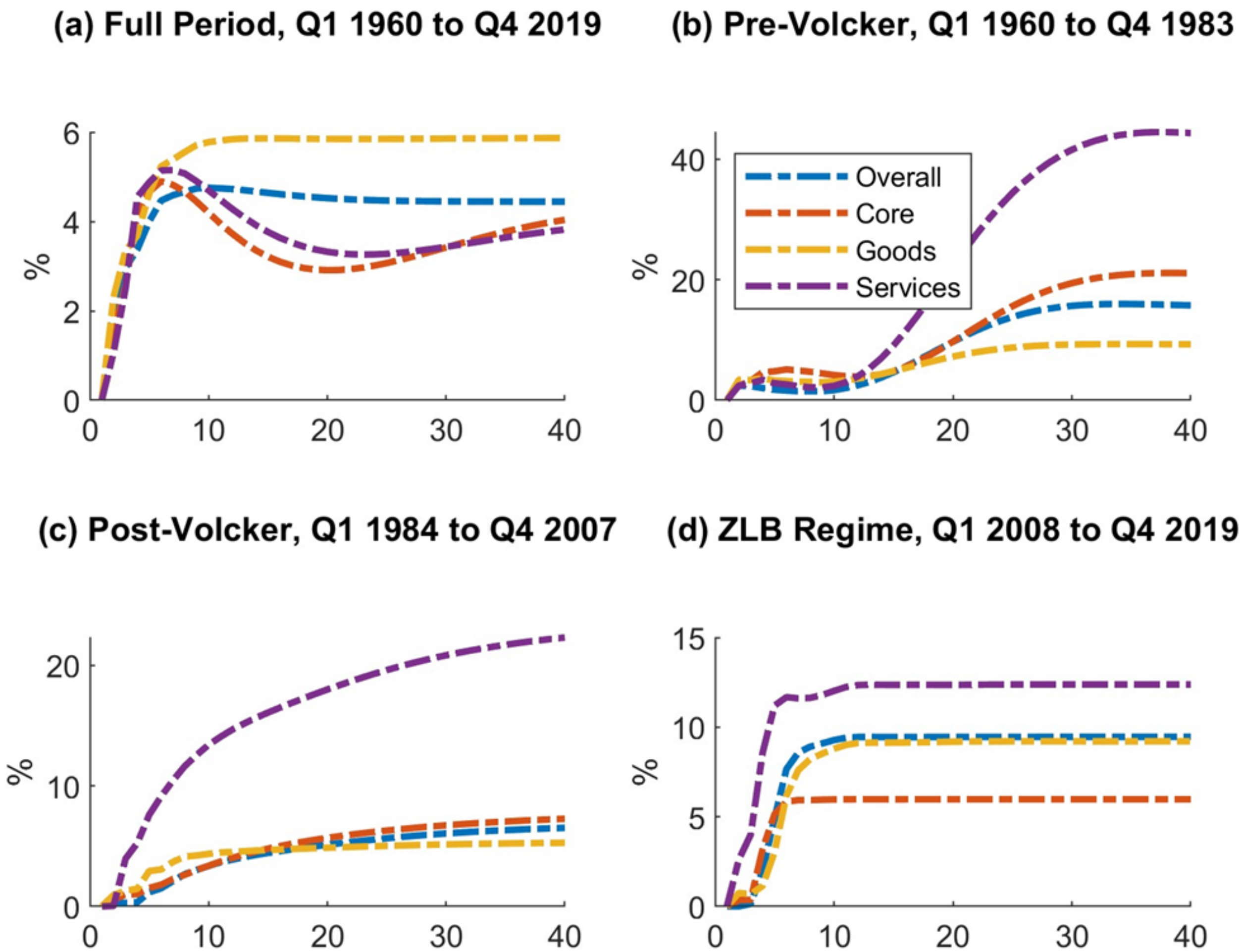

Figure 2: Forecast Error Variance Decomposition of PCE Inflation - Monetary Policy Share

section, this seems to be a facet of the data as monetary policy does not contribute significantly to its determination. Indeed, the effect of monetary policy on the energy sector is largely ignored as sudden changes in energy prices operate like supply shocks and are usually studied from that perspective. While a closer examination of the interaction between monetary policy and energy is needed, it is beyond the purview of this paper.

As expected, results from using the base FFR differ only during the ZLB period by exhibiting sine-curve like dynamics and an increased volatility, but this may be the result of coefficient bias due to the interest rate operating at its floor for a large share of the period. Including S&P 500 returns in the VAR and switching the order of the variables so that output reacts before inflation barely changes the IRFs in any way and all conclusions made above continue to be true.

3. Forecast Error Variance Decompositions

The prior section showed that policy rate changes by themselves cannot significantly alter inflation. This section provides

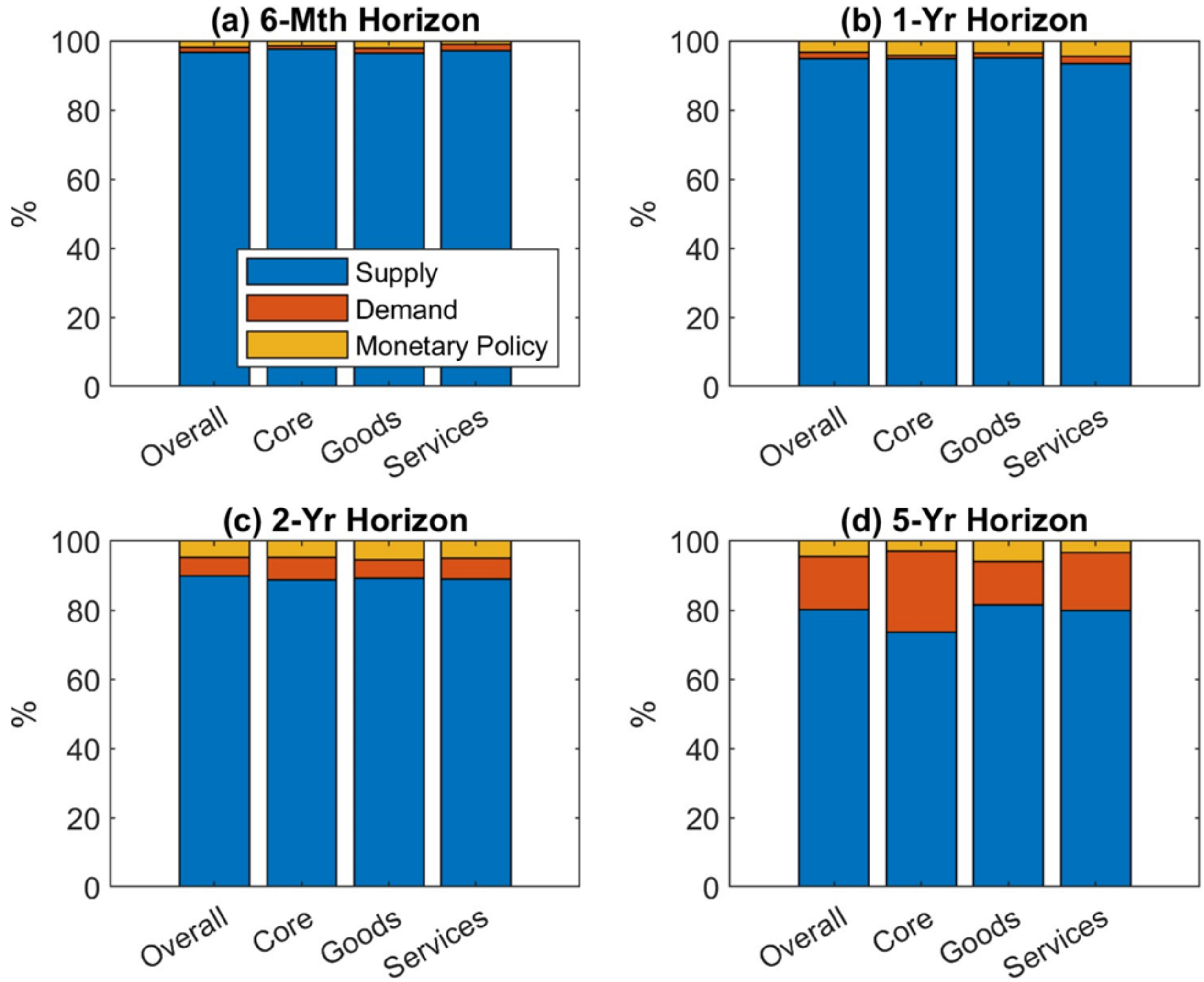

Figure 3: FEVD of PCE Inflation - Breakdown by Source, Full Period

estimates of how much monetary policy contributes to the overall variation in inflation. To provide these estimates, it presents results from the forecast error variance decomposition ("FEVD") of PCE inflation metrics: overall, core, goods, and services. The FEVD is the percentage of the variance in the forecast of inflation that results from any of the shocks to the system. The FEVD may be computed for any forecast horizon; in any given horizon the contributions from the respective shocks must add up to 100%. As Stock and Watson (2001) highlight, the FEVD "is like a partial R^2 for the forecast error, by forecast horizon."

Figure 2 plots the monetary policy share of inflation FEVD at various horizons. It is immediately apparent that Fed policy accounts for a small part of the overall variation in inflation. At near-term horizons of one year or less, monetary policy usually accounts for less than 2% of inflation variance. Monetary shocks increase in importance at longer horizons when the deflationary effects of monetary policy are

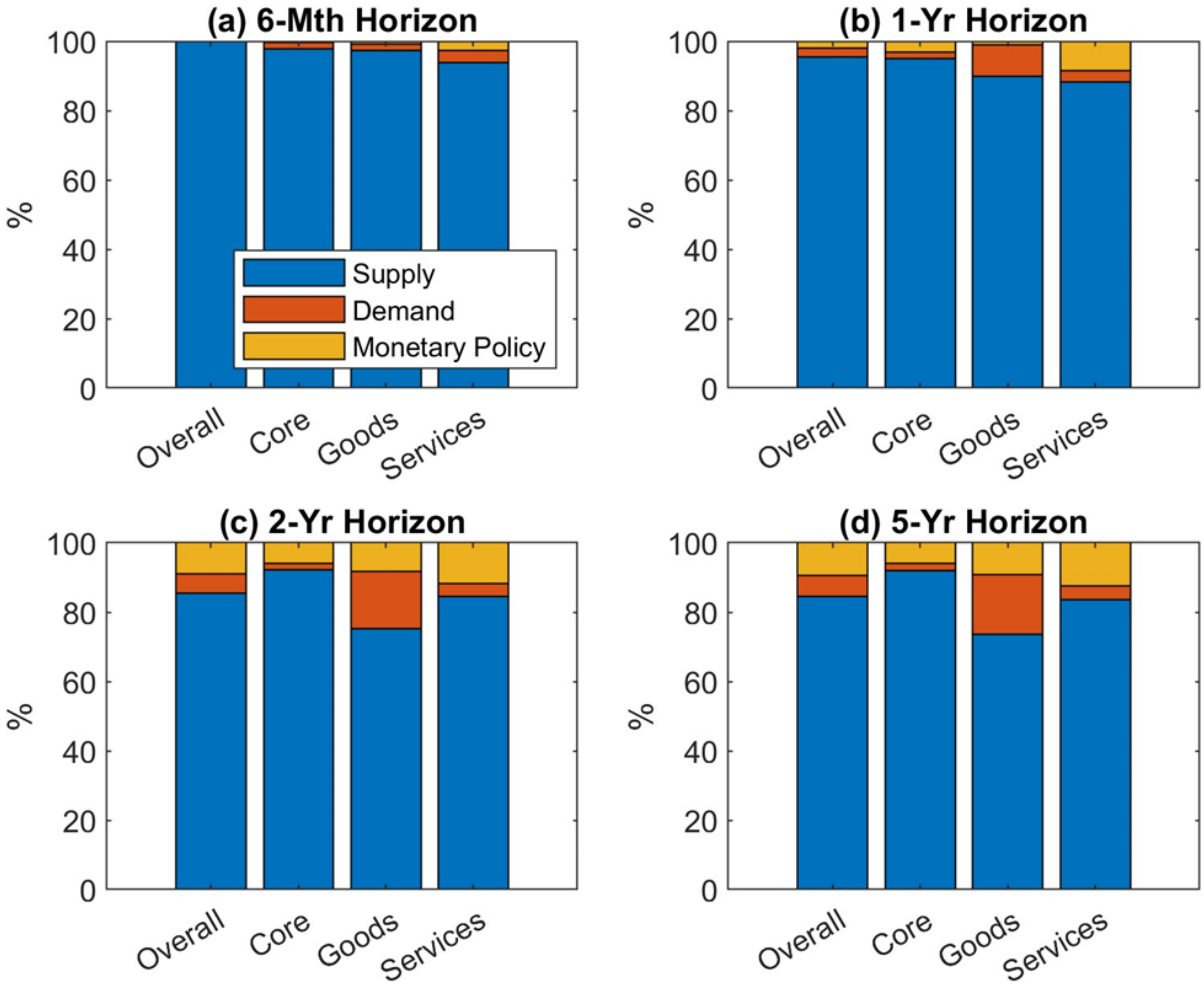

Figure 4: FEVD of PCE Inflation - Breakdown by Source, ZLB Regime

triggered, but even at those horizons the FEVD share never exceeds 6% for the full period. Within the various time periods, interest shocks primarily matter for service sector inflation but not as much for the other sectors. This is because the services sector is the only one that responds to the deflationary pressures exerted by interest rate changes, which primarily manifests itself at longer horizons.

As with the IRFs, monetary policy matters the most during the pre-Volcker period, contributing as much as 20% to core inflation variance at longer horizons. However, in the post-Volcker and ZLB periods monetary policy is significantly less important in determining inflation volatility. In these periods, interest rate changes did not exert much deflationary influence on the economy; consequently, monetary policy does not contribute much to determining inflation. While services seem affected to a slightly greater extent, overall variation during these time periods within services is low to begin with, so interest rates explain a larger share of a smaller pie. For the other sectors, monetary shock shares are low, remaining between 5 to 10% even at longer horizons.

These results are robust across a variety of sensitivity tests. For instance, while PCE energy inflation is very volatile overall, monetary policy contributes very little to its FEVD, suggesting again that the energy sector evolves in a very different manner to other price indexes in the economy. Similar to the IRFs, using the base FFR (as opposed to the shadow rate) only changes the results for the ZLB period by marginally increasing the share of monetary policy. However, it is difficult to trust these coefficient estimates owing to the biases caused by the FFR not reflecting the accurate stance of monetary policy by remaining stuck at the ZLB. Including the S&P 500 marginally increases the importance of Fed policy during the ZLB period but only for services; the share is now between 20-25% at longer horizons. All other sectors remain below 10%. Changing the variable ordering has no effect on the conclusions.

Additionally, the share of monetary policy is small in comparison to other sources of variation. As will be clear from the following graphs, despite the focus on Fed policy, supply factors are the dominant determinants of inflation volatility across horizons. Figure 3 shows the breakup of FEVD for various PCE inflation metrics for the full period into its constituent demand, supply, and monetary policy shocks. At all horizons, supply factors dominate the variability of inflation. Even at a 5-year forecast horizon, supply factors diminish in importance but still account for over 70% of variance regardless of the PCE metric. As the chart shows, while monetary policy increases in importance with the horizon, it is still dwarfed by supply factors. In fact, after 8 quarters, demand and monetary policy factors become equally important and after 20 quarters, demand factors outweigh the Fed in importance. Demand factors especially outweigh interest changes with respect to the core PCE, the primary inflation rate of interest to the Fed.

The role of the Fed is similarly small when focusing on the modern macroeconomy. Figure 4 shows the breakup of FEVD for various PCE inflation metrics for the ZLB regime into its constituent demand, supply, and monetary policy shocks. Once again, at all horizons, supply factors dominate the determination of inflation, although monetary policy is marginally more important during this period than the full dataset. Services is the only sector where the share of monetary policy exceeds 10%. Supply factors exceed 80% of the FEVD share in every case except in the goods market where demand factors also become important, especially at longer horizons. It is clear from the graphs that the role of the Fed is significantly lower than those of supply factors in controlling U.S. inflation.

Conclusion

U.S. voters and politicians alike place a large amount of importance on the Fed in relation to containing inflation. Using a monetary SVAR methodology, this paper documents empirical evidence that the Fed's impact has been grossly overstated. This finding holds when looking at the U.S. economy as a whole since 1960 and even when looking at specific monetary eras, particularly post-Volcker (1984 to 2007) and the ZLB period following the Great Recession (2008 to 2019). Impulse responses show that inflation is generally mildly responsive to monetary policy shocks. For instance, only inflation in the goods market responds strongly, but goods inflation only increases – the opposite of what the Fed wants to achieve – and it never reduces in response to monetary tightening. An analysis of the Fed policy's contribution to inflation variance unveils that monetary shocks contribute very little to the overall variability in inflation, usually between just 5% and 10% of the total. The majority of inflation variance is due to supply shocks; this finding holds for all PCE metrics, in all periods, and at all horizons. This analysis prompts further investigation into the Fed's role in managing the economy and necessitates a deeper exploration of what policy the Fed is implementing. Future CMFA working papers will investigate these questions.

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