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The origins of monetary policy disagreement: the role of supply and demand shocks*

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Abstract

We investigate how dissent in the FOMC is affected by structural macroeconomic shocks obtained using a medium-scale DSGE model. We find that dissent is less (more) frequent when *demand* (*supply*) shocks are the predominant source of inflation fluctuations. In addition, supply shocks are found to raise private sector forecasting uncertainty about the path of interest rates. Since supply shocks impose a trade-off between inflation and output stabilization while demand shocks do not, our findings are consistent with heterogeneous preferences over the dual mandate among FOMC members as a driver of policy disagreement.

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1 Introduction

Central bank decision making by a committee of experts is an increasingly ubiquitous feature of monetary policy design (Reis, 2013). This institutional feature is seen as beneficial for aggregating the private assessments of economic conditions (Gerlach-Kristen, 2006) and providing a diversity of views about the best course of action (Hansen et al., 2014). However, precious little is known about the macroeconomic factors that cause disagreement among committee members. In particular, although central bank communication is couched in terms of structural models of the economy, no study has been previously done examining how central bank committee deliberations are affected by structural macroeconomic shocks.

In this paper, we investigate how macroeconomic shocks affect the frequency of dissent votes in the Federal Open Market Committee (FOMC or Committee), which sets US monetary policy.[1] We obtain structural shocks from the estimation of the medium-scale dynamic stochastic general equilibrium (DSGE) model by Smets and Wouters (2007), which has been shown to perform well in forecasting relative to standard time-series models. We then classify the shocks as either *supply shocks*, *demand shocks*, or *monetary shocks*, based on their implications for the behavior of inflation, output, and interest rates. We show that FOMC dissent increases when inflation variability is substantially affected by supply shocks. In contrast, we observe that FOMC dissent is less frequent when inflation movements are determined by demand shocks. These effects are precisely estimated and robust across various specifications, using several different measures of dissent, both in the aggregate time series and using panel data on individual members voting records.[2]

We interpret this finding using a simple structural model of committee deliberation and dissent, related to the framework in Riboni and Ruge-Murcia (2014) that introduces heterogeneity in the

[1]We choose the FOMC because the economics literature has devoted greater attention to FOMC deliberations relative to other central banks, making it also the natural choice for us. See for example (among many): Belden (1989), Havrilesky and Gildea (1991), Tootell (1991), Meade and Stasavage (2008), Eichler and Lähner (2014), Thornton and Wheelock (2014), Sablik (2014), Hansen et al. (2018), and Malmendier et al. (2021). There is also considerable literature on the Bank of England (BoE). However, in the case of the BoE voting has only occurred since 1997. Voting in the FOMC has happened since 1957, which allows us to have a significantly larger data sample.

[2]In proposing to interpret the actions and judgments of economic practitioners based on structural shocks obtained from a DSGE model, our paper relates to work by Monti (2010), who shows how it is possible to interpret the forecasts of professional forecasters using such shocks.

preferences of the committee members. This heterogeneity is assumed to be well represented by assigning heterogeneous coefficients to simple monetary policy rules used by the Committee members (a similar approach is adopted by Malmendier et al., 2021). Through the lenses of New Keynesian theory, the distinct feature of supply shocks is that they imply a trade-off between inflation and output stabilization. Thus, the finding that supply shocks lead to higher disagreement at FOMC meetings is consistent with the view that Committee members have heterogeneous preferences over these two objectives. Instead, demand shocks move inflation and output in the same direction. Thus, if the Committee members have heterogeneous preferences over the dual mandate, demand shocks should be associated with less disagreement among Committee members, whereas supply shocks should lead to increased disagreement.

In our baseline, we use a DSGE model to decompose historical shocks into supply, demand, and monetary shocks. Predictive regressions then link inflation volatility from these shocks to dissent. The results confirm our hypothesis: supply shocks raise dissent, while demand shocks lower it. These findings hold robustly when using a sign-restricted structural vector autoregression model (SVAR) for shock identification instead of a DSGE model. Furthermore, we show that FOMC dissent is not explained by uncertainty (the results are robust to including disagreement in FOMC members' expectations or adding stock market volatility as explanatory variables). Conversely, we show that supply shocks increase dispersion in the expectations of private sector agents concerning the path of interest rates. This provides an alternative interpretation of Belden (1989)'s result that periods of greater uncertainty about policy actions are associated with heightened dissent.

We offer a new perspective on the nexus between macroeconomic conditions and monetary policy deliberations by committees. Prior to this work little was known about how macroeconomic conditions affect monetary policy deliberations. Recently, Thornton and Wheelock (2014) found no evidence of a systematic association between FOMC dissent and either inflation or unemployment. Our findings suggest that the apparent absence of robust macroeconomic predictors of dissent has to do with the previous use of observable macroeconomic variables such as unemployment and inflation, instead of the underlying latent shocks responsible for the macroeconomic volatility.

We contribute to the debate over the importance of heterogeneity in preferences versus information in shaping committee deliberations. Riboni and Ruge-Murcia (2008) find evidence of heterogeneity in the weights attached to output and inflation stabilization among members of the Bank of England (BoE), whilst, using a different methodology, Besley et al. (2008) find preferences to be fairly homogeneous. Based on FOMC voting records, Malmendier et al. (2021) argue personal experiences exert a persistent influence on individual preferences and are a source of heterogeneity. Bordo and Istrefi (2023) show that the FOMC composition in terms of hawks and doves affects the setting of the monetary policy. Thus, it is fair to say that the literature is inconclusive.

Differently to, for example, Riboni and Ruge-Murcia (2008) and Besley et al. (2008), we estimate predictive regressions for the frequency of dissent instead of estimating individual interest rate rules. This matters as the estimation of heterogeneous interest rate rules using dynamic panel data models is notoriously difficult (Pesaran and Smith, 1995). Our test of preferences heterogeneity as a determinant of policy disagreement does not hinge on testing for heterogeneous coefficients in simple reaction functions. Instead, it relies on the insight that only supply shocks impose a trade-off between conflicting policy objectives (a point also made by Riboni and Ruge-Murcia, 2008, but which they do not explore empirically). As we focus on the incidence of dissent, we avoid the estimation of heterogeneous reaction functions.

Prior literature struggled to identify macroeconomic factors predicting FOMC dissent, but did find some support for individual characteristics. Malmendier et al. (2021) discovered that personal inflation experiences influence FOMC members' voting behavior, with varied experiences leading to different votes and speech tones. Belden (1989) and Thornton and Wheelock (2014) observed governors tend to dissent for easier policies and bank presidents for tighter ones, attributed to differences in their career backgrounds. However, Havrilesky and Gildea (1991) and Eichler and Lähner (2014) provide an alternative explanation. Nevertheless, Tootell (1991) rejects significant voting behavior differences between bank presidents and governors.

Finally, we contribute to the literature looking at the interplay between deliberation by monetary policy committees and the macroeconomy. Romer and Romer (2008) find differences between

FOMC and Federal Reserve staff forecasts predict monetary policy shocks. Madeira and Palma (2018) use a DSGE model to analyze FOMC deviations from the Taylor rule, whilst Madeira and Madeira (2019) document positive stock market excess returns around FOMC meetings when votes are unanimous, but negative excess returns when dissent occurs. Blot et al. (2023) also show that dissent in the ECB – both expansionary and restrictive – has a negative effect on stock prices. Hack et al. (2023) show that fiscal multipliers are larger when the composition of the FOMC is more dovish, indicating that the preferences of the FOMC members affect macroeconomic outcomes.

The paper is organized as follows. Section 2 covers the institutional features of the FOMC and summarizes its voting records. Section 3 introduces a structural model to interpret dissent in committee meetings within a DSGE framework. Section 4 presents the main empirical results, and section 5 explores additional empirical experiments. Finally, section 6 concludes.

2 Voting in the FOMC

The Federal Open Market Committee (FOMC) oversees the US monetary policy and open market operations of the Federal Reserve System (Fed). It consists of twelve members, including seven members of the Federal Reserve Board of Governors nominated by the President, the New York Federal Reserve bank president, and four rotating Federal Reserve bank presidents. The FOMC currently sets policy based on a target level for the federal funds rate. Meeting minutes record all member votes, including dissents.[3] Following Thornton and Wheelock (2014), we focus on FOMC votes starting from 1957, and we stop in 2018Q1 covering Yellen's last meeting as Chair.[4]

The FOMC holds eight regular meetings per year, with additional unscheduled meetings as

[3]The first dissent occurred in 1957. Thornton and Wheelock (2014) suggest that earlier lack of dissent may have been due to infrequent meetings and vaguely worded directives. This changed in 1956 with more frequent meetings and all members voting on the operating directive.

[4]The FOMC communication and policy changed substantially over this period. In March 1993 the FOMC starts publishing minutes after the subsequent meeting. In February 1994 the FOMC issued its first statement after a meeting. In August 1997 the FOMC starts announcing its policy in terms of a federal funds rate target. In March 2002 the FOMC starts including in statements the individual member votes. In August 2003 the FOMC starts including forward guidance in its statements. In November 2007 the FOMC starts including in minutes a Summary of Economic Projections (SEP). In November 2008 the Fed announces its first large-scale asset purchase (LSAP). In January 2012 the FOMC specifies an inflation target of 2%. For a more detailed history see Cecchetti and Schoenholtz (2019).

needed. Table 1 shows the average fraction of dissent votes (DIS_t) per quarter for each Chair's tenure. Following Thornton and Wheelock (2014), dissent votes are categorized as "tighter" (DT_t) or "easier" (DE_t) policies, indicating disagreement with the majority's stance on money supply growth or interest rates. "Other" (DO_t) represents dissent with no specific reasons mentioned in the records or related to policy language or future actions.

Table 1 also reports, for each Chair tenure, the percentage of quarters with dissent, across categories: overall dissent ($DIS_t > 0$); dissent for tighter ($DT_t > 0$); dissent for easier ($DE_t > 0$); dissent with other motives ($DO_t > 0$). Dissent votes are a small fraction of the total FOMC votes. Except for Miller's short term, dissent represents 10% or less of the votes during any Chair's term.[5] Nonetheless, dissent is quite frequently observed over time and all Chairs have observed dissent occurring in over 50% of quarters. Miller and Volcker are the Chairs with the highest observed dissent, for both tighter and easier policies. Greenspan is the Chair with the lowest observed dissent behavior. Close to half of the quarters have dissent votes for tighter policy and about one-third for easier. Other dissents are rare (less than 1% of all votes), but have increased substantially with the Bernanke and Yellen terms. One potential reason behind this increase is that the zero lower bound (ZLB) was binding during much of the Bernanke and Yellen terms and the Fed had to rely on an alternative set of policy instruments. Dissent with a bias in favor of easier monetary policies is less frequent (25% of the quarters or fewer) in the Greenspan, Bernanke, and Yellen terms, but quite common with previous Chairs. Dissent for easier is particularly low in Bernanke's term. A possible reason for this is that this is when the ZLB became binding.

One may question if all dissents come from a single member who opposes the Chair. But to the contrary, the third panel in Table 1 shows that all Chairs had to face dissent by several FOMC members. While most votes cast are in favor of the policy proposed by the Chair (dissent represents only 6.4% of votes in our sample period, see Table 1), most FOMC members have dissented at some point (79 of a total of 148 FOMC members in our sample period have done so). Thus, dissent

[5]As there is typically more than one meeting per quarter, occasionally the first meeting has a different Chair from subsequent meetings in the same quarter. We assign such quarters to the first Chair. For example, there were two meetings in the first quarter of 2018. The first meeting was the last with Yellen as Chair. The second meeting was the first with Powell as Chair. We labeled the 2018:1 observation as corresponding to Yellen.

is not a minor aspect that can be explained away by the behavior of a few odd members acting as outliers within the Committee. Also, there are no members who dissent in all meetings. Between 1957 and 2018, only four members had a dissent rate equal to 50% or above.

Table 2 shows the distribution of the probability of dissent of each FOMC member over each Chair's term, conditioning on members who dissented at least once. Overall, the median dissenter is someone who disagrees with the Chair in fewer than 10% of the meetings. The strongest dissenting members (that is, those in the percentile 75 of the highest dissent rate) had an overall dissent rate below 20%, which is far below someone who disagrees all the time. For example, during the Volcker and Miller term the strongest dissenters (those in the percentile 75) had dissent rates around 17%. Therefore, although Volcker and Miller faced respectively dissent in 84% and 100% of quarters (Table 1) it is not true that particular members almost always dissented.

3 Making sense of FOMC dissents

In this section, we establish possible structural predictors of FOMC dissent through the lenses of a Dynamic Stochastic General Equilibrium (DSGE) model. We first present a simple framework of monetary policy committee deliberation within the three-equations New Keynesian (NK) model. Next, we set the scene for the empirical work in section 4, by illustrating how structural shocks affect committee disagreement with a calibrated example.

3.1 Committee deliberations in the three equations NK model

We consider a simple model of monetary policy deliberation by committee. The economy is described by the canonical three-equation NK model as laid out in, for example, Clarida et al. (1999) and Sbordone et al. (2010), as follows

$$y_t = y_{t-1} - (r_t - E_t\pi_{t+1}) - u_t^d, \tag{1}$$

$$\pi_t = \beta E_t\pi_{t+1} + \gamma y_t + u_t^s, \tag{2}$$

$$r_t = \rho r_{t-1} + (1-\rho)\Big[r^\star + r_\pi\left(\pi_t - \pi^\star\right) + r_y y_t\Big], \tag{3}$$

with y_t the output gap, r_t the nominal interest rate and π_t the inflation rate. The long-run targets for the nominal interest rate and inflation rate are $r^\star$ and $\pi^\star$. Equation (1) is the traditional IS condition and equation (2) is the Phillips curve. The exogenous disturbances u_t^d and u_t^s are demand and supply shocks, respectively. Equation (3) determines the interest rate preferred by the majority of members and is, therefore, the chosen interest rate at date t (under simple majority).

Underpinning the choice of interest rate in (3) is a committee voting process. We assume the committee adopts an agenda-setting protocol: proposals are passed by simple majority rule; the Chair sets the agenda, which allows her/him to make a proposal at every meeting; this proposal is either approved or voted down; if the proposal is voted down, the adopted interest rate is the previous period interest rate r_{t-1}. Since the Chair holds the agenda-setting power and is also the median voter, this model collapses to the dictator model, with the Chair able to choose her/his favorite interest rate. This corresponds to what Riboni and Ruge-Murcia (2010) call the frictionless model, in which a committee is observationally equivalent to having the Chair as the single policymaker and, thus, the policy function is indistinguishable from a standard Taylor rule, which has been shown to describe well the monetary policy in the US (Taylor, 1993).[6]

Even in the frictionless case, modeling the committee deliberation and voting protocol explicitly helps understand dissent. As in Riboni and Ruge-Murcia (2014) we assume that, at the end of the voting game, each member of the monetary policy committee has the opportunity to express dissent. The committee is comprised of N members labeled $i = 1, \ldots, N$. As in Besley et al. (2008) and Riboni and Ruge-Murcia (2014), each member's preferences for the value of the interest

[6]The frictionless model is a simplification; in fact, Riboni and Ruge-Murcia (2010) suggest the consensus formation model, where no committee member controls the agenda and a supermajority is required, aligns better with the data. Yet, Riboni (2010) offers a rationale for delegating policy to a committee led by a strong Chair who controls the agenda but must put her policy to a vote. The committee may offer the Chair a commitment device to implement time-inconsistent policies (see Coroneo et al., 2018, for a test of the time-consistent model of optimal monetary policy in the US).

rate, $r_{i,t}$, is adequately represented by a simple rule

$$r_{i,t} = \rho r_{t-1} + (1-\rho)\Big[r^\star + r_{i,\pi}(\pi_t - \pi^\star) + r_{i,y} y_t\Big], \tag{4}$$

with $r_{i,\pi} \geq 0$ and $r_{i,y} \geq 0$ denoting the individual specific weights on the inflation and output stabilization objectives, and $\rho \in (0, 1)$ capturing interest rate smoothing.[7] Preferences are symmetric around the bliss point $r_{i,t}$, and dissent by individual i occurs when $|r_{i,t} - r_t| \geq \alpha$, with $\alpha > 0$, capturing the committee's norms and institutional culture (as in Riboni and Ruge-Murcia, 2014).

3.2 Calibrated example

To illustrate how supply shocks (which move inflation and output in opposite directions) and demand shocks (which move inflation and output in the same direction) affect committee deliberations differently, we consider a calibrated example of the model described by equations (1), (2) and (3).[8] We set $r^\star = \pi^\star = 0$. Following Sbordone et al. (2010), we set $\beta = 0.99$ and $\gamma = 0.1$. For the monetary policy rule of the Chair, we set $\rho = 0.75$, $r_\pi = 1.5$ and $r_y = 0.5$ which are standard values (i.e., they correspond to the prior mean values in Smets and Wouters, 2007). We assume that the demand (u_t^d) and supply (u_t^s) shocks obey an autoregressive process, $u_t^d = \rho u_{t-1}^d + \varepsilon_t^d$ and $u_t^s = \rho u_{t-1}^s + \varepsilon_t^s$, with $\rho = 0.9$. The example is based on the assumption that there are two minority groups, labeled "hawks" and "doves". Each group represents an extreme type (in the sense that they

[7] Fendel and Rülke (2012) offer direct empirical evidence that individual forecasts of FOMC members align with a Taylor-type rule similar to the aggregate FOMC behavior. Carvalho and Nechio (2014) show that professional forecasters and some US households form expectations in line with a Taylor rule for interest rates. Notably, (4) does not predict permanent disagreement between FOMC members as the steady state nominal interest rate, $r^\star$, is the same for all members. This aligns with the fact that no FOMC member always dissents. Additionally, Coibion and Gorodnichenko (2012) present evidence from FOMC discussions supporting the interest rate smoothing hypothesis.

[8] Similar definitions of demand and supply shocks have a long-established tradition in macroeconometrics and are often used, for example, in structural analysis with vector autoregressions (VAR) models identified with sign restrictions (see, for example, Peersman, 2005; Fry and Pagan, 2011; Canova and Paustian, 2011).

are not the median voter).[9] The interest rates favored by, in turn, hawks and doves are

$$r_{h,t} = \rho r_{t-1} + (1-\rho)\Big[r^\star + r_{h,\pi}\left(\pi_t - \pi^\star\right) + r_{h,y} y_t\Big], \tag{5}$$

$$r_{d,t} = \rho r_{t-1} + (1-\rho)\Big[r^\star + r_{d,\pi}\left(\pi_t - \pi^\star\right) + r_{d,y} y_t\Big]. \tag{6}$$

The hawk/dove committee members differ from the Chair in terms of only the weights attached to inflation ($r_{h,\pi} > r_\pi > r_{d,\pi}$) and output ($r_{h,y} \leq r_y \leq r_{d,y}$). In the baseline, committee members with hawk views adopt an interest rate rule with a higher weight on inflation and a lower weight on output ($r_{h,\pi} = 2$ and $r_{h,y} = 0.25$), and doves adopt an interest rate rule with a lower weight on inflation and a higher weight on output ($r_{d,\pi} = 1$ and $r_{d,y} = 0.75$). The model is symmetric, as $|r_t - r_{h,t}| = |r_t - r_{d,t}|$, so that hawks and doves can dissent together. Empirically, dissent for tighter and easier sometimes coexist, but, of course, this needs not be the case.

The relevant variable behind dissent in our framework is the absolute value of the difference between the interest rate favored by the Chair and the interest rate favored by hawk and dove members of the committee, $|r_{h,t} - r_t|$ and $|r_{d,t} - r_t|$. Member $i = 1, \ldots, N$, dissents if

$$\Delta_{i,t} \equiv \left|\frac{r_{i,t} - r_t}{1-\rho}\right| = \Big|\left(r_{i,\pi} - r_\pi\right)\left(\pi_t - \pi^\star\right) + \left(r_{i,y} - r_y\right) y_t\Big| \geq \left(\frac{\alpha}{1-\rho}\right). \tag{7}$$

and plugging in (7) the parameter values for hawks yields

$$\Delta_{h,t} = \Big|\left(r_{h,\pi} - r_\pi\right)\left(\pi_t - \pi^\star\right) + \left(r_{h,y} - r_y\right) y_t\Big| = \Big|0.5\left(\pi_t - \pi^\star\right) - 0.25 y_t\Big|, \tag{8}$$

which is equal to the same measure for doves ($\Delta_{d,t}$). Thus, $\Delta_{h,t}$ is a measure of policy disagreement, as higher realizations imply greater dissent. We also consider an alternative case

[9] Reviewing statements from several FOMC members, Sablik (2014) argues that members labeled as doves are concerned with inflation and that members labeled as hawks also attach weight to employment. Thus, it is wrong to think of hawks as always favoring higher interest rates and doves lower rates. Instead, Sablik (2014) argues that the differences between members are with respect to the weights of monetary policy responses to inflation and economic activity, consistent with our formulation. Similarly, using narrative records in the US press, Bordo and Istrefi (2023) argue that within an FOMC, for the same objective and same economic conditions, some members are perceived to be on the hawkish side and some on the dovish side.

($\Delta_{h,t} = |(r_{h,\pi} - r_\pi)\, \pi_t|$) in which hawks/doves differ from the Chair with respect to the weight attached to inflation ($r_{h,\pi} = 2$ and $r_{d,\pi} = 1$, as in the baseline case) but not for the output gap ($r_{h,y} = r_{d,y} = r_y = 0.5$). This alternative specification illustrates that disagreement is affected differently by supply and demand shocks only if committee members have heterogeneous preferences over both inflation and output stabilization.

When confronting demand and supply shocks, we calibrate the magnitude of the shocks so that both cause inflation to move 1% away from target. In Figure 1 we present the impulse response functions (IRFs) to demand and supply shocks for our calibrated model. The first panel has the IRFs for inflation and the second panel for the output gap. They illustrate the main difference between supply and demand shocks: the supply shock moves inflation and the output gap in opposite directions, while the demand shock moves them in the same direction. Thus, supply shocks yield a trade-off between inflation and output stabilization, whereas demand shocks do not.

The third and fourth panels have the responses to each shock of $\Delta_{h,t}$ (and, equivalently, $\Delta_{d,t}$) for, respectively, the baseline case (with disagreement over both targets) and the alternative case (only inflation). On the bottom-left panel we look at the baseline measure of policy disagreement, $\Delta_{h,t}$, as defined in (8). The figure shows that supply shocks generate substantial policy disagreement in the baseline case, whilst demand shocks do not. Instead the bottom-right panel, for the alternative measure of disagreement, shows little difference between supply and demand shocks. Comparing the two bottom panels, we can observe that policy disagreement generated by supply shocks is higher (and more persistent) in the baseline case than in the alternative case. On the other hand, policy disagreement generated by demand shocks is lower in the baseline case.

To sum up, these results show that with heterogeneous preferences over the dual mandate among FOMC members we should observe more dissent with supply shocks than with demand shocks.[10] In the next section we investigate this hypothesis empirically, using demand and supply shocks obtained from an estimated medium-scale DSGE model.

[10]Heterogeneous beliefs about the state of the economy can only replicate such a pattern if in addition one assumes supply shocks raise the dispersion of beliefs and that demand shocks lower dispersion. Thus, an explanation based on heterogeneous preferences is preferable to an explanation based on heterogeneous beliefs because the latter is less parsimonious (the Occam's razor principle advocates opting for explanations with the smallest possible set of elements).

4 Structural shocks as predictors of FOMC dissent

In this section we carry out a formal empirical investigation of the hypothesis that the structural shocks identified using the medium-scale DSGE model are predictors of FOMC dissent. This is done using both time-series data on FOMC aggregate voting records and panel longitudinal data on each individual member's voting records.

4.1 Predictors of dissent based on a medium-scale DSGE model

The first step in our analysis is to obtain structural macroeconomic shocks (which we posit are important drivers of FOMC dissent) using the medium-scale DSGE model developed by Smets and Wouters (2007). This model is the workhorse framework to study the business cycle, used in many central banks for policy analysis, forecasting and communication (Debortoli et al., 2019). It features a variety of frictions including sticky prices and wages, habit formation in consumption, and adjustment costs.[11] The model's exogenous disturbances include productivity, price markup, wage markup, exogenous spending, monetary policy, risk premium, and investment shocks.[12]

We estimate the model with Bayesian techniques and the same seven US quarterly time series used by Smets and Wouters (2007): the log difference of the GDP deflator, real GDP, real consumption, real investment, real wage, the log of hours worked, and the federal funds rate. Our estimation only differs from Smets and Wouters (2007) in the sample range.[13] Smets and Wouters (2007) estimated their model for the period 1966:1 – 2004:4. We estimate our model for the period 1950:1 – 2018:1. We extend the sample period to obtain historical decompositions from 1957:1 until 2018:1.

The estimated mean IRFs for deviations of output, inflation, and the interest rate from the steady state of each shock are shown in Figure 2. Each shock is classified as either, supply, demand or

[11] Some empirically relevant frictions are not included, such as firm-specific employment (Madeira, 2014), firm-specific capital (Madeira, 2015) and labor adjustment costs (Madeira, 2018).

[12] Estimating the Smets and Wouters (2007) model for the US economy, Debortoli et al. (2019) find substantial welfare improvements associated with assigning the central bank with a dual mandate. Thus there is a meaningful trade-off between inflation and output stabilization faced by policy-makers. The drivers of this trade-off in the estimated model by Debortoli et al. (2019) are price and wage-markup shocks, which are supply shocks.

[13] See An and Schorfheide (2007) and Madeira (2013) for two useful reviews of the Bayesian approach.

monetary, based on its contemporaneous impact on output, inflation, and the interest rate. The shocks classified as supply are wage markup, price markup, and productivity shocks. The demand shocks are the exogenous spending, risk premium, and investment shocks, and there is a single monetary policy shock, given by the shock to the interest rate policy rule. We consider supply shocks to be those causing inflation and output to move in opposite directions, while demand shocks make inflation and output move in the same direction. Although the monetary shock is under this criterion a demand shock, we treat it separately for two reasons. First, while the other demand shocks cause the interest rate to move in the same direction as inflation and output, monetary policy shocks cause the interest rate to move in the opposite direction of inflation and output.[14] Second, monetary shocks are the result of policy decisions and thus are endogenous to the FOMC deliberations.

In our empirical analysis, we propose as dissent predictors the absolute value of the contribution of supply and demand shocks to inflation: $|\pi_t^{\text{sup}}|$ and $\left|\pi_t^{\text{dem}}\right|$. We focus on inflation because the Federal Reserve's long-run goals consist of targeting inflation and "concerns about prospective inflation were often given as a reason for members' dissents" (Thornton and Wheelock, 2014), and to avoid collinearity from also including the historical shock decomposition for the output gap. The realized absolute value of inflation is a volatility measure and is preferred to the squared realization of inflation because it is more robust to measurement error, jumps, and outliers. The historical shock decomposition for inflation is shown in Figure 3. Supply shocks are important in the mid 1970s to early 1980s, and again in the late 1990s. Demand shocks are an important source of volatility in the late 1950s, in the 1980s, and from the mid-1990s onwards.

The time series of $|\pi_t^{\text{sup}}|$ and $\left|\pi_t^{\text{dem}}\right|$ are shown in Figure 4, together with the fraction of dissent votes. In support of the arguments presented earlier, we observe that when the contributions of demand shocks to movements in inflation are high there are fewer dissenting votes in the FOMC deliberations (period prior to the mid-1970s and from the mid-1990s to the start of the Great Recession at the end of 2007). Instead, when the contribution of supply shocks is high, the

[14]For this reason Keating (2013) also considers monetary policy shocks apart from other demand shocks.

frequency of dissent increases (for example, from the mid-1970s to early 1980s).

4.2 Time-series regressions

We now test formally the hypothesis that supply shocks lead to increased dissent whereas demand and monetary shocks lower dissent. First, we present results using quarterly time-series. The baseline regression specification is

$$V_t = \theta_0 + \theta_1 \pi_t + \theta_2 u_t + \theta_3 \left|\pi_t^{\text{sup}}\right| + \theta_4 \left|\pi_t^{\text{dem}}\right| + F_t + T_t + \varepsilon_t, \tag{9}$$

with V_t a measure of dissent. We consider several alternative measures of dissent. Specifically, DIS_t, the fraction of votes for dissent, $DIS_t > 0$, a dummy variable for whether there was dissent at quarter t, $DT_t > 0$ taking value 0 if there is no dissent and 1 if there is dissent for tighter, and finally $DE_t > 0$, taking value 0 if there is no dissent and 1 if there is dissent for easier.[15]

The model's main specification includes year fixed effects (T_t) to control for clustering and lower frequency changes in voting, and because Committee members change each year due to rotation between Federal Reserve bank presidents. We include Chair fixed effects (F_t) to control for differences in the Chair's ability to generate consensus (for evidence, see Belden, 1989, and Blinder, 2007).[16] The predictors of dissent we propose are the variability of inflation attributed to supply and demand shocks ($\left|\pi_t^{\text{sup}}\right|$ and $\left|\pi_t^{\text{dem}}\right|$), and control for inflation (π_t) and unemployment (u_t), as there may be a relationship between the volatility of inflation and unemployment and its levels (Ball et al., 1990). We use unemployment instead of the output gap to ease comparison with ealier work on FOMC dissent (Havrilesky and Gildea, 1991; Thornton and Wheelock, 2014).

We estimate (9) using ordinary least squares (OLS) from 1957:1 to 2018:1, and report robust

[15]The time aggregation is not affecting our findings. In section 4.3 we do not aggregate dissent at the quarterly level and, instead, specify the panel regressions across meetings and obtain similar results.

[16]Our results are at the quarterly frequency. At lower frequencies, clustering in the frequency of dissent is evident (see Figure 4). Clustering results from various factors, such as changes in committee composition, communication protocols, and macroeconomic conditions. Including year-fixed effects captures both medium and lower frequency movements in dissent frequency. But, the predictors of dissent remain consistent even when omitting time effects (column c. in Table 3). Chair fixed effects account for low-frequency changes in dissent intensity relating to variations in meeting protocols under each Chair.

standard errors. The first set of results is shown in Table 3, where the dependent variable is DIS_t. In column (a) we estimate a specification that includes only the constant, π_t, u_t, and Chair fixed effects, F_t. The specification in column (b) is the same as that in (a) but we have also added year fixed effects. The specification in column (c) is the same as that in (a) but we now include the absolute value of the contribution of supply and demand shocks to inflation (respectively, $|\pi_t^{\text{sup}}|$ and $|\pi_t^{\text{dem}}|$). The specification in column (d) is the same as that in (c) but with year fixed effects.

In all four specifications, inflation does not affect dissent. Unemployment has a positive and significant effect when year fixed-effects are excluded, indicating lower consensus during economic weakness. However, when year fixed-effects are included, the impact of business cycle conditions is absorbed, making unemployment no longer relevant in those specifications. This aligns with Thornton and Wheelock (2014), who also found that unemployment's correlation with FOMC dissent weakens after excluding outliers. The year fixed effects significantly increase the adjusted R^2, highlighting the importance of clustering and lower frequency changes in FOMC voting.

Structural shocks are important in predicting dissent in the FOMC. In particular, in all specifications, the frequency of dissent is increased when the contribution of supply shocks to inflation volatility is high. This effect is precisely estimated, both in the model that omits the year fixed effects in column (c), and in the model including them in column (d). On the other hand, demand-driven inflation volatility is found to lower the frequency of dissent. In column (c) where year fixed effects are excluded, the coefficient on $|\pi_t^{\text{dem}}|$ is negative but not statistically significant. With year fixed effects in column (d), the effect of $|\pi_t^{\text{dem}}|$ is large and highly statistically significant. As in column (b), the inclusion of the year fixed effects significantly improves the fit to the data. Therefore, we maintain year fixed effects throughout the remainder of this section.

Previous studies find a change in FOMC deliberations after the 1993 decision to release full transcripts, with members more reluctant to offer dissenting opinions following the increase in transparency (see Meade and Stasavage, 2008; Hansen et al., 2018). For this reason it is better to measure dissent using a discrete dummy variable instead of the fraction of votes. In Table 4 we look at an alternative set of predictive regressions for the discrete variable indicating if there has been at least one dissent vote for the current quarter. Three different specifications of the dependent variable are considered: $DIS_t > 0$, $DT_t > 0$ and $DE_t > 0$.[17]

Results for $DIS_t > 0$ as dependent variable are in Table 4 (columns 1 and 2). For both OLS and logit models, supply shocks raise dissent frequency and demand shocks lower it. Inflation and unemployment levels are not robust predictors, underscoring the importance of distinguishing the source of inflation. Differentiating between dissent for tighter and easier (columns 3 and 4 in Table 4), we find supply shocks raise dissent frequency for both, while demand shocks mainly lowers dissent for tighter. This aligns with supply shocks reflecting the inflation-output trade-off.

Finally, we look at individual disagreements about macroeconomic conditions as a possible channel to explain our findings. This is important since recent studies have found that different assessments by committee members of economic conditions affect votes after controlling for individual preferences.[18] Therefore, we explore if structural shocks can explain FOMC dissent beyond differences in members' expectations for inflation and unemployment. We do this by using the information in the Monetary Policy Reports (MPRs) submitted semi-annually (June and December) to Congress by the Federal Reserve Board from 1979, which includes the range of FOMC member forecasts for nominal GDP, real GDP, CPI, and unemployment.

We use the MPRs to construct measures of disagreement among FOMC members in expectations of inflation and unemployment (in turn π_t^D and u_t^D), by subtracting the lowest from the highest projection. From the range of FOMC member forecasts of the June MPRs we calculate π_t^D and u_t^D for the second and third quarters. From the range of FOMC member forecasts of the December MPRs we calculate π_t^D and u_t^D for the fourth quarter and the first quarter of the subsequent year.

[17]We estimate the discrete dependent variable model using both the OLS and the logit specifications. We consider both specifications because, given the clustering of dissent described earlier, on occasions the year fixed effect predicts dissent perfectly constraining the logit model to be estimated without year fixed effects.

[18]Hansen et al. (2014) look at voting records from the BoE's MPC and find that private assessments are an important driver of voting. Also, Eichler and Lähner (2014) find that higher individual inflation and growth forecasts relative to the Committee's median raise the probability of dissent in favor of tighter monetary policy, while higher unemployment rate forecasts lower it.

We then introduce π_t^D and u_t^D in our regressions of the fraction of votes for dissent, as follows

$$DIS_t = \theta_0 + \theta_1 \pi_t + \theta_2 u_t + \theta_3 \pi_t^D + \theta_4 u_t^D + \theta_5 \left|\pi_t^{\text{sup}}\right| + \theta_6 \left|\pi_t^{\text{dem}}\right| + F_t + T_t + \varepsilon_t. \qquad (10)$$

The estimates are reported in Table 5. For the regression without the structural shock variables, see column (a), none of the variables are statistically significant. Including our main predictors of dissent (the inflation volatility explained by each set of structural shocks), we find that also controlling for disagreement among FOMC members about future macroeconomic conditions, inflation volatility attributed to supply shocks still raises dissent. This is statistically significant at the 1% level, see column (b). We also confirm the previous findings that inflation volatility attributed to demand shocks lowers dissent (an effect statistically significant at the 5% level).

In summary, the time series regressions support the theory presented in section 3. We find that inflation volatility attributed to supply shocks raises dissent in FOMC deliberations, while that attributed to demand shocks lowers dissent. These results are robust to controlling for disagreement among Committee members over the forecasted paths of inflation and unemployment.

4.3 Panel data regressions

We now study the determinants of dissent using individual members' data at the meeting level and panel data regressions. We consider again different measures of dissent as the dependent variable ($V_{i,t}$), including, $DIS_{i,t} > 0$, a dummy variable for whether member i voted dissent at meeting t, $DT_{i,t} > 0$, a dummy variable that takes a value of 0 if member i did not dissent and 1 if member i dissented for tighter at meeting t, and $DE_{i,t} > 0$, taking value 0 if member i did not dissent and 1 if member i dissented for easier at meeting t. The estimated equation is

$$\begin{aligned} V_{i,t} = {} & \theta_0 + \theta_1 \pi_t + \theta_2 u_t + \theta_3 \left|\pi_t^{\text{sup}}\right| + \theta_4 \left|\pi_t^{\text{dem}}\right| \\ & + \theta_5 D_{i,t} + \theta_6 N_{i,t} + \theta_7 N_t^C + M_i + F_t + T_t + \varepsilon_{i,t}, \end{aligned} \qquad (11)$$

where $D_{i,t}$ is a dummy variable that takes a value of 1 if the dissenting member is a governor and 0 if the dissenting member is a bank president, $N_{i,t}$ is the number of previous meetings attended by FOMC member i at time t, N_t^C is the number of previous meetings attended by the Chair at time t and M_i are individual FOMC member fixed effects.

We estimate the model by OLS, with observations on each FOMC member over the period 1957-2018. All regressions have fixed effects for each member and for the Chair.[19] Results are in Table 6. The first column displays the model without the structural shocks. Only the coefficient for N_t^C (count of previous meetings attended by the Chair) is significant, indicating dissent is less likely in the early stages of the Chair's term. In the second column, including the structural shocks, inflation volatility attributed to supply shocks raises dissent, and volatility from demand shocks lowers it. Columns three and four have, in turn, dissent for tighter and dissent for easier as dependent variables. The results align with previous findings, as demand-driven volatility lowers dissent for tighter and dissent for easier, with the impact more pronounced for tighter dissent. Supply-driven inflation volatility raises dissent for both tighter and easier policies.

In summary, the regressions using individual voting records support our main hypothesis. Inflation volatility from supply shocks raises dissent, and volatility from demand shocks lowers it. This supports FOMC members having heterogeneous preferences across the dual mandate.

5 Additional empirical results

In this section we consider additional empirical checks. First, we consider a different method (a SVAR model) to identify the structural shocks and their contribution to inflation variability. Second, we consider uncertainty as a potential explanation for FOMC dissent. Third, we examine the relationship between the shocks' contribution to inflation variability and private sector forecast uncertainty. Finally, we discuss other exercises relegated to the Online Appendix.

[19]The OLS model is robust to the incidental parameters problem, as it yields consistent estimates of the slope coefficients even if the estimated fixed effects are inconsistent in finite samples (Wooldridge, 2001).

5.1 Structural shocks based on SVAR

We have so far worked with structural shocks obtained from the Smets and Wouters (2007) DSGE model, widely used by central banks. But, another popular approach to identify shocks and their propagation relies on the use of structural VAR models. In this Section we consider a SVAR to obtain an alternative decomposition of inflation volatility attributed to the supply shocks ($|\pi_t^{\text{sup}}|$), demand shocks ($\left|\pi_t^{\text{dem}}\right|$ and monetary shocks $|\pi_t^{\text{mon}}|$), based on sign restrictions (Uhlig, 2005). The model includes real GDP growth, inflation, and the policy interest rate (the federal funds rate). To identify the shocks, the following restrictions are imposed over a horizon of 2 periods (6 months): supply shocks raise growth and lower inflation; demand shocks raise growth, inflation, and interest rates; and monetary shocks also raise both growth and inflation but, in contrast to demand shocks, lower the federal funds rate. The estimated structural IRFs are shown in Figure 5. Details of the SVAR specification and estimation are in Appendix A.

Comparing the historical decomposition of inflation from the SVAR and DSGE models (Figure 6), we find strong consistency between the two approaches. Both models attribute significant inflation volatility to supply shocks, especially during the late 1970s. Fluctuations attributed to demand also align closely, whilst the contribution of monetary policy shocks is noisier and smaller. In Table 7 we estimate predictive regressions for dissent using the SVAR historical decompositions as predictors. Similar to the DSGE-based shocks, inflation volatility attributed to supply shocks raises dissent and that attributed to demand shocks lowers dissent. The SVAR-based predictors show slightly more precise estimates for the coefficients associated with demand-driven inflation volatility. At any rate the historical decomposition from the SVAR aligns with that from the DSGE model, and the impact of supply and demand shocks on dissent remains similar.

5.2 Uncertainty

Next, we consider uncertainty as a direct driver of FOMC dissent (we already considered disagreement in expectations of FOMC members in the time series regressions, which is maybe associated with uncertainty). As in Bloom (2009), we use monthly stock market volatility as an uncertainty proxy ($smvol$). We obtain this variable using the VXO index from 1986 onward, and pre-1986 the monthly standard deviation of the daily S&P500 index normalized to the same mean and variance as the VXO index when they overlap from 1986.[20] To address endogeneity concerns, as financial markets quickly react to monetary policy releases, we incorporate lagged stock market volatility ($smvol_{t-1}$) as a regressor in (11) to control for uncertainty. However, the coefficients on $smvol_{t-1}$ are statistically insignificant and close to zero (see Table 8). The parameter estimates for the other variables remain nearly identical to those in Table 6. Thus, uncertainty does not drive FOMC dissent, and our results are robust to accounting for it.

5.3 Dispersion in expectations of monetary policy

Next, we examine if inflation volatility from different structural shocks raises private sector uncertainty about policy. This hypothesis is important given the finding by Baker et al. (2016) that economic policy uncertainty is detrimental to business investment. The recent result by Madeira and Madeira (2019) that FOMC dissent negatively affects stock market prices may be explained in part by the association between FOMC disagreement and inflation volatility associated with supply shocks. Moreover, if Committee dissent raises uncertainty (as recently explored by Husted et al., 2020), then dissent undermines the central bank's ability to control expectations.[21]

We measure private sector uncertainty using survey expectations data on future interest rate obtained from the Survey of Professional Forecasters (SPF) by the Federal Reserve Bank of Philadelphia. The expectations dispersion measure for interest rates we use from the SPF data, $s_t(r_{t+k})$, is the surveys' interquartile range (IQR) for the k quarter horizon forecast of the 3 month Treasury bill. We consider the horizons $k = \{0, 1, 2\}$. The sample period for the SPF data is 1981:3 –2018:1. The regression equation we estimate is the following

$$s_t(r_{t+k}) = \theta_0 + \theta_1 \pi_t + \theta_2 u_t + \theta_3 \left|\pi_t^{\text{sup}}\right| + \theta_4 \left|\pi_t^{\text{dem}}\right| . \qquad (12)$$

[20] Codes are available from Nick Bloom's website to implement this method. We merely updated the data series.

[21] Coibion et al. (2018) study how central bank communication strategies should be designed to achieve better control over private sector expectations.

The results are in Table 9. Both higher inflation and unemployment raise dispersion in expectations of interest rates by professional forecasters at all horizons (although for the current quarter horizon, the coefficient for unemployment is insignificant). Inflation volatility originating from supply shocks raises the dispersion of expectations of interest rates by professional forecasters at all horizons. This effect is precisely estimated and large. Instead, inflation volatility originating from demand shocks is not associated with the dispersion of expectations at any horizon. Including the absolute value of supply and demand shocks improves the fit significantly at all forecast horizons, with a more than 10% increase in adjusted R^2 compared to excluding these predictors.

These results suggest supply shocks make it harder for agents to predict how Committee members will respond to economic developments, thus raising uncertainty in interest rate expectations. This echoes well with the finding by Belden (1989) that periods of greater uncertainty about the impact of policy actions are associated with heightened dissent.

5.4 Real-time data

The real-time information flow has been shown to matter for monetary policy decision-making (Orphanides, 2001; Giannone et al., 2004). For this reason we investigate the impact of real-time data on our findings. To do this we re-estimate equation (9) using a real-time historical shock decomposition. This approach uses the vintage of data that would have been available to the FOMC members at the time of each meeting, obtained from the Real-Time Data Set for Macroeconomists maintained by the Federal Reserve Bank of Philadelphia (Croushore and Stark, 2001).[22] The results (shown in Table A1 of the Online Appendix) confirm the patterns observed in our baseline results. Inflation volatility stemming from demand shocks reduces FOMC dissent, while inflation volatility from supply shocks also lowers dissent. In the specification with year-fixed effects, the impact

[22]This decomposition is informationally feasible for the economic agents given the real-time data flow. We perform the historical decomposition recursively and using each time the vintage available for the corresponding date of the decomposition (however, the DSGE model is estimated only once on the revised data). The first historical vintage available is from 1965:Q4, and so the first historical decomposition we construct is for that same period, until 2018:Q2. We still start the sample in 1957:Q3, but up to 1965:Q4 the historical decompositions are pseudo-real time in the sense the Kalman filtering is still done recursively using only contemporaneous and past observations, but these observations are obtained from later vintages.

of supply-driven inflation volatility on dissent is not statistically significant, although the point estimate remains positive as in the baseline results. At any rate our findings remain robust when using real-time data, showing that dissent is positively associated with supply-driven inflation volatility and negatively with demand-driven inflation volatility.

5.5 Standard errors

Table 6 shows results with robust Huber-White standard errors, confirming our findings. We test alternative methods for handling unobserved serial dependence or cross-sectional dependence. In Table A2, we use fixed-effects with AR(1) error components, robust to serial dependence but not general heteroscedasticity or unobserved cross-sectional dependence. Table A3 presents results with Newey-West standard errors, robust to cross-sectional heterogeneity and first-order serial dependence, but not unobserved cross-sectional dependence or non-moving average error components. Table A4 displays results with Driscoll-Kraay standard errors, robust to general heteroscedasticity, cross-sectional dependence, and unobserved serial dependence, offering nonparametric covariance matrix estimation for comprehensive cross-sectional and temporal dependence. All methods confirm the findings in Table 6. Full details are in the Online Appendix, Tables A2, A3, and A4.

5.6 Results across different sub-periods

The estimation results in section 4 cover a long period (1957:1 to 2018:1), accounting for various events that may have influenced FOMC deliberations. Therefore, we re-estimated equation (11) for shorter sub-periods without year and chair fixed effects. The sub-periods are defined to ensure comparable sample sizes. The first sub-period is from 1957:1 to 1969:4, a period of robust growth and low inflation. The second sub-period is from 1970:1 to 1983:4, marked by high inflation and unemployment ("The Great Inflation"). The third sub-period is from 1984:1 to 2006:4, known as the "Great Moderation" due to low economic volatility. The fourth sub-period is from 2007:1 to 2018:1, involving the 2007–2008 financial crisis and a weak economic recovery and ZLB period. Despite smaller sample sizes, the results show statistically significant evidence in the first and third sub-periods that supply shocks raise dissent. We also find statistically significant evidence that demand shocks decreased dissent in the first and fourth sub-periods. In the second sub-period, supply shocks raise dissent for easier. Overall, the evidence from the sub-periods confirms the analysis in section 4, indicating that inflation volatility from supply shocks raises FOMC dissent, while that from demand shocks lowers it. Tables A5, A6, A7, A8 in the Online Appendix show results for each sub-period.

5.7 Bank of England

Our analysis in section 3 shows that supply and demand shocks affect monetary policy deliberations differently only when the central bank has a dual mandate. To explore this further, we look at the Monetary Policy Committee (MPC) of the Bank of England (BoE), which has a single mandate to achieve a symmetric 2% inflation target after gaining operational independence in 1997. We re-estimate equation (11) using MPC member voting data from 1997:2 to 2018:1. To identify the structural shocks, we estimate a SVAR model with real GDP growth, inflation (measured by the CPI, the measure targeted by the BoE), and the policy interest rate, similar to the US SVAR.

Consistent with our analysis in section 3, the results (Table A9 in the Online Appendix) indicate that neither supply nor demand shocks explain dissent in the MPC. We also re-estimated the model without certain fixed effects (similar to our sub-period analysis) in Table A10 of the Online Appendix, obtaining similar non-significant results. Our findings are likely not simply due to the sample being smaller in the case of the MPC (in our analysis for the sub-periods we obtained statistically significant results for the FOMC with shorter samples). The absence of significant differences between the effects of supply and demand shocks on MPC voting aligns with our theoretical analysis. Inflation volatility caused by supply shocks is predicted to produce dissent only when a dual mandate exists.

5.8 Other robustness exercises

In the Online Appendix, we demonstrate the robustness of our main results when using alternative variables to control for economic conditions. These include output gap measures based on the estimated DSGE model (Tables A11 and A12), the Hodrick-Prescott filtered output (Tables A13 and A14), and an alternative unemployment gap measure using the Hodrick-Prescott filtered civilian unemployment rate (Tables A15 and A16). Additionally, we find that the results in Table 5 remain robust when using different measures of FOMC members' disagreement in expectations of inflation and unemployment (Table A17).[23] Regarding panel data results, we estimate the same model with logit random effects and find very similar results for all macroeconomic variables (Table A18).[24] The results are also robust to excluding the variable N_t^C from the panel regressions (Table A19).

6 Conclusion

This paper shows the source of inflation volatility is an important and robust predictor of dissent in the FOMC. Volatility attributed to supply shocks raises the frequency of dissent and, instead, inflation volatility attributed to demand shocks lowers dissent. Through the lenses of the three equations NK model, this is explained if FOMC members have heterogeneous preferences over inflation and output stabilization. We also show that inflation volatility from supply shocks raises private sector uncertainty over the path of interest rates.

The findings in this paper are particularly relevant in the current economic climate, as the global economy recovers from the COVID-19 pandemic which has disrupted global supply chains, labor markets, and commodity markets. Confronted with these shocks, Committee members deliberating over the best course for monetary policy may find consensus formation especially challenging, and this in turn may affect the ability of policymakers to steer private sector expectations.

[23] In the Online Appendix, we construct measures of disagreement in expectations of inflation (πt^{DCT}) and unemployment (ut^{DCT}) by considering the highest and lowest projections for the central tendency in the MPRs. We re-estimate (10) using πt^{DCT} and ut^{DCT} instead of πt^{D} and ut^{D}, as we cannot include the standard deviation of FOMC members' forecasts as a measure of disagreement in expectations.

[24] The logit random effects model includes the entire sample of members. In contrast, the logit fixed effects model excludes members who always report the same outcome, potentially biasing the coefficient values (Wooldridge, 2001).

Appendix

A SVAR model specification

The VAR specification used in section 5 includes three endogenous macroeconomic time-series: the growth rate of real GDP (Δy_t), the inflation rate measured from the GDP deflator (π_t), and the federal funds rate (r_t). The vector of endogenous macroeconomic time-series, $X_t = [\Delta y_t, \pi_t, r_t]'$, is assumed to follow a reduced-form VAR model with $p = 12$ lags, as follows

$$X_t = \alpha_t + \sum_{i=1}^{p} \mathbf{A}_i X_{t-i} + \eta_t, \tag{A.1}$$

where α_t denotes the deterministic component (represented using quadratic polynomials), and $\eta_t = \mathbf{B}\varepsilon_t$ contains the reduced form innovations, with ε_t the structural shocks. In order to identify the structural shocks ε_t we rely on sign restrictions (Uhlig, 2005). Specifically, to identify the supply, demand, and monetary shocks, the following sign restriction are imposed over a horizon of 2 periods (6 months):

$$\begin{matrix} & & \epsilon^{\text{sup}}, \epsilon^{\text{dem}}, \epsilon^{\text{mon}} \\ \begin{bmatrix} \Delta y_t \\ \pi_t \\ r_t \end{bmatrix} & = & \begin{bmatrix} + & + & + \\ - & + & + \\ \bullet & + & - \end{bmatrix} \end{matrix}. \tag{A.2}$$

Thus, supply shocks raise real GDP growth and lower inflation, demand shocks raise GDP growth, inflation and interest rates, and monetary shocks also raise both GDP growth and inflation but, in contrast to standard demand shocks, lower the federal funds rate.

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Tables

Table 1: Dissent vote in the FOMC

Chair	Sample period	Votes of dissent (%)				Quarters with dissent (%)				# of members who dissented				
		DIS_t	DT_t	DE_t	DO_t	$DIS_t > 0$	$DT_t > 0$	$DE_t > 0$	$DO_t > 0$	# Meetings per quarter	# DIS	# DT	# DE	# DO
Martin	1957:1 – 1970:1	5.6	2.4	2.6	0.6	64.2	41.5	45.3	7.5	4.2	26	17	14	8
Burns	1970:2 – 1978:1	5.0	2.6	2.0	0.4	71.9	50.0	37.5	9.4	3.2	20	13	12	3
Miller	1978:2 – 1979:3	17.4	13.4	4.1	0.0	100.0	100.0	66.7	0.0	3.2	11	8	3	0
Volcker	1979:4 – 1987:3	10.1	5.4	4.5	0.2	84.4	65.6	50.0	6.3	2.3	19	13	9	2
Greenspan	1987:4 – 2006:1	4.7	2.5	1.4	0.7	51.4	33.8	23.0	10.8	2.1	20	13	11	5
Bernanke	2006:2 – 2014:1	7.1	5.1	0.8	1.2	68.8	56.3	12.5	18.8	2.1	10	7	3	3
Yellen	2014:2 – 2018:1	6.7	3.1	2.0	1.6	68.8	37.5	25.0	12.5	1.9	9	4	3	3
Overall	1957:1 – 2018:1	6.4	3.5	2.2	0.7	65.7	46.5	33.1	10.2	2.7	79	53	46	22

The first panel (votes of dissent, %) reports the frequency of each dissent category across sub-samples. The categories considered are DIS, denoting overall votes of dissent, DT denoting dissent for tighter, DE denoting dissent for easier, DO denoting other forms of dissent. The second panel (quarters with dissent, %) reports the percentage of quarters in which dissent occurs, across categories and for each sub-sample. The third panel reports the average number of meetings per quarter and the total number of dissents of each type, split across each Chair tenure. Each sub-sample corresponds to a different Chair tenure. The overall sample period runs from 1957:1 to 2018:1.

Table 2: Probability of dissent vote (percentiles of FOMC members who dissented)

	Percentile 25				Percentile 50				Percentile 75			
Chair	DIS	DT	DE	DO	DIS	DT	DE	DO	DIS	DT	DE	DO
Martin	2.6	1.7	1.4	1.2	4.9	3.6	2.4	1.6	7.9	7.1	5.1	3.0
Burns	4.8	3.0	1.9	1.2	7.3	4.9	4.0	1.5	11.1	8.8	7.1	3.0
Miller	5.6	3.8	2.6	0.8	8.1	7.5	4.4	2.3	17.4	17.4	6.9	3.7
Volcker	4.7	4.0	2.0	1.8	8.3	7.1	3.3	3.6	16.8	13.6	6.2	4.5
Greenspan	4.5	4.5	1.7	3.6	11.3	12.9	2.8	9.4	20.0	18.8	4.6	12.9
Bernanke	6.7	8.1	6.1	8.0	14.5	12.5	6.3	12.7	30.1	20.0	7.1	15.8
Yellen	9.1	9.5	6.3	8.0	28.5	12.5	7.1	12.7	37.5	31.3	12.5	15.8
Overall	4.6	3.7	1.9	1.5	8.0	7.4	3.6	3.6	17.4	14.3	7.1	9.4

The table reports the 25^{th}, 50^{th} and 75^{th} percentiles of the distribution of the frequency of dissent across members of the FOMC, conditioning on the member dissenting at least once. The dissent types considered are: overall dissent (DIS); dissent for tighter (DT); dissent for easier (DE); other types of dissent (DO). Each sub-sample corresponds to a different Chair tenure. The overall sample is from 1957:1 to 2018:1.

Table 3: FOMC dissent (fraction of dissent votes)

	(a)	(b)	(c)	(d)
π_t	0.013	−0.008	0.013	−0.012
	(0.010)	(0.019)	(0.011)	(0.018)
u_t	0.007*	0.002	0.010***	−0.004
	(0.004)	(0.017)	(0.004)	(0.015)
$\lvert\pi_t^{\text{sup}}\rvert$			0.046***	0.067***
			(0.015)	(0.022)
$\lvert\pi_t^{\text{dem}}\rvert$			−0.041	−0.183***
			(0.039)	(0.064)
Chair FE	✓	✓	✓	✓
Year FE	×	✓	×	✓
Adjusted R^2	12.4%	19.6%	14.9%	24.4%
Observations	245	245	245	245

The dependent variable is the fraction of dissent votes, DIS_t. Constant included but not reported. Newey-West standard errors are shown in parenthesis. * , ** and *** denote respectively 10%, 5% and 1% significance. The data sample is from 1957:1 to 2018:1. We measure the contribution of supply and demand shocks to inflation volatility using the absolute value of inflation measured in percentage points (in deviation from its long-run level), attributed to the two shocks. The dependent variable is the average fraction of dissent votes across meetings in each quarter. Thus the coefficients associated with $\lvert\pi_t^{\text{sup}}\rvert$ and $\lvert\pi_t^{\text{dem}}\rvert$ are directly interpretable as the expected increase in the fraction of dissent votes in FOMC meetings given a 1 percentage point increase in the absolute deviation of inflation from its target attributed to, in turn, supply and demand shocks.

Table 4: FOMC dissent (discrete dependent variable)

	(a)	(b)	(c)	(d)
	$DIS_t > 0$	$DIS_t > 0$	$DT_t > 0$	$DE_t > 0$
π_t	-0.133	0.767	0.516	0.341
	(0.151)	(0.533)	(0.443)	(0.391)
u_t	-0.168^{*}	0.240	0.0352	0.149
	(0.098)	(0.149)	(0.133)	(0.121)
$\lvert\pi_t^{\text{sup}}\rvert$	0.363^{**}	2.198^{***}	1.907^{***}	0.961^{*}
	(0.160)	(0.738)	(0.677)	(0.549)
$\lvert\pi_t^{\text{dem}}\rvert$	-0.813^{*}	-1.009	-1.268	0.351
	(0.483)	(1.359)	(1.238)	(1.274)
Chair FE	✓	✓	✓	✓
Year FE	✓	×	×	×
Model	OLS	logit	logit	logit
R^2/Pseudo R^2	48.7%	9.5%	10.1%	8.8%
Observations	245	245	245	245

Constant included but not reported. $DIS_t > 0$ is a dummy variable taking value 1 if there has been dissent; $DT_t > 0$ is a dummy variable taking value 1 if there has been dissent for tighter; $DE_t > 0$ is a dummy variable taking value 1 if there has been dissent for easier. Newey-West standard errors are reported in column (a), and robust standard errors in columns (b)–(d). The symbols * , ** and *** denote respectively 10%, 5% and 1% significance. The data sample is from 1957:1 to 2018:1. The logit model does not include year fixed effects because for several years this dummy would predict dissent perfectly resulting in observations having to be dropped.

Table 5: FOMC Dissent
and expectations disagreement

	(a)	(b)
π_t	-0.024	0.004
	(0.036)	(0.028)
u_t	0.005	0.001
	(0.025)	(0.021)
π_t^D	-0.025	-0.019
	(0.025)	(0.025)
u_t^D	-0.017	0.001
	(0.037)	(0.039)
$\lvert\pi_t^{\text{sup}}\rvert$		0.093^{***}
		(0.031)
$\lvert\pi_t^{\text{dem}}\rvert$		-0.196^{**}
		(0.080)
Adjusted R^2	17.8%	22.8%
Observations	155	155

The dependent variable is the fraction of dissent votes, DIS_t. π_t^D is the difference between highest and lowest projection among FOMC members for inflation. u_t^D is the difference between highest and lowest projection among FOMC members for unemployment. Constant included but not reported. All specifications include Chair fixed effects and year fixed effects. Newey-West standard errors are shown in parenthesis. * , ** and *** denote respectively 10%, 5% and 1% significance. The data sample is from 1979:2 to 2018:1.

Table 6: Panel regressions

	$DIS_{i,t} > 0$	$DIS_{i,t} > 0$	$DT_{i,t} > 0$	$DE_{i,t} > 0$
π_t	-0.007	-0.015	0.003	-0.005
	(0.019)	(0.019)	(0.012)	(0.009)
u_t	-0.008	-0.014	-0.009	-0.005
	(0.010)	(0.010)	(0.008)	(0.006)
$\lvert\pi_t^{\text{sup}}\rvert$		0.067^{***}	0.028^{**}	0.032^{***}
		(0.022)	(0.013)	(0.012)
$\lvert\pi_t^{\text{dem}}\rvert$		-0.162^{**}	-0.146^{***}	-0.035
		(0.071)	(0.054)	(0.032)
$D_{i,t}$	0.064	0.064	0.016	0.028^{***}
	(0.055)	(0.056)	(0.061)	(0.004)
$N_{i,t}$	0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
N_t^C	0.003^{***}	0.002^{**}	0.000	0.002^{***}
	(0.001)	(0.001)	(0.001)	(0.001)
Adjusted R^2 (total)	12.9%	13.2%	16.7%	8.1%
Observations	7,248	7,248	7,038	6,949

Constant included but not reported. The variable $D_{i,t}$ is a dummy variable for whether the member is a governor; $N_{i,t}$ is the number of previous meetings attended by member i at time t; N_t^C is the number of previous meetings attended by the Chair at time t. $DIS_{i,t} > 0$ if there has been dissent; $DT_{i,t} > 0$ if there has been dissent for tighter; $DE_{i,t} > 0$ if there has been dissent for easier. All specifications include Chair fixed effects, member fixed effects and year fixed effects. Robust standard errors are shown in parenthesis. * , ** and *** denote respectively 10%, 5% and 1% significance. The data sample includes all the FOMC meetings from 1957:1 to 2018:1.

Table 7: FOMC dissent using SVAR historical decompositions

	(a)	(b)	(c)	(d)
	$DIS_t > 0$	$DIS_t > 0$	$DT_t > 0$	$DE_t > 0$
π_t	-0.121	0.777^{*}	0.640^{*}	0.762^{*}
	(0.158)	(0.419)	(0.365)	(0.381)
u_t	-0.130	0.228^{*}	-0.009	0.174
	(0.098)	(0.135)	(0.117)	(0.125)
$\lvert\pi_t^{\text{sup}}\rvert$	0.306^{*}	1.753^{**}	1.040	0.646
	(0.185)	(0.818)	(0.750)	(0.758)
$\lvert\pi_t^{\text{dem}}\rvert$	-0.363	-2.913^{***}	-2.090^{**}	-1.903^{**}
	(0.276)	(0.991)	(0.911)	(0.958)
Chair FE	✓	✓	✓	✓
Year FE	✓	×	×	×
Model	OLS	logit	logit	logit
R^2/Pseudo R^2	47.0%	10.0%	8.7%	9.2%
Observations	245	245	245	245

Constant included but not reported. $DIS_t > 0$ is a dummy variable taking value 1 if there has been dissent; $DT_t > 0$ is a dummy variable taking value 1 if there has been dissent for tighter; $DE_t > 0$ is a dummy variable taking value 1 if there has been dissent for easier. Newey-West standard errors are reported in column (a), and robust standard errors in columns (b)–(d). The symbols * , ** and *** denote respectively 10%, 5% and 1% significance. The data sample is from 1957:1 to 2018:1. The logit model does not include year fixed effects because for several years this dummy would predict dissent perfectly resulting in observations having to be dropped.

Table 8: FOMC dissent and uncertainty

	$DIS_{i,t} > 0$	$DIS_{i,t} > 0$	$DT_{i,t} > 0$	$DE_{i,t} > 0$
π_t	-0.006	-0.015	0.003	-0.007
	(0.019)	(0.019)	(0.012)	(0.012)
u_t	-0.009	-0.015	-0.009	-0.005
	(0.010)	(0.010)	(0.009)	(0.006)
$smvol_{t-1}$	0.050	0.041	0.024	0.053
	(0.064)	(0.063)	(0.038)	(0.045)
$\lvert\pi_t^{\text{sup}}\rvert$		0.066^{***}	0.027^{**}	0.031^{*}
		(0.022)	(0.013)	(0.017)
$\lvert\pi_t^{\text{dem}}\rvert$		-0.163^{**}	-0.146^{***}	-0.021
		(0.071)	(0.055)	(0.046)
$D_{i,t}$	0.064	0.064	0.016	0.034^{*}
	(0.055)	(0.056)	(0.061)	(0.018)
$N_{i,t}$	0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
N_t^C	0.003^{***}	0.002^{**}	0.000	0.001^{***}
	(0.001)	(0.001)	(0.001)	(0.001)
Adjusted R^2 (total)	12.9%	13.2%	16.7%	8.1%
Observations	7,248	7,248	7,038	6,949

Constant included but not reported. $smvol_t$ is US monthly stock market volatility. The variable $D_{i,t}$ is a dummy variable for whether the member is a governor; $N_{i,t}$ is the number of previous meetings attended by member i at time t; N_t^C is the number of previous meetings attended by the Chair at time t. $DIS_{i,t} > 0$ if there has been dissent; $DT_{i,t} > 0$ if there has been dissent for tighter; $DE_{i,t} > 0$ if there has been dissent for easier. All specifications include Chair fixed effects, member fixed effects and year fixed effects. Robust standard errors are shown in parenthesis. * , ** and *** denote respectively 10%, 5% and 1% significance. The data sample includes all the FOMC meetings from 1957:1 to 2018:1.

Table 9: Disagreement in interest rate expectations

	$s_t(r_t)$		$s_t(r_{t+1})$		$s_t(r_{t+2})$	
π_t	0.408***	0.455***	0.769***	0.850***	0.846***	0.947***
	(0.108)	(0.095)	(0.185)	(0.153)	(0.175)	(0.128)
u_t	0.017	0.021*	0.041*	0.047**	0.035*	0.044**
	(0.011)	(0.011)	(0.021)	(0.022)	(0.019)	(0.020)
$\left\|\pi_t^{\text{sup}}\right\|$		0.318***		0.564***		0.692***
		(0.077)		(0.118)		(0.121)
$\left\|\pi_t^{\text{dem}}\right\|$		0.083		0.195		0.193
		(0.101)		(0.169)		(0.166)
Adjusted R^2	40.1%	51.9%	48.7%	60.0%	49.1%	64.1%
Obs	147	147	147	147	147	147

Constant included but not reported. $s_t(r_{t+k})$, is the SPF surveys' interquartile range for interest rate forecasts. Newey-West standard errors are shown in parenthesis. * , ** and *** denote respectively 10%, 5% and 1% significance. The sample period is 1981:3 to 2018:1.

Figures

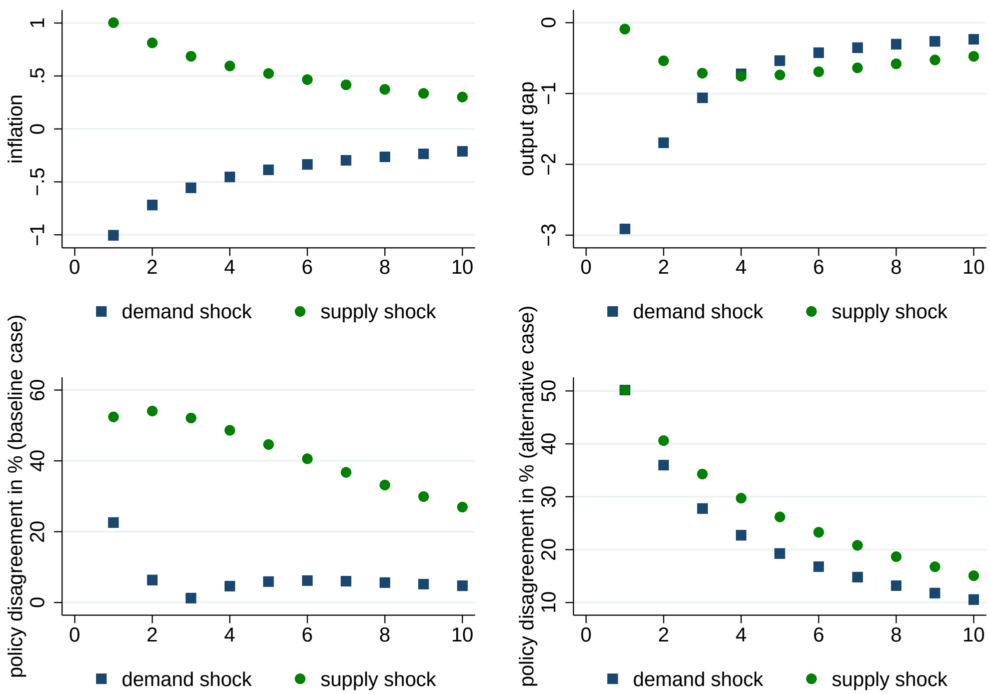

Figure 1: Dissent in the three equations NK model.
Notes: the upper panels show IRFs for inflation and the output gap in response to demand and supply shocks that move inflation away from target by 1 percentage point. The lower panels show the implied absolute difference between the interest rate favored by hawk and dove committee members and that favored by the Chair in response to demand and supply shocks (policy disagreement). We consider the baseline case (lower-left panel), where committee members disagree over the response weights to inflation and the output gap, and an alternative case (lower-right panel), where committee members assign a different weight only to inflation. Each unit in the horizontal axis corresponds to one calendar quarter.

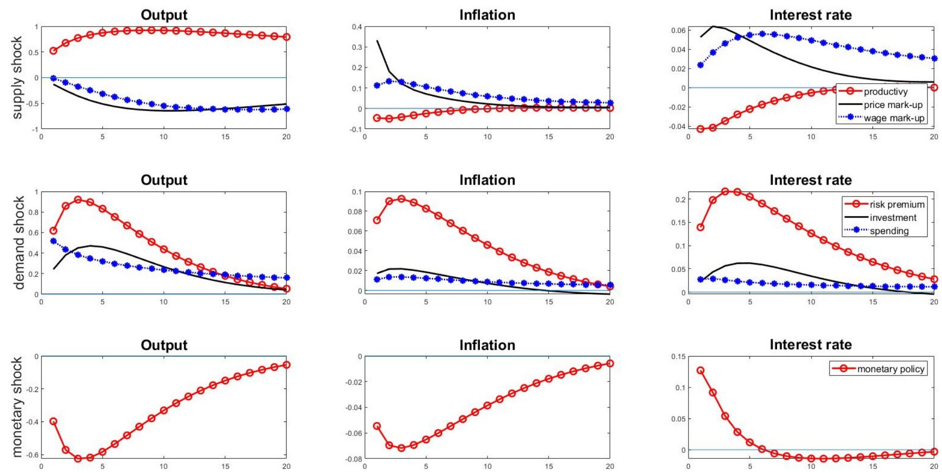

Figure 2: Estimated mean IRFs of the DSGE model.
Notes: Each unit in the horizontal axis corresponds to one calendar quarter.

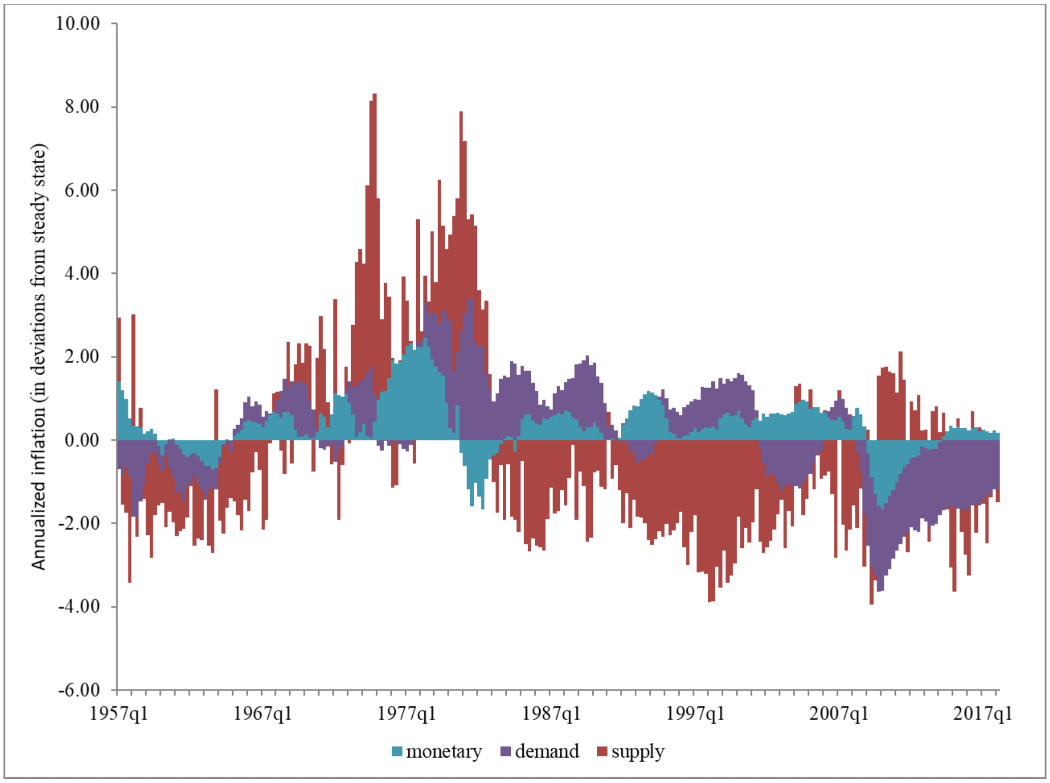

Figure 3: Historical shock decomposition of US inflation.
Notes: Values were annualized by multiplying by 4. The data sample is from 1957:1 to 2018:1.

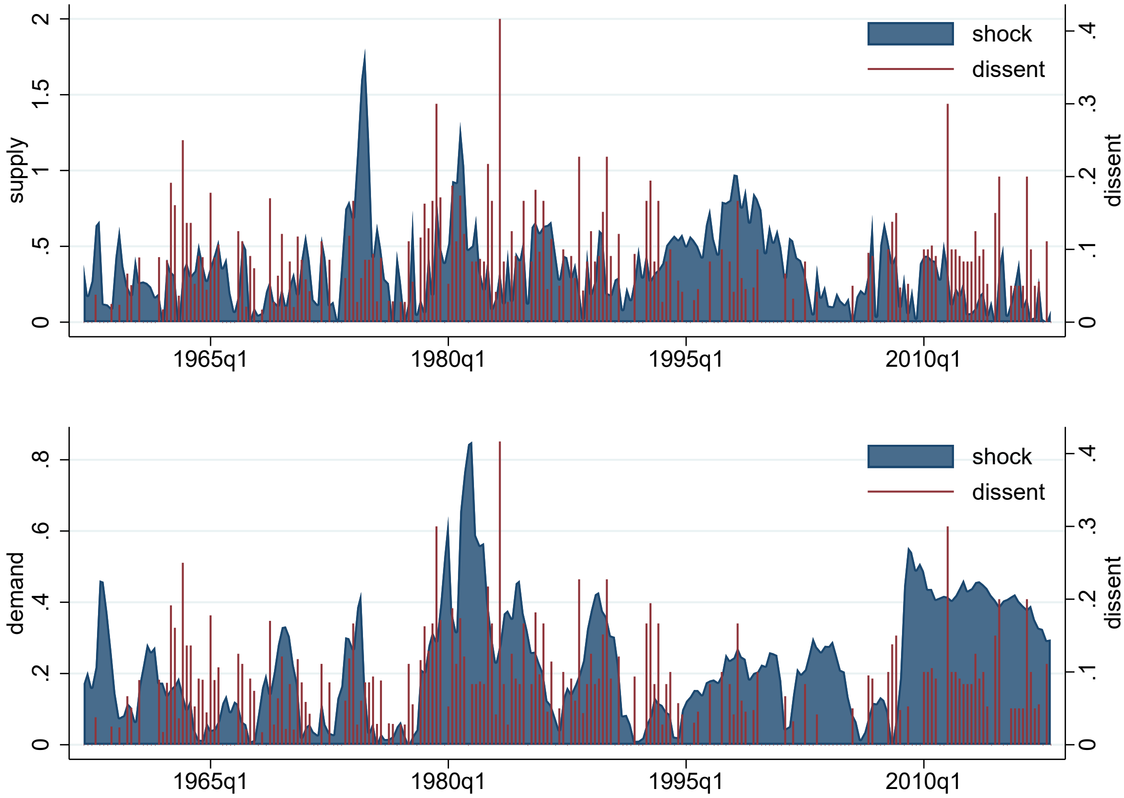

Figure 4: Sources of inflation volatility and FOMC dissent.
Notes: The data sample is from 1957:1 to 2018:1.

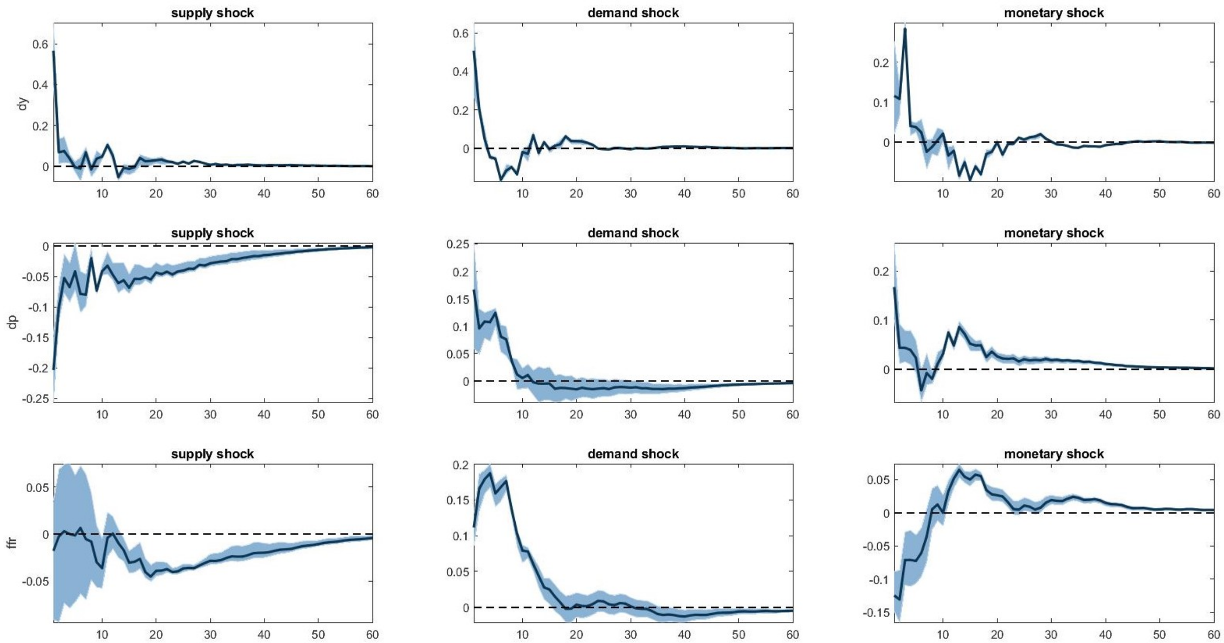

Figure 5: IRF from SVAR model.
Notes: Columns 1, 2 and 3 represent the IRFs conditional on, in turn, a supply shock, a demand shock, and a monetary shock. Row 1 shows the response of output growth (dy), row 2 the response of inflation (dp), and row 3 that of the federal funds rate (ffr). The figure shows the median IRFs, and 80 percent coverage intervals.

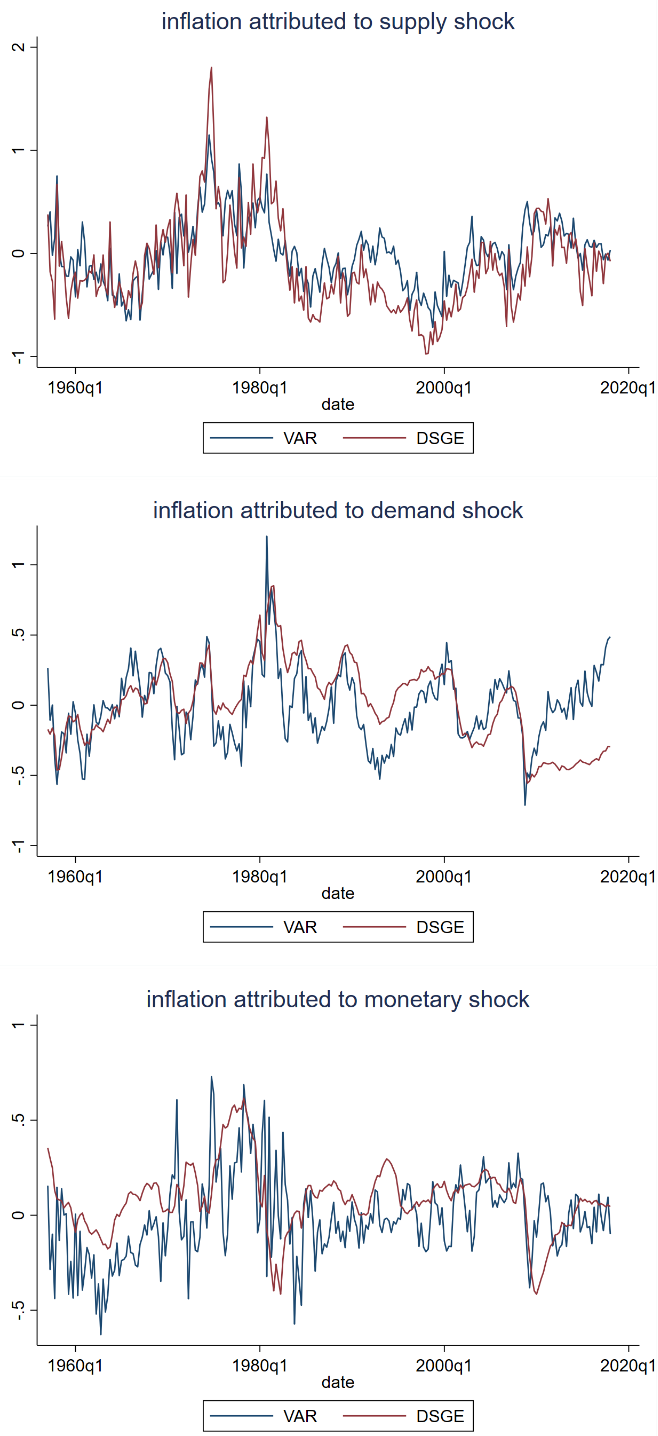

Figure 6: Historical decomposition for inflation (SVAR and DSGE).

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