

# Money and Business Cycles: A Historical Comparison

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July 2024

## Abstract

A Bayesian vector autoregression, estimated with interwar and postwar US data, is used to reassess and extend Friedman and Schwartz's historical analysis of money and business cycles. The results show that while aggregate demand and supply disturbances play important roles as well, monetary policy shocks drive much of the volatility in inflation and output during both sample periods. And while monetary policy appears to have become more active in stabilizing inflation and output in the postwar compared to the interwar years, its shifting stance is reflected consistently by changes in money growth as well as interest rates. In more ways than not, postwar business cycles resemble their interwar counterparts.

*JEL Codes:* E31, E32, E41, E51, E52, N12.

*Keywords:* Aggregate demand and supply, Bayesian vector autoregression, Business cycles, Monetary policy, Money demand and supply.

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\*I would like to thank Michael Belongia, Jim Dorn, Pablo Guerrón-Quintana, and seminar participants at Texas Tech University for extremely helpful comments on previous drafts. Please address correspondence to: Peter N. Ireland, Department of Economics, Boston College, 140 Commonwealth Avenue, Chestnut Hill MA 02467. Email: [peter.ireland@bc.edu](mailto:peter.ireland@bc.edu). Web: [irelandp.com](http://irelandp.com).

# 1 Introduction

Friedman and Schwartz (1963*a*, 1963*b*) emphasize monetary instability as a key driving force behind real instability in the US economy over a period extending from 1867 through 1960. In both their statistical (1963*a*) and narrative (1963*b*) accounts – and most vividly in their analysis of the Great Depression from the latter – the shifting stance of monetary policy is signaled most accurately by changes in the money growth rate rather than movements in interest rates.<sup>1</sup>

By sharp contrast, studies using post-1960 data typically find at most a modest role for monetary policy in generating business cycles. For example, Cochrane (1994, p.295), after considering a wide range of statistical models and results, arrives at the pessimistic conclusion that “we will forever remain ignorant of the fundamental causes of economic fluctuations.” Ramey’s (2016) more recent survey strikes a more optimistic tone, yet still finishes (Table 13, p.153) with a model that, when estimated with data from 1954:3 through 2005:4, attributes less than 10 percent of the 4-to-20 quarters-ahead forecast error variances in output to monetary policy shocks.

Also by sharp contrast, to the extent that monetary policy does play a role in driving postwar business cycles, its effects appear to be captured through measures of interest rates rather than the money stock. Sims (1980) ranks among the first to detect this general tendency; Bernanke and Blinder (1992) and Friedman and Kuttner (1992) emphasize it more forcefully. Partly reflecting these findings, New Keynesian models of the business cycle, presented in textbooks such as Woodford (2003), Galí (2015), Walsh (2017), and Alogoskoufis (2019), frequently describe monetary policy and its effects with exclusive reference to interest rates, without any reference to the money stock at all. Likewise, Ramey’s (2016) model contain no measure of money and identifies monetary policy shocks through the federal

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<sup>1</sup>Analysis and arguments anticipating those from Friedman and Schwartz (1963*a*, 1963*b*) appear in earlier work by Currie (1934, 1935), Mints (1950), and Warburton (1945, 1948, 1950, 1962); see Nelson (2020, pp.39-41) for a discussion of these links. Similarly, Fisher’s (1923, 1925) characterization of the “so-called business cycle” as a “dance of the dollar” becomes an important antecedent to Friedman and Schwartz’s view if, as argued by Belongia and Ireland (2021), Fisher saw price movements as reflecting changes in the money stock.

funds rate alone.

Friedman and Schwartz’s quantity-theoretic results might be reconciled with evidence accumulating more recently if either the structure of the US economy or the conduct of US monetary policy changed substantially after World War II. But it is also possible that stronger similarities across the interwar and postwar eras have been masked by differences in methodology across Friedman and Schwartz’s (1963a, 1963b) early studies and those conducted more recently. Johnson (1971, p.13) anticipates this possibility in warning that monetarism’s “own success is likely to be transitory” precisely because it has “espoused a methodology that has put it in conflict with long-run trends in the development of the subject.”<sup>2</sup> Of course, these possibilities are not mutually exclusive: a consistent analytic approach might reveal any combination of differences and similarities in both the structure of the economy and the conduct of monetary policy before and after World War II.<sup>3</sup>

To explore these ideas more systematically, this paper builds most directly on Sims (1980, 1998) by comparing estimates from a single vector autoregressive (VAR) time-series model obtained from both interwar and postwar data samples. Sims’ (1980) original study used Granger causality tests, impulse response analysis, and variance decompositions implied by a four-variable VAR for output, the price level, the nominal interest rate, and the M1 money stock that gives a structural interpretation to innovations in the money stock via a triangular (Cholesky) decomposition of the reduced-form error covariance matrix that orders the interest rate first and the money stock second. If the innovation to money is taken to be the monetary policy shock, the economic interpretation of this identifying assumption is that

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<sup>2</sup>Gordon (1949) and Cagan (1989), by contrast, stress the value of historical narrative over time series analysis. This paper, by further contrast, shares the position taken by Fernández-Villaverde, Guerrón-Quantana, and Rubio-Ramírez (2010): that statistical analysis need not conflict with and often usefully complements archival research.

<sup>3</sup>A third possibility is raised by what Chrystal and MacDonald (1994, p.76) call the “Barnett Critique.” This argument emphasizes that tighter statistical connections between money growth and business cycles appear when, following Barnett (1980), economic aggregation and index number theory are combined to construct Divisia monetary aggregates to substitute for the much more commonly-used “simple sum” measures that add together the dollar value of funds held in the form of very different liquid assets ranging from currency to small certificates of deposit. As shown below, however, the results here are generally robust to the choice between simple-sum and Divisia monetary aggregates.

monetary policymakers set their target for the money stock with contemporaneous feedback from interest rates but not broader economic conditions. According to Sims' (1980) results, policy-induced movements in the money stock play a sizable role in generating interwar fluctuations in output and prices, but a much smaller role in the postwar period.

Sims' (1998) extension expands the VAR to include both currency and M1 as measures of the money stock and commodity prices as an indicator of emerging inflationary pressures. It identifies monetary policy shocks allowing for simultaneous interaction between both measures of money and the interest rate, with a contemporaneous reaction to commodity prices as well. It supplements its analysis of impulse responses and variance decompositions with counterfactual simulations in which the identified monetary policy equation estimated with postwar data is imported into the interwar VAR and vice versa. Despite its use of a more detailed model and a richer information set, this second study presents results that suggest an even smaller role for money and monetary policy, not just for the postwar period but for the interwar as well.

Here, the statistical comparison of interwar and postwar business cycles is extended still further, using Baumeister and Hamilton's (2015, 2018) Bayesian methods to bring a wider range of *a priori* beliefs about the structural relationships between inflation, the output gap, interest rates, and money growth to bear in isolating the effects, not only of monetary policy, but also of aggregate supply, aggregate demand, and money demand disturbances on the economy. Historical decompositions of movements in inflation and the output gap into components attributable to each of the four shocks are then used, together with estimates of the structural parameters, impulse responses, and variance decompositions to provide a sharper, richer, and more detailed account of US economy history both before and after World War II.

As argued by Belongia and Ireland (2021), Bayesian methods are ideally-suited to bridge the gap between the contemporary New Keynesian perspective on the business cycle, with its emphasis on interest rates as an indicator of monetary policy, and the older quantity-theoretic

view, with its focus on the money stock, taken by Friedman and Schwartz (1963*a*, 1963*b*). Here, in particular, Bayesian priors inspired by the New Keynesian model are used to help isolate the effects of aggregate demand and supply shocks, and are also calibrated to favor the view that, during both the interwar and postwar periods, monetary policy affects inflation and output mainly through its influence over interest rates. At the same time, however, these Bayesian priors admit that there is considerable uncertainty about the additional role played by changes in the stock of money, both in describing the stance of monetary policy – accommodative or restrictive – and in shaping how monetary policy disturbances affect inflation and output through the structural aggregate demand and supply relationships. Finally, the Bayesian priors help disentangle shocks to money supply and money demand, a task that lies at the heart of any quantity-theoretic analysis. In sum, this Bayesian approach draws on economic theory to help makes sense of the data, in very much the same spirit as a historical narrative would, while still allowing those data to speak about the relative importance and quantitative effects of multiple structural disturbances, a task difficult to accomplish without a formal statistical model.

Some of the results from this exercise appear as expected. Structural disturbances estimated with interwar data are substantially larger than those from the postwar period. Contractionary monetary policy emerges as the most important driving force behind the severity and length of the Great Depression. Money growth appears more important in transmitting the effects of monetary policy to aggregate demand in the interwar than in the postwar period. And monetary policy appears largely unresponsive to changing economic conditions during the interwar period, but more active in stabilizing inflation and output during the postwar years.

Other results, however, come as more of a surprise. Although monetary policy does play the biggest role in accounting for the Great Depression and the subsequent recession in 1937, other disturbances are important as well, throughout the interwar period. Aggregate supply shocks drive most of the dramatic but short-lived movements in inflation and output

during the 1920-21 recession, and aggregate demand disturbances appear to trigger the initial downturn in the fall of 1929 and also to drive the final stages of economic recovery in 1941. Similarly, during the postwar period, monetary policy plays a sizable role in explaining the long-run rise and fall of inflation and the recessions of the 1970s and early 1980s, but aggregate supply and demand shocks contribute importantly, too. For neither period can it be said that monetary policy is the *only* source of business cycles. But for both periods, broadly consistent with Friedman and Schwartz’s (1963*a*, 1963*b*) accounts, instability in monetary policy in general and money growth in particular appear as important drivers of volatility in both output and inflation.

Before introducing the model, mention should be made of other antecedents, which use VARs or similar small-scale time series models to analyze and interpret the role of monetary policy in shaping the interwar data. Surveyed by Evans, Hasan, and Tallman (2004), these include Burbidge and Harrison (1985), McCallum (1990), Cecchetti and Karras (1994), Fackler and Parker (1994), Bordo, Choudhri, and Schwartz (1995), Coe (2002), Anari, Kolar, and Mason (2005), Karras, Lee, and Stokes (2006), Ritschl and Woitek (2006), Ahmadi and Ritschl (2009), Gordon and Krenn (2010), and Jacobson, Leeper, and Preston (2023). Studies that use VARs to study the postwar US business cycle are, of course, too numerous to mention individually here; as noted above, however, these are surveyed by Ramey (2016).

## 2 The Model, Priors, and Data

### 2.1 Model

The model describes the behavior of four variables: the year-over-year inflation rate  $P_t$ , the output gap  $Y_t$ , the short-term nominal interest rate  $R_t$ , and the year-over-year money growth rate  $M_t$ . All variables are expressed in percentage points. Collecting them in the  $4 \times 1$  vector

$$X_t = \begin{bmatrix} P_t & Y_t & R_t & M_t \end{bmatrix}'$$

allows the structural model to be written compactly as

$$AX_t = \mu + \sum_{j=1}^q B_j X_{t-j} + \varepsilon_t, \quad (1)$$

where  $A$  is a  $4 \times 4$  matrix of impact coefficients with ones along the diagonal,  $\mu$  is a  $4 \times 1$  vector of intercept terms, each  $B_j$ ,  $j = 1, 2, \dots, q$ , is a  $4 \times 4$  matrix of autoregressive coefficients, and  $\varepsilon_t$  is a  $4 \times 1$  vector of structural disturbances, assumed to be normally distributed with zero mean and a diagonal  $4 \times 4$  covariance matrix  $D$ .

While (1) leaves the autoregressive dynamics unconstrained, the matrix  $A$  of impact coefficients is parameterized to give each equation its structural interpretation. Specifically, with

$$A = \begin{bmatrix} 1 & -\alpha_{py} & 0 & 0 \\ \alpha_{ym} - \alpha_{yr} & 1 & \alpha_{yr} & -\alpha_{ym} \\ -\alpha_{rp} & -\alpha_{ry} & 1 & -\alpha_{rm} \\ -1 & -1 & \alpha_{mr} & 1 \end{bmatrix}, \quad (2)$$

the first equation from (1) can be written as

$$P_t = \alpha_{py} Y_t + \mu^{(P)} + \sum_{j=1}^q B_j^{(P)} X_{t-j} + \varepsilon_t^{as}, \quad (3)$$

where  $\mu^{(P)}$  is the intercept term from the first row of  $\mu$  and each  $B_j^{(P)}$ ,  $j = 1, 2, \dots, q$ , is the  $1 \times 4$  vector corresponding to the first row of  $B_j$ . Equation (3) describes an aggregate supply relationship between inflation and the output gap, inspired by the New Keynesian Phillips curve. Likewise, the second equation from (2),

$$Y_t = -\alpha_{yr}(R_t - P_t) + \alpha_{ym}(M_t - P_t) + \mu^{(Y)} + \sum_{j=1}^q B_j^{(Y)} X_{t-j} + \varepsilon_t^{ad}, \quad (4)$$

with  $\mu^{(Y)}$  and each  $B_j^{(Y)}$ ,  $j = 1, 2, \dots, q$ , formed from the second rows of  $\mu$  and  $B_j$ , describes an aggregate demand relationship linking the output gap to the real interest rate and real

money growth. In the special case where  $\alpha_{ym} = 0$ , the contemporaneous relationship between output and the real interest rate alone resembles the one drawn by the New Keynesian IS curve.

The third equation,

$$R_t - \alpha_{rm}M_t = \alpha_{rp}P_t + \alpha_{ry}Y_t + \mu^{(R)} + \sum_{j=1}^q B_j^{(R)} X_{t-j} + \varepsilon_t^{mp}, \quad (5)$$

with  $\mu^{(R)}$  and each  $B_j^{(R)}$ ,  $j = 1, 2, \dots, q$ , formed from the third rows of  $\mu$  and  $B_j$ , describes how the central bank adjusts the interest rate and the money growth rate to stabilize inflation and output. When  $\alpha_{rm} = 0$ , the contemporaneous response of the nominal interest rate alone to movements in inflation and the output gap in (5) takes the same form as that prescribed by the Taylor (1993) rule. Finally, the fourth equation

$$M_t - P_t - Y_t = -\alpha_{mr}R_t + \mu^{(M)} + \sum_{j=1}^q B_j^{(M)} X_{t-j} + \varepsilon_t^{md}, \quad (6)$$

with  $\mu^{(M)}$  and each  $B_j^{(M)}$ ,  $j = 1, 2, \dots, q$ , formed from the fourth rows of  $\mu$  and  $B_j$ , is the model's money demand curve, with unitary price and income elasticities and a negative interest semi-elasticity with absolute value  $\alpha_{mr}$ . Under these interpretations, the structural disturbances in the vector

$$\varepsilon_t = \begin{bmatrix} \varepsilon_t^{as} & \varepsilon_t^{ad} & \varepsilon_t^{mp} & \varepsilon_t^{md} \end{bmatrix}'$$

correspond to aggregate supply, aggregate demand, monetary policy, and money demand shocks and the diagonal elements of the covariance matrix  $D$  can be labeled similarly and arranged as

$$D = \begin{bmatrix} d_{as} & 0 & 0 & 0 \\ 0 & d_{ad} & 0 & 0 \\ 0 & 0 & d_{mp} & 0 \\ 0 & 0 & 0 & d_{md} \end{bmatrix}. \quad (7)$$



The reduced form implied by the structural model (1) can be written as

$$X_t = \phi + \sum_{j=1}^q \Phi_j X_{t-j} + u_t, \quad (8)$$

where  $\phi = A^{-1}\mu$ ,  $\Phi_j = A^{-1}B_j$  for  $j = 1, 2, \dots, q$ , and  $u_t = A^{-1}\varepsilon_t$  is a  $4 \times 1$  vector of reduced-form innovations that is normally distributed with zero mean and  $4 \times 4$  covariance matrix  $\Omega = A^{-1}D(A^{-1})'$ . The reduced form (8) summarizes all the information contained in the data, and the availability of only six distinct off-diagonal elements in the reduced-form error covariance matrix  $\Omega$  implies that the structural model (1) remains unidentified unless at least one more restriction is imposed on the 7 parameters entering into the matrix  $A$  as parameterized in (2).

## 2.2 Priors

As an alternative, Baumeister and Hamilton (2015, 2018) outline methods for combining Bayesian prior distributions with information communicated through the likelihood function to characterize posterior distributions for the structural parameters. These methods do not solve the fundamental identification problem: within the Bayesian framework, the same problem manifests itself in the continued influence of the prior distribution in shaping the posterior, even as the data sample size grows without bound. Nevertheless, the approach provides a coherent way, first, of bringing *a priori* information to bear in interpreting the data and, second, of using the information contained in the data to update optimally the priors on the values of the structural parameters.

Here, in particular, economic theory suggests that all seven of the impact parameters in (2) are non-negative. The Phillips curve (3) should slope upward, associating a positive output gap with higher inflation. The aggregate demand curve (4) should imply that monetary policy has expansionary effects on output by lowering the real interest rate or increasing real money growth. The monetary policy rule (5) should dictate that the central

bank tighten monetary policy by increasing the nominal interest rate or decreasing money growth when either inflation or the output gap rises. Finally, money supply as described by (5) and money demand as described by (6) can be distinguished both because, when viewed as functions of the interest rate, the money supply curve slopes up and the money demand curve slopes down and because, according to the quantity theory as articulated by Friedman (1956), for instance, money supply describes the behavior of the *nominal* money stock while money demand describes the demand for *real* balances relative to income or, equivalently, the behavior of velocity.

With these ideas in mind, each coefficient from (2) is assigned an independent Student  $t$  prior distribution with location parameter  $\bar{\alpha}_i$ , scale parameter  $\sigma_i$ , and  $\nu_i$  degrees of freedom, as shown in table 1. By itself, this assumption implies that coefficient  $\alpha_i$ ,  $i \in \{py, yr, ym, rp, ry, rm, mr\}$ , has mean and mode equal to  $\bar{\alpha}_i$  and standard deviation equal to  $\sigma_i \sqrt{\nu_i / (\nu_i - 2)}$ . Each distribution, however, is truncated at zero to impose the strong prior belief that the coefficient has the sign suggested by theory.

Although this truncation makes the prior distributions asymmetric, the location parameters continue to pin down the prior modes. In table 1, the setting  $\bar{\alpha}_{py} = 0.5$  for the slope of the Phillips curve (3) is based on Lubik and Schorfheide's (2004), while the setting  $\bar{\alpha}_{yr} = 1$  for the elasticity of aggregate demand in (4) to innovations in the real interest rate is the same as in the New Keynesian model when households have logarithmic utility over consumption. Taylor (1993) suggests values of 1.5 and 0.5 for the coefficients on inflation and the output gap in an interest rate rule for monetary policy, while Stewart (2024) estimates an interest semi-elasticity of M2 demand equal to 4 based on a long sample of US data spanning 1915 and 2019. To allow for interest rate smoothing in monetary policy and partial adjustment in money demand, each of these values is divided by 4 to obtain settings  $\bar{\alpha}_{rp} = 0.375$  and  $\bar{\alpha}_{ry} = 0.125$  for the response coefficients in the policy rule (5) and  $\bar{\alpha}_{mr} = 1$  for the interest semi-elasticity parameter in the money demand curve (6). Finally, the settings  $\bar{\alpha}_{ym} = 0$  and  $\bar{\alpha}_{rm} = 0$  place the heaviest weight on the New Keynesian assumption that there are no

distinct roles for real money balances in the aggregate demand relationship (5) and nominal money growth in the policy rule (5). The settings for the scale and degrees of freedom parameters  $\sigma_i$  and  $\nu_i$ , however, acknowledge that considerably uncertainty surrounds all of these *a priori* judgments, particularly for the interest elasticity of money demand.

Thus, here as in Belongia and Ireland (2021), the empirical exercise is designed to follow the thought patterns of an economist who accepts the New Keynesian model as a useful benchmark, but is at the same time willing to consider a monetarist alternative that assigns larger roles to money growth, both in describing the conduct of monetary policy and in transmitting the effects of monetary policy to output and inflation. The empirical exercise acknowledges, as well, that to the extent that the monetarist alternative is relevant, it must distinguish successfully between money supply and money demand.

Turning next to the volatility parameters from  $D$  as shown in (7), the reciprocal of each  $d_i$ ,  $i \in \{as, ad, mp, md\}$ , is assigned an independent gamma prior distribution with parameters  $\kappa_i$  and  $\tau_i$  such that  $\kappa_i/\tau_i$  equals its prior mean and  $\kappa_i/\tau_i^2$  its prior variance. The Bayesian updating equations presented by Baumeister and Hamilton (2015, p.1968) imply that the setting  $\kappa_i = 2$  places a weight on these priors equivalent to that provided by  $2\kappa_i = 4$  observations of data. The setting for each  $\tau_i$  is then obtained by fitting a univariate  $q$ th order autoregression to each individual data series, computing the covariance matrix

$$S = T^{-1} \sum_{t=1}^T e_t e_t', \quad (9)$$

where  $e_t$  denotes the  $4 \times 1$  vector of residuals from these univariate models, and assigning to  $\tau_i$  a value equal to  $\kappa_i$  times the corresponding diagonal element of  $\bar{A}S\bar{A}'$ , where  $\bar{A}$  is the matrix formed by substituting into (2) the value  $\bar{\alpha}_i$  for each element  $\alpha_i$  set previously.

Finally, conditional on  $D$ , normal priors for the intercept and autoregressive parameters in (1) are calibrated based on an extension of Litterman's (1986) "Minnesota" prior similar to Sims and Zha's (1998). Specifically, the elements of  $B_1$  are assigned prior means equal to

the corresponding elements  $\rho\bar{A}$  and the elements of  $B_2, B_3, \dots, B_q$  are assigned mean zero, where the setting  $\rho = 1$  then corresponds to Litterman’s original random-walk assumption while an alternative with  $\rho < 1$  implies less serial correlation in the reduced form (8). The prior covariance matrix for these autoregressive parameters is diagonal, with variance of the coefficient on lag  $j = 1, 2, \dots, q$  for variable  $h = 1, 2, 3, 4$  in equation  $i = 1, 2, 3, 4$  given by

$$\frac{\lambda_0^2 \lambda_1^2 d_i}{j^{2\lambda_2} s_h},$$

where  $d_i$  and  $s_h$  denote the  $i$ th and  $h$ th diagonal elements of the covariance matrices  $D$  from (7) and  $S$  from (9). The elements of the intercept vector  $\mu$  in (1) are assigned independent normal priors, each with mean zero and variance  $\lambda_0^2 \lambda_3^2$ . Thus, as in Sims and Zha (1998), the parameter  $\lambda_0$  governs the overall weight on the Minnesota prior,  $\lambda_1$  determines the weight on the prior belief that, in the reduced form (8),  $\Phi_1 = \rho I$ ,  $\lambda_2$  governs the weight on the prior that the autoregressive coefficients are zero at longer lags, and  $\lambda_3$  applies to the tightness of the prior on the intercept terms. The settings  $\rho = 0.75$ ,  $\lambda_0 = 0.1$ ,  $\lambda_1 = \lambda_2 = 1$ , and  $\lambda_3 = 100$  are typical of those used in other applications of the Minnesota prior and coincide with those chosen by Baumeister and Hamilton (2018).

With these prior distributions, the Gibbs sampling algorithm outlined by Baumeister and Hamilton (2015, p.1989) is used to generate draws from the posterior distribution. Specifically, draws for the impact coefficients from the matrix  $A$  in (2) are taken via a random-walk Metropolis-Hastings step, using a multivariate Student  $t$  proposal distribution with 2 degrees of freedom and a tuning parameter that is set to target a 30 percent acceptance rate. Then, draws for the reciprocals of the volatility coefficients in  $D$  from (7) and the intercept and autoregressive coefficients  $\mu$  and  $B_j, j = 1, 2, \dots, q$ , from (1) are taken directly from their conditional gamma and normal distributions. After discarding the first one million draws to allow for burn in, the results presented next are based on the one million draws that follow. Convergence and adequate mixing of the Markov Chain Monte Carlo method is confirmed,

informally, by checking that the results do not change when the random number generator is seeded differently and, more formally, by monitoring the convergence and numerical efficiency statistics described by Geweke (1992).

## 2.3 Data

The quarterly data used to estimate the model come from two sources: Balke and Gordon (1986) for the interwar sample and the Federal Reserve Bank of St. Louis' FRED database for the postwar period. For the interwar period year-over-year percentage changes in the GNP deflator measure the inflation rate. The percentage-point difference between Balke and Gordon's figures for real and trend real GNP measures the output gap. The commercial paper rate, again in percentage points, measures the interest rate and year-over-year percentage changes in the M2 money stock measure monetary growth. For the postwar period, FRED data are used, likewise, to compute inflation as year-over-year percentage changes in the GDP deflator and the output gap as the percentage-point difference between real GDP and potential real GDP. The federal funds rate in percentage points measures the interest rate, and year-over-year percentage changes in M2 measure money growth.

For both periods  $q = 4$  quarterly lags are included in the estimated VAR. Thus, the interwar sample runs from 1920:1 through 1941:4, with data from 1919 used for initial conditions. The postwar sample runs from 1961:1 through 2007:4, with data from 1960 used for initial conditions. In generating the benchmark results, the postwar sample terminates in 2007:4 so as to exclude the episodes of near-zero nominal interest rates that follow, though additional results show what happens when the sample is extended through 2023:1.

Figure 1 provides an overview of the data from both samples. Of course, the massive decline in output during the Great Depression, together with a prolonged period of deflation and monetary contraction, dominate the interwar sample. Also clearly visible in the graphs from the left-hand column, however, is the brief but severe recession of 1920-21, the initial recovery starting in 1933, the renewed contraction in 1937, and the final stages of recovery

from 1938 through 1941. Inflation’s rise during the 1960s and 1970s and fall during the 1980s can be seen just as clearly in the graphs for the postwar period in the right-hand column, together with recessions in 1960-61, 1969-70, 1973-75, 1980, 1981-82, 1990-91, and 2001. And while cyclical patterns in money growth appear in the postwar data as well, at first glance at least movements in money growth seem less tightly linked to movements in inflation and output than they do for the interwar period. Estimates from the model, described next, provide a deeper and more detailed interpretation of all these data.

## 3 Results

### 3.1 Parameter Estimates

Table 2 presents summary statistics for the posterior distributions of the model’s impact and volatility coefficients from the matrices  $A$  and  $D$  in (2) and (7). For added detail, figures 2 and 3 plot the prior and posterior densities for the impact coefficients. Most notably, estimates of all the volatility coefficients fall dramatically moving from the interwar to the postwar period. This structural model, like Karras, Lee, and Stokes’ (2006) reduced form, attributes most of the decline in business cycle volatility since World War II to a corresponding decline in the volatility of shocks.

The data push the posterior distribution of the parameter  $\alpha_{py}$  to the left relative to the prior, implying a flatter Phillips curve (3) for the interwar period and, even more so, for the postwar. Meanwhile, while the real interest rate elasticity of aggregate demand  $\alpha_{yr}$  from (4) remains stable across the two samples, the coefficient  $\alpha_{ym}$  falls noticeably, indicating a stronger effect of real money balances on aggregate demand in the interwar period compared to the postwar. The coefficient  $\alpha_{rm}$  on nominal money growth in the monetary policy rule, however, appears just as large for the postwar period as it is for the interwar. The policy response coefficients  $\alpha_{rp}$  and  $\alpha_{ry}$  on inflation and the output gap are much larger when estimated with postwar data.

The results in table 3 reinforce this last finding, by showing posterior statistics for the long-run monetary policy response coefficients obtained by summing the parameters on the current and lagged values of each variable in (5), after isolating the interest rate  $R_t$  on the left-hand side. These results indicate that monetary policy introduced substantial inertia into interest rate movements over both sample periods. But while monetary policy has responded countercyclically to movements in inflation and the output gap over the postwar period, it appears almost entirely unresponsive to these stabilization concerns during the interwar. This message – that the Federal Reserve’s consistent *inaction* prolonged and deepened interwar business cycles, particularly the Great Depression – also lies at the heart of Friedman and Schwartz’s (1963*b*) narrative.

Finally for the postwar period, the posterior distribution for the parameter  $\alpha_{mr}$ , measuring the interest semi-elasticity of money demand in (6), remains consistent with the prior inspired by Stewart’s (2024) long-run estimates. The interwar data, however, push the posterior quite far to the right, implying a much larger response of real money demand to changes in the nominal interest rate. Overall, therefore, the parameter estimates from tables 2 and 3 and figures 2 and 3 point to some important changes, in both the structure of the economy and the conduct of monetary policy, moving from the interwar era to the postwar. The Phillips curve becomes flatter, aggregate demand becomes less responsive to changes in real money balances, and real money demand becomes less responsive to changes in the nominal interest rate. Monetary policy, on the other hand, becomes more responsive to movements in inflation and the output gap. At the same time, however, money growth appears as an important variable in the monetary policy rule across both sample periods. This message, too, is consistent with Friedman and Schwartz’s (1963*a*, 1963*b*).

### 3.2 Impulse Responses and Variance Decompositions

The impulse responses plotted in figures 4-7 summarize the influence of the autoregressive parameters from  $B_j$ ,  $j = 1, 2, 3, 4$ , on the estimated model’s implications. Figure 4 shows

that for both sample periods, an estimated aggregate supply shock triggers a sharp rise in inflation, a decline in the output gap, and an increase in the nominal interest rate. The inflation and output gap movements are larger for the interwar period, reflecting the larger estimate of the volatility parameter  $d_{as}$  from table 2, noted previously, but the responses are more persistent in the postwar. From these results, only the brief but small increase in the output gap on impact appears as a puzzle. The monetary policy response appears somewhat ambiguous across both samples: interest rates rise, but money growth displays an erratic pattern following aggregate supply shocks.

In figure 5, aggregate demand shocks increase inflation, the output gap, and the nominal interest rate and decrease money growth in both samples. Once again, the responses of inflation and the output gap – though not the interest rate – are larger in the interwar period. Inflation is more persistent, but the output gap less so, in the postwar.

Figure 6 presents some key results, showing the effects of monetary policy shocks across the two sample periods. As expected, a contractionary monetary policy shock reduces inflation and the output gap, with effects that are larger in the interwar period. Movements in inflation induced by monetary policy shocks, like those following aggregate demand disturbances, are more persistent in the postwar, but movements in the output gap are more persistent in the interwar. For both sample periods, a contractionary monetary policy shock produces a large and persistent decline in money growth. For both samples as well, a short-lived liquidity effect that initially increases the nominal interest rate gets followed by a more persistent expected inflation effect that lowers the interest rate. Together with the consistently positive estimates of the policy response parameter  $\alpha_{rm}$  from table 2, these results confirm, again, Friedman and Schwartz's (1963*a*, 1963*b*) that the stance of monetary policy is communicated most clearly by fluctuations in money growth rather than interest rates. These results go beyond Friedman and Schwartz's, however, by showing that the money growth remains an important monetary policy indicator even in data since 1960.

Finally, figure 7 displays the effects of money demand shocks. Rising money growth



coupled with rising interest rates suggest that, over both sample periods, monetary policy only partially accommodates an increase in money demand with an increase in money supply. Shocks increasing the demand for money generate deflationary pressures, without large effects on output, during the interwar period, and a slight decline in the output gap, without large effects on inflation, during the postwar.

Table 4 complements the impulse response analysis with forecast error variance compositions. This table shows the mean, as opposed to the median, of each statistic's posterior distribution so that, looking across all four structural disturbance, the percentages of volatility in each variable at each forecast horizon always sum to unity. For the interwar period, monetary policy shocks account for about 20 percent of the volatility in inflation and 60 percent of the volatility in output. Aggregate supply shocks also contribute importantly to inflation volatility, and aggregate demand shocks to volatility in the output gap. These results linking monetary and real instability over the interwar period are, of course, consistent with Friedman and Schwartz's (1963*a*, 1963*b*). But they also share the spirit of those from Gordon and Wilcox (1981), by providing a nontrivial role for aggregate supply and demand disturbances in driving interwar fluctuations in inflation and output even as monetary policy appears as a dominating force.

In the postwar sample, monetary policy plays an even larger role in driving persistent movements in inflation, accounting for more than 25 percent of the forecast error variance five years ahead. Monetary policy's role in driving output fluctuations is reduced compared to the interwar, but still quite substantial: between 30 and 45 percent of the forecast error variance at various horizons gets attributed to monetary policy shocks. And while monetary policy shocks account for very little of the observed volatility in postwar interest rates, they do account for more than 50 percent of the observed movements in money growth. To be sure, the results from table 4 corroborate Friedman and Schwartz's assertion that alternative monetary policies directed at stabilizing money growth would have greatly shortened and ameliorated the Great Depression. And they suggest that more stable money growth would

have led to more favorable outcomes in the postwar period as well.

### 3.3 Estimated Shocks and Historical Decompositions

Figure 8 plots the median estimates of the model's four structural shocks, while figures 9 and 10 illustrate the effects of these shocks on the historical path of each of the four observable variables. Across all of these graphs, more volatile shocks appear, once again, as the principal force behind the more volatile interwar economy compared to the postwar.

The graphs also show that the model struggles, somewhat, to account for the large swings in inflation and the output gap just before and during the 1920-21 recession. Friedman and Schwartz (1963*b*, pp.231-39) blame the recession on monetary policy, arguing that the Fed first waited too long to react to the post-World War I surge in inflation, but then tightened excessively, generating the deep but brief deflationary downturn. Figure 1 shows, however, that inflation continued to rise even as the output gap fell sharply during the first half of 1920. Thus, as shown in figures 8 and 9, the model attributes the recession mainly to unfavorable aggregate supply shocks.

The results from figures 8 and 9 support Friedman and Schwartz's account of the Great Depression as driven by relentlessly contractionary monetary policy, but add some nuances that have been noted previously elsewhere. In particular, consistent with Temin (1976) and Romer (1996), the model attributes much of the initial decline in both inflation and output in late 1929 to aggregate demand shocks. A series of very large and contractionary monetary policy shocks begins, however, in 1930:3 and continues through 1933:2; this period includes all three of the major banking panics described by Friedman and Schwartz (1963*b*, pp.342-50). This series is interrupted in 1932:4, just following the Fed's short-lived program of large-scale open market purchases, discussed by Friedman and Schwartz (1963*b*, pp.384-91) and studied in greater detail by Bordo and Sinha (2023). And the largest contractionary monetary policy shock, in 1931:4, coincides with the Fed's contractionary response to Britain's departure from the gold standard. As shown in figure 9, these monetary policy shocks account for the largest

and most persistent movements in both inflation and the output gap during the Depression. They account, as well, for the persistent contraction in the money stock, which, as figure 9 also reveals, is associated with falling, not rising, nominal interest rates.

A mixture of favorable aggregate demand and monetary policy shocks in 1933-34 drive both the sharp pickup in inflation and the initial stages of economic recovery reflected in the rising output gap. Jacobson, Leeper, and Preston (2023) estimate a structural VAR that describes the linkages between fiscal and monetary policy during this episode in much greater detail; the findings here can be seen as corroborating theirs by suggesting, more generally, that the initial recovery was triggered by coordinated, or at least coincident, monetary and fiscal policy impulses. Again echoing Friedman and Schwartz (1963*b*, pp.524-32), the model singles out tight monetary policy as the chief culprit behind renewed deflation and decline in 1937. The final stages of recovery in 1941, however, are driven by aggregate demand, a result consistent with Gordon and Krenn's (2010) analysis.

Thus, overall, the estimated model interprets the interwar data in much the same way as Friedman and Schwartz (1963*a*, 1963*b*) do. Monetary policy disturbances account for the largest and most persistent movements in inflation and the output gap, particularly during the Great Depression. And the contractionary thrust of monetary policy, especially during the Depression but also in 1937, is reflected mainly in through movements in the money stock. The deflationary effects of tight monetary policy work mostly to decrease, rather than increase, the nominal interest rate. So while, as noted above, the results are consistent with one element from Temin's (1976) critique of Friedman and Schwartz (1963*b*), by indicating that the initial adverse shock in 1929:3 was non-monetary in origin, the results contradict a second and more fundamental component of Temin's argument: that falling rates of interest, by themselves, provide evidence that monetary policy was appropriately accommodative, rather than excessively tight, during the early years of the Depression. Instead, the results support Brunner and Meltzer's (1968) assertion that Federal Reserve officials were mistaken in interpreting falling interest rates as a sign that their policies were accommodative, and in

ignoring the declining money stock as a sign that policy was becoming ever more restrictive. The results in figure 9 are certainly consistent with those in McCallum (1990) and Bordo, Chourhri, and Schwartz (1995), suggesting that a monetary policy directed stabilizing the money growth rate would have shortened and ameliorated the Great Depression.

Figure 10, meanwhile, reveals several striking similarities across the model's interpretations of interwar and postwar business cycles. First, aggregate supply shocks account for the large but short-lived bursts of inflation in 1973-75 and 1979-81, much as they do for the temporarily high inflation of 1920. Of course, the two postwar episodes coincide with the first OPEC oil embargo and the second disruption to world oil markets from the revolution in Iran. Monetary policy, however, explains much of the more persistent rise and fall of postwar inflation, much as it explains the persistent movements in inflation during and following the Great Depression.

Second, although postwar business cycles appear to be driven by a shifting mixture of aggregate supply, aggregate demand, and monetary policy shocks, the latter remain important, especially in accounting for the recessions of 1969-70, 1973-75, 1980, and 1981-82. Third and finally, the shifting stance of monetary policy as it accounts for both long-run swings in inflation and shorter-run fluctuations in output gets reflected in figure 10 through changes in money growth as well as the federal funds rate. Monetary policy was certainly not as disruptive a force during the postwar period as it was during the Great Depression. But figure 10, like figure 9, still suggests that alternative monetary policy directed at stabilizing the path for money growth might have avoided much of the Great Inflation of the 1970s and therefore reduced costs of reducing inflation in the early 1980s. While again adding nuance to the basic message, the results obtained here suggest that Friedman and Schwartz's (1963*a*, 1963*b*) insights continue to apply to the postwar US economy: monetary policy remains an important source of real instability and its changing stance is reflected in measures of money growth.

### 3.4 Robustness Checks and Extensions

Tables 5-7 and figures 11-14 confirm the robustness of these findings for the postwar period by making several changes to the sample’s starting and ending dates and by replacing the Federal Reserve’s official, simple-sum M2 monetary aggregate with the corresponding Divisia M2 aggregate. Barnett (1980) first observes that simple-sum monetary aggregation implicitly assumes that all assets comprising the aggregate are perfect substitutes – a hypothesis that can be rejected immediately when all of these assets are held in positive quantities, despite paying interest at different rates. Barnett’s (1980, 2012) preferred, Divisia monetary aggregates are constructed, instead, based on microeconomic aggregation theory that measures the liquidity service flow provided by each component asset using the observable spread between its own rate of return and the return on an illiquid benchmark asset. A series on quarterly, year-over-year Divisia M2 growth, running from 1968:1 through 2023:1, is available through the Center for Financial Stability’s website; Barnett, Liu, Mattson, and van den Noort (2013) describe in detail the construction of this series.

Figure 11 reveals that simple-sum and Divisia M2 growth often exhibit divergent behavior. Differences are particularly pronounced during the disinflationary period of the 1980s, when contraction in Divisia M2 signals monetary restraint much more clearly than continued robust growth in simple-sum M2. Differences appear, as well, in the early-to-mid 1990s, when Divisia M2 grows noticeably faster during a period that Duca (2000) associates with “missing” simple-sum M2. In large part because of these differences, Belongia (1996), Hendrickson (2014), and Belongia and Ireland (2015, 2016) find significantly tighter statistical relationships between inflation, output, and money over the post-1980 period using Divisia in place of simple-sum monetary aggregates.

Table 5 shows that when the original postwar sample, including data on simple-sum M2, is extended to run through 2023:1, shortened to begin in 1968:1 (to match the availability of the corresponding Divisia series), or both, and when Divisia M2 replaces simple-sum M2 in samples ending in either 2007:4 or 2023:1, parameter estimates continue to imply a modest

role for real money balances in the aggregate demand equation (4) but a more important role for money growth in the monetary policy rule (5). Likewise, table 6 shows only small changes in estimated long-run monetary policy coefficients across the same samples of data. Table 7, meanwhile, shows that when the sample period is extended through 2023:1, monetary policy shocks explain somewhat smaller – but still sizable – fractions of the forecast error variances in inflation and the output gap than when the postwar sample ends in 2007:4. This is as expected, assuming that the dramatic swings in inflation and output during and since 2020 are not entirely the direct effects of monetary policy shocks.

Since the results in tables 5-7 show only small differences across estimates from the various data samples, figures 12-14 focus on those obtained from data running from 1968:1 through 2023:1 and using Divisia M2 to measure money growth. In figure 12, estimated impulse responses appear as expected, except that an adverse supply shock generates a small but short-lived increase in the output gap on impact, similar to the one shown in figure 4 for the interwar period. Inflation rises immediately, however, and the output gap exhibits a larger and more persistent decline with a lag. Expansionary aggregate demand shocks increase inflation, output, and the interest rate, while decreasing the money growth rate. Most notably, as in the benchmark results for both the interwar and postwar periods, a contractionary monetary policy shock produces a large and persistent decline in money growth, with a modest liquidity effect that raises interest rates in the short run followed by an expected inflation effect that lowers the interest rate over longer horizons.

Figures 13 and 14 add to the analysis by providing the model's interpretations of the Great Recession of 2007-09, the slow recovery that followed, and the steep decline but quick recovery of output together with the burst of inflation that followed the March 2020 economic shutdowns. The estimated model attributes the Great Recession to a combination of adverse aggregate demand shocks and contractionary monetary policy disturbances. The figures also show that the sluggish recovery and slow inflation that followed the Great Recession reflects persistently tight monetary policy, reflected in slow Divisia money growth to an

equal if not greater extent than higher nominal interest rates. In all these respects, the Great Recession resembles earlier episodes, including the Great Depression and the two disinflationary recessions of the early 1980s.

Perhaps not surprisingly, the 2020 recession appears to the model as entirely unique. All four shocks play a role. Aggregate demand shocks explain the largest initial output losses, though money demand shocks appear, for the first time in any historical episode, to play an important role, too. Monetary policy, reflected again through an increase in money growth, contributes importantly to both the vigor of the economy recovery and the subsequent rise in inflation. Aggregate supply and money demand disturbances also contribute to the post-crisis burst in inflation. Note from figure 12, however, that with this expanded sample, estimated shocks that increase money demand cause output to decrease but inflation to rise with a lag. This pattern of impulse responses makes sense only if the initial increase in money demand is accommodated less than fully on impact but more than necessary after a lag. Under this interpretation, monetary policy, through its response to the contractionary money demand shock, can be blamed for even more of the rise in inflation during 2021-22.

## 4 Conclusion

Previous studies appear to point to important differences in business cycles across the interwar and postwar periods of US economy history. Friedman and Schwartz (1963*a*, 1963*b*) emphasize the role of monetary policy as the primary driving force behind interwar business cycles, including but by no means limited to the Great Depression. Their quantity-theoretic framework emphasizes, as well, that the shifting stance of monetary policy is reflected most accurately by fluctuations in the rate of money growth. More recent research, surveyed by Cochrane (1994) and Ramey (2016), finds a much smaller role of monetary policy in generating postwar business cycles. And, to the extent that monetary policy does have effects in the postwar period, these effects seem to be triggered by changes in interest rates rather

than money growth.

These apparent differences certainly could reflect changes in the structure of the US economy, changes in the conduct of monetary policy, or any combination of the two, across the interwar and postwar periods. On the other hand, differences in methodologies – especially between Friedman and Schwartz’s (1963*b*) narrative approach and more recent analyses using vector autoregressive time series models – could be masking deeper similarities in business cycles over time.

This paper examines both interwar and postwar data with the same VAR, in hopes of bridging the gaps between Friedman and Schwartz’s monetarist framework and the more contemporary New Keynesian view with its focus on interest rates in the conduct of monetary policy and in the transmission of its effects to inflation and output. Specifically, it uses Bayesian priors that favor the New Keynesian view, but leave enough flexibility to allow the data to reveal more important role for money in measuring the stance of monetary policy and transmitting its effects to the economy. The same Bayesian priors use New Keynesian theory to describe and isolate shocks to aggregate supply and aggregate demand, but draw also on monetarist principles to distinguish between money supply and money demand.

Some differences, but some similarities as well, appear in the model’s interpretation of interwar versus postwar business cycles. The estimated shocks are much larger, and monetary policy appears more important as a source of business cycle fluctuations, in the interwar period compared to the postwar. On the other hand, across both sample periods, a mixture of aggregate supply, aggregate demand, and monetary policy shocks combine to explain volatility in inflation and output and to account for specific historical episodes. Even in the postwar period, monetary policy drives persistent movements in inflation and a sizable fraction – between 30 and 40 percent – of the forecast error variance in the output gap. Finally and most importantly, across both sample periods, monetary policy shocks produce large and sustained movements in money growth with much short-lived liquidity effects on interest rates. Over longer horizons, contractionary monetary policy gets reflected



in lower, not higher, rates of interest.

While adding considerable nuance, the results do support and extend Friedman and Schwartz's earlier insights. Instability in monetary policy in general and money growth in particular, has been and remains an important source of instability in the US economy.

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Table 1. Prior Parameters for Impact Coefficients

Parameter	Description	$\bar{\alpha}_i$	$\sigma_i$
$\alpha_{py}$	Phillips curve slope	0.500	0.3
$\alpha_{yr}$	Aggregate demand elasticity: real interest rate	1.000	0.3
$\alpha_{ym}$	Aggregate demand elasticity: real money growth	0.000	0.3
$\alpha_{rp}$	Monetary policy response: inflation	0.375	0.3
$\alpha_{ry}$	Monetary policy response: output gap	0.125	0.3
$\alpha_{rm}$	Monetary policy response: money growth	0.000	0.3
$\alpha_{mr}$	Interest semi-elasticity of money demand	1.000	1.0

*Note:* Each parameter has a Student  $t$  prior distribution with the location and scale parameters  $\bar{\alpha}_i$  and  $\sigma_i$  shown and  $\nu_i = 3$  degrees of freedom, truncated at zero to enforce the view that the parameter is nonnegative.

Table 2. Posterior Statistics for Impact and Volatility Coefficients

Parameter	Interwar Sample				Postwar Sample			
	Mean	Percentile			Mean	Percentile		
		50	16	84		50	16	84
$\alpha_{py}$	0.33	0.33	0.24	0.42	0.17	0.17	0.13	0.21
$\alpha_{yr}$	0.69	0.69	0.56	0.82	0.74	0.73	0.62	0.86
$\alpha_{ym}$	0.48	0.47	0.34	0.63	0.13	0.12	0.04	0.22
$\alpha_{rp}$	0.11	0.09	0.03	0.19	1.20	1.17	0.83	1.56
$\alpha_{ry}$	0.11	0.09	0.03	0.19	1.03	1.02	0.84	1.23
$\alpha_{rm}$	0.82	0.75	0.55	1.07	0.95	0.93	0.77	1.13
$\alpha_{mr}$	15.99	15.47	12.85	19.12	0.94	0.94	0.84	1.04
$d_{as}$	6.39	6.29	5.43	7.35	0.13	0.13	0.11	0.14
$d_{ad}$	9.27	9.01	7.64	10.85	1.24	1.21	1.02	1.46
$d_{mp}$	10.37	7.70	4.39	15.09	2.27	2.15	1.69	2.83
$d_{md}$	73.21	66.90	46.95	98.29	1.33	1.31	1.17	1.48

Table 3. Posterior Statistics for Long-Run Monetary Policy Response Coefficients

Variable	Interwar Sample				Postwar Sample			
	Mean	Percentile			Mean	Percentile		
		50	16	84		50	16	84
$P$	-0.03	-0.03	-0.10	0.04	0.06	0.06	-0.02	0.14
$Y$	0.00	0.00	-0.03	0.03	0.16	0.16	0.10	0.22
$R$	1.27	1.24	1.04	1.49	1.05	1.05	1.00	1.10
$M$	0.17	0.16	0.09	0.25	0.07	0.06	0.01	0.12



Table 4. Forecast Error Variance Decomposition

	Interwar Sample				Postwar Sample				
Inflation									
$k$	AS	AD	MP	MD	AS	AD	MP	MD	
4	68.0	12.0	17.4	2.5	85.6	12.0	1.8	0.6	
8	58.7	11.2	20.6	9.5	76.8	16.2	6.1	1.0	
12	56.7	11.9	19.5	11.8	68.3	16.2	14.0	1.5	
16	55.1	12.6	20.0	12.4	61.7	15.0	21.3	1.9	
20	53.9	12.8	20.6	12.7	57.1	14.3	26.3	2.3	
Output Gap									
$k$	AS	AD	MP	MD	AS	AD	MP	MD	
4	5.6	45.5	47.9	1.0	3.1	56.5	35.7	4.8	
8	12.0	29.0	57.3	1.7	11.4	40.1	44.1	4.4	
12	13.6	23.4	60.3	2.6	18.1	37.9	39.6	4.5	
16	13.9	21.1	61.4	3.6	21.2	39.4	34.5	4.9	
20	14.1	20.1	61.2	4.6	22.5	40.1	32.1	5.3	
Interest Rate									
$k$	AS	AD	MP	MD	AS	AD	MP	MD	
4	15.1	19.7	3.3	61.9	15.6	68.3	4.8	11.3	
8	17.0	22.1	10.4	50.5	17.2	66.7	4.5	11.5	
12	16.0	22.7	17.1	44.2	18.0	63.1	7.0	12.0	
16	15.3	22.3	21.9	40.6	18.5	59.5	10.0	12.0	
20	15.0	21.6	25.1	38.3	18.9	56.8	12.5	11.9	
Money Growth									
$k$	AS	AD	MP	MD	AS	AD	MP	MD	
4	2.8	2.0	91.9	3.3	2.4	7.2	54.7	35.7	
8	4.4	2.9	85.8	7.0	3.0	11.0	52.5	33.6	
12	6.9	4.5	78.9	9.6	6.0	11.2	50.7	32.0	
16	8.1	5.8	75.5	10.7	9.8	11.5	48.7	29.9	
20	8.5	6.4	73.9	11.2	12.2	11.9	47.8	28.2	

*Note:* Each entry shows the mean of the posterior distribution for the percentage of the  $k$  quarters ahead forecast error variance in the indicated variable attributable to aggregate supply (AS), aggregate demand (AD), monetary policy (MP), or money demand (MD) shocks.

Table 5. Posterior Statistics for Impact and Volatility Coefficients

Parameter	1960:1 - 2007:4, Sum M2				1960:1 - 2023:1, Sum M2			
	Mean	Percentile			Mean	Percentile		
		50	16	84		50	16	84
$\alpha_{py}$	0.17	0.17	0.13	0.21	0.12	0.12	0.10	0.15
$\alpha_{yr}$	0.74	0.73	0.62	0.86	0.78	0.77	0.64	0.91
$\alpha_{ym}$	0.13	0.12	0.04	0.22	0.04	0.03	0.01	0.07
$\alpha_{rp}$	1.20	1.17	0.83	1.56	0.67	0.66	0.47	0.87
$\alpha_{ry}$	1.03	1.02	0.84	1.23	0.80	0.79	0.68	0.92
$\alpha_{rm}$	0.95	0.93	0.77	1.13	0.74	0.73	0.63	0.86
$\alpha_{mr}$	0.94	0.94	0.84	1.04	1.72	1.71	1.53	1.91
$d_{as}$	0.13	0.13	0.11	0.14	0.15	0.15	0.13	0.16
$d_{ad}$	1.24	1.21	1.02	1.46	1.80	1.77	1.53	2.07
$d_{mp}$	2.27	2.15	1.69	2.83	1.94	1.87	1.53	2.35
$d_{md}$	1.33	1.31	1.17	1.48	4.20	4.15	3.70	4.69

Parameter	1968:1 - 2007:4, Sum M2				1968:1 - 2007:4, Divisia M2			
	Mean	Percentile			Mean	Percentile		
		50	16	84		50	16	84
$\alpha_{py}$	0.18	0.18	0.14	0.22	0.16	0.16	0.12	0.20
$\alpha_{yr}$	0.73	0.73	0.61	0.85	0.70	0.69	0.58	0.82
$\alpha_{ym}$	0.14	0.13	0.05	0.24	0.11	0.10	0.03	0.19
$\alpha_{rp}$	1.14	1.10	0.76	1.52	0.90	0.88	0.61	1.20
$\alpha_{ry}$	1.12	1.10	0.90	1.33	1.11	1.09	0.92	1.29
$\alpha_{rm}$	0.85	0.83	0.68	1.03	0.61	0.60	0.48	0.73
$\alpha_{mr}$	0.89	0.89	0.79	0.99	1.01	1.00	0.88	1.13
$d_{as}$	0.14	0.14	0.12	0.15	0.14	0.14	0.12	0.15
$d_{ad}$	1.40	1.36	1.13	1.66	1.38	1.34	1.12	1.64
$d_{mp}$	2.40	2.26	1.77	3.01	1.93	1.84	1.48	2.37
$d_{md}$	1.39	1.38	1.22	1.57	2.04	2.01	1.78	2.30

Parameter	1968:1 - 2023:1, Sum M2				1968:1 - 2023:1, Divisia M2			
	Mean	Percentile			Mean	Percentile		
		50	16	84		50	16	84
$\alpha_{py}$	0.13	0.13	0.11	0.16	0.12	0.12	0.10	0.15
$\alpha_{yr}$	0.78	0.78	0.64	0.92	0.75	0.74	0.61	0.89
$\alpha_{ym}$	0.04	0.03	0.01	0.07	0.03	0.03	0.01	0.06
$\alpha_{rp}$	0.63	0.62	0.42	0.83	0.55	0.55	0.37	0.74
$\alpha_{ry}$	0.82	0.81	0.70	0.95	0.79	0.78	0.68	0.91
$\alpha_{rm}$	0.70	0.69	0.59	0.81	0.59	0.58	0.50	0.68
$\alpha_{mr}$	1.65	1.64	1.46	1.84	1.71	1.70	1.51	1.91
$d_{as}$	0.16	0.16	0.15	0.18	0.16	0.16	0.15	0.18
$d_{ad}$	1.98	1.95	1.67	2.29	1.93	1.89	1.63	2.23
$d_{mp}$	2.03	1.95	1.58	2.46	1.77	1.71	1.41	2.12
$d_{md}$	4.58	4.53	4.03	5.14	4.94	4.88	4.35	5.53

Table 6. Posterior Statistics for Long-Run Monetary Policy Response Coefficients

Variable	1960:1 - 2007:4, Sum M2				1960:1 - 2023:1, Sum M2			
	Mean	Percentile			Mean	Percentile		
		50	16	84		50	16	84
<i>P</i>	0.06	0.06	-0.02	0.14	0.18	0.18	0.12	0.24
<i>Y</i>	0.16	0.16	0.10	0.22	0.16	0.16	0.11	0.20
<i>R</i>	1.05	1.05	1.00	1.10	0.92	0.92	0.89	0.96
<i>M</i>	0.07	0.06	0.01	0.12	0.05	0.05	0.01	0.08

Variable	1968:1 - 2007:4, Sum M2				1968:1 - 2007:4, Divisia M2			
	Mean	Percentile			Mean	Percentile		
		50	16	84		50	16	84
<i>P</i>	0.06	0.06	-0.03	0.14	0.12	0.12	0.06	0.19
<i>Y</i>	0.26	0.26	0.18	0.34	0.27	0.27	0.20	0.34
<i>R</i>	1.05	1.05	0.99	1.10	1.05	1.05	0.99	1.10
<i>M</i>	0.06	0.06	0.01	0.12	0.07	0.06	0.01	0.12

Variable	1968:1 - 2023:1, Sum M2				1968:1 - 2023:1, Divisia M2			
	Mean	Percentile			Mean	Percentile		
		50	16	84		50	16	84
<i>P</i>	0.16	0.16	0.09	0.22	0.20	0.19	0.14	0.25
<i>Y</i>	0.24	0.23	0.18	0.29	0.23	0.23	0.18	0.28
<i>R</i>	0.92	0.92	0.88	0.96	0.92	0.92	0.88	0.96
<i>M</i>	0.05	0.05	0.02	0.09	0.04	0.04	0.00	0.08

Table 7. Forecast Error Variance Decomposition

	1960:1 - 2023:1				1968:1 - 2023:1				
	Sum M2				Divisia M2				
Inflation									
$k$	AS	AD	MP	MD	AS	AD	MP	MD	
4	89.7	7.7	1.2	1.4	88.7	8.2	0.9	2.2	
8	78.7	7.8	7.0	6.5	77.3	8.5	4.8	9.5	
12	66.9	7.3	14.3	11.5	67.5	8.2	9.1	15.2	
16	59.6	7.4	18.6	14.4	62.0	8.7	11.4	18.0	
20	55.5	8.1	20.7	15.7	59.0	9.7	12.3	19.0	
Output Gap									
$k$	AS	AD	MP	MD	AS	AD	MP	MD	
4	0.8	76.9	17.1	5.2	0.8	80.4	14.4	4.4	
8	3.6	66.2	25.7	4.4	2.3	72.3	20.8	4.5	
12	7.7	59.7	28.2	4.4	4.6	67.7	22.9	4.9	
16	10.8	56.6	27.9	4.8	6.6	65.7	22.8	5.0	
20	12.7	54.8	27.2	5.3	7.8	64.4	22.4	5.3	
Interest Rate									
$k$	AS	AD	MP	MD	AS	AD	MP	MD	
4	13.1	61.4	7.1	18.3	12.3	64.0	8.6	15.1	
8	16.3	61.5	4.7	17.5	16.2	64.7	5.5	13.6	
12	17.7	58.6	5.6	18.1	18.8	61.6	5.1	14.5	
16	18.0	55.6	7.6	18.8	20.1	58.4	5.8	15.6	
20	18.0	53.4	9.5	19.2	20.8	56.1	6.6	16.5	
Money Growth									
$k$	AS	AD	MP	MD	AS	AD	MP	MD	
4	1.7	10.8	47.3	40.1	2.5	17.9	41.6	38.0	
8	2.6	13.7	45.1	38.7	5.9	25.3	36.7	32.1	
12	3.3	14.1	44.1	38.5	7.6	25.7	35.6	31.2	
16	4.3	14.8	43.1	37.7	8.2	25.5	35.3	31.0	
20	5.0	15.4	42.4	37.2	8.5	25.5	35.1	30.9	

*Note:* Each entry shows the mean of the posterior distribution for the percentage of the  $k$  quarters ahead forecast error variance in the indicated variable attributable to aggregate supply (AS), aggregate demand (AD), monetary policy (MP), or money demand (MD) shocks.

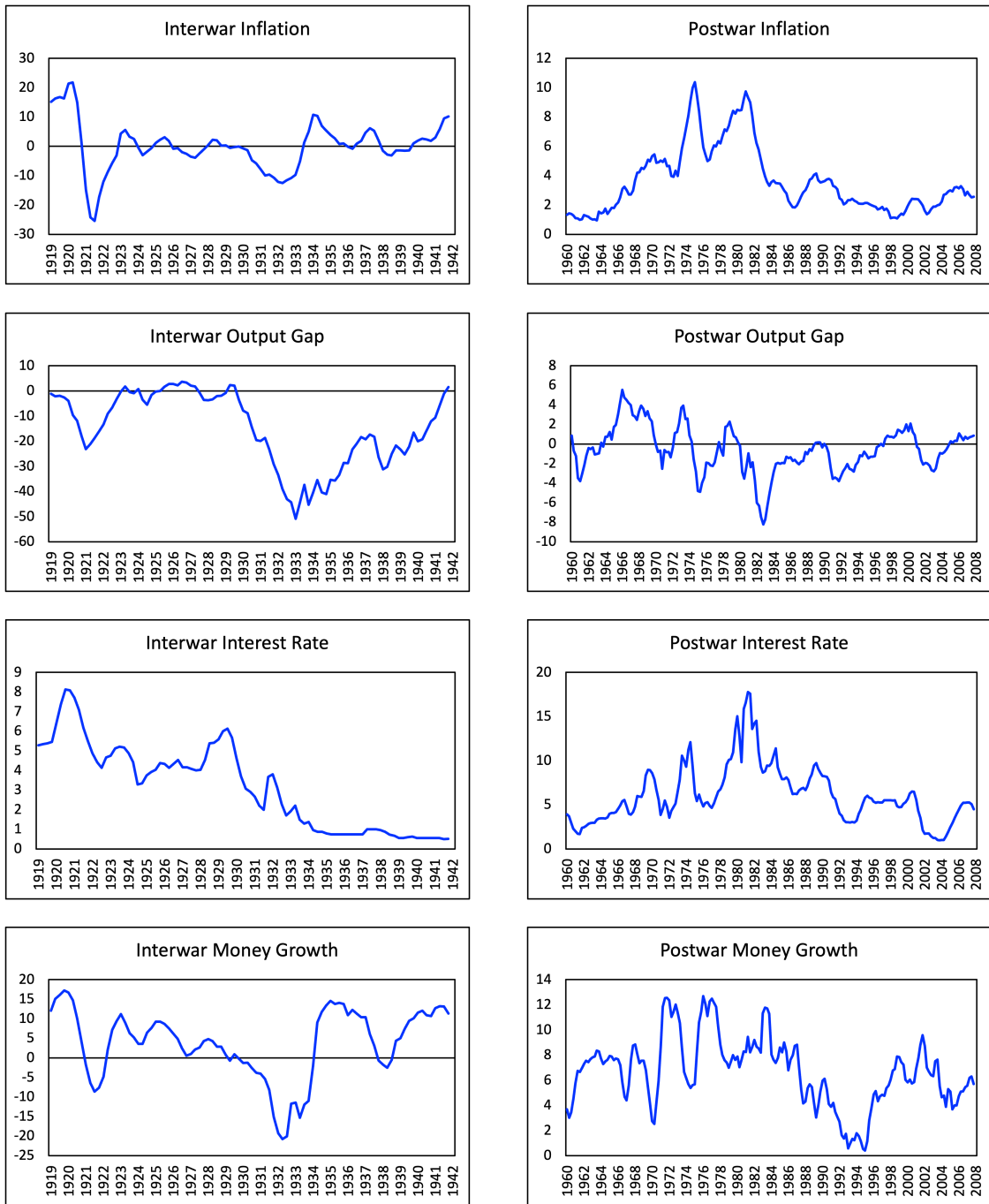


Figure 1. Interwar and Postwar Data. Interwar data are from Balke and Gordon (1986); postwar data are from FRED.

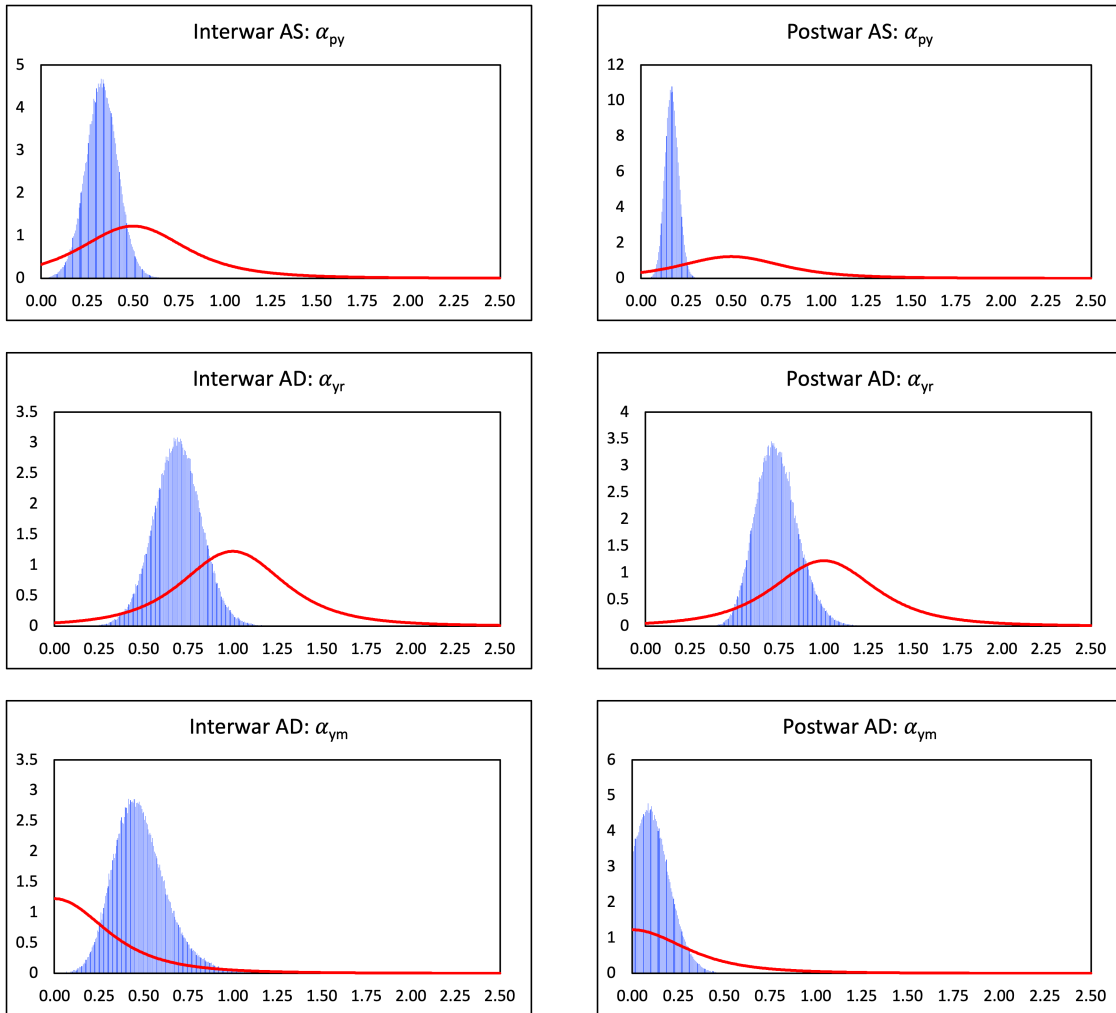


Figure 2. Impact Coefficients for Aggregate Supply and Aggregate Demand. Each panel illustrates the prior (red line) and posterior (blue bars) densities of the indicated parameter over the indicated sample.

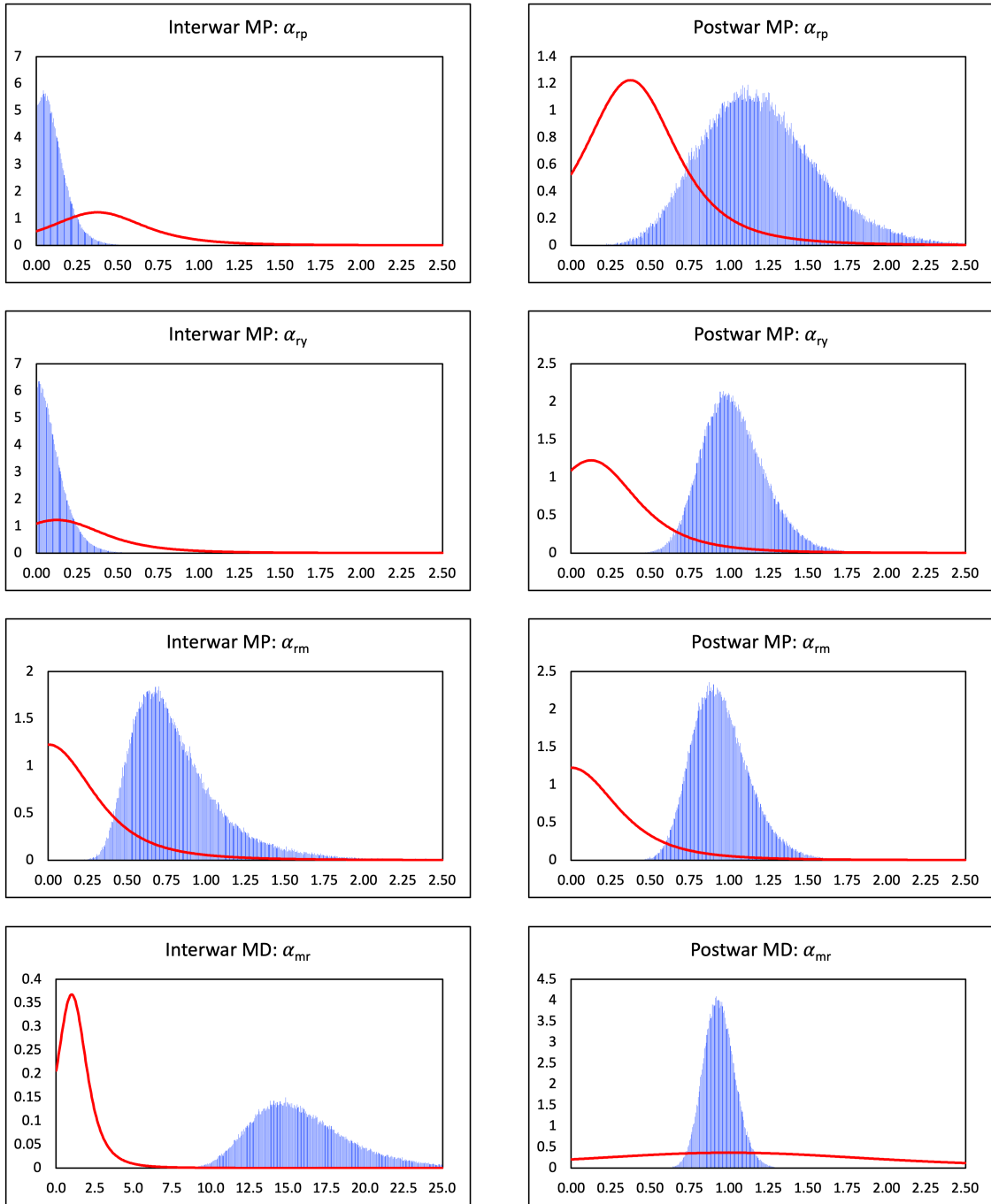


Figure 3. Impact Coefficients for Monetary Policy and Money Demand. Each panel illustrates the prior (red line) and posterior (blue bars) densities of the indicated parameter over the indicated sample.

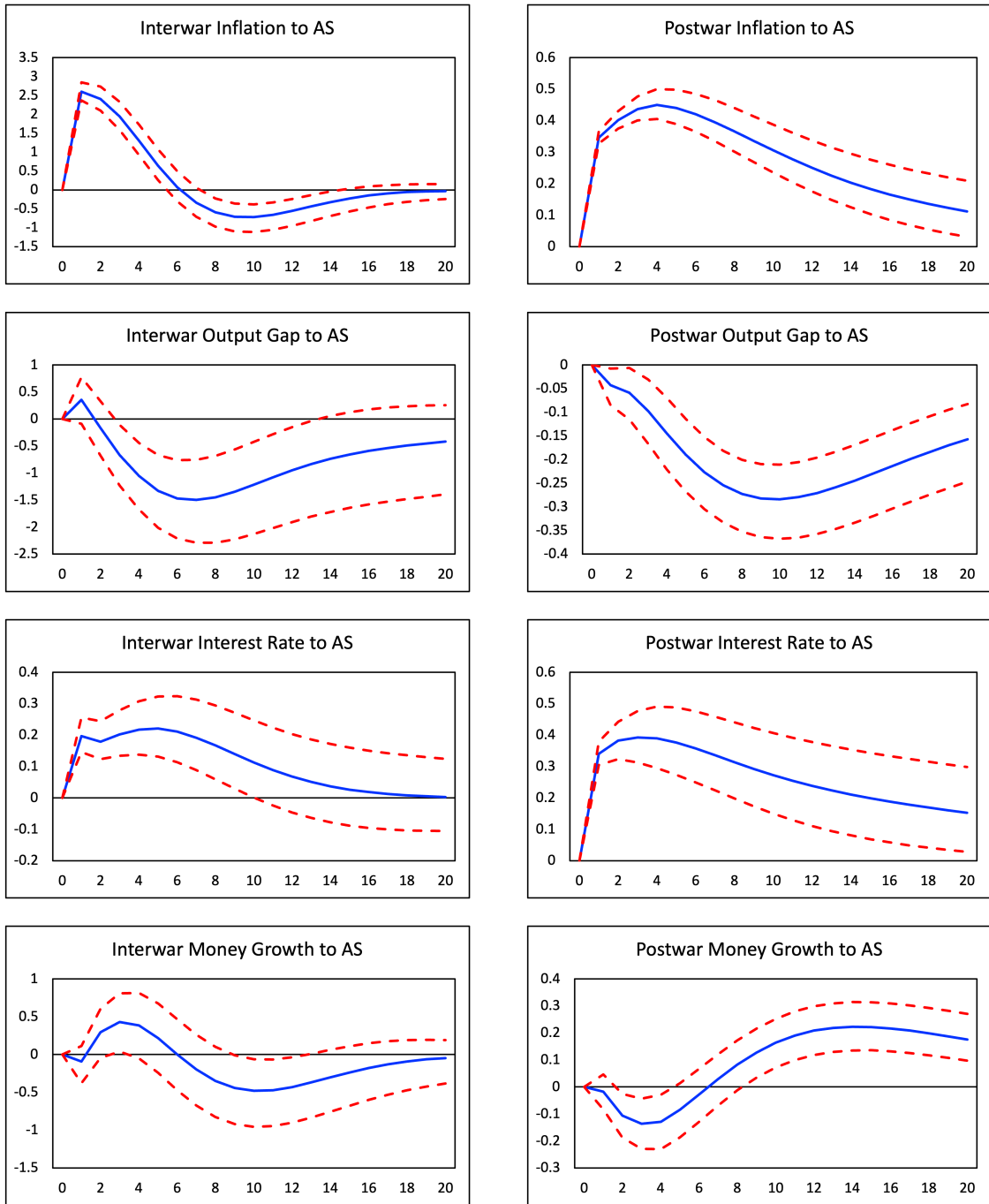


Figure 4. Impulse Responses to Aggregate Supply. Each panel plots the median (solid blue line) and the 16th and 84th percentiles (dashed red lines) of the posterior distribution of the indicated impulse response, computed as the percentage-point change in the indicated variable in response to a one-standard-deviation aggregate supply shock.



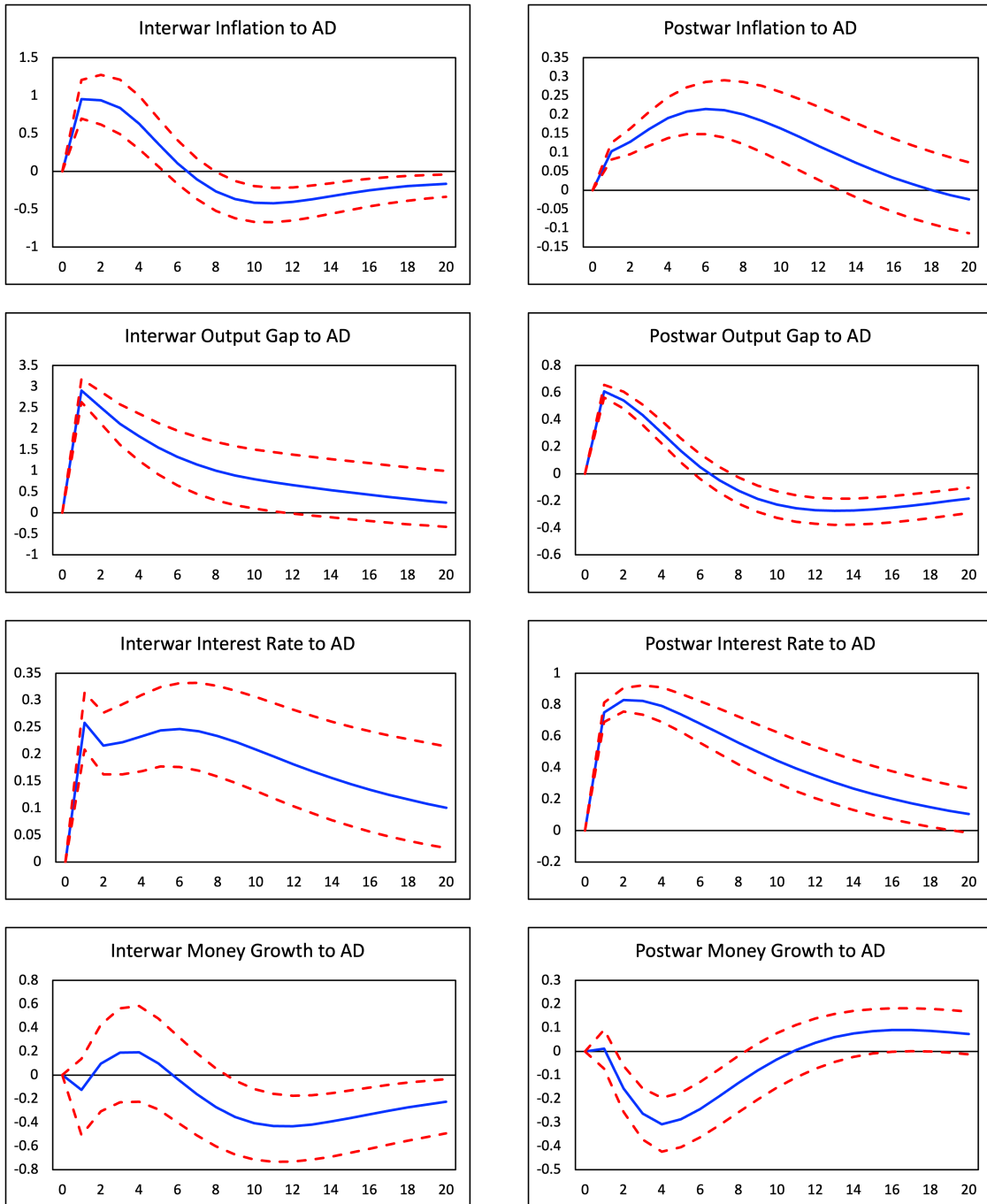


Figure 5. Impulse Responses to Aggregate Demand. Each panel plots the median (solid blue line) and the 16th and 84th percentiles (dashed red lines) of the posterior distribution of the indicated impulse response, computed as the percentage-point change in the indicated variable in response to a one-standard-deviation aggregate demand shock.

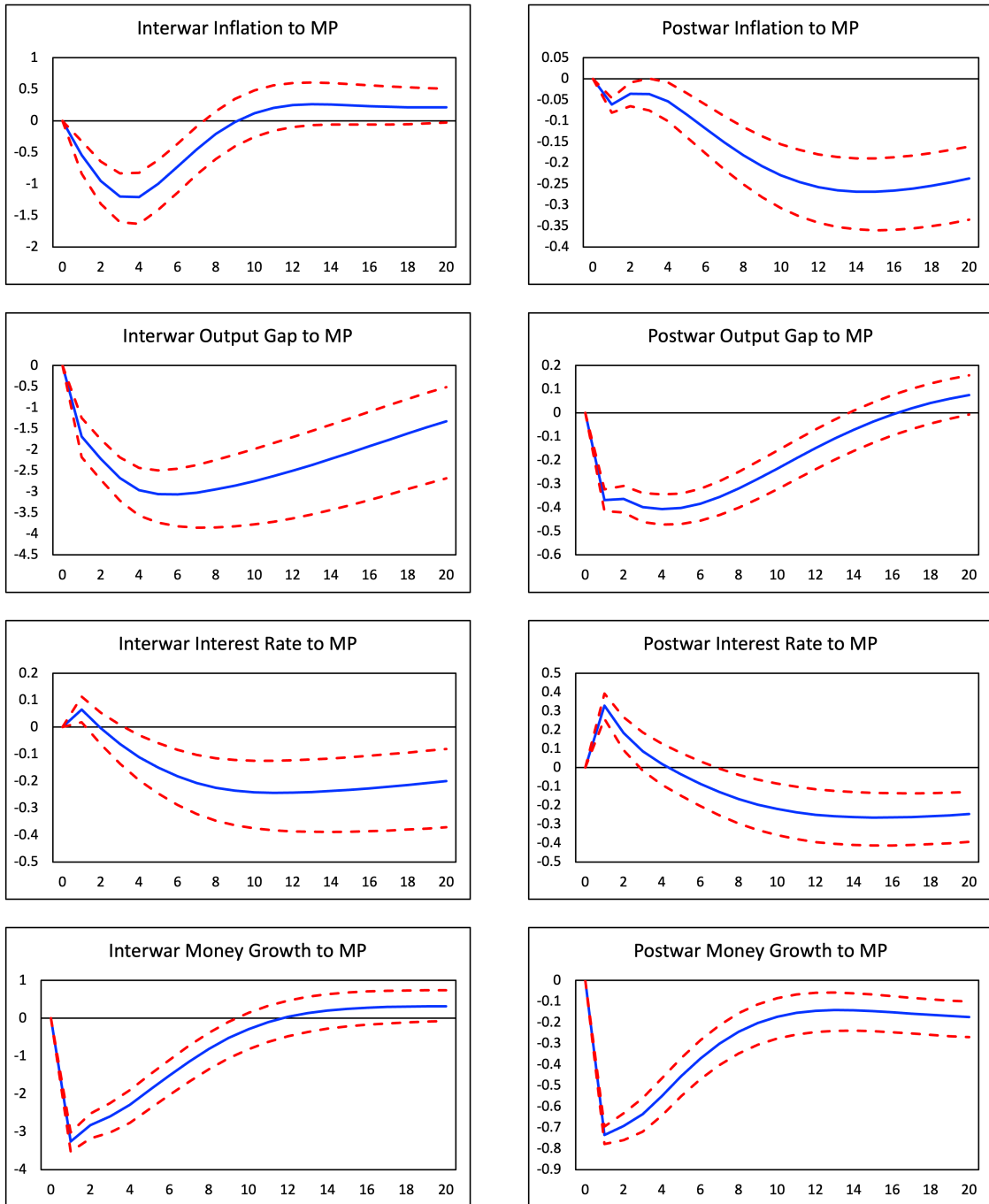


Figure 6. Impulse Responses to Monetary Policy. Each panel plots the median (solid blue line) and the 16th and 84th percentiles (dashed red lines) of the posterior distribution of the indicated impulse response, computed as the percentage-point change in the indicated variable in response to a one-standard-deviation monetary policy shock.

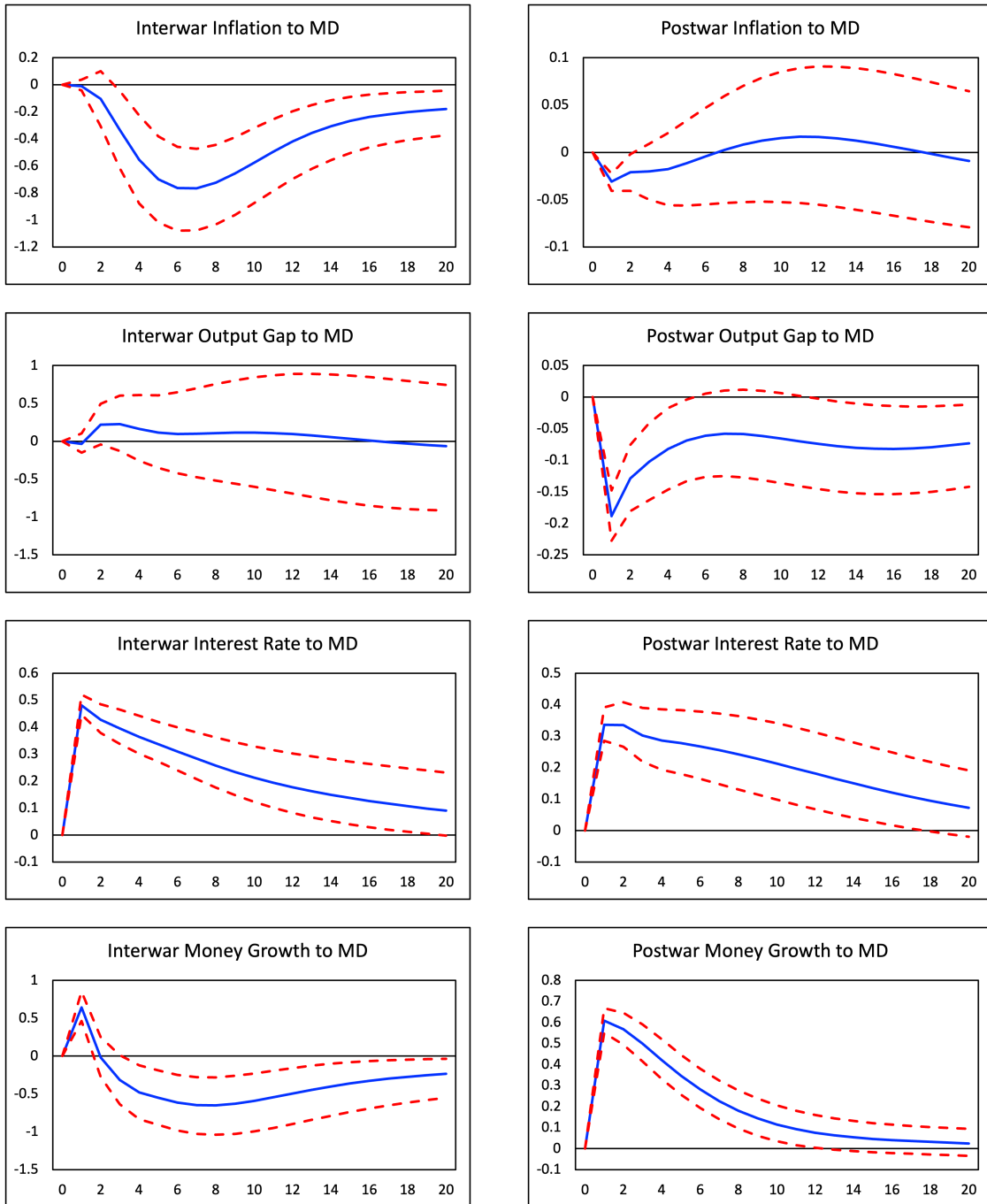


Figure 7. Impulse Responses to Money Demand. Each panel plots the median (solid blue line) and the 16th and 84th percentiles (dashed red lines) of the posterior distribution of the indicated impulse response, computed as the percentage-point change in the indicated variable in response to a one-standard-deviation money demand shock.

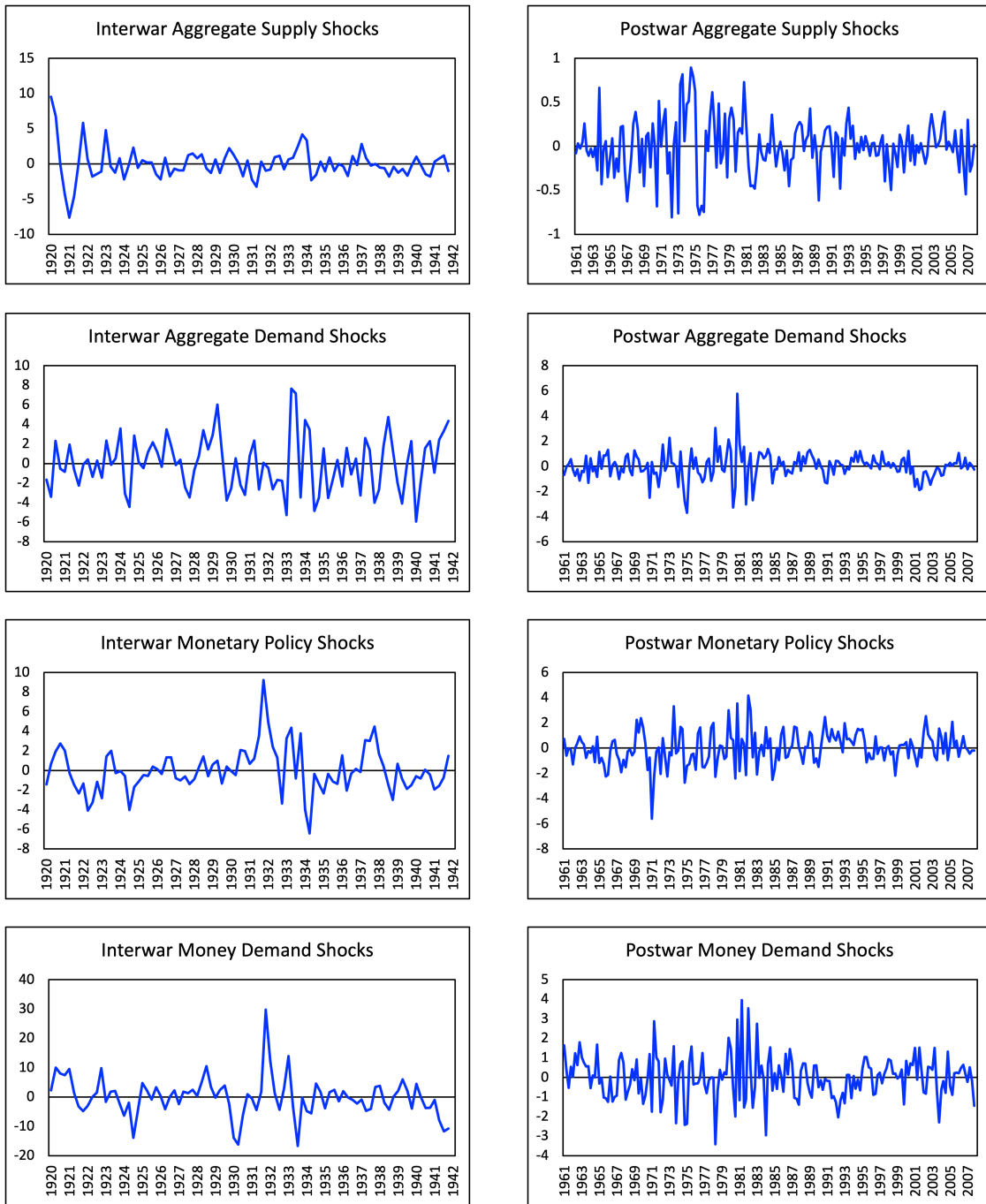


Figure 8. Estimated Shocks. Each panel plots the median of the posterior distribution of the indicated structural disturbance.

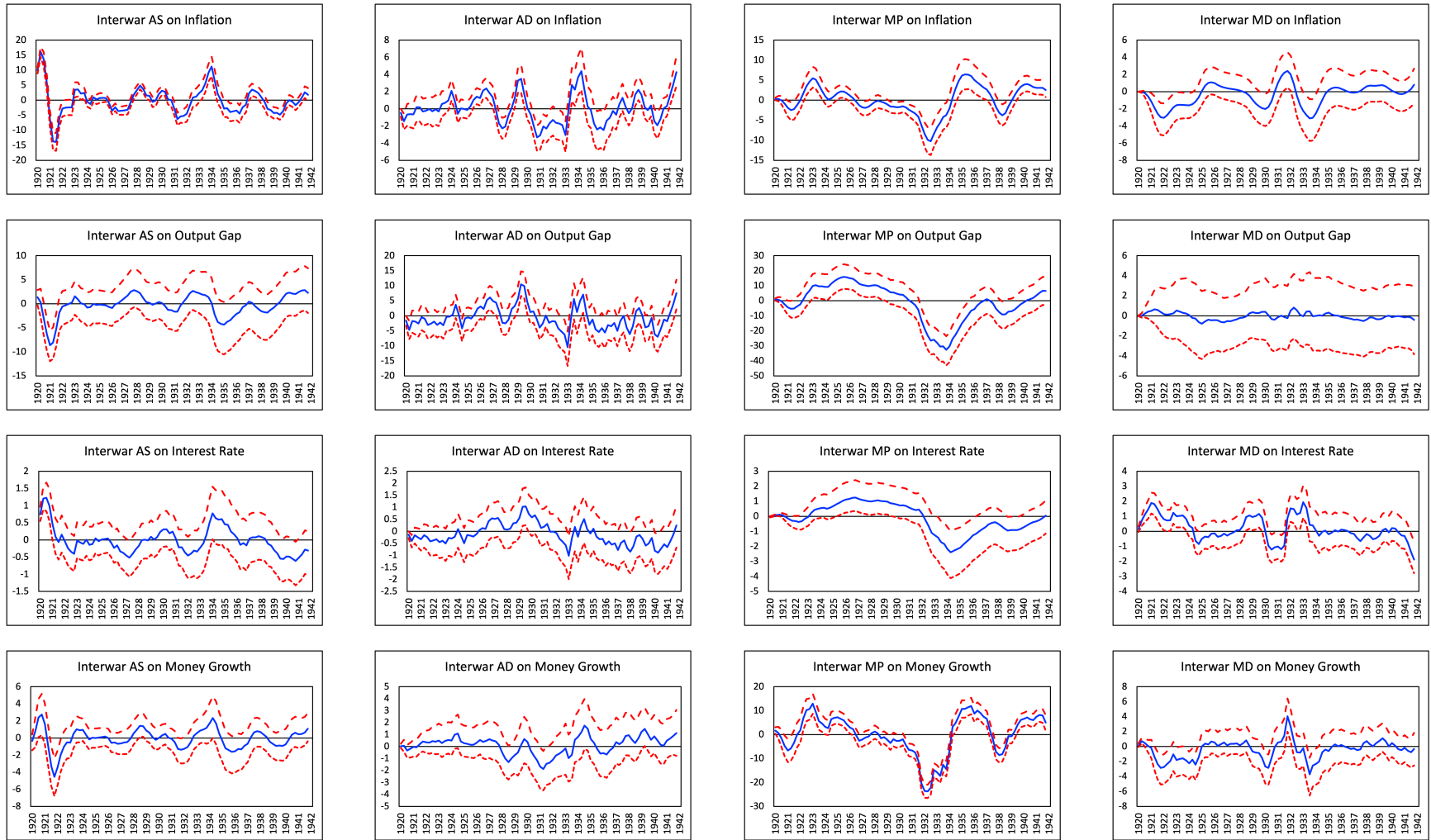


Figure 9. Historical Decomposition of Interwar Business Cycles. Each panel shows the median (solid blue line) and the 16th and 84th percentiles (dashed red lines) of the posterior distribution of the historical contribution of the indicated shock to the indicated variable.

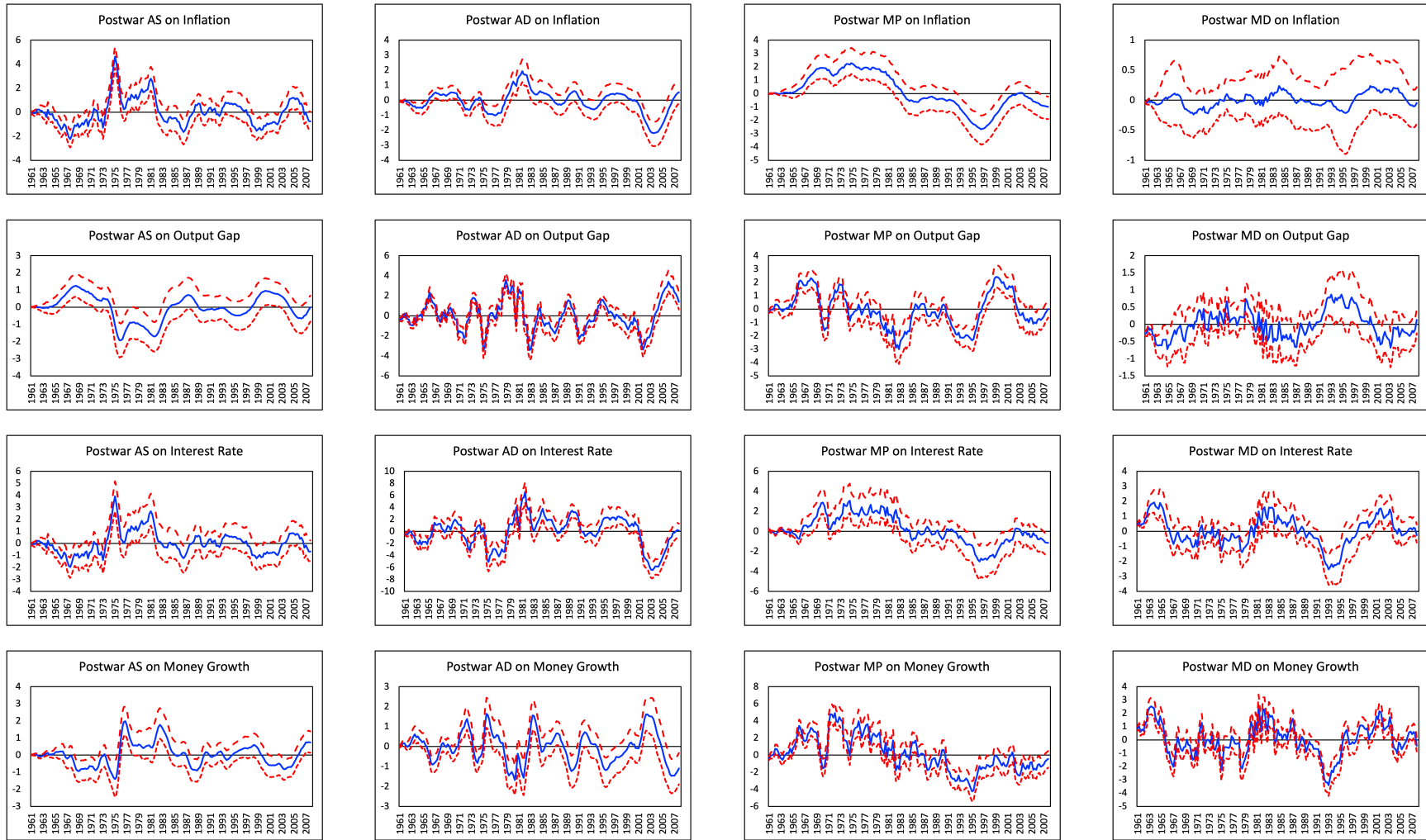


Figure 10. Historical Decomposition of Postwar Business Cycles. Each panel shows the median (solid blue line) and the 16th and 84th percentiles (dashed red lines) of the posterior distribution of the historical contribution of the indicated shock to the indicated variable.

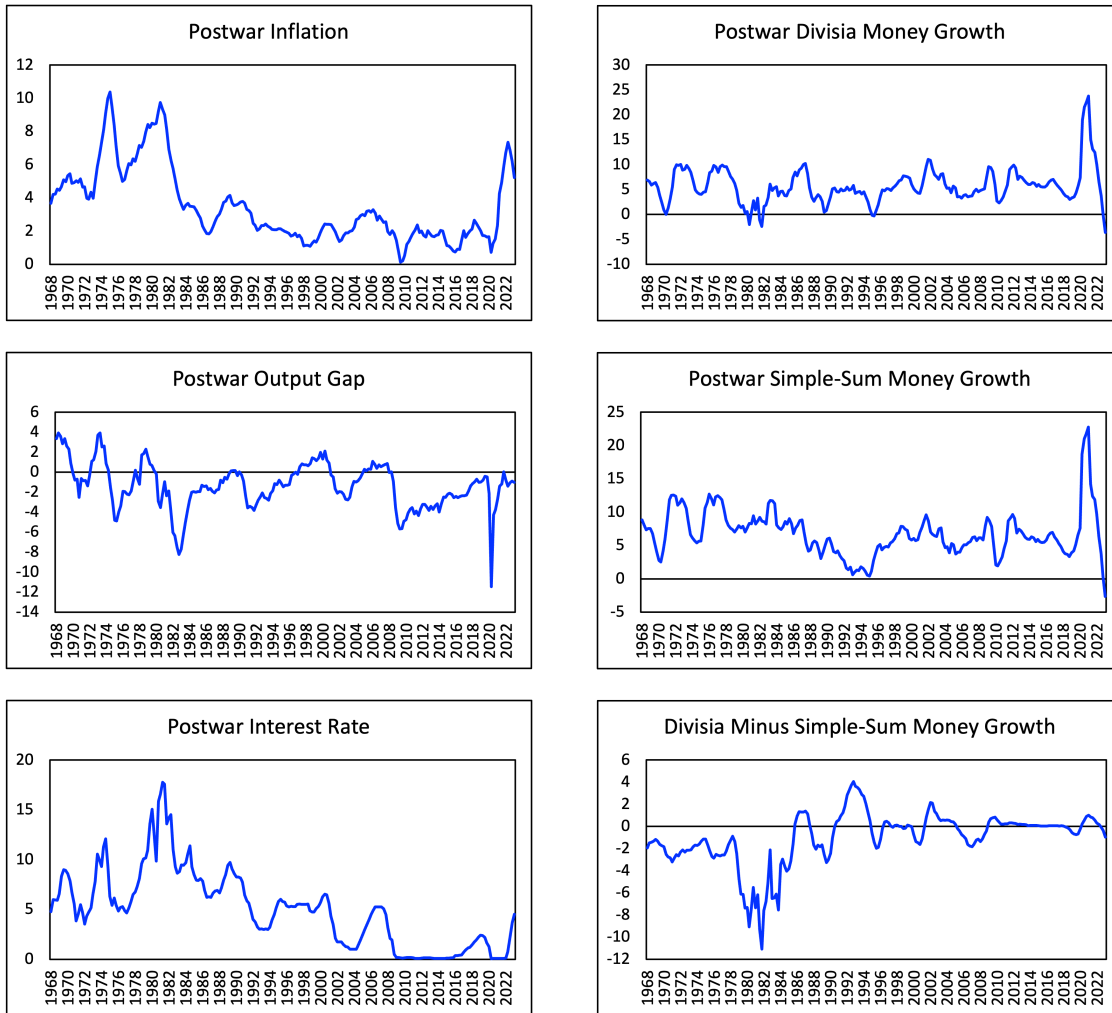


Figure 11. Postwar Data, 1968:1 - 2023:1. Data on inflation, the output gap, the interest rate, and simple-sum M2 growth are from FRED; data on Divisia M2 growth are from the Center for Financial Stability.

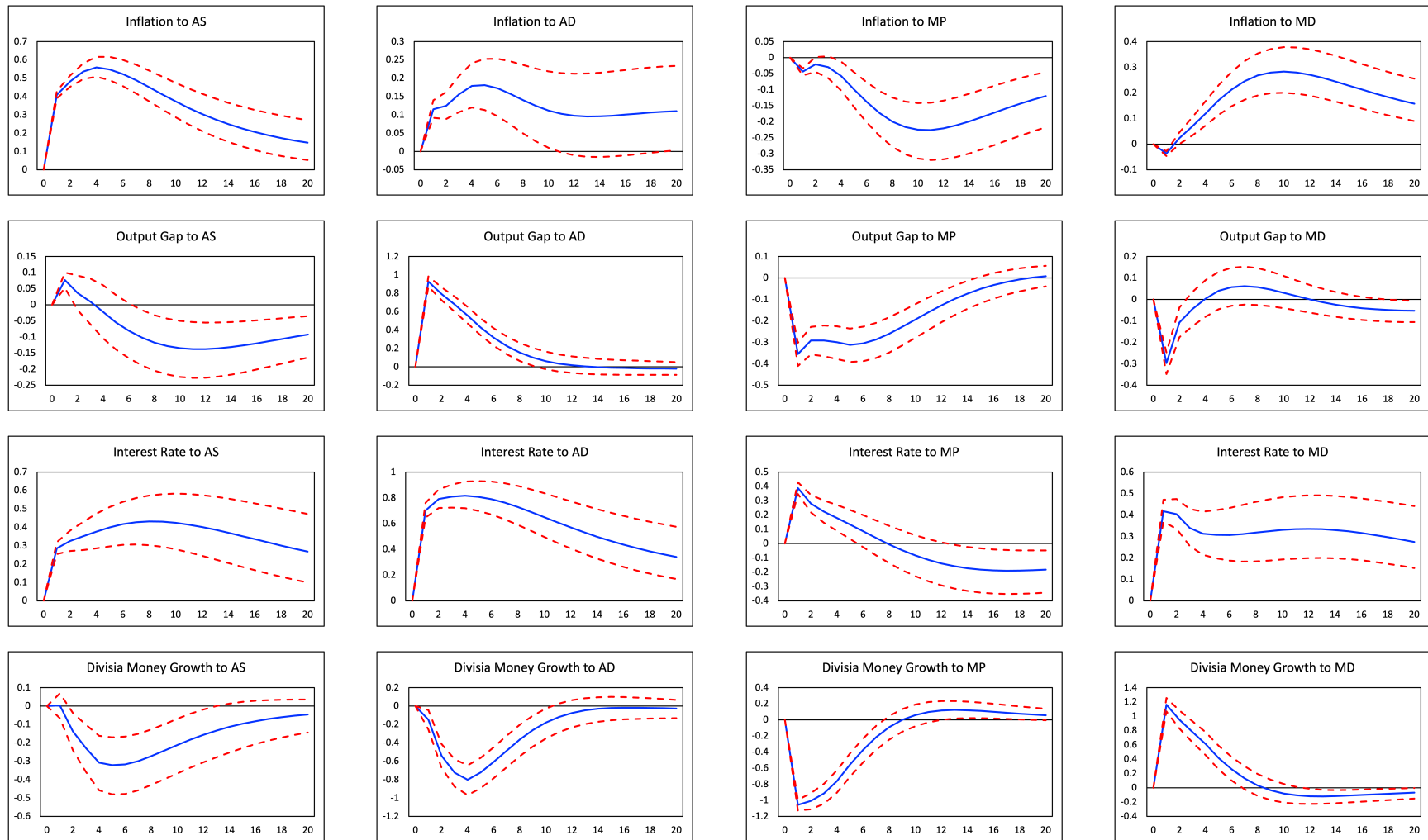


Figure 12. Impulse Responses, 1968:1 - 2023:1. Each panel plots the median (solid blue line) and the 16th and 84th percentiles (dashed red lines) of the posterior distribution of the indicated impulse response.



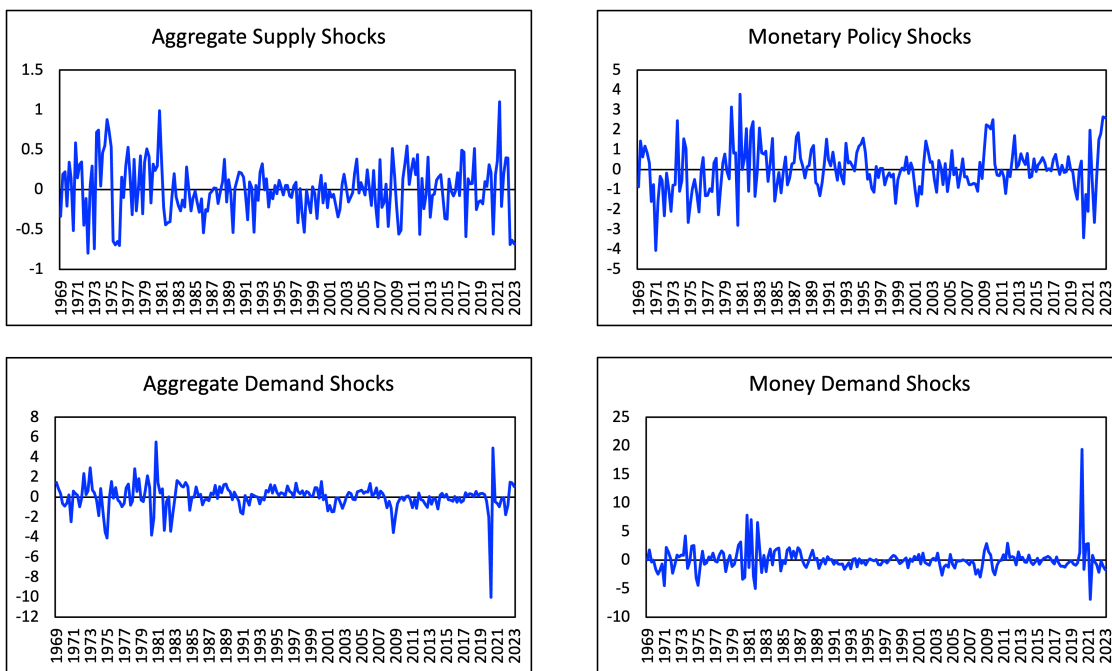


Figure 13. Estimated Shocks, 1968:1 - 2023:1. Each panel plots the median of the posterior distribution of the indicated structural disturbance.

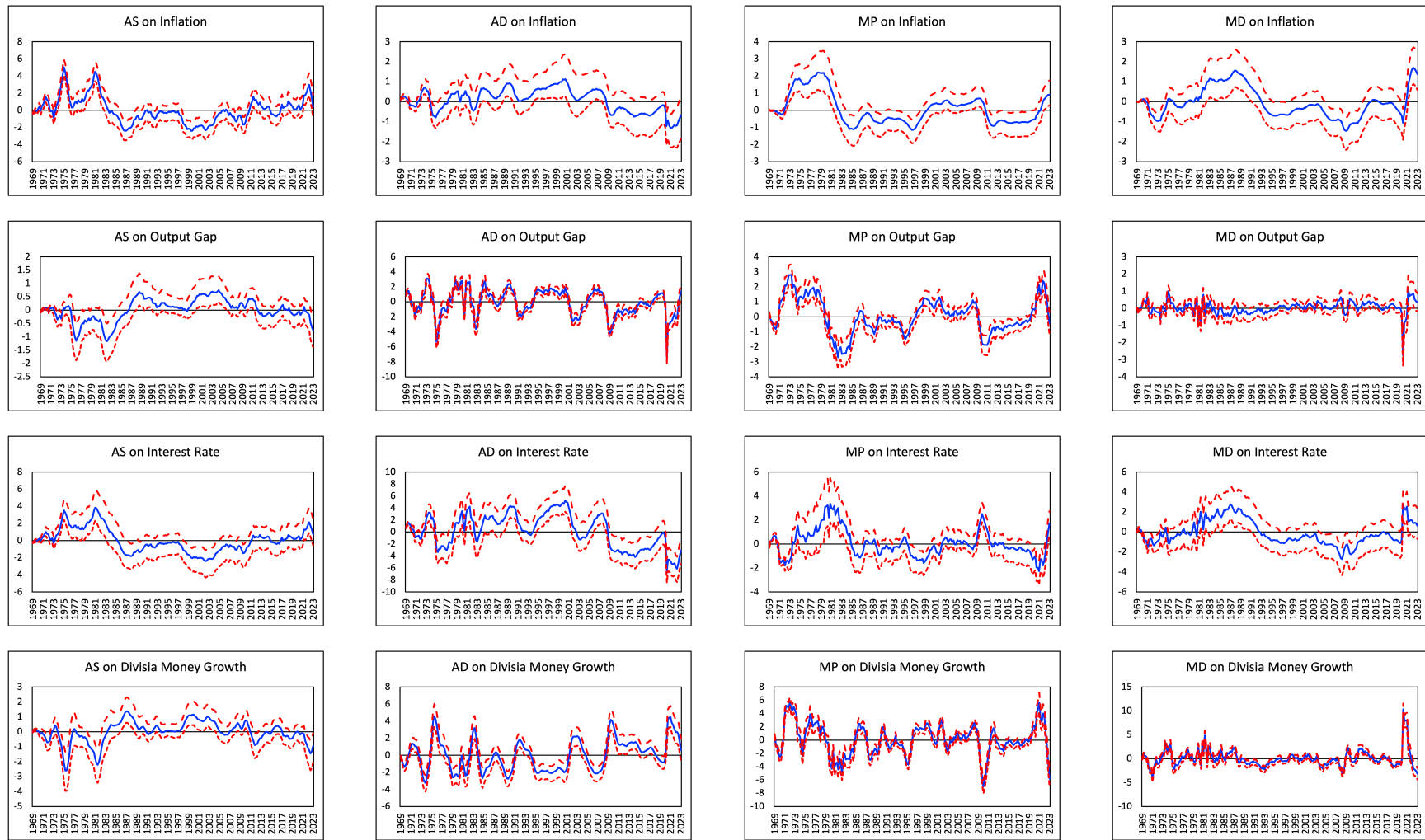


Figure 14. Historical Decomposition of Business Cycles, 1968:1 - 2023:1. Each panel shows the median (solid blue line) and the 16th and 84th percentiles (dashed red lines) of the posterior distribution of the historical contribution of the indicated shock to the indicated variable.