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ARTICLE

The credit-augmented Divisia aggregates and the monetary business cycle†

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Abstract

We follow Belongia and Ireland (2021) and investigate the role that the Center for Financial Stability credit card-augmented Divisia monetary aggregates could play in monetary policy and business cycle analysis. We use Bayesian methods to estimate a structural VAR under priors that reflect Keynesian channels of monetary transmission, but produce posterior distributions for the structural parameters consistent with classical channels. We also find that valuable information is contained in the credit-augmented Divisia monetary aggregates and that they perform even better than the conventional Divisia aggregates, in terms of highlighting the role of the money supply in aggregate demand.

Keywords: Divisia aggregates; New Keynesian model; structural VAR; monetary policy

1. Introduction

The current approach to monetary policy and business cycle analysis is based on the New Keynesian model. It is expressed through the central bank's manipulation of the interest rate on overnight loans between banks, such as the federal funds rate in the United States, and ignores variations in the quantity of money. In this regard, recently Belongia and Ireland (2021, pp. 362) argue that "focusing entirely on interest rates and excluding measures of money, the strict New Keynesian model provides an overly narrow view of channels through which monetary policy affects the economy."

The question then that arises is whether there is a useful role of monetary aggregates in monetary policy and business cycle analysis. In answering this question, as McCallum and Nelson (2011, p. 138) put it, "one should note that the shift toward analyses that ignore or downplay money largely reflects a change in empirical judgments. In the era in which monetary aggregates were used as guides to policy, policymakers expressed the view that—although monetary policy actions did work on spending via interest rates, and the authorities did typically employ a short-term nominal interest rate as their policy instrument—it was a more straightforward matter to establish money/inflation relations than it was to establish connections between policy-rate actions and subsequent inflation movements."

Over the years, a large number of publications have shown that most of the puzzles and paradoxes in monetary economics are resolved by use of aggregation theoretic monetary aggregates, such as Barnett's (1980) Divisia monetary aggregates. See, for example, the journal articles reprinted in Barnett and Serletis (2000), Barnett and Chauvet (2011), Schunk (2001), Serletis (2009), Serletis and Rahman (2013), Serletis and Gogas (2014), Hendrickson (2014), Belongia and

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Ireland (2014, 2015, 2016, 2018), Ellington (2018), and Dery and Serletis (2019), among others. In fact, Belongia and Ireland (2015, p. 268) again "call into question the conventional view that the stance of monetary policy can be described with exclusive reference to its effects on interest rates and without consideration of simultaneous movements in the monetary aggregates." They argue that properly measured monetary aggregates, such as the new Center for Financial Stability (CFS) Divisia monetary aggregates (available since 1967), can and should play an important role (either as intermediate targets or indicator variables) for the conduct of monetary policy, in addition to that of the short-term nominal interest rate.

The original CFS Divisia monetary aggregates do not include the transaction services provided by credit cards. However, as noted by Liu et al. (2020), the volume of credit card transaction services has more than doubled in recent years and over 80% of American households with credit cards are currently borrowing and paying interest on credit cards. Motivated by these developments in the financial services industry, Barnett et al. (2023) and Barnett and Su (2016, 2018, 2019) derive Divisia monetary aggregates that jointly aggregate the services provided by credit cards and the services provided by monetary assets. The new aggregates are known as the credit card-augmented Divisia and credit card-augmented Divisia inside monetary aggregates. Data on these aggregates are also available from the CFS, but these series start in July 2006.

Regarding the (relatively new) credit card-augmented Divisia monetary aggregates, many recent papers have found that they perform well relative to the conventional (original) Divisia monetary aggregates. For example, Barnett et al. (2023), in the context of a multivariate state space model, find that nowcasting with credit card-augmented Divisia aggregates yields substantially smaller mean squared error than with the conventional Divisia aggregates. Liu et al. (2020) find that both the narrow and broad credit card-augmented Divisia aggregates are superior to the conventional Divisia aggregates, and that broad Divisia monetary aggregates provide better measures of the flow of monetary services generated in the economy. In this regard, Liu and Serletis (2020) also find that the volatility of the credit card-augmented (broad) Divisia M4 monetary aggregate has a statistically significant negative impact on output whereas there is no effect of the conventional Divisia M4 growth volatility on output. More recently, Barnett and Park (2023a), by using an autoregressive distributed lag model and Bayesian VAR, find that credit-augmented Divisia monetary aggregates are the better indicators for forecasting inflation and output. Also, Barnett and Park (2023b), in the context of a sign-restricted Bayesian VAR, find that considering credit-related variables and shocks helps to interpret recent economic phenomena, with the credit card-augmented Divisia aggregates being especially informative.

Clearly, despite the well-established literature on the conventional Divisia monetary aggregates, the credit card-augmented Divisia monetary aggregates are mostly unexplored. In this paper, we follow Belongia and Ireland (2021) and, in the context of a five-variable structural VAR for inflation, the output gap, the short-term nominal interest rate, money balances, and the user cost of money, investigate whether there is a role of the CFS credit card-augmented Divisia monetary aggregates in the monetary business cycle. As in Belongia and Ireland (2021), we allow classical channels of monetary transmission to operate alongside the New Keynesian interest rate channel and estimate the model using the Bayesian methods outlined in Baumeister and Hamilton (2015, 2018). We estimate the model under priors that reflect the New Keynesian view of the business cycle but produce posterior distributions for the model's parameters consistent with a classical view of the cycle. We conclude that valuable information is contained in the credit card-augmented Divisia monetary aggregates about monetary policy and its effects on the economy. A comparison with the Belongia and Ireland (2021) results based on the CFS conventional Divisia M2 monetary aggregate favors the credit card-augmented Divisia monetary aggregates used in the present paper.

The remainder of the paper is organized as follows. In section 2 we provide a brief discussion of the Divisia approach to monetary aggregation, from both the demand side and the supply side. Section 3 discusses the Belongia and Ireland (2021) approach based on methods developed by Baumeister and Hamilton (2015, 2018). Section 4 discusses the data and section 5 presents the empirical results. The final section concludes the paper and discusses the implications for monetary theory and policy and business cycle theory.

2. Divisia monetary aggregates

In this section, we review the development of the Divisia monetary aggregates, developed by Barnett (1978, 1980) and Barnett et al. (2023).

2.1. Conventional Divisia aggregates

Barnett (1978) derived the formula for the real user cost of a monetary asset as

$$\pi_{it}^{a} = \frac{R_t - r_{it}^{a}}{1 + R_t} \tag{1}$$

where R_t is the rate of return on the benchmark asset, measuring the maximum expected rate of return available in the economy, and r_{it}^{a} is the own rate of return on monetary asset i during period t. Barnett (1980) argued that the simple sum monetary aggregates provided by the Federal Reserve are inconsistent with economic aggregation theory because they assume that the monetary assets are perfect substitutes with the same user cost. He developed the Divisia monetary aggregates which do not assume perfect substitution between component assets (and hence permit different user costs of the component assets).

The Divisia monetary aggregate (in discrete time) computes the growth rate of the aggregate as the share-weighted average of its monetary asset component growth rates as follows

$$d \log M_t = \sum_{i=1}^{I} s_{it} d \log m_{it}^{a} \tag{2}$$

where m_{it}^{a} denotes the real balances of monetary asset i and

$$s_{it} = \pi_{it}^{a} m_{it}^{a} / \sum_{i=1}^{I} \pi_{it}^{a} m_{it}^{a},$$

is the expenditure share on monetary asset i during period t.

Over the years, most of the modern formal investigations of the impact of money on economic activity are carried out using the Divisia monetary aggregates. See, for example, Belongia (1996), Serletis and Gogas (2014), Hendrickson (2014), and Keating et al. (2019), among others.

2.2. Credit card-augmented Divisia aggregates

The conventional Divisia monetary aggregates exclude credit card transaction services. Barnett et al. (2023), using economic aggregation and index number theory, derived the credit card-augmented Divisia monetary aggregates which also include the transaction services of credit cards. Under the assumption of risk neutrality, Barnett et al. (2023) derive the user cost of credit card transaction services, π_{lt}^{c}, as

$$\pi_{lt}^{c} = \frac{e_{lt} - R_t}{1 + R_t} \tag{3}$$

where e_{lt} is the expected interest on the credit card transaction l and R_t is as before the rate of return on the benchmark asset.

The credit card-augmented Divisia monetary aggregate is then given by

$$d\log M_t = \sum_{i=1}^{I} s_{it} d\log m_{it}^a + \sum_{l=1}^{L} s_{lt} d\log m_{lt}^c \tag{4}$$

where

$$s_{it} = \pi_{it}^a m_{it}^a / (\sum_{i=1}^{I} \pi_{it}^a m_{it}^a + \sum_{l=1}^{L} \pi_{lt}^c m_{lt}^c)$$

is the user-cost-evaluated expenditure share of monetary asset i, $i = 1, \ldots, I$, and

$$s_{lt} = \pi_{lt}^c m_{lt}^c / (\sum_{i=1}^{I} \pi_{it}^a m_{it}^a + \sum_{l=1}^{L} \pi_{lt}^c m_{lt}^c)$$

is the user-cost-evaluated expenditure share of credit card transaction l, $l = 1, \ldots, L$.

2.3. Credit card-augmented Divisia inside aggregates

The conventional Divisia aggregates and the credit card-augmented Divisia monetary aggregates emphasize the demand side of liquidity services. However, conditions from the supply side of liquidity services are at least equally important. In this regard, the monetary services produced by financial firms are known as inside money and are highly relevant to the transmission mechanism of monetary policy. In fact, quantitative easing during the global financial crisis and the coronavirus pandemic, with the goal of affecting the supply of liquid assets, impacted inside money directly.

To account for the monetary services produced by deposit-based financial firms, Barnett (1987) introduces Divisia supply monetary aggregates which are based upon supply-side aggregation theory, in the context of a conventional neoclassical model of financial intermediary monetary assets supply. These aggregates highlight the existence of noninterest-bearing required reserves for banks. This is important, because a regulatory wedge is created for the user of the monetary services produced by banks. Thus, the user cost of a monetary asset needs to subtract the implicit tax as follows

$$\pi_{it}^a = \frac{(1 - k_i)R_t - r_{it}}{1 + R_t} \tag{5}$$

where k_i is the required reserve ratio on monetary asset i.

Barnett and Su (2018) construct the credit card-augmented Divisia inside monetary aggregates as in equation (4) with quantities demanded, m_{it}^a, replaced by quantities supplied and with paid user costs, π_{it}^a, replaced by received user costs calculated as in equation (5).

In what follows, we posit our empirical work on the most recently developed credit card-augmented Divisia monetary aggregates and credit card-augmented Divisia inside monetary aggregates.

3. The structural VAR

We consider a five-variable structural VAR model, consistent with the Belongia and Ireland (2021) expanded New Keynesian model, in the inflation rate, π_t, the output gap, $\tilde{y}_t$, the short-term nominal interest rate, i_t, the nominal money growth rate, μ_t, and the user cost of money, uc_t, as follows

$$\boldsymbol{A} z_t = \boldsymbol{C} + \sum_{i=1}^{k} \boldsymbol{\Gamma}_i z_{t-i} + \boldsymbol{\epsilon}_t \tag{6}$$

where

$$z_t = \begin{bmatrix} \pi_t \\ \tilde{y}_t \\ i_t \\ \mu_t \\ uc_t \end{bmatrix}; \quad \boldsymbol{A} = \begin{bmatrix} 1 & a_{12} & 0 & 0 & 0 \\ a_{21} - a_{23} & 1 & a_{23} & -a_{21} & 0 \\ a_{31} & a_{32} & 1 & a_{34} & 0 \\ -1 & a_{42} & 0 & 1 & a_{45} \\ a_{51} & 0 & a_{53} & -a_{51} & 1 \end{bmatrix}; \quad \boldsymbol{\epsilon}_t = \begin{bmatrix} \epsilon_{\pi,t} \\ \epsilon_{\tilde{y},t} \\ \epsilon_{i,t} \\ \epsilon_{\mu,t} \\ \epsilon_{uc,t} \end{bmatrix};$$

$$\boldsymbol{C} = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \end{bmatrix}; \quad \boldsymbol{\Gamma}_i = \begin{bmatrix} \gamma_{i,11} & \gamma_{i,12} & \gamma_{i,13} & \gamma_{i,14} & \gamma_{i,15} \\ \gamma_{i,21} & \gamma_{i,22} & \gamma_{i,23} & \gamma_{i,24} & \gamma_{i,25} \\ \gamma_{i,31} & \gamma_{i,32} & \gamma_{i,33} & \gamma_{i,34} & \gamma_{i,35} \\ \gamma_{i,41} & \gamma_{i,42} & \gamma_{i,43} & \gamma_{i,44} & \gamma_{i,45} \\ \gamma_{i,51} & \gamma_{i,52} & \gamma_{i,53} & \gamma_{i,54} & \gamma_{i,55} \end{bmatrix}.$$

The structural errors, $\boldsymbol{\epsilon}_t$, are assumed to follow the normal distribution with zero mean and the identity matrix for their variance. The $\boldsymbol{A}$ matrix identifies the model with seven zero restrictions and three equality restrictions. Based on Belongia and Ireland (2021), the parameterized $\boldsymbol{A}$ matrix is consistent with New Keynesian theory, which is augmented by incorporating money and the cost of holding monetary balances.

We have the following structural interpretation for each equation in (6). The inflation rate equation

$$\pi_t = -a_{12}\tilde{y}_t + c_1 + \sum_{i=1}^{k}\sum_{j=1}^{5} \gamma_{i,1j} z_{t-i,j} + \epsilon_{\pi,t} \tag{7}$$

mimics the New Keynesian Phillips curve. It shows a contemporaneous relationship between the inflation rate, π_t, and the output gap, $\tilde{y}_t$. The structural error term, $\epsilon_{\pi,t}$, is referred to as the aggregate supply shock.

The second equation in the VAR system is

$$\tilde{y}_t = -a_{23}(i_t - \pi_t) + a_{21}(\mu_t - \pi_t) + c_2 + \sum_{i=1}^{k}\sum_{j=1}^{5} \gamma_{i,2j} z_{t-i,j} + \epsilon_{\tilde{y},t} \tag{8}$$

is basically the New Keynesian IS curve. It shows how the real (short-term) interest rate, $i_t - \pi_t$, affects the output gap, $\tilde{y}_t$. In general, an increase in the real interest rate will reduce the output gap. In particular, Belongia and Ireland (2021) augment the IS curve by allowing the growth rate of real money balances, $\mu_t - \pi_t$, to impact real economic activity. This mechanism represents the classical view about the role of money in the economy. $\epsilon_{\tilde{y},t}$ in equation (8) is referred to as the output shock.

The third equation gives the monetary policy rule

$$i_t = -a_{31}\pi_t - a_{32}\tilde{y}_t - a_{34}\mu_t + c_3 + \sum_{i=1}^{k}\sum_{j=1}^{5} \gamma_{i,3j} z_{t-i,j} + \epsilon_{i,t}. \tag{9}$$

The monetary policy rule assumes that the central bank adjusts the interest rate by tracking inflation and output gap changes. $\epsilon_{i,t}$ is the monetary policy shock. It is to be noted that this policy rule also includes the growth rate of nominal money balances, μ_t. It indicates that a monetary policy shock can be considered a combined result of changes in the interest rate and the money stock. For example, an expansionary monetary shock may reflect a combination of a lower interest rate and higher nominal money growth.

The fourth equation is the money demand equation, which shows that the growth rate of real money balances is determined by the output gap (the scale variable) and the user cost of money (an opportunity cost variable), as follows

$$\mu_t - \pi_t = -a_{42}\tilde{y}_t - a_{45}uc_t + c_4 + \sum_{i=1}^{k}\sum_{j=1}^{5}\gamma_{i,4j}z_{t-i,j} + \epsilon_{(\mu-\pi),t} \tag{10}$$

where $\epsilon_{(\mu-\pi),t}$ is the money demand shock.

The fifth equation characterizes the opportunity cost of holding money balances which is the user cost, uc_t, as follows

$$uc_t = -a_{53}i_t + a_{51}(\mu_t - \pi_t) + c_5 + \sum_{i=1}^{k}\sum_{j=1}^{5}\gamma_{i,5j}z_{t-i,j} + \epsilon_{uc,t}. \tag{11}$$

According to Belongia and Ireland (2014, 2021), an increase in the interest rate raises the cost of holding reserves from the viewpoint of commercial banks. The banks then pass the cost to consumers by lowering the return on deposits and other monetary assets, which directly increases the user cost. Moreover, the increase in the interest rate also signals a higher return on non-monetary assets in the financial market. Therefore, the opportunity cost of holding monetary assets should increase, also leading to a higher user cost. The second term in equation (11) tells that the additional creation of real money balances may impact its user cost. Belongia and Ireland (2021) refer to $\epsilon_{uc,t}$ as the monetary system shock.

The reduced form of model (6) is

$$z_t = \widetilde{\boldsymbol{C}} + \sum_{i=1}^{k}\widetilde{\boldsymbol{\Gamma}}_{t-i}z_{t-i} + \widetilde{\boldsymbol{\epsilon}}_t \tag{12}$$

where

$$\begin{aligned}\widetilde{\boldsymbol{C}} &= \boldsymbol{A}^{-1}\boldsymbol{C}\\ \widetilde{\Gamma}_{t-i} &= \boldsymbol{A}^{-1}\Gamma_{t-i}\\ \widetilde{\boldsymbol{\epsilon}}_t &= \boldsymbol{A}^{-1}\boldsymbol{\epsilon}_t\end{aligned}$$

with the reduced from errors, $\widetilde{\boldsymbol{\epsilon}}_t$, following the normal distribution, $\widetilde{\boldsymbol{\epsilon}}_t \sim N(\mathbf{0}, \boldsymbol{\Omega})$, where $\boldsymbol{\Omega} = \boldsymbol{A}^{-1}\mathbf{I}\left(\boldsymbol{A}^{-1}\right)'$.

4. The data

We use quarterly data for the United States over the period from 2006:q3 to 2023:q2.[1] For the real output series, y_t, we use the real GDP series GDPC1 from the Federal Reserve Economic Database (FRED) maintained by the Federal Reserve Bank of St. Louis. We use the Congressional Budget Office's estimate for potential real GDP, $\bar{y}_t$, which is also retrieved from FRED. We then calculate the output gap, $\tilde{y}_t$, as the difference between observed real GDP and potential real GDP expressed as a percentage of potential real GDP, $\tilde{y}_t = (y_t - \bar{y}_t)/\bar{y}_t$.

The inflation rate, π_t, is the year-over-year percentage change in the personal consumption expenditures price index, retrieved from FRED (series CPIAUCSL). The nominal interest rate, i_t,

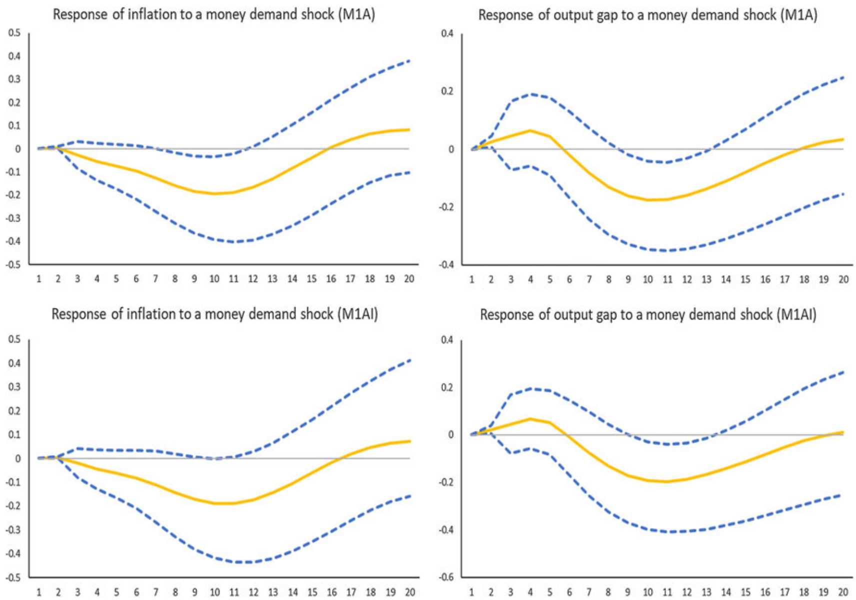

Figure 1. Impulse response functions to a money demand shock based on M1A and M1AI.

is the effective federal funds rate from FRED. However, we use the Wu and Xia (2016) shadow federal funds rate for the time period from 2009:q1 to 2015:q4, since the federal funds rate hit the zero lower bound during this period.

Belongia and Ireland (2021) take advantage of the Divisia aggregates and their theoretically coherent measures of the user cost and use the Divisia M2 monetary aggregate. In this paper, we focus on the new credit card-augmented Divisia and credit card-augmented Divisia inside monetary aggregates. In particular, we consider eight credit card-augmented Divisia monetary aggregates. They are the credit card-augmented Divisia M1 monetary aggregate (M1A), the credit card-augmented Divisia M2 monetary aggregate (M2A), the credit card-augmented Divisia M3 monetary aggregate (M3A), the credit card-augmented Divisia M4 monetary aggregate (M4A), the credit card-augmented Divisia M1 inside monetary aggregate (M1AI), the credit card-augmented Divisia M2 inside monetary aggregate (M2AI), the credit card-augmented Divisia M3 inside monetary aggregate (M3AI), and the credit card-augmented Divisia M4 inside monetary aggregate (M4AIM).[2]

For a graphical presentation and brief discussion of the monthly growth rates of the conventional Divisia aggregates, the credit card-augmented Divisia monetary aggregates, and the credit card-augmented Divisia inside monetary aggregates, see Figure 1 in Andreadis et al. (2023).

5. Empirical evidence

We follow Belongia and Ireland (2021) and perform Bayesian estimation. In particular, we calibrate Bayesian prior distributions for the structural parameters of the model that reflect the New Keynesian view of the cycle, combine them with information contained in the data, and through the likelihood function characterize the posterior distributions of the same parameters. Next, we examine whether the posterior distributions of the structural parameters support specifications that allow classical channels of monetary transmission. That is, whether changes in the growth rate of nominal money balances signal more clearly than changes in the nominal interest rate

Table 1. Bayesian priors

Parameter	16%	median	84%	t-distribution (degrees of freedom and scale)	Meaning
a_{12}	0.10	0.50	0.90	(2, 0.3)	Effect of output gap on inflation
a_{21}	−0.40	0.00	0.40	(2, 0.3)	Effect of real money growth on output gap
a_{23}	0.60	1.00	1.40	(2, 0.3)	Effect of real interest rate on output gap
a_{31}	−0.02	0.38	0.77	(2, 0.3)	Fed's response to inflation
a_{32}	−0.27	0.13	0.52	(2, 0.3)	Fed's response to output gap
a_{34}	−0.40	0.00	0.40	(2, 0.3)	Fed's response to money supply
a_{42}	−12.96	0.25	13.46	(2, 0.3)	Effect of output gap on real money growth
a_{45}	−12.34	0.88	14.09	(2, 0.3)	Effect of user cost on real money growth
a_{51}	−10.21	3.00	16.21	(2, 0.3)	Effect of interest rate on user cost
a_{53}	−13.21	0.00	13.21	(2, 0.3)	Effect of real money growth on user cost

Table 2. Estimates of the a_{21} and a_{34} parameters

	Parameter					
	a_{21}			a_{34}		
Divisia monetary aggregate	16%	median	84%	16%	median	84%
Divisia M1A	0.25	0.53	0.94	0.15	0.21	0.30
Divisia M2A	0.30	0.62	1.11	0.20	0.28	0.40
Divisia M3A	0.16	0.45	0.99	0.13	0.20	0.28
Divisia M4A	0.12	0.29	0.56	0.10	0.14	0.20
Divisia M1AI	0.22	0.46	0.88	0.12	0.18	0.26
Divisia M2AI	0.30	0.61	1.11	0.19	0.27	0.38
Divisia M3AI	0.16	0.45	1.04	0.12	0.18	0.26
Divisia M4AIM	0.10	0.35	0.79	0.10	0.16	0.23
Belongia and Ireland's (2021) estimates with Divisia M2	0.24	0.40	0.59	0.97	1.23	1.57
Our estimates with Divisia M2 over 2006:q3 to 2023:q2	0.15	0.37	0.72	0.20	0.27	0.37

Notes: Sample period, quarterly data, 2006:q3 to 2023:q2.
The posterior distribution for the parameters is reported with the median, 16th percentile, and 84th percentile.

whether monetary policy is contractionary or expansionary and whether changes in real money balances, together with changes in the real interest rate, affect real output.

The restrictions and other prior information of the model are presented in Table 1. For example, the a_{21} coefficient in the augmented version of the New Keynesian aggregate demand curve (8), which captures the impact of nominal money growth, μ_t, on the output gap (via changes in the growth rate of real money balances, $\mu_t - \pi_t$), is assigned a zero prior mean to be consistent with the New Keynesian interest rate channel of monetary policy transmission that links the output gap only to policy-induced changes in the real short-term interest rate. Similarly, the coefficient a_{34} in equation (9), which captures the effect of changes in nominal money growth on the short-term nominal interest rate, is assigned a zero prior mean to be consistent with the New Keynesian view that changes in nominal money play no role in formulation of monetary policy. We follow Belongia and Ireland (2021) in assigning Bayesian priors for all the other parameters not shown in Table 1—see Belongia and Ireland (2021) for more details.

In Table 2, we summarize posterior estimates (medians together with 16th and 84th percentiles) for the two coefficients that characterize the potential role of money in the economy—a_{21} in the

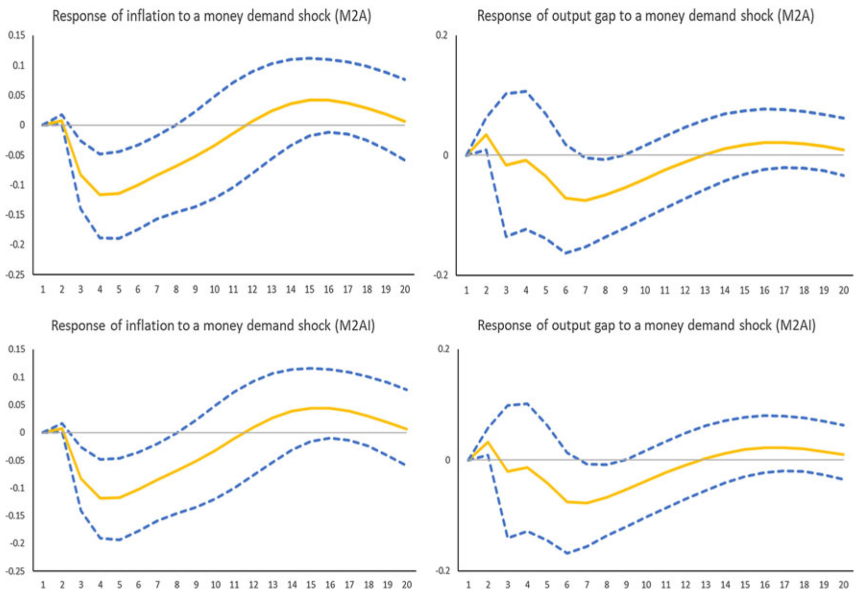

Figure 2. Impulse response functions to a money demand shock based on M2A and M2AI.

augmented New Keynesian aggregate demand equation (8) and a_{34} in the monetary policy rule (9). For comparison purposes, we also include the Belongia and Ireland (2021) estimates with the original Divisia M2 monetary aggregate over their sample period, from 1967:q1 to 2017:q4, as well as our estimates with the original Divisia M2 monetary aggregate over our sample period, from 2006:q3 to 2023:q2. Consistent with the evidence in Belongia and Ireland (2021), our estimates suggest that the data prefer a more classical version of both the augmented New Keynesian aggregate demand equation (8) and the monetary policy rule (9).

Moreover, the posterior median for the coefficient on real money balances in the augmented New Keynesian aggregate demand equation (8) is much higher than the one reported by Belongia and Ireland (2021). In particular, it is 0.62 with the credit card-augmented Divisia M2 (Divisia M2A) aggregate and 0.61 with the credit card-augmented Divisia M2 inside (Divisia M2AI) monetary aggregate. On the other hand, the posterior median for the a_{34} coefficient in the monetary policy rule (9) is much smaller than the estimate in Belongia and Ireland (2021) although similar to our estimate when the model is estimated with Divisia M2 over the 2006:q3 to 2023:q2 sample period. It is 0.28 with Divisia M2A and 0.27 with Divisia M2AI compared to 1.23 in Belongia and Ireland (2021), suggesting a weaker (but nontrivial) policy-rate response to changes in the growth rate of the credit-augmented Divisia monetary aggregates. Overall, our estimates suggest that the credit-augmented Divisia aggregates play an even more important role in shaping the monetary business cycle than the original Divisia aggregates. This result can be linked to the incorporation of credit payments. Credit card transaction services have been an important part of the general economic activity and include additional information when measuring monetary services. Our results highlight how such information enhances the understanding of money's role in the business cycle.

To access the dynamic role of the credit-augmented Divisia aggregates in the monetary business cycle, we report selected impulse response functions in Figures 1–4.[3] They show the responses of inflation and the output gap to a one-standard deviation money demand shock. As can be seen, a positive money demand shock is likely to decrease inflation after about eight quarters with the narrow Divisia M1A and Divisia M1AI monetary aggregates and much earlier (about

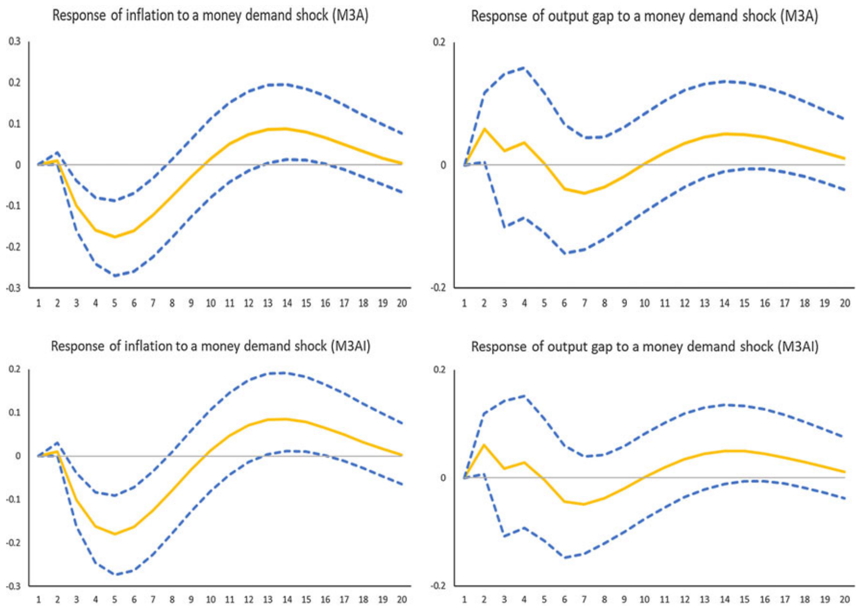

Figure 3. Impulse response functions to a money demand shock based on M3A and M3AI.

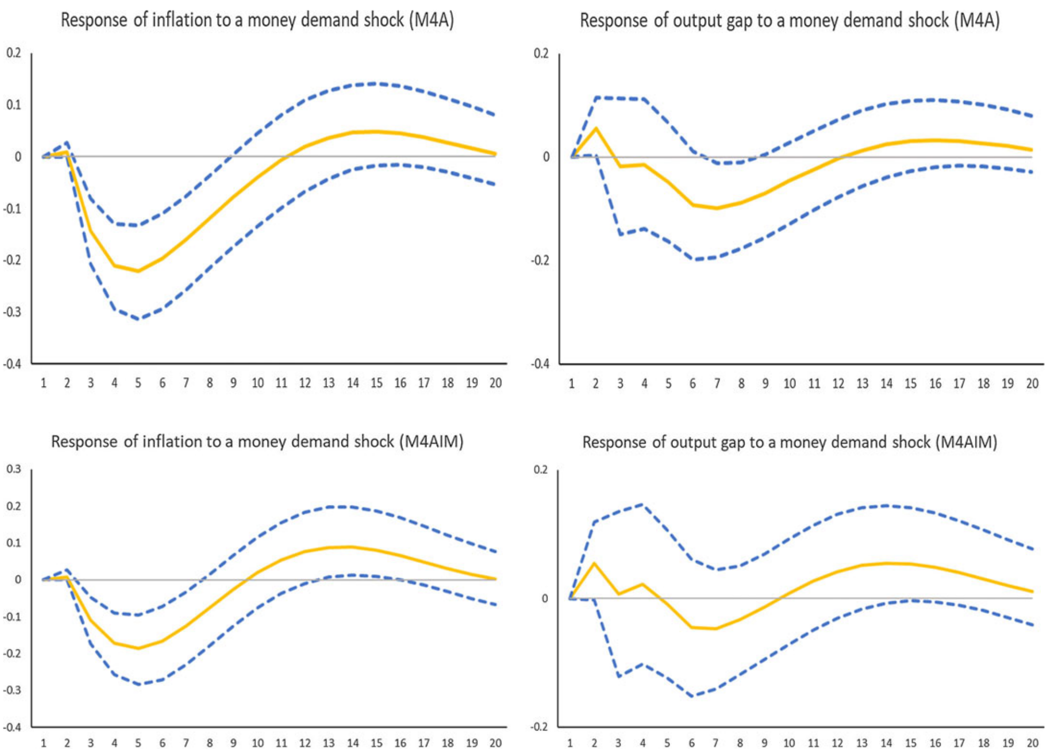

Figure 4. Impulse response functions to a money demand shock based on M4A and M4AI.

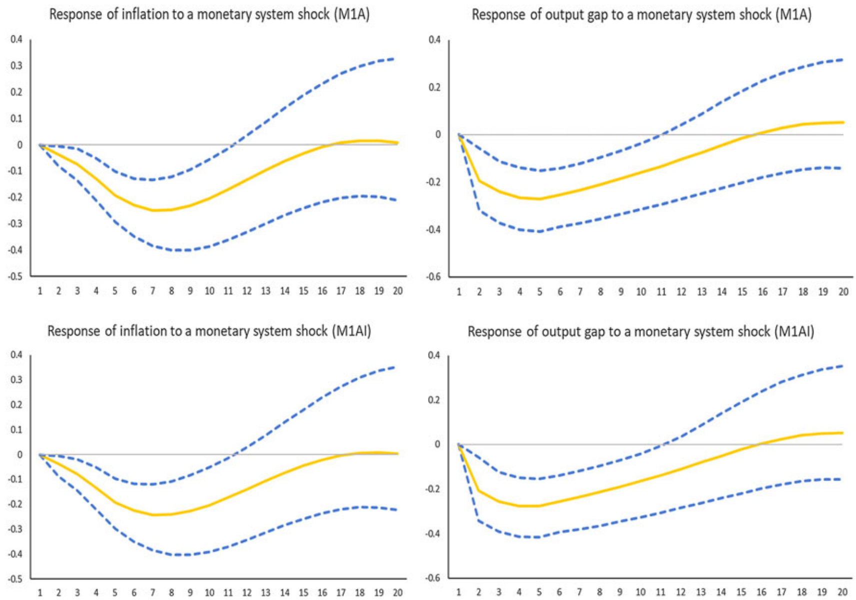

Figure 5. Impulse response functions to a monetary system shock based on M1A and M1AI.

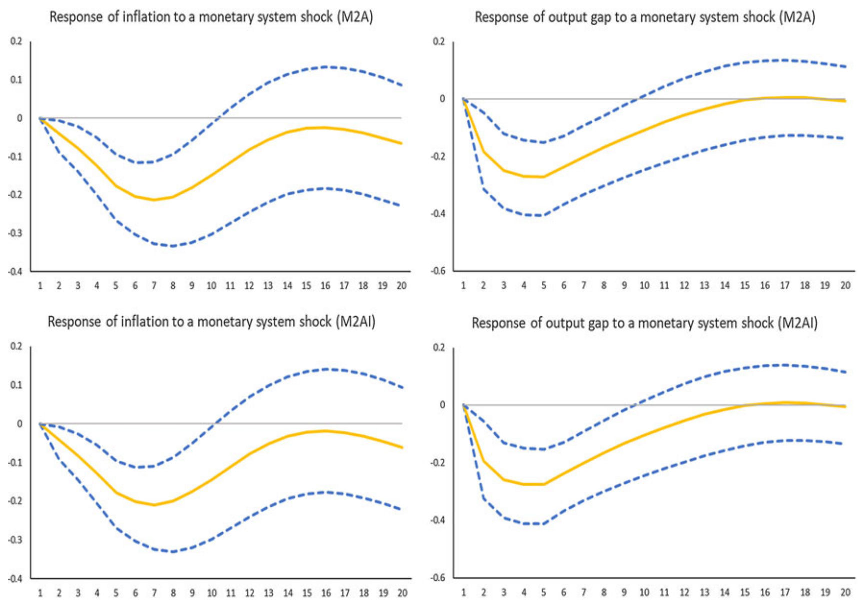

Figure 6. Impulse response functions to a monetary system shock based on M2A and M2AI.

two quarters) with the broader monetary aggregates. The effect, however, on the output gap is generally statistically insignificant.

Figures 5–8 plot the responses of inflation and the output gap to a one-standard deviation monetary system shock. The monetary system shock captures the impacts of the creation of monetary assets on the supply side. It is interesting to see that an unexpected increase in user costs will cause a decline in inflation and the output gap. This effect is likely to appear after two quarters, and all

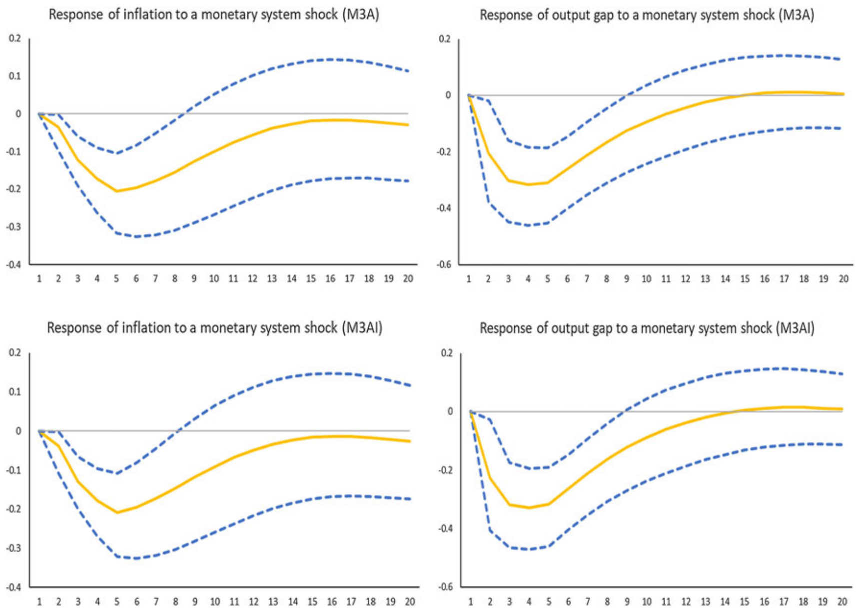

Figure 7. Impulse response functions to a monetary system shock based on M3A and M3AI.

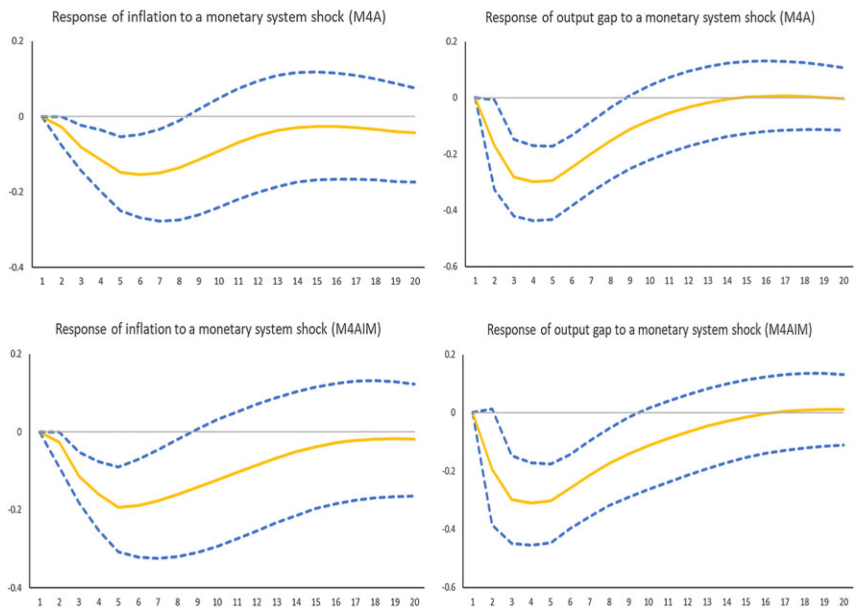

Figure 8. Impulse response functions to a monetary system shock based on M4A and M4AI.

Figures 5–8 show the same pattern. The intuition is that an increase in the user cost is associated with a higher interest rate which slows down economic activity, reducing inflation and output.

Finally, we report the variance decompositions in Figures 9–16. As can be seen (in Figures 9–12), money demand shocks explain less than 10% of inflation and output gap variations in the long run. On the other hand, monetary system shocks (see Figures 13–16) explain around 10% of

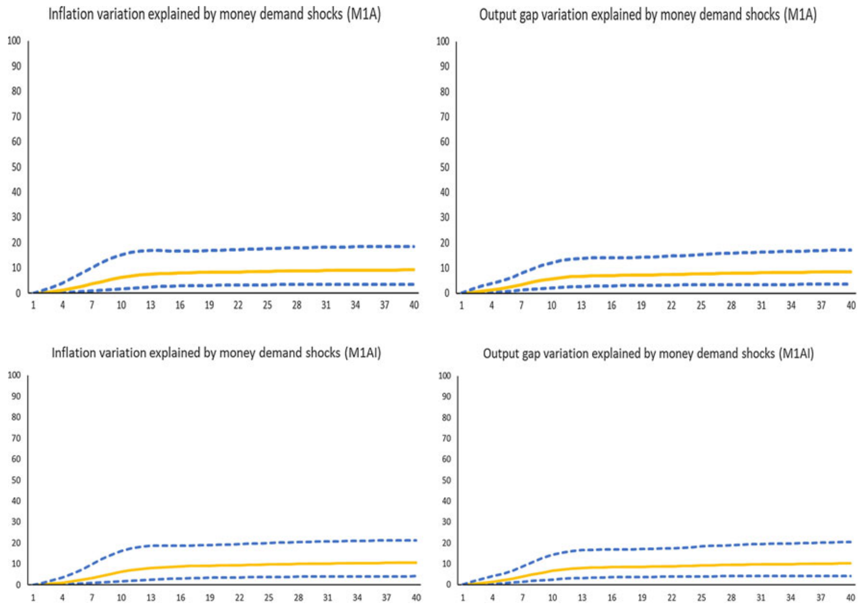

Figure 9. Variance decomposition for money demand shocks based on M1A and M1AI.

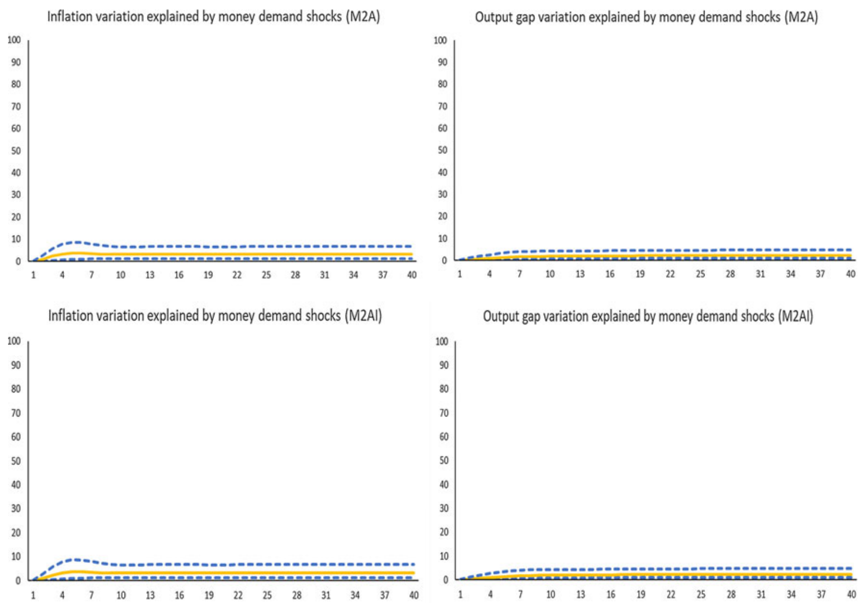

Figure 10. Variance decomposition for money demand shocks based on M2A and M2AI.

inflation variation and play an even larger role in explaining output fluctuations. As in Belongia and Ireland (2021), these results point to additional classical channels of monetary transmission, captured by movements in the credit-augmented Divisia aggregates above and beyond movements in the real interest rate.

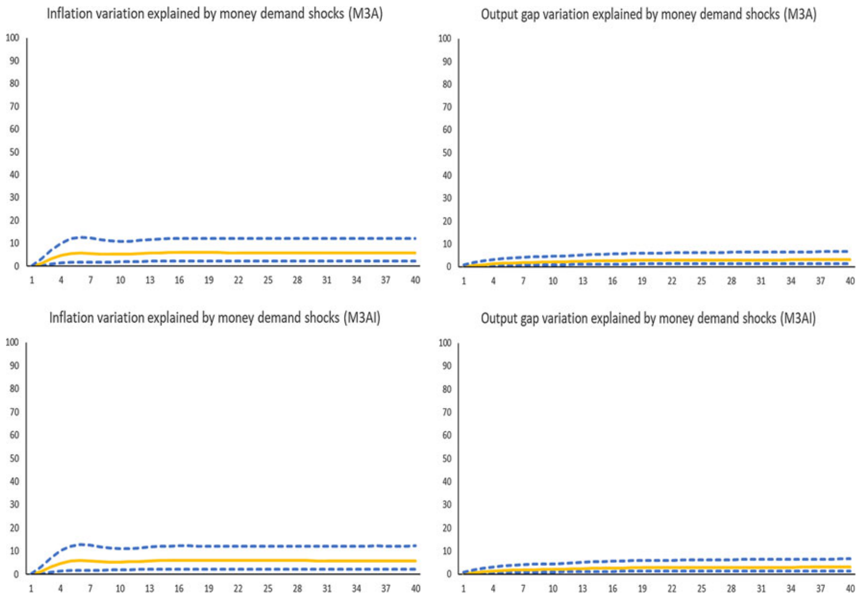

Figure 11. Variance decomposition for money demand shocks based on M3A and M3AI.

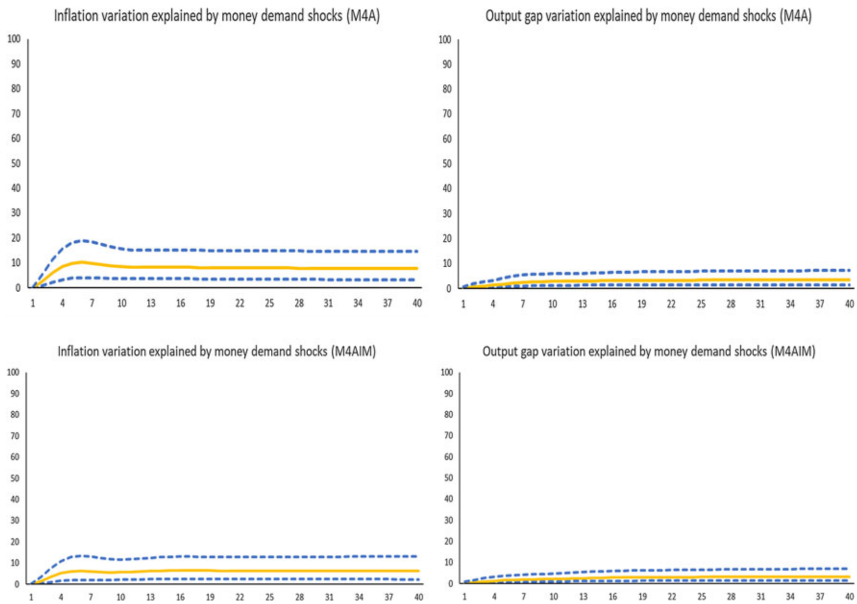

Figure 12. Variance decomposition for money demand shocks based on M4A and M4AIM.

In the Appendix, we report the responses of inflation and the output gap to a positive monetary shock as well as the full set of variance decompositions based on all the credit-augmented Divisia monetary aggregates. As can be seen in Appendix Figures A1–A4, the responses of inflation and the output gap to a positive monetary shock are all consistent with economic theory. In particular, a contractionary monetary policy (an increase in the federal fund rate) reduces inflation and limits economic activities, and there are no output and price puzzles. Appendix Figures A5–A44 show

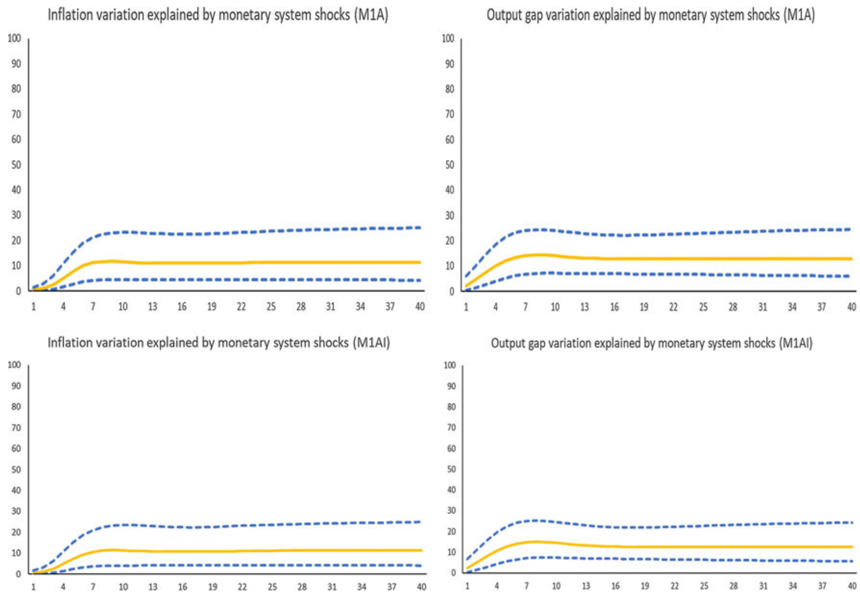

Figure 13. Variance decomposition for monetary system shocks based on M1A and M1AI.

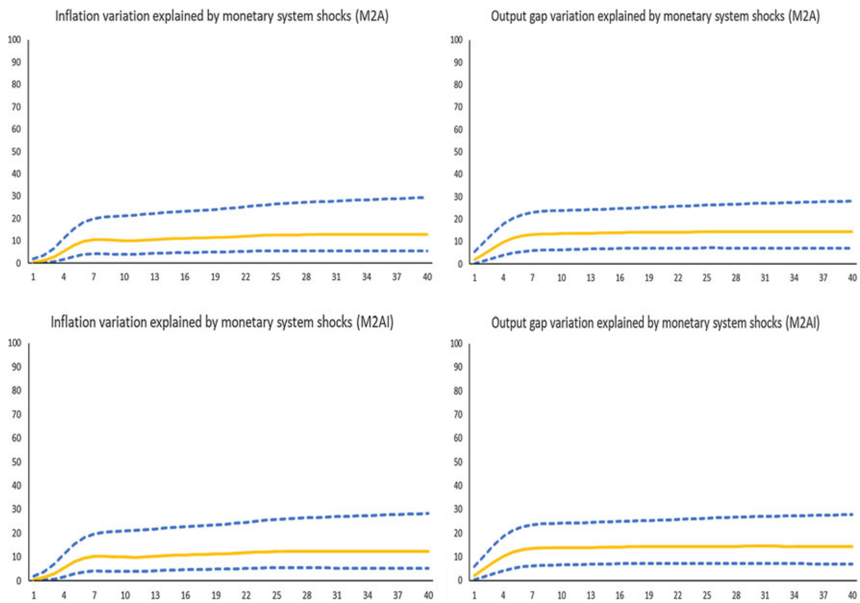

Figure 14. Variance decomposition for monetary system shocks based on M2A and M2AI.

the full set of variance decompositions with all the credit-augmented Divisia aggregates. There is robust evidence (see Appendix Figures A5, A10, A15, A20, A25, A30, A35, and A40) suggesting that the aggregate supply shock dominates the fluctuations in inflation in the long run. On the other hand, the aggregate demand shock is an important factor that explains the variations in all five macroeconomic variables in the long run, based on Appendix Figures A6, A11, A16, A21, A26, A31, A36, and A41.

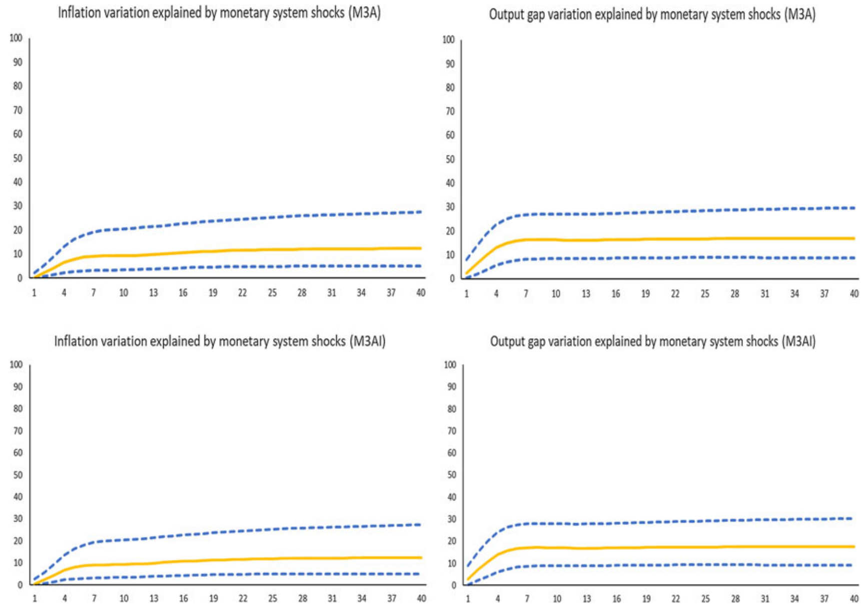

Figure 15. Variance decomposition for monetary system shocks based on M3A and M3AI.

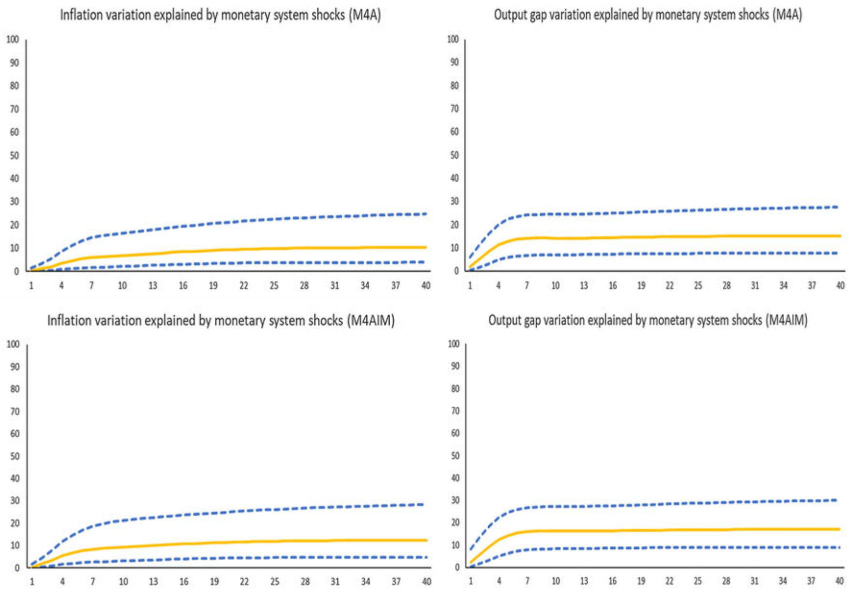

Figure 16. Variance decomposition for monetary system shocks based on M4A and M4AIM.

6. Conclusion

The main objective of this paper is to investigate whether there is a role of the credit card-augmented Divisia monetary aggregates and credit card-augmented Divisia inside monetary aggregates, recently produced by the Center for Financial Stability, in monetary policy and business cycle analysis. We follow Belongia and Ireland (2021), estimate a five-variable structural VAR using Bayesian methods, and discover monetary policy transmission channels working through interactions between the demand and supply of the credit-augmented Divisia monetary aggregates. We also find that the classical monetary policy transmission channels are stronger with the credit-augmented Divisia monetary aggregates relative to the conventional Divisia aggregates.

As Belongia and Ireland (2021, pp. 362) put it, "these results call out for a new class of models, or at least substantial extensions of existing ones, that provide a richer and more realistic description of the monetary business cycle. They call out, as well, for a reconsideration of the role that measures of money play in the formation of Federal Reserve policy."

Notes

1 The quarterly Divisia series are constructed by taking the average of the monthly observations in each quarter.

2 The Center for Financial Stability does not provide the credit card-augmented Divisia M4 inside monetary aggregate (M4AI). Therefore, we choose M4AIM, which is the same as M4AI, except for excluding Treasury bills.

3 The full set of impulse response functions is available upon request.

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APPENDIX A

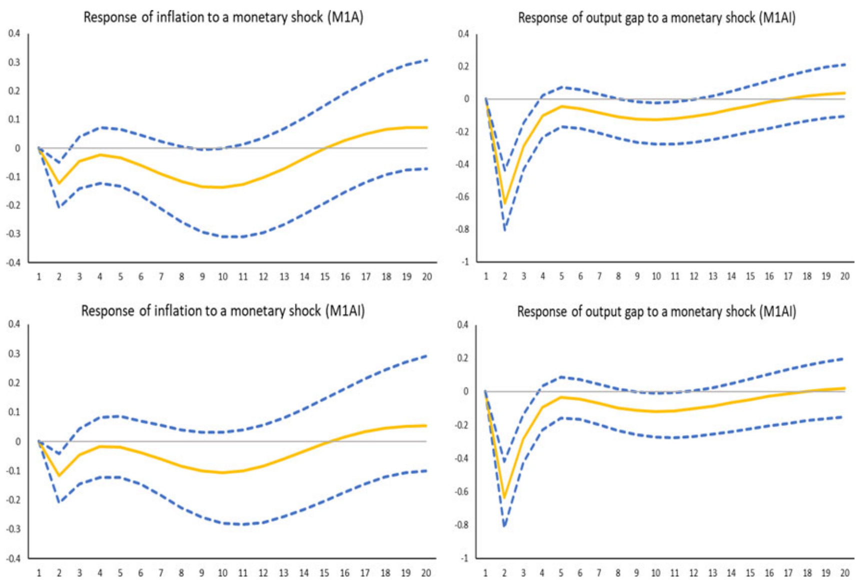

Figure A1. Impulse response functions to a monetary shock based on M1A and M1AI.

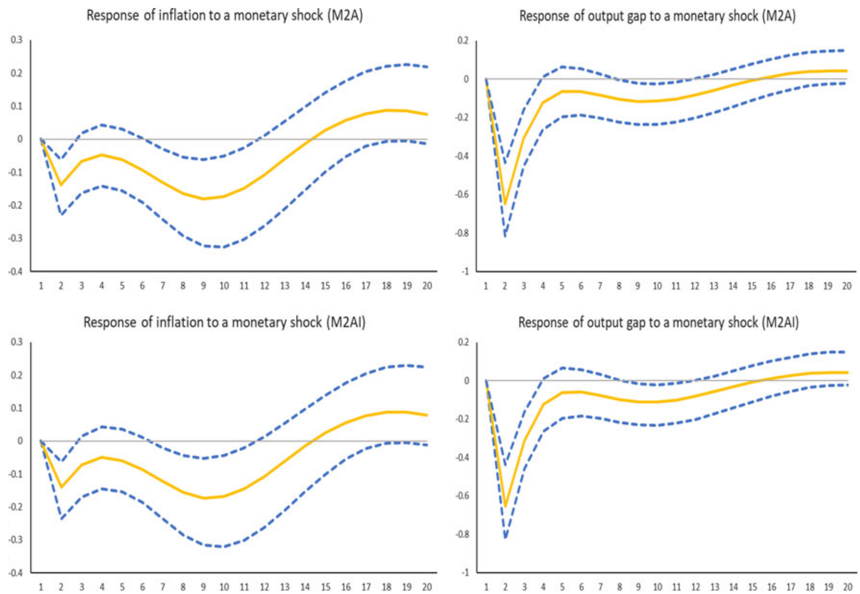

Figure A2. Impulse response functions to a monetary shock based on M2A and M2AI.

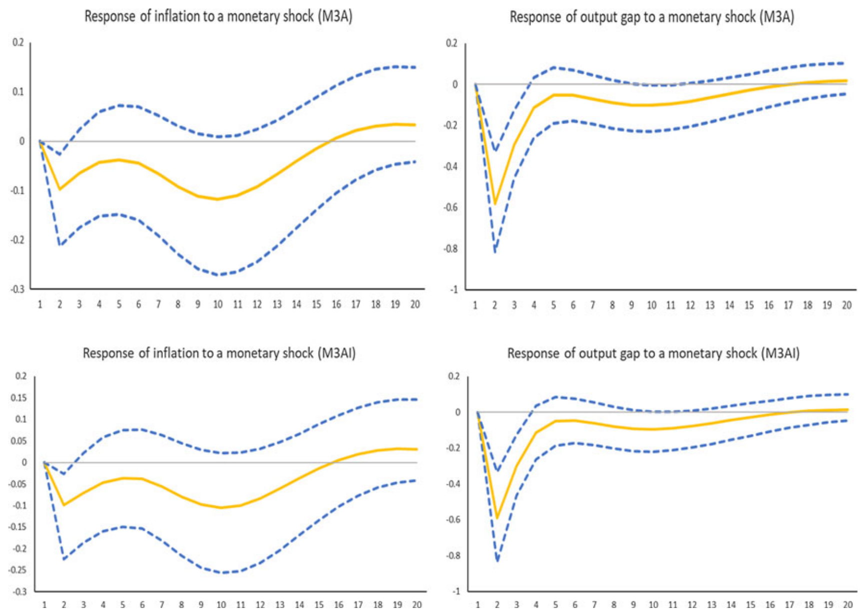

Figure A3. Impulse response functions to a monetary shock based on M3A and M3AI.

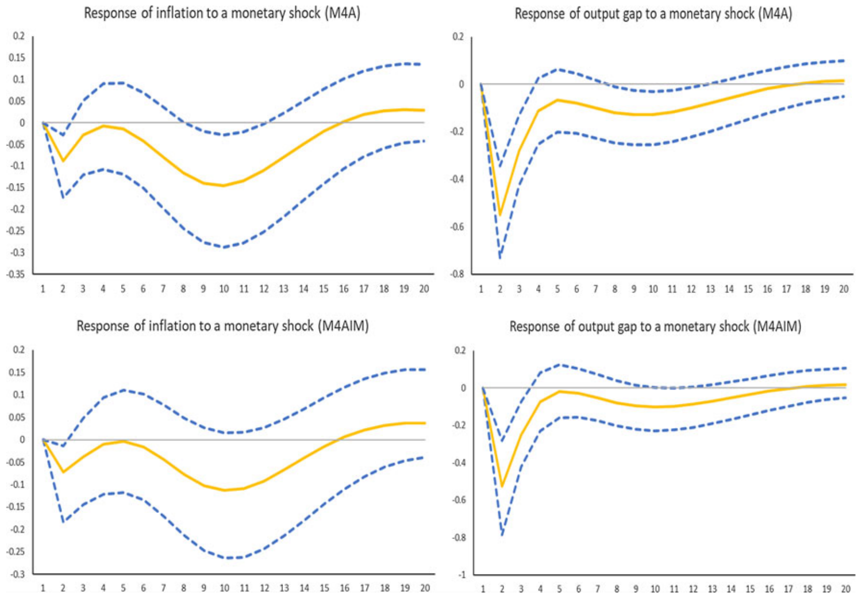

Figure A4. Impulse response functions to a monetary shock based on M4A and M4AIM.

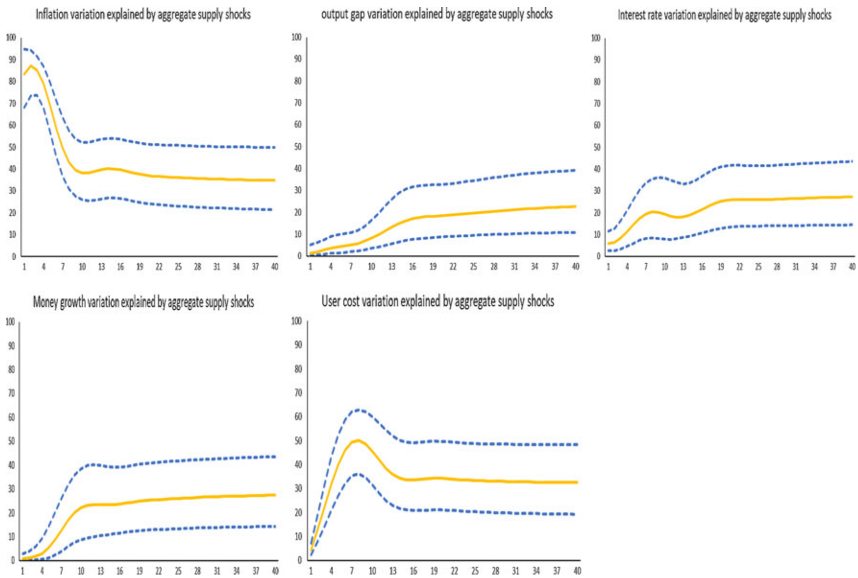

Figure A5. Variance decomposition for aggregate supply shocks based on M1A.

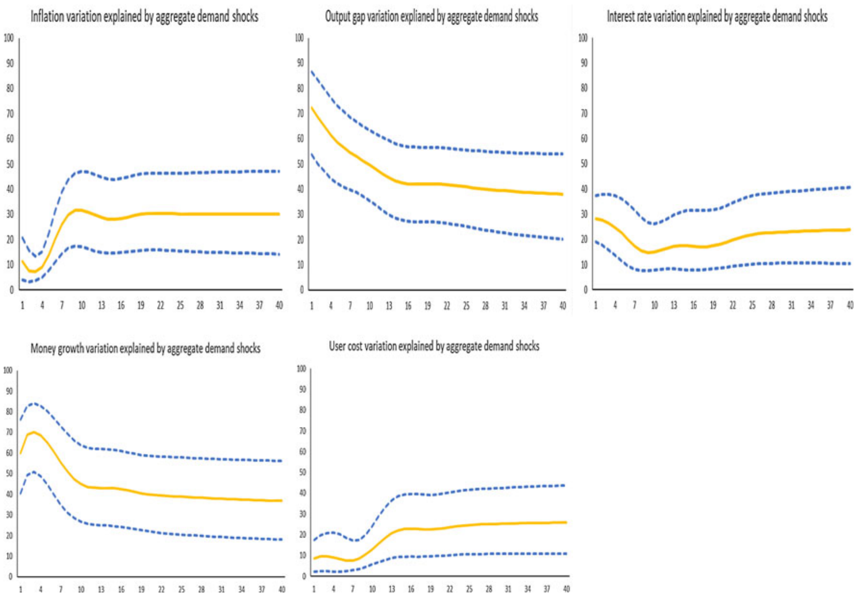

Figure A6. Variance decomposition for aggregate demand shocks based on M1A.

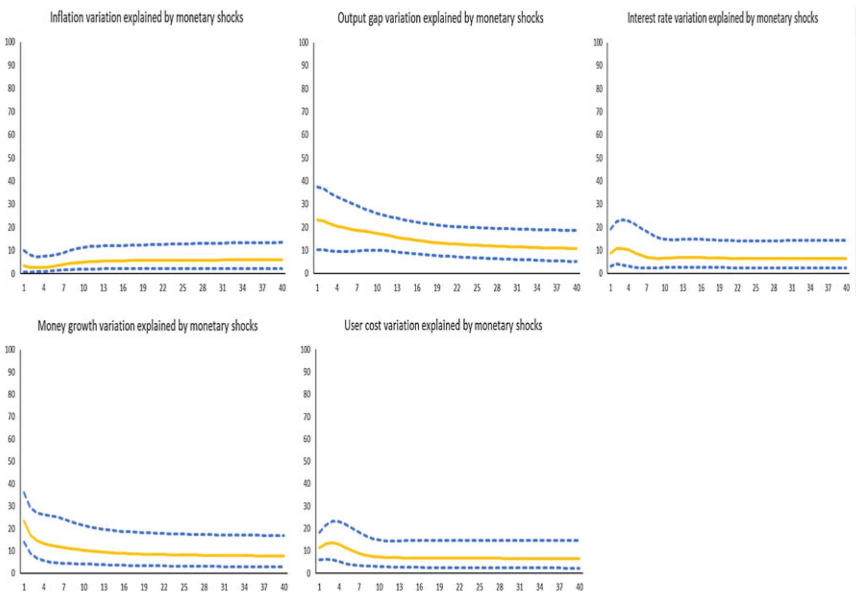

Figure A7. Variance decomposition for monetary shocks based on M1A.

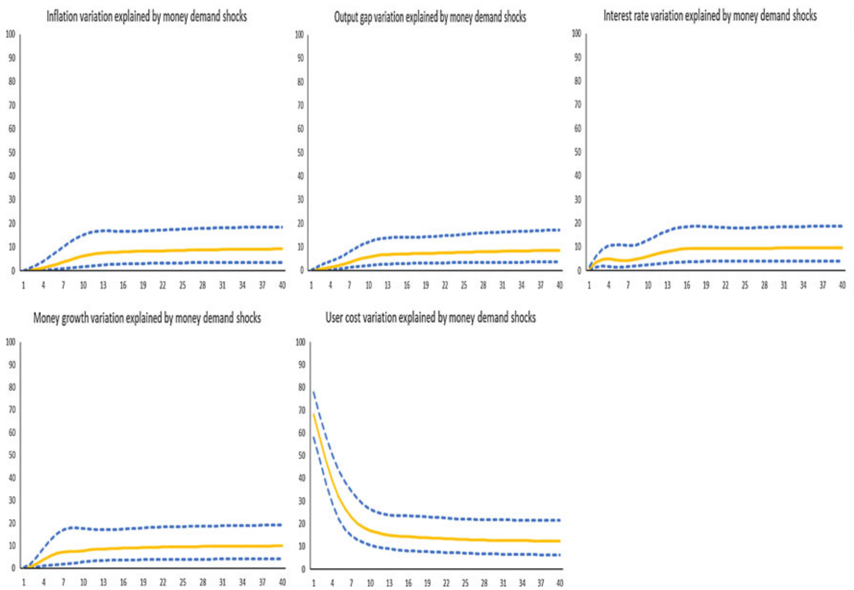

Figure A8. Variance decomposition for money demand shocks based on M1A.

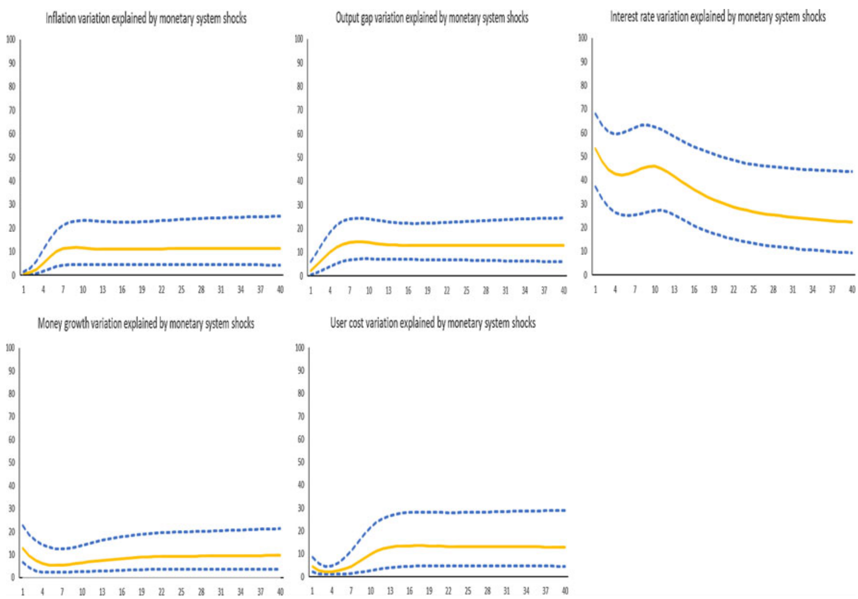

Figure A9. Variance decomposition for monetary system shocks based on M1A.

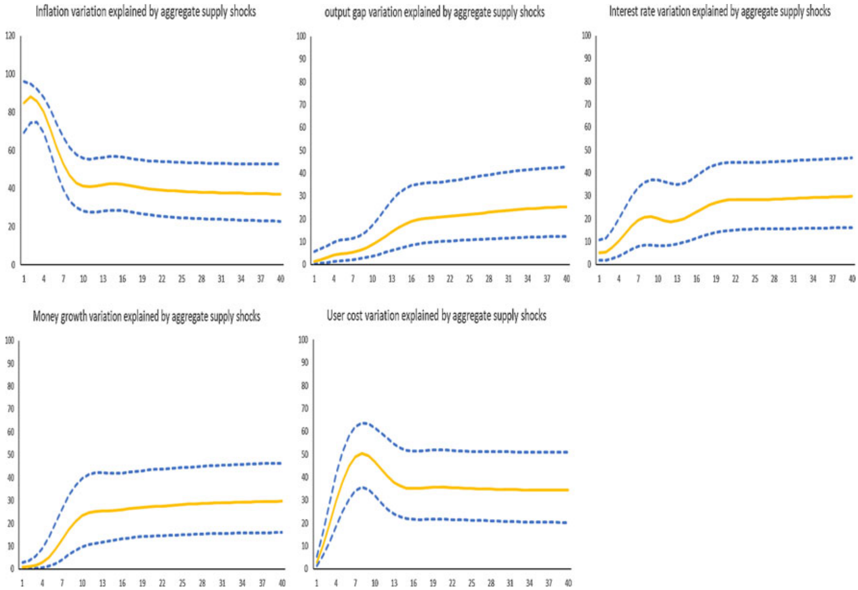

Figure A10. Variance decomposition for aggregate supply shocks based on M1AI.

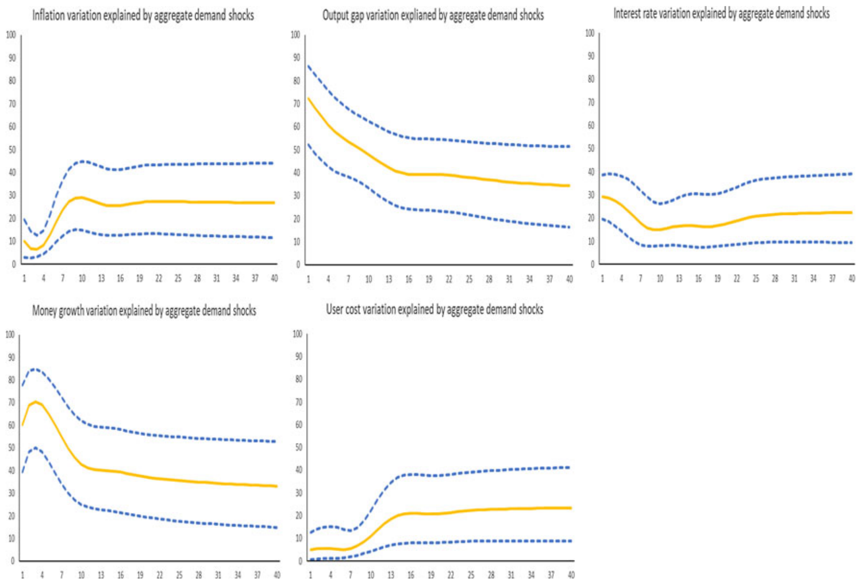

Figure A11. Variance decomposition for aggregate demand shocks based on M1AI.

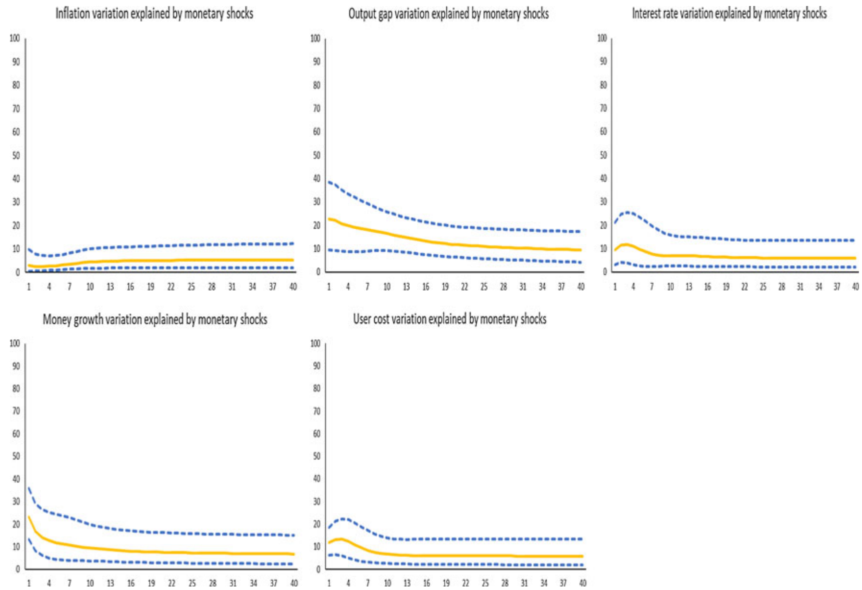

Figure A12. Variance decomposition for monetary shocks based on M1AI.

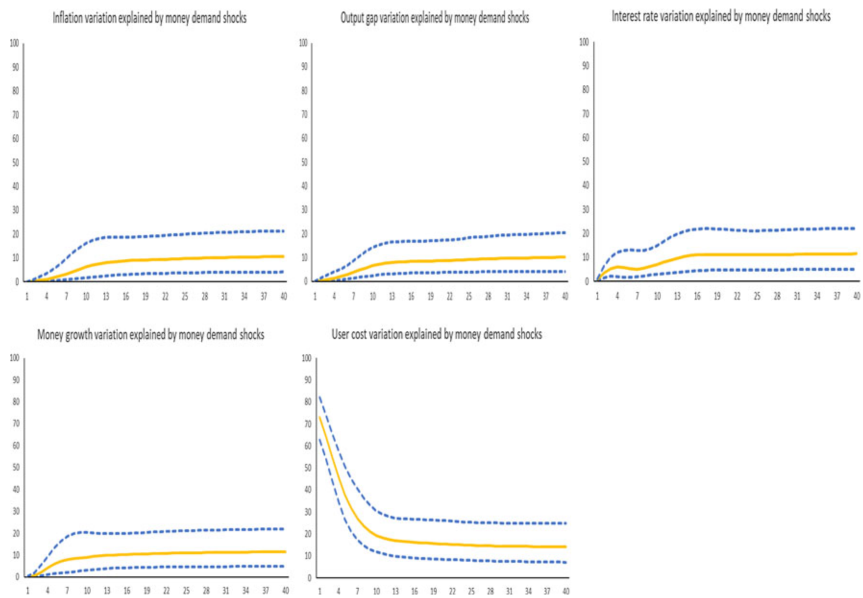

Figure A13. Variance decomposition for money demand shocks based on M1AI.

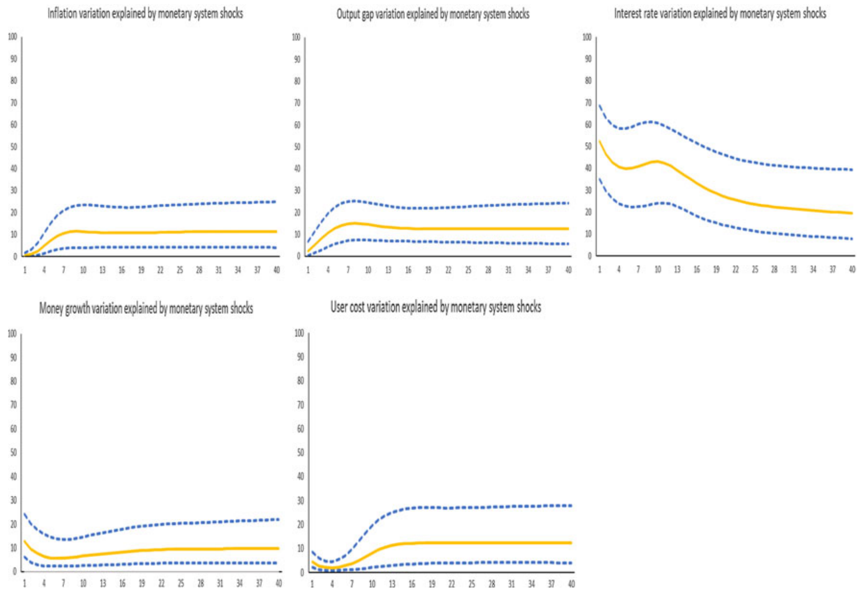

Figure A14. Variance decomposition for monetary system shocks based on M1AI.

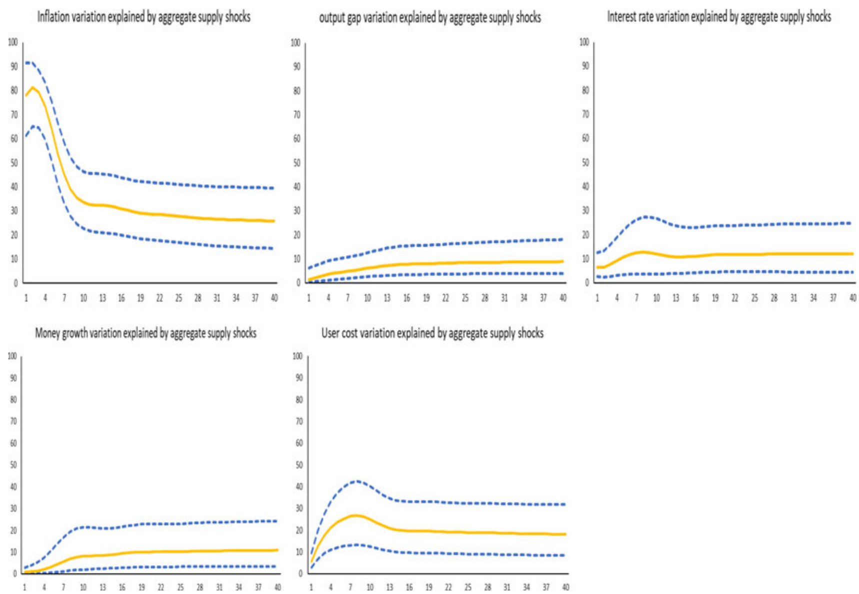

Figure A15. Variance decomposition for aggregate supply shocks based on M2A.

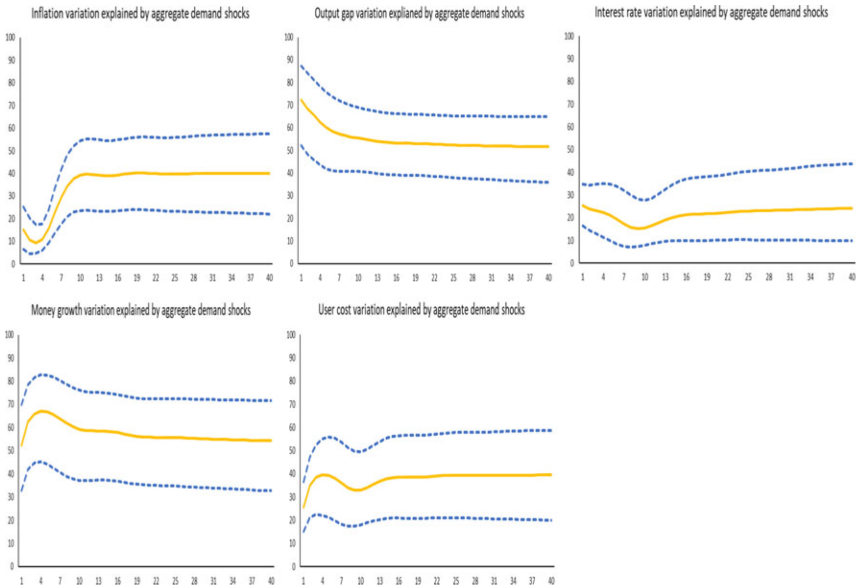

Figure A16. Variance decomposition for aggregate demand shocks based on M2A.

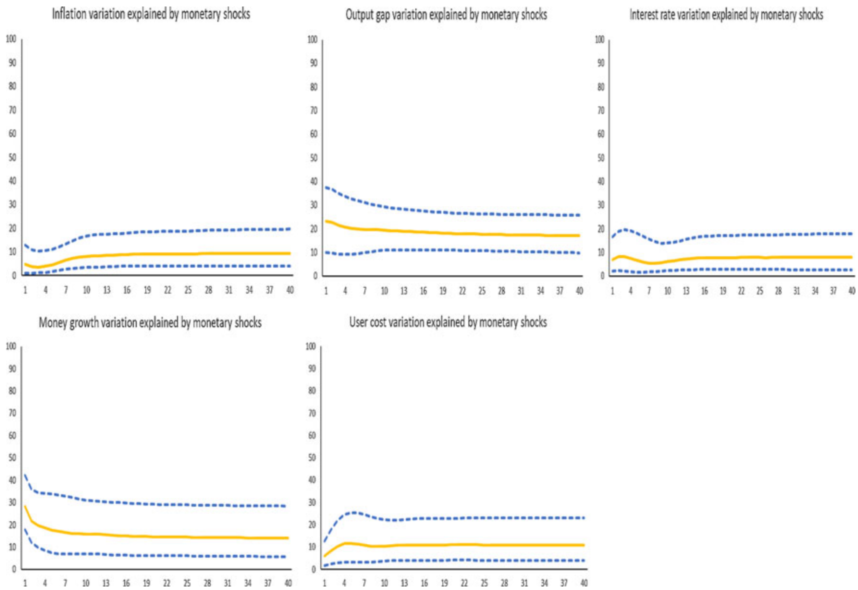

Figure A17. Variance decomposition for monetary shocks based on M2A.

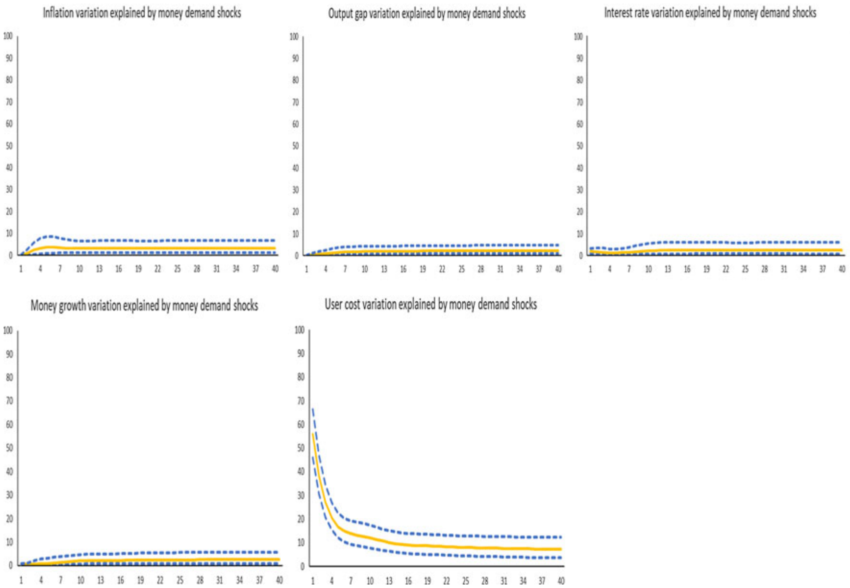

Figure A18. Variance decomposition for money demand shocks based on M2A.

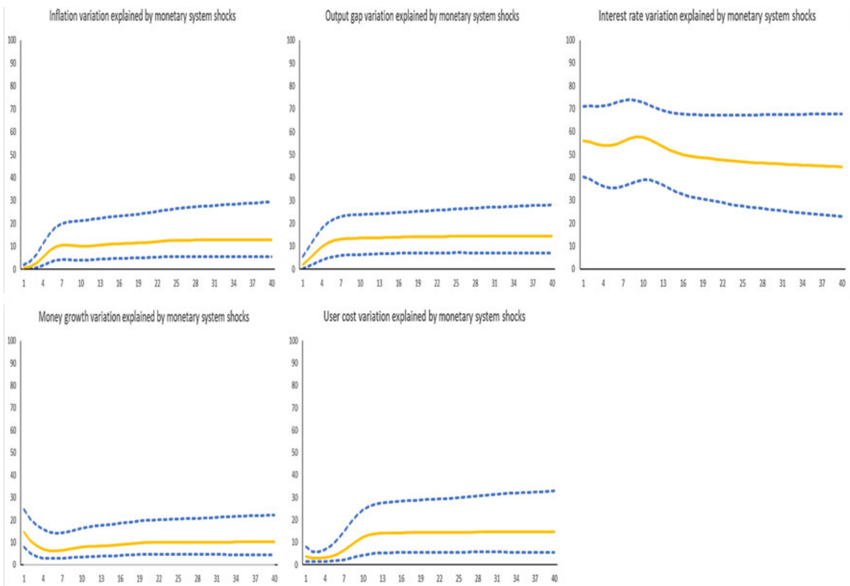

Figure A19. Variance decomposition for monetary system shocks based on M2A.

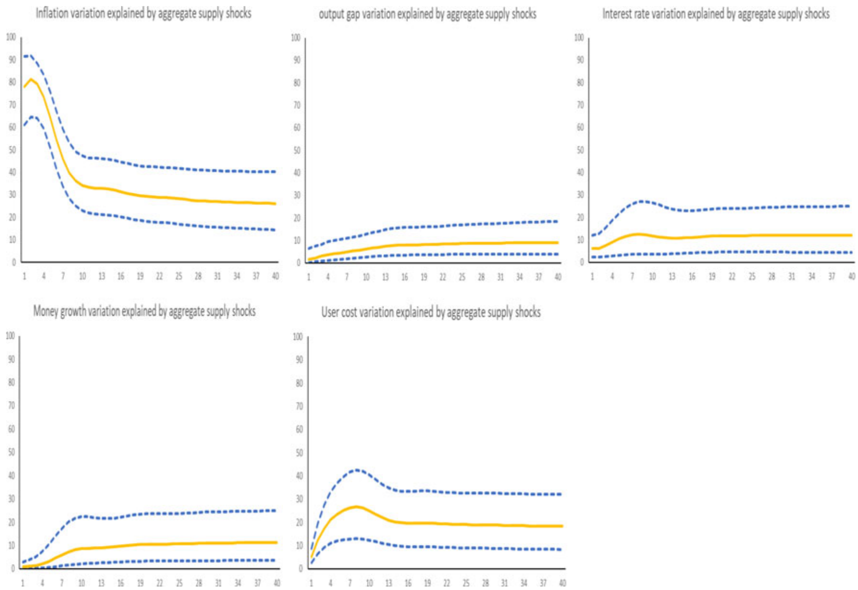

Figure A20. Variance decomposition for aggregate supply shocks based on M2AI.

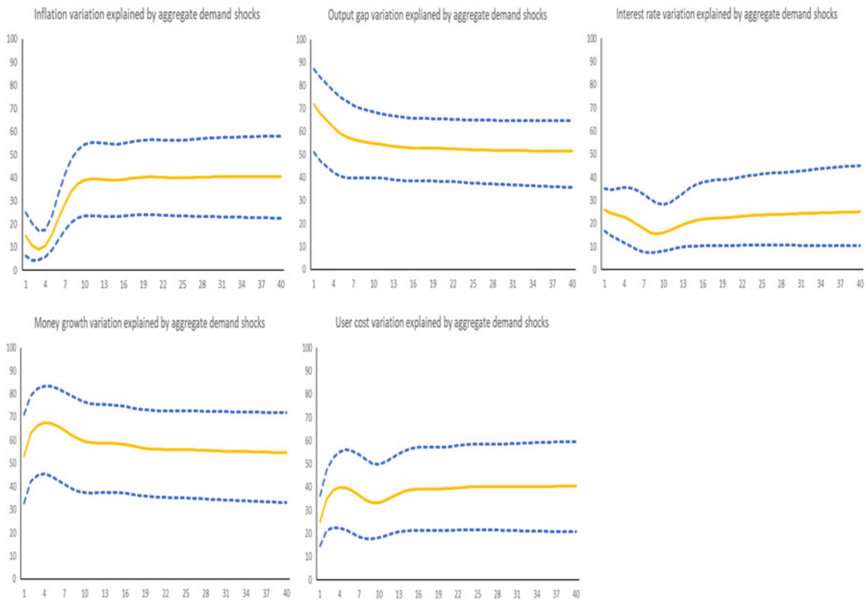

Figure A21. Variance decomposition for aggregate demand shocks based on M2AI.

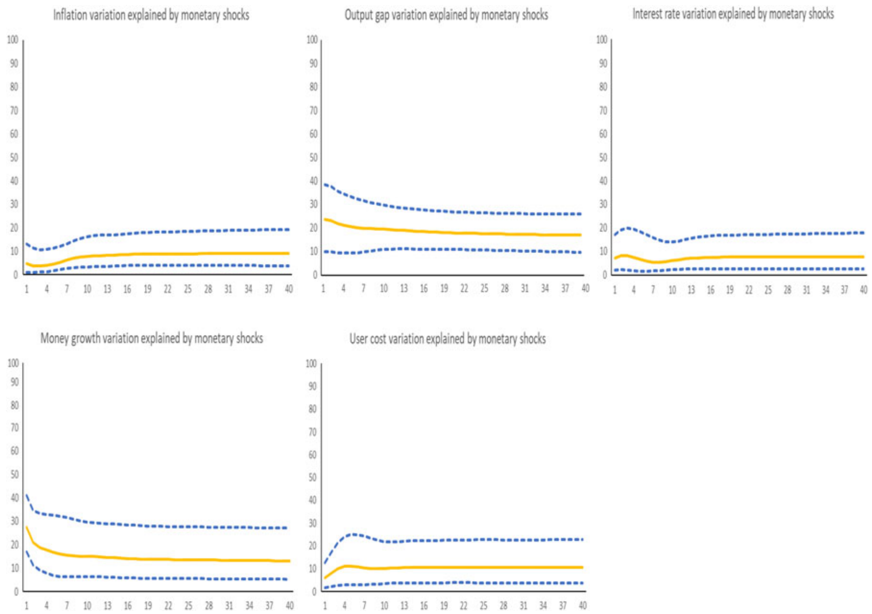

Figure A22. Variance decomposition for monetary shocks based on M2AI.

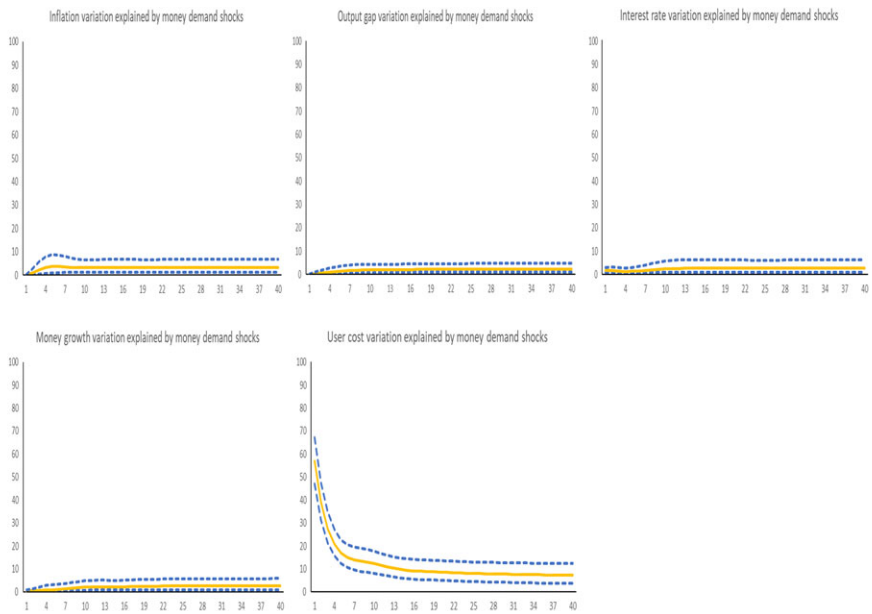

Figure A23. Variance decomposition for money demand shocks based on M2AI.

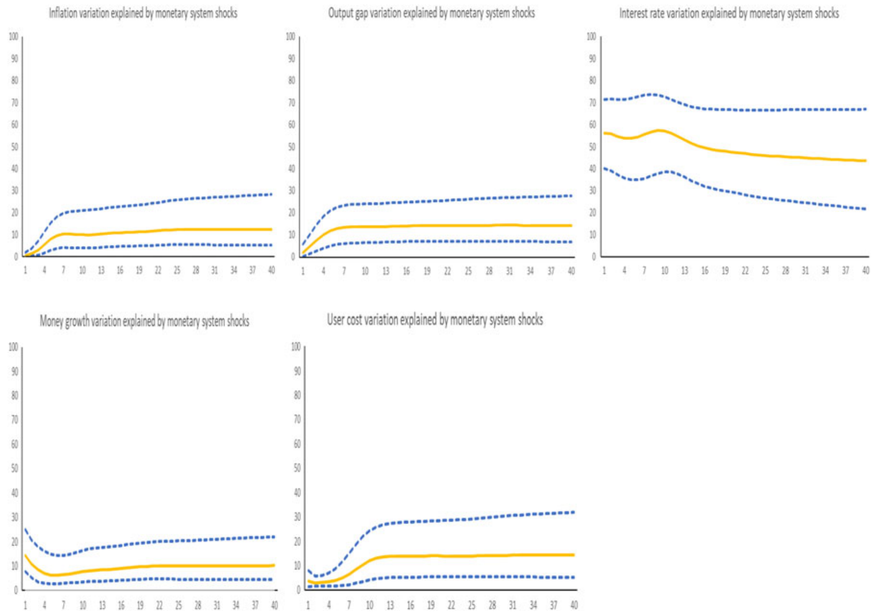

Figure A24. Variance decomposition for monetary system shocks based on M2AI.

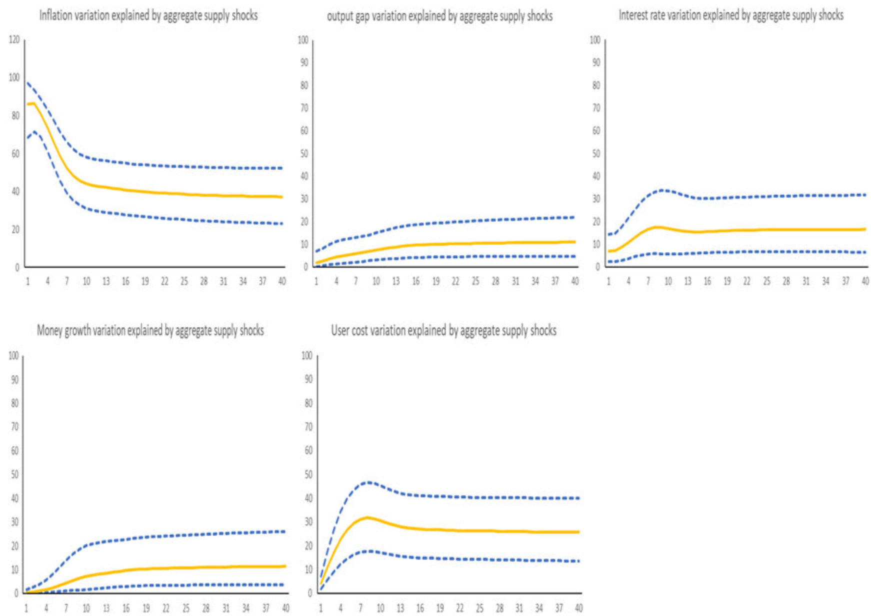

Figure A25. Variance decomposition for aggregate supply shocks based on M3A.

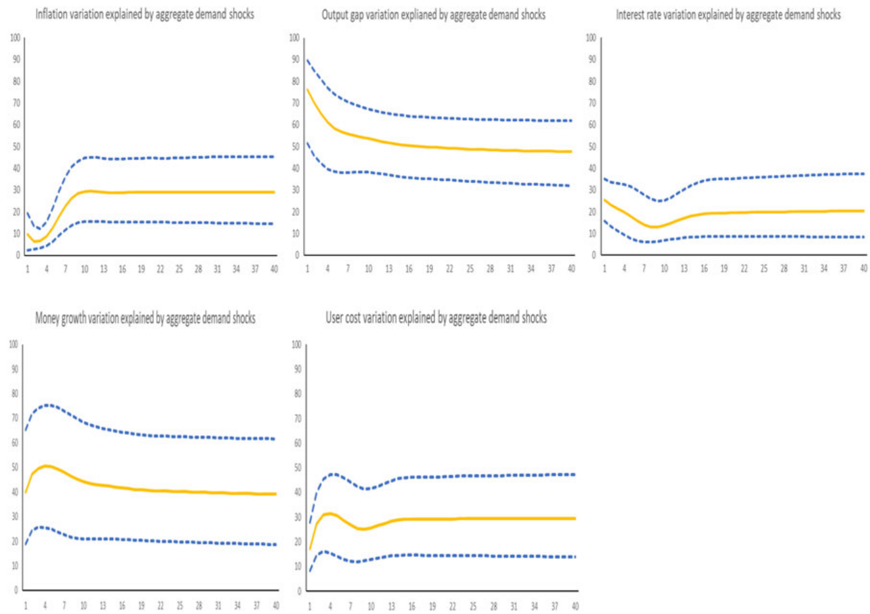

Figure A26. Variance decomposition for aggregate demand shocks based on M3A.

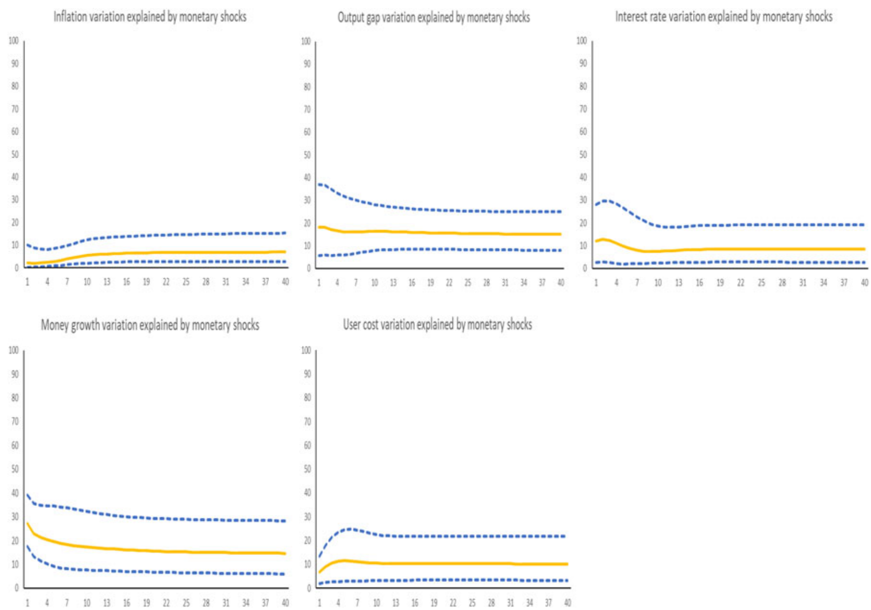

Figure A27. Variance decomposition for monetary shocks based on M3A.

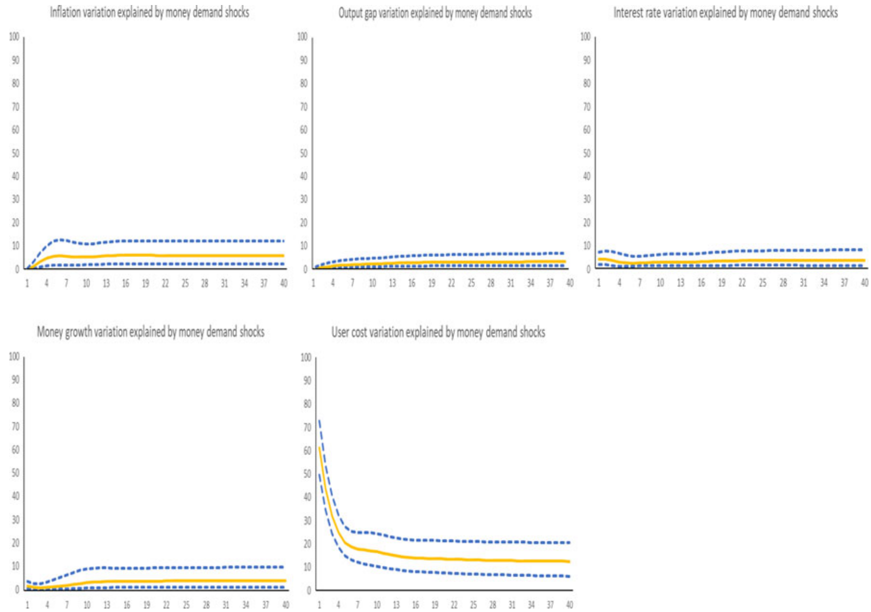

Figure A28. Variance decomposition for money demand shocks based on M3A.

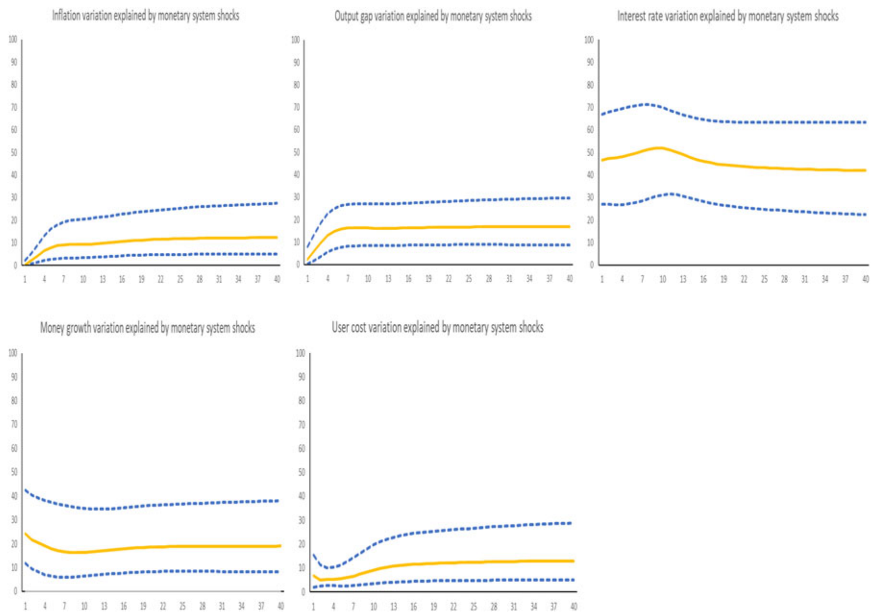

Figure A29. Variance decomposition for monetary system shocks based on M3A.

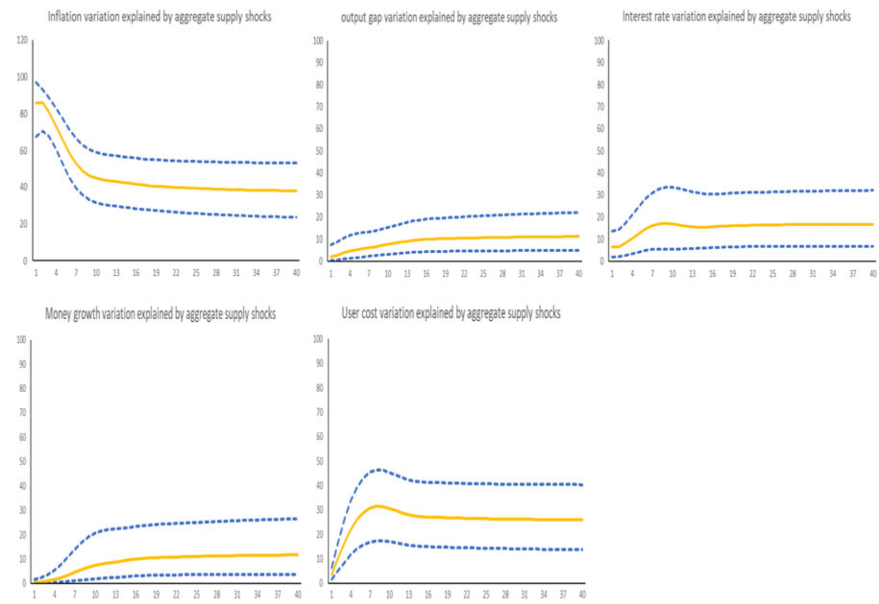

Figure A30. Variance decomposition for aggregate supply shocks based on M3AI.

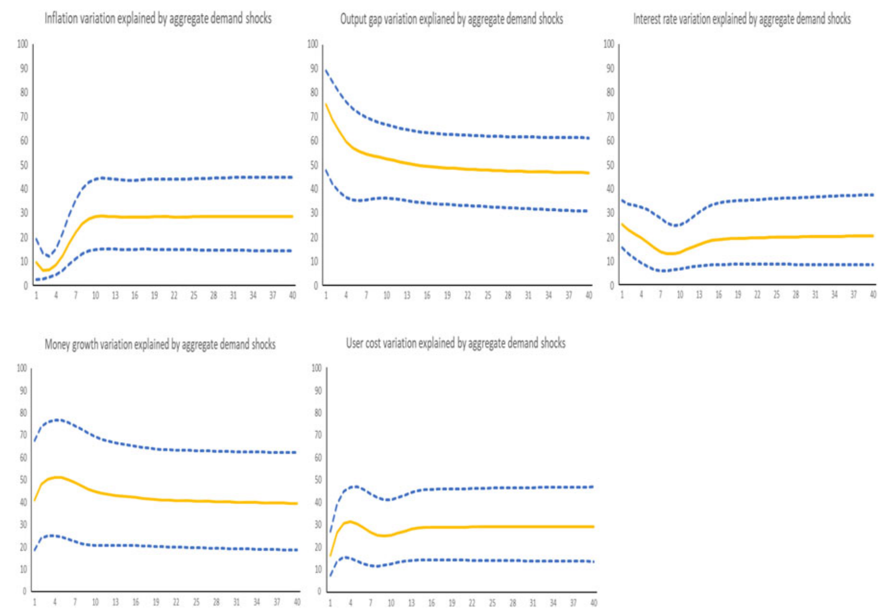

Figure A31. Variance decomposition for aggregate demand shocks based on M3AI.

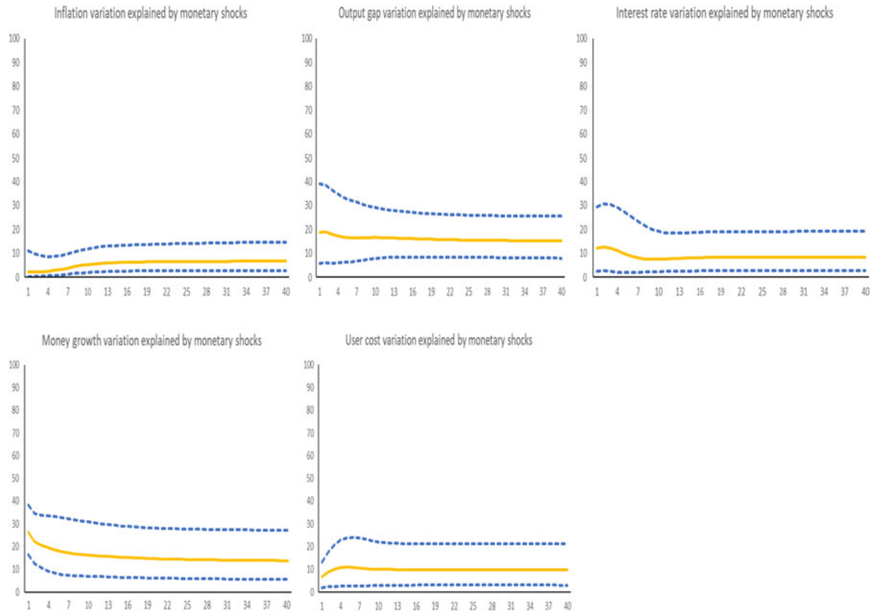

Figure A32. Variance decomposition for monetary shocks based on M3AI.

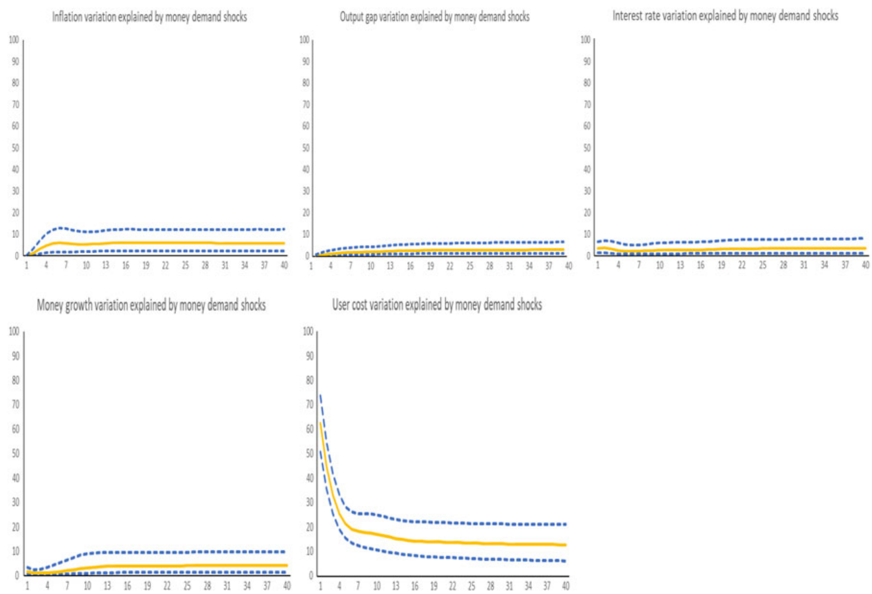

Figure A33. Variance decomposition for money demand shocks based on M3AI.

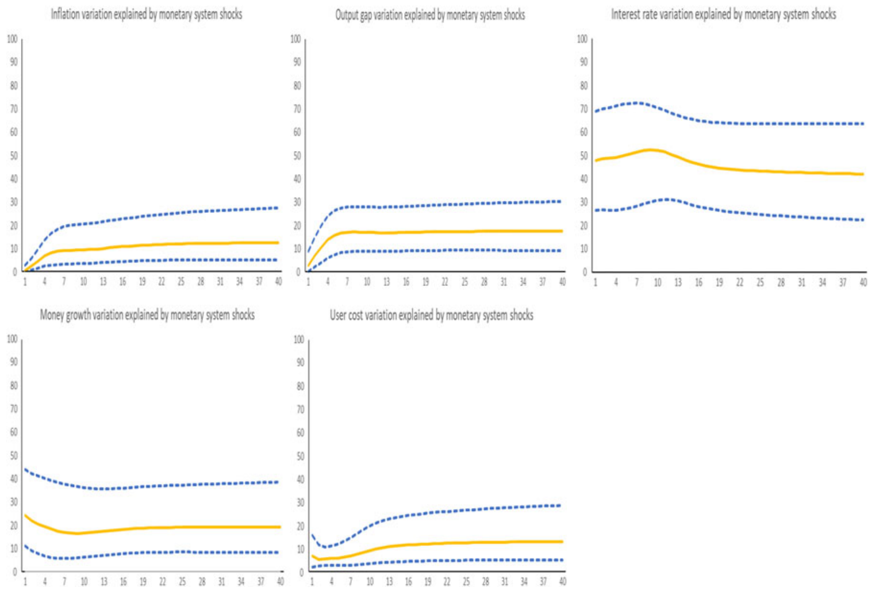

Figure A34. Variance decomposition for monetary system shocks based on M3AI.

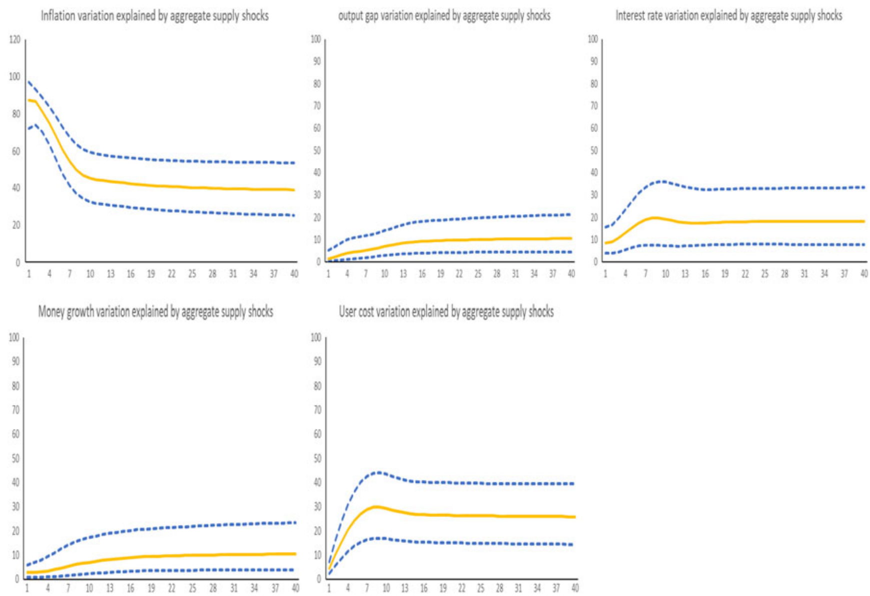

Figure A35. Variance decomposition for aggregate supply shocks based on M4A.

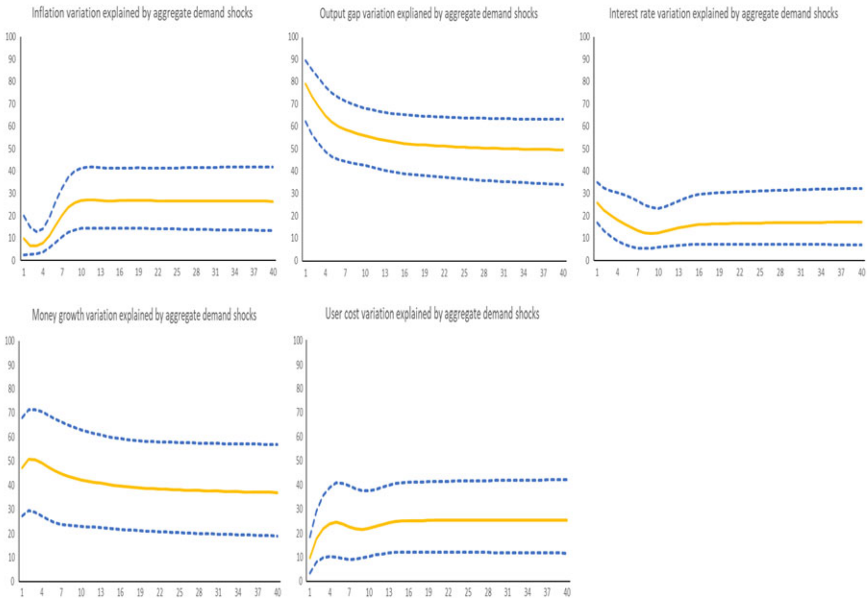

Figure A36. Variance decomposition for aggregate demand shocks based on M4A.

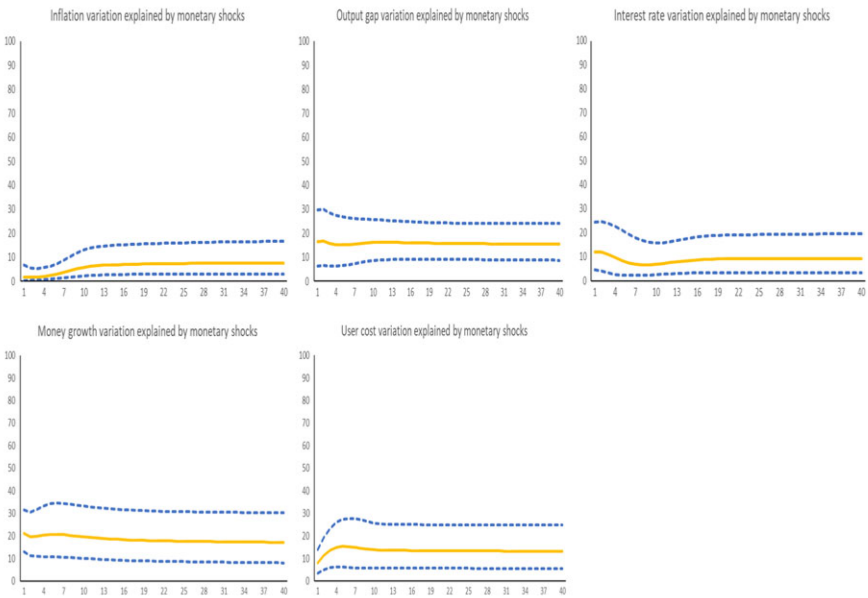

Figure A37. Variance decomposition for monetary shocks based on M4A.

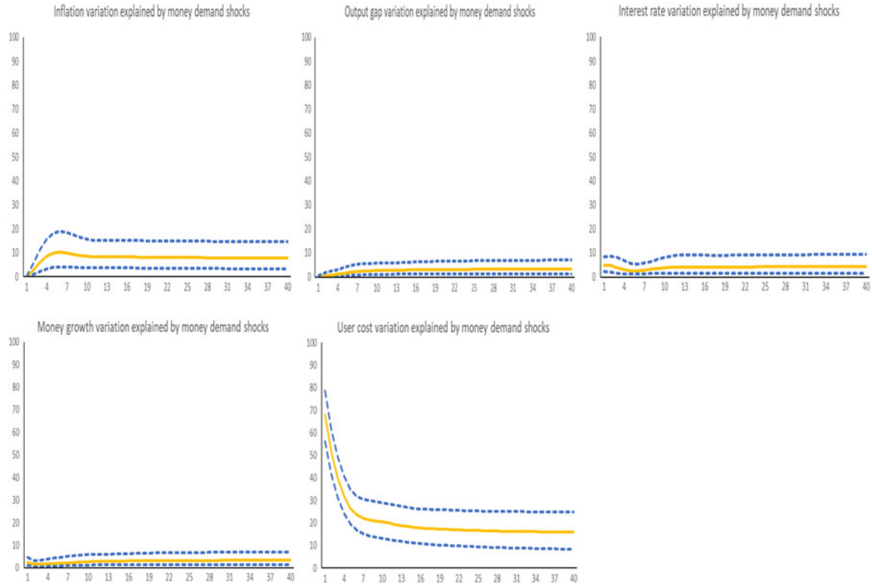

Figure A38. Variance decomposition for money demand shocks based on M4A.

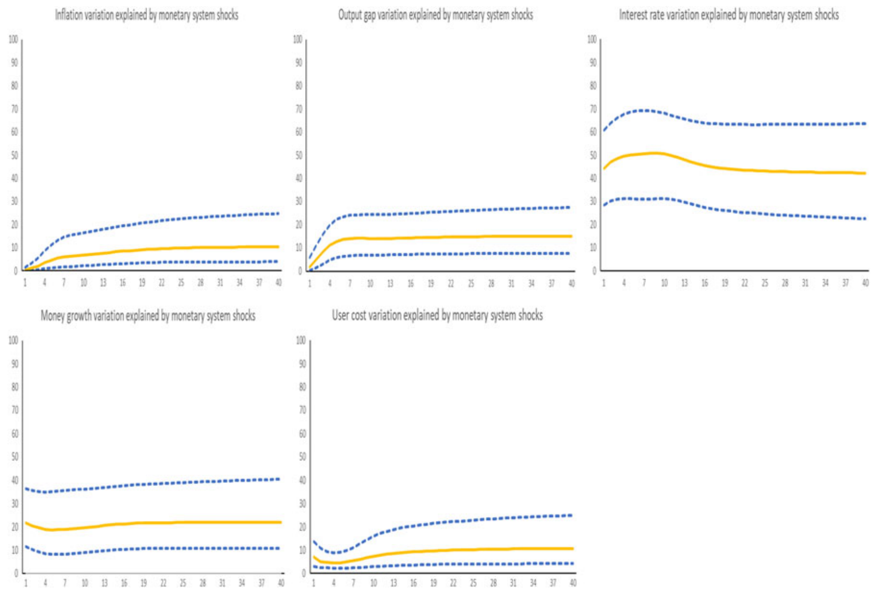

Figure A39. Variance decomposition for monetary system shocks based on M4A.

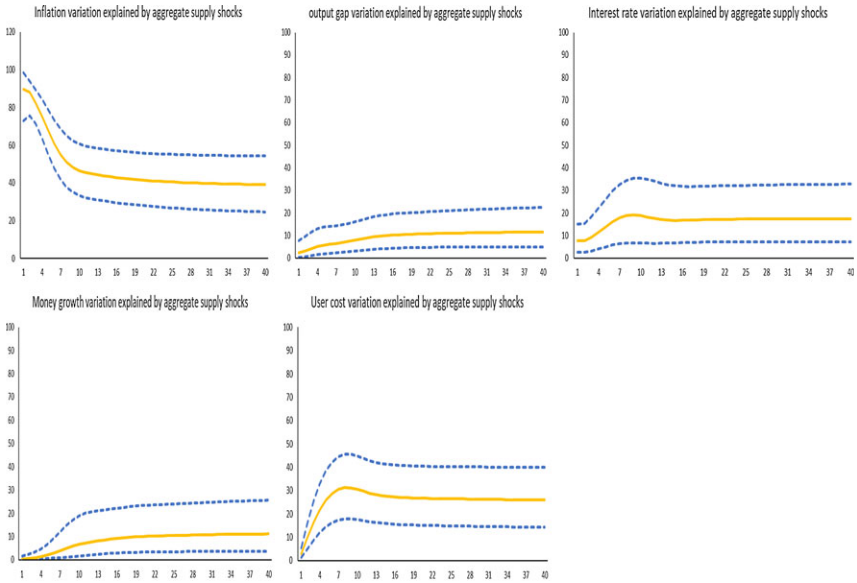

Figure A40. Variance decomposition for aggregate supply shocks based on M4AIM.

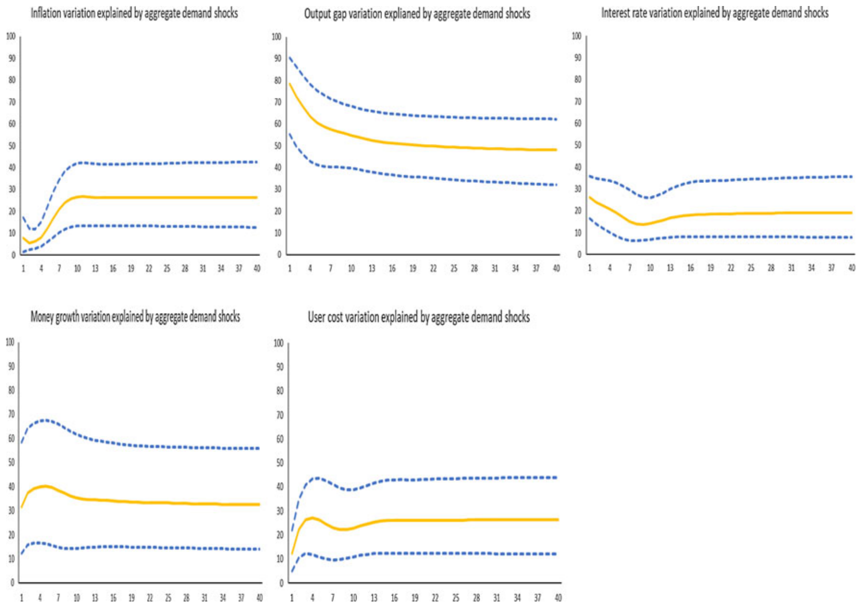

Figure A41. Variance decomposition for aggregate demand shocks based on M4AIM.

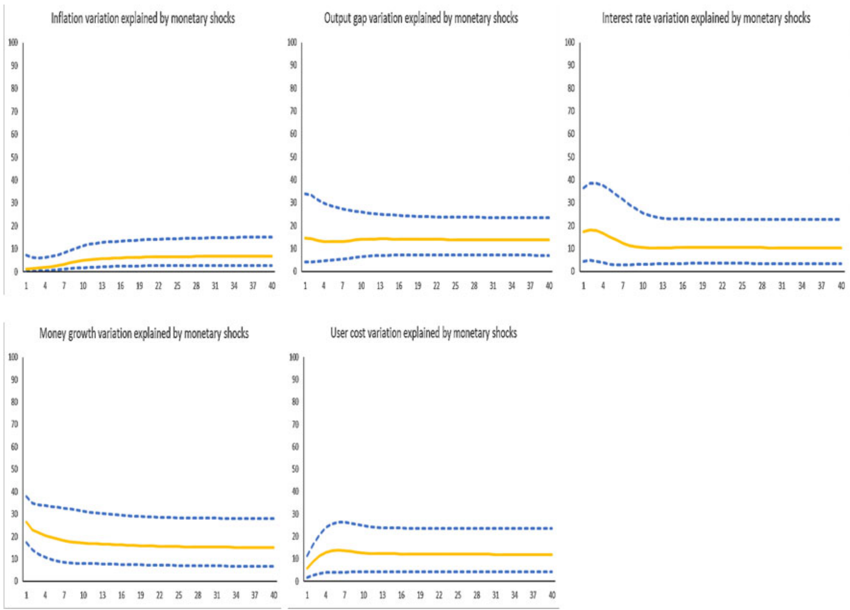

Figure A42. Variance decomposition for monetary shocks based on M4AIM.

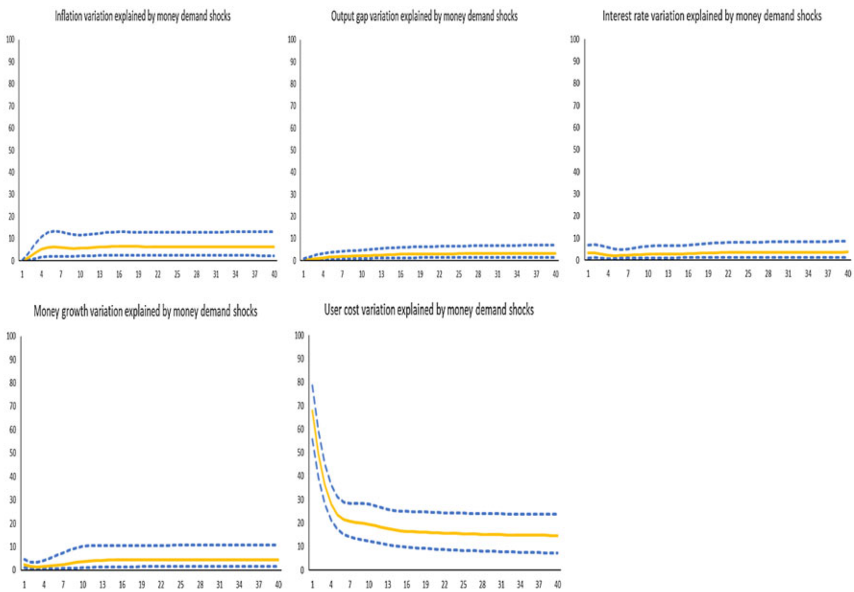

Figure A43. Variance decomposition for money demand shocks based on M4AIM.

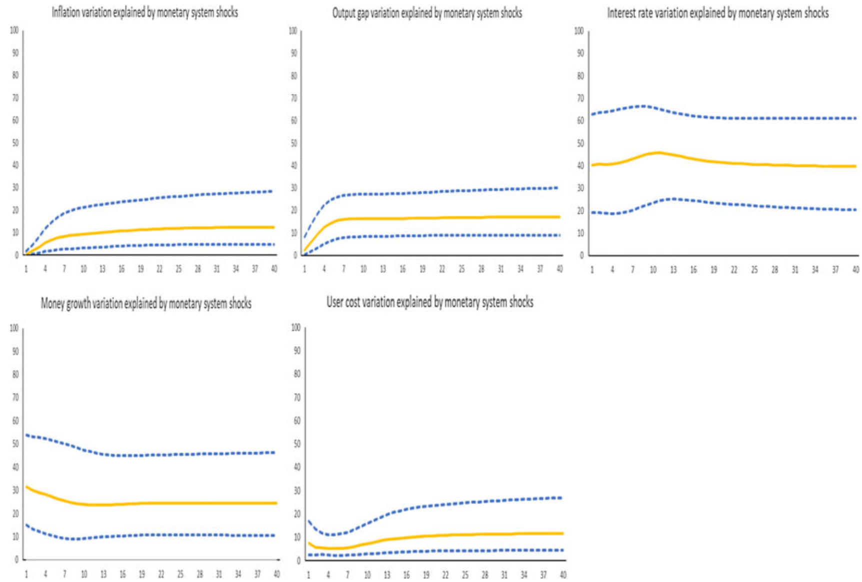

Figure A44. Variance decomposition for monetary system shocks based on M4AIM.

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