The Relative Impact of Fiscal versus Monetary Actions on Output: A Vector Autoregressive (VAR) Approach

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Abstract

The seminal work of Andersen and Jordan [1] on the relative importance of fiscal and monetary policy for output stabilization (the St. Louis equation) caused many debates among economists for a long period. They run a single equation model testing the relative importance of monetary versus fiscal policy on nominal GNP and concluded that monetary policy is effective and fiscal policy is ineffective on output stabilization. This finding attracted a wide range of criticisms and debates mainly due to possible endogeneity between policies and economic activity, and misspecification of the model. This study takes the St. Louis equation seriously. Our main concern is that, the economic activity is represented by nominal output and to our surprise; the impact of monetary or fiscal policies on prices has not been given any attention. All such models with nominal output as the dependent variable could not address the question of how policy induced changes are split between a change in real output and a change in prices. This paper investigates the relative impact of monetary and fiscal policies on the U.S. real economic activity, using quarterly data between 1959:I and 2010:II. We employ Granger causality tests and Vector Autoregressive (VAR) models. The VAR methodology also helps in resolving the issue of endogeneity between policies and output. The results from both models indicate that monetary policy is relatively better than fiscal policy in affecting the real output. No other study attempted to investigate the relative impact of monetary and fiscal policy actions on real output in the St. Louis framework as well as the econometric approach used in this paper to address the issue.

Keywords: Monetary policy; Fiscal policy; VAR; Granger causality.

1. Introduction

The seminal work of Andersen and Jordan [1] on the relative importance of fiscal and monetary policy for output stabilization (the St. Louis equation) caused many debates among economists for a long period. Their finding shows that monetary policy has a significant impact on nominal output stabilization while fiscal policy does not. This finding was in direct contradiction to the conventional wisdom of the time regarding the relative importance of monetary and fiscal policies. Accordingly, the St. Louis equation received numerous criticisms largely due to the conclusion of fiscal policy ineffectiveness.

In their approach, Andersen and Jordan [1] (AJ hereafter) run a single equation model testing the relative importance of monetary and fiscal policy on nominal GNP. They used the monetary base and money stock as measures of monetary policy and high-employment government expenditure and receipts as measures of fiscal policy. They tested the propositions that the response of economic activity to fiscal policy relative to monetary policy is larger, more predictable and faster using quarterly data from 1953:II to 1968:II. After regressing nominal GNP on the two policy measures (with three lags), they concluded that the response of economic activity to monetary policy relative to fiscal policy is larger, more predictable and faster - in direct contradiction with the existing conventional wisdom. This attracted a wide range of criticisms and debates especially in the 1970's and 1980's.

The criticisms against AJ can be grouped into three categories. First, it was argued that there is misspecification bias due to exclusion of non-policy exogenous variables in the right hand side of the equation. Second, the measure of fiscal policy used in AJ was claimed to bias the coefficients on fiscal policy towards zero. Finally, it was claimed that the possible endogeneity of policies and economic activity could bias the estimates [2-6].

Regarding the monetary policy choice, De Leeuw and Kalchbrenner [2] criticized the AJ's use of the monetary base on the grounds that some of its components (currency and borrowed reserves) were endogenous and may not be directly controlled by the Federal Reserve. Accordingly, they suggested subtraction of currency and borrowed reserves from the monetary base as an alternative measure. After incorporation of their criticism, when they re-estimate the AJ equation, though the magnitude on the cumulative money multiplier declined, it remained significant while the fiscal policy is still insignificant. Regarding the fiscal policy measure, Blinder and Solow [6] argued in favor of using actual government expenditure instead of high employment government expenditure. However, incorporating actual government expenditure did not change AJ's result.

On the other hand, Modigliani [4] criticized the AJ model on the basis of omitted exogenous non-policy variable among the regressors, based on a Monte-Carlo type of experiment. First, he generated artificial data by non-stochastic simulation of a model, which represents a known structure of a hypothetical economy. Then he used the data in the AJ type of equation to estimate the reduced form parameters. The resulting estimated multipliers, when compared to the "true" values (the values from the structural model), showed that the monetary multipliers were upward biased. Modigliani argued that the bias was caused by a positive correlation between the money supply and omitted exogenous variables. However, he did not further explain what variables were actually omitted from the AJ model. In response, McCallum [7] made a detailed elaboration of the difference between the "true" coefficients of the structural model of Modigliani and the coefficients in the reduced equation of AJ and concluded that the two are not comparable. Ahmed and Johannes [8] included exports as an additional regressor in the AJ model and reached on the same conclusion as that of AJ.

The issue of endogeneity was also picked up by Goldfeld and Blinder [5]. Their findings show that, although endogeneity of policy could bias the estimates of both structural and reduced form equations, it is more severe in the later case. They suggest that the bias can be reduced (though not eliminated) if policy responds to economic activity with a lag. However, this issue is no more a problem since the development of Vector Autoregressive (VAR) model by Sims [9], in which we treat all the variables in the reduced form equation as endogenous.

Silber [10] splits the period of AJ into Republican (1953:I - 1960:IV) and Democratic (1961:I - 1969:IV) administrations and found that fiscal policy is significant in the Democratic period. He noted that his finding is consistent with the observed systematic use of fiscal policy in the later period. The AJ's period was also extended by Friedman [11] up to 1976:II and where he concluded that the St. Louis equation believes in fiscal policy (or the fiscal policy variables become significant in the extended period). However, Carlson [12] showed that while the difference form equation (originally used by AJ) complies with the classical regression assumptions over the AJ period, it suffers from heteroscedasticity in the extended Friedman's [11] period. When the variables are instead defined in growth rates, the problem of heteroscedasticity disappears. However, in this case, only the monetary policy variables remain significant and the St. Louis equation no more believes in fiscal policy.

Regarding the test for other countries, Batten and Hafer [13] estimated the St. Louis equation for Canada, France, Germany, Japan, the United Kingdom and the United States under flexible and floating exchange rate regimes. They found that monetary policy (measured by changes in money growth) has consistent and lasting impact on nominal income (GNP) growth for all countries. The impact was also stable under both exchange rate regimes. On the other hand, fiscal policy is significant only for the United Kingdom and France. However, they noted that the effect is not stable in the United Kingdom where fiscal policy seems to be effective only under floating exchange rate regime.

From the discussions so far, the St. Louis equation has been subject to many criticisms and tests. However, the criticisms and modifications suggested have not generally resulted in dramatic changes in the original conclusions made by AJ. Our main concern is that, economic activity is represented by nominal output and the impact of monetary or fiscal policies on prices has not been given any attention. All such models with nominal output as the dependent variable could not address the question of how policy induced change is split between a change in real output and a change in prices. If prices are sensitive to changes in monetary or fiscal policy, it could directly be reflected in the nominal GNP and lead to the conclusion that the policy is effective. The effectiveness of a policy should be measured in terms of its impact on real variables and not in prices. For this, we need to filter out the price responses to policy actions by considering the real economic activity measure instead of a nominal one. In addition, the issues of endogeneity between policies and output could be taken care of by the use of the VAR approach.

This study is different from other related studies for the following reasons. First, following the arguments of Bernanke and Blinder [14] and Eichenbaum [15], we use the Federal funds rate as well as non-borrowed reserves as an alternate monetary policy. Actual government expenditures are used as a measure of fiscal policy. Second, we employ the VAR methodology (to take care of possible policy endogeneity problems) and multivariate Granger causality test in determining the relative impact of the two policies. Third, we use long and up to date time-series data. The economic activity is represented by real as well as nominal GDP for comparison purposes. No other study has made an investigation on the relative impact of the two policies on real output in the St. Louis framework as well as the econometric approach used in this paper to address the issue.

2. The Econometric Methodology

We start our analysis by examining the stationarity of our variables. For this, the unit root test is conducted using the Augmented Dickey-Fuller (ADF) test. If a unit root is detected for more than one variable, we further conduct the test for cointegration to determine whether we should use Vector Error Correction methodology.

2.1 Granger Causality Test

The Granger causality test examines whether the lagged values of a variable helps predict another variable. For example, in a trivariate case (with variables say, X, Y and Z), X does not Granger cause Y (conditioned on the presence of Z) if the prediction of Y based on past values of Y, X and Z is no better than the prediction based Y and Z only. We test both the bivariate and trivariate Granger causality between monetary or fiscal policy and real/nominal income.

In the bivariate model the causal relationship between X and Y is examined through the Granger causality test as:

$$Y_t = \alpha_1 + \Sigma\, \beta_i X_{t-i} + \Sigma\, \delta_i Y_{t-i} + \varepsilon_t \qquad (1)$$

$$X_t = \alpha_2 + \Sigma\, \beta_j Y_{t-j} + \Sigma\, \delta_j X_{t-j} + u_t \qquad (2)$$

In addition, we test the null hypothesis of $\beta_i = 0, \forall i$ to determine if X Granger causes Y and $\beta_j = 0, \forall j$ to see if Y Granger causes X.
The trivariate Granger causality test includes a third variable say Z_t into equation (1) and (2):

$$Y_t = \alpha_1 + \Sigma\, \beta_i X_{t-i} + \Sigma\, \delta_i Y_{t-i} + \Sigma\, \theta_i Z_{t-i} + \varepsilon_t \qquad (3)$$

$$X_t = \alpha_2 + \Sigma\, \beta_j Y_{t-j} + \Sigma\, \delta_j X_{t-j} + \Sigma\, \theta_j Z_{t-j} + u_t \qquad (4)$$

This model examines the causal relationship between Y_t and X_t conditional on the presence of Z_t. In all the cases, the lag is determined using Schwarz Information Criterion (SIC). Following the argument of Bernanke and Blinder [14], if a policy affects the economic activity, then it should be a good predictor of the economic activity in the above reduced form equation. In other words, monetary and fiscal policy should be able to Granger cause real GDP to claim that they are effective.

2.2 Vector Autoregressive (VAR) Model

The VAR model for the three variables: fiscal policy, monetary policy and output can be set up as the following system of equations:

$$G_t = \beta_0 + \Sigma\, \beta_{1i} Y_{t-i} + \Sigma\, \beta_{2i} MP_{t-i} + \Sigma\, \beta_{3i} G_{t-i} + \varepsilon_{1t} \qquad (5)$$

$$MP_t = \alpha_0 + \Sigma\, \alpha_{1i} Y_{t-i} + \Sigma\, \alpha_{2i} MP_{t-i} + \Sigma\, \alpha_{3i} G_{t-i} + \varepsilon_{2t} \qquad (6)$$

$$Y_t = \theta_0 + \Sigma\, \theta_{1i} Y_{t-i} + \Sigma\, \theta_{2i} MP_{t-i} + \Sigma\, \theta_{3i} G_{t-i} + \varepsilon_{3t} \qquad (7)$$

Where: Y_t is either NY_t - the growth rate of Nominal GDP or RY_t – the growth real GDP.
MP_t is the measure of monetary policy, which is either the Federal funds rate (in differences) or the growth rate of Non-borrowed Reserves, and G_t is the growth rate of government current expenditure.

The lag length is determined by SIC.

We report both the impulse response functions (IRFs) and the variance decompositions (VDs) to examine the role of the two policies. With the IRFs, we can trace the impact of a one-time shock to a variable (monetary or fiscal policy measure) on all variables in the VAR over the future time horizon. The VDs would also allow us to capture the percentage variation in the output that is accounted for the monetary and fiscal policy actions. In effect, the VAR model is also useful to see the dynamic relationships among the variables [9]. Antonios [16] uses a similar approach to investigate the casual relationship between stock market development and economic growth for Germany.

3. Data

The data for the study are obtained from Federal Bank of St. Louis. The period for the study (the maximum period obtained for all variables) is 1959:I to 2010:II, with a total of 206 observations for each variable. The variables include the Federal funds rate (in percents), Non-borrowed reserves (in billions of dollars), Government current expenditure (in billions of dollars), Gross Domestic Product (in billions of dollars) and the GDP deflator (index, 2005 = 100). All the variables (except Federal funds rate) are seasonally adjusted. We obtain the real GDP after dividing the nominal GDP by the GDP deflator.

4. Empirical Results

4.1 The Unit Root Test

We start by examining the stationarity of each series. The ADF unit root test with and without trend is reported in Table 1.

Table 1: Unit root test (ADF test).

Variable	Level		First Difference	
	ADF statistic (with constant)	ADF statistic (with constant & trend)	ADF statistic (with constant)	ADF statistic (with constant & trend)
Log Nominal GDP	-2.771 [1]	0.651 [1]	-6.429* [1]	-10.101* [0]
Log Real GDP	-1.161 [1]	-3.045 [2]	-7.189* [1]	-10.932* [0]
Log Government Expenditure	-2.483 [3]	-0.218 [3]	-3.388** [3]	-4.997* [2]
Non-borrowed Reserves	-1.146 [2]	-0.039 [2]	-10.041* [1]	-10.178* [1]
Effective Federal Funds Rate	-3.035 [5]	-3.084 [5]	-5.101* [4]	-5.107* [4]

Notes: * Significant 1 percent.
** Significant 5 percent.
Numbers in the brackets are the lag length.

As can be seen above, all series have a unit root at level and they are stationary I(0) in their first differences. Next, the cointegration test is conducted for models with real as well as nominal output with the alternative measures of monetary policy. Both the trace and max-eigenvalue test indicate no cointegration at 5 percent level of significance. Therefore, the unrestricted VAR model is utilized.

4.2 Empirical Results from the Granger Causality Test

The Granger causality test is reported for models involving nominal and real GDP growth in Table 2 and 3 below. We checked for both bivariate [17] and trivariate Granger causality tests to see if the causality by either policy is affected when conditioned on the presence of the alternative policy as noted by Sims [9].

Table 2: Granger causality test with nominal output (F - test).

Bivariate case		
Null Hypothesis	**P - value**	**Conclusion**
NY does not Granger cause FFR	0.000	Reject the null hypothesis
FFR does not Granger cause NY	0.000	Reject the null hypothesis
NY does not Granger cause NBR	0.584	Do not reject the null hypothesis
NBR does not Granger cause NY	0.150	Do not reject the null hypothesis
NY does not Granger cause G	0.198	Do not reject the null hypothesis
G does not Granger cause NY	0.063	Do not reject the null hypothesis

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Trivariate case		
NY does not Granger cause FFR/G	0.000	Reject the null hypothesis
FFR does not Granger cause NY/G	0.000	Reject the null hypothesis
NY does not Granger cause NBR/G	0.057	Do not reject the null hypothesis
NBR does not Granger cause NY/G	0.619	Do not reject the null hypothesis
NY does not Granger cause G/FFR	0.060	Do not reject the null hypothesis
G does not Granger cause NY/FFR	0.112	Do not reject the null hypothesis

Where: NY – growth rate of nominal GDP
FFR – first difference of the effective Federal funds rate
NBR – growth rate of non-borrowed reserves
G – growth rate of government current expenditure

For the model with nominal output growth (Table 2), there are two-way causalities between monetary policy and nominal output at 1 percent level of significance when FFR is used as a measure of monetary policy. This has been the case in both the bivariate and trivariate Granger causality test. The hypothesis of no Granger causality is not rejected for monetary policy measured by non-borrowed reserves and fiscal policy. However, as argued earlier, we are more concerned with the impact of these policies on real output.

Table 3: Granger causality test with real output (F - test).

Bivariate case		
Null Hypothesis	**P - value**	**Conclusion**
RY does not Granger cause FFR	0.000	Reject the null hypothesis
FFR does not Granger cause RY	0.000	Reject the null hypothesis
RY does not Granger cause NBR	0.089	Do not reject the null hypothesis
NBR does not Granger cause RY	0.041	Reject the null hypothesis
RY does not Granger cause G	0.184	Do not reject the null hypothesis
G does not Granger cause RY	0.130	Do not reject the null hypothesis
Trivariate case		
RY does not Granger cause FFR/G	0.001	Reject the null hypothesis
FFR does not Granger cause RY/G	0.000	Reject the null hypothesis
RY does not Granger cause NBR/G	0.202	Do not reject the null hypothesis
NBR does not Granger cause RY/G	0.041	Reject the null hypothesis
RY does not Granger cause G/FFR	0.229	Do not reject the null hypothesis
G does not Granger cause RY/FFR	0.128	Do not reject the null hypothesis

Where: RY – growth rate of real GDP

From Table 3, we still see two-way causalities between FFR and real output, in both bivariate and trivariate model. When non-borrowed reserve is used as a measure of monetary policy, we have a one-way causality from monetary policy to real output in both models. However, the fiscal policy does not Granger cause real output at 5 percent level of significance. Therefore, the Granger causality test shows monetary policy does a better job over fiscal policy in affecting real output. The next section further investigates the impact of these policies using the IRFs and VDs from the VAR model.

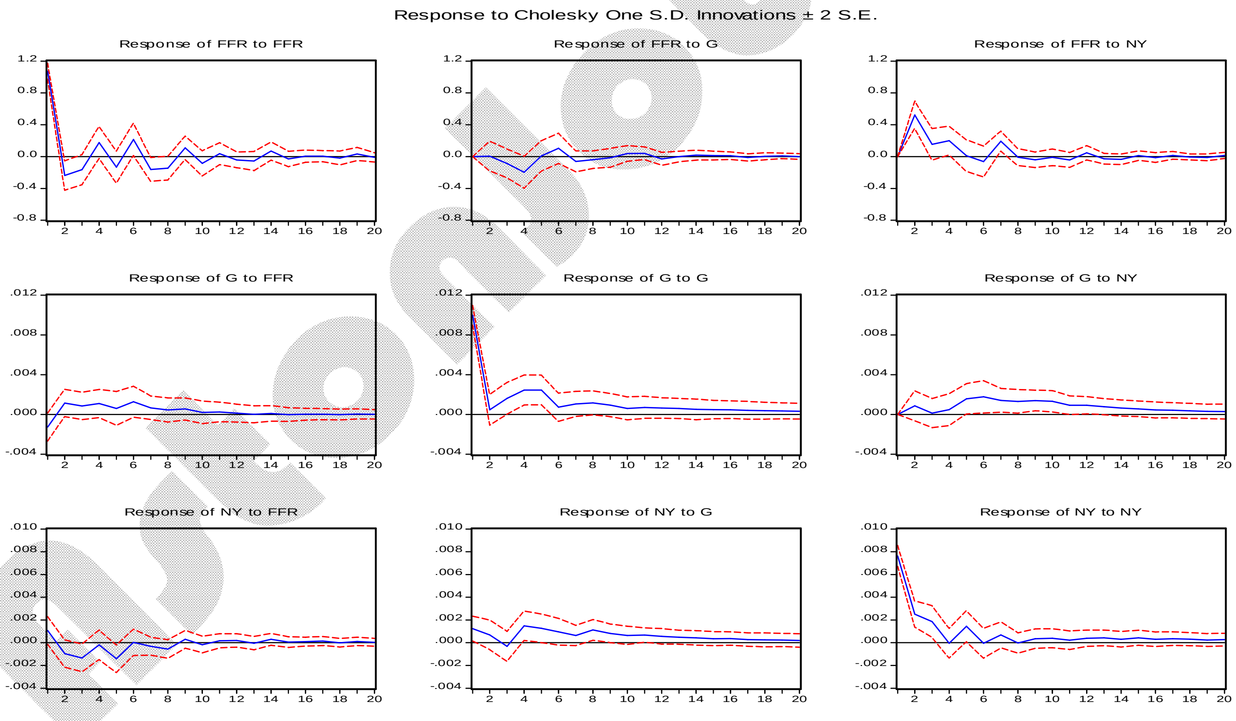
4.3 Empirical Results from Impulse Response Functions and Variance Decompositions

In this section, we further examine the relative impact of the two policies on both the nominal and real output growth. The IRFs and VDs are obtained from the VAR model described in section 2.2. In setting up the model, we used the Choleski decomposition in order to orthogonalize the residuals with ordering of FFR (or NBR) first, G next and NY (or RY) last. In effect, we are assuming that contemporaneously, the fiscal authorities set their policies after observing the actions taken by the monetary authorities.[1] Based on SIC, the lag length of five is selected when monetary policy is measured by FFR for both models with nominal and real output growth. Similarly, the lag length of four and two are selected for the models with nominal and real output growth, respectively, when monetary policy is measured by NBR.

Figures 1 through 4 show the IRFs for the model with nominal and real output growth for the alternative measures of monetary policy. As can be seen from Figures 1 and 2, the response of NY to the shocks of G is significant between 4th and 6th quarter (when FFR is used as monetary policy) which extends to the 10th quarter when NBR is the monetary policy measure. Similarly, NY responds negatively to contractionary shock of the monetary policy (increase in FFR). However, it remained insignificant to the shock of NBR, a similar result as that of the Granger causality test.

When the real output is considered, the monetary policy (measured either in FFR or NBR) gains significance. The real output responds negatively to the contractionary monetary policy shock or a positive shock to FFR (Figure 3), and it responds positively to the expansionary monetary policy shock or a positive shock to NBR (Figure 4). However, the response of real output to shocks of G remained to be insignificant. Again, the results are consistent with the Granger causality test. From this, we can conclude that monetary policy is effective and fiscal policy is ineffective when it comes to real output.

Figure 1: Impulse responses for the VAR model with nominal output (when FFR is the monetary policy measure).



[1] We also checked with the ordering of G first, FFR/NBR next and NY/RY last and the qualitative results and conclusions remain the same.

Figure 2: Impulse responses for the VAR model with nominal output (when NBR is the monetary policy measure).

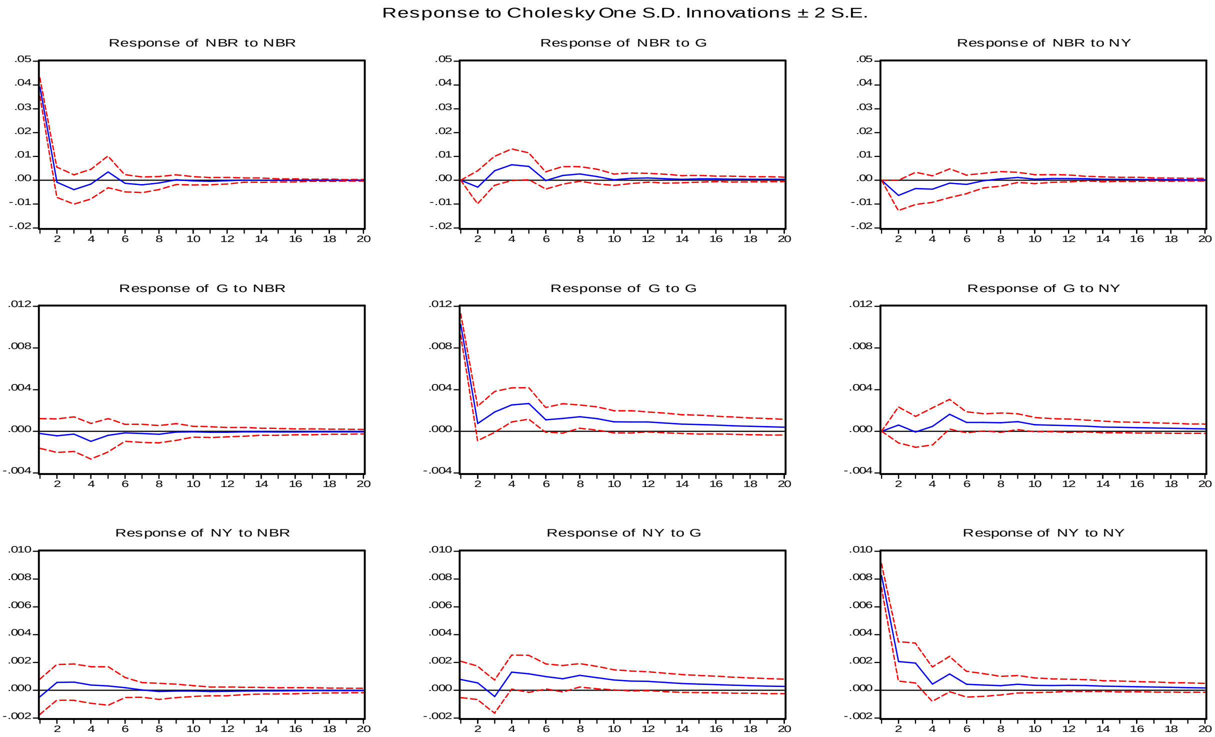


Figure 3: Impulse responses for the VAR model with real output (when FFR is the monetary policy measure).

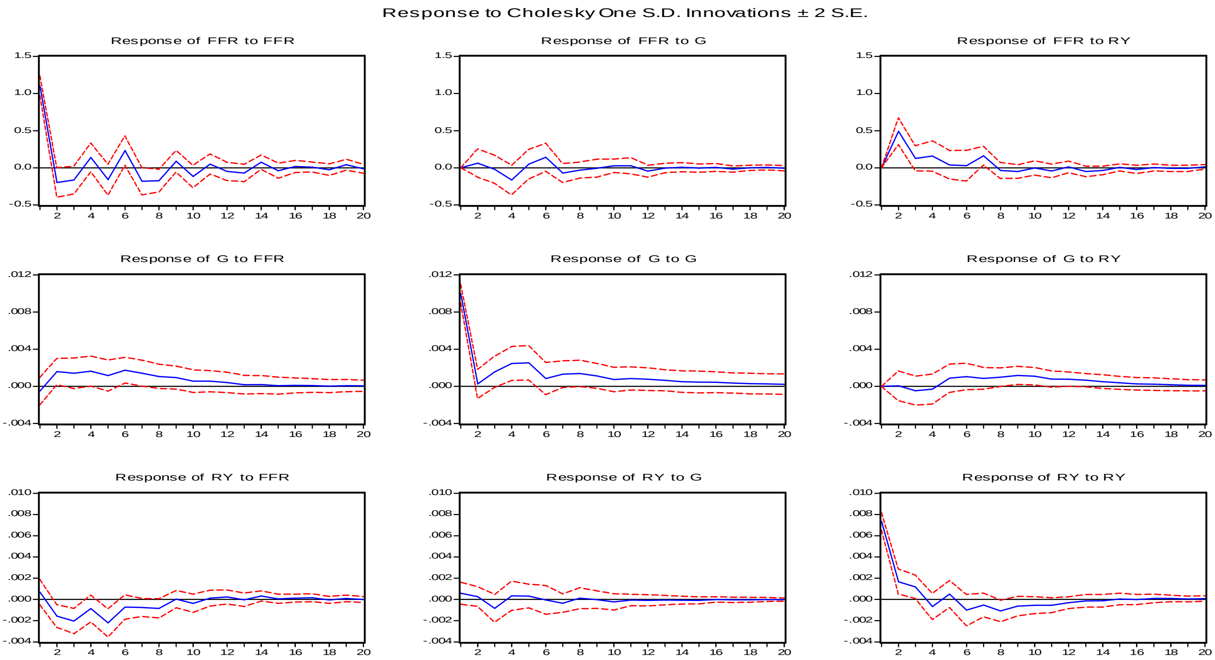
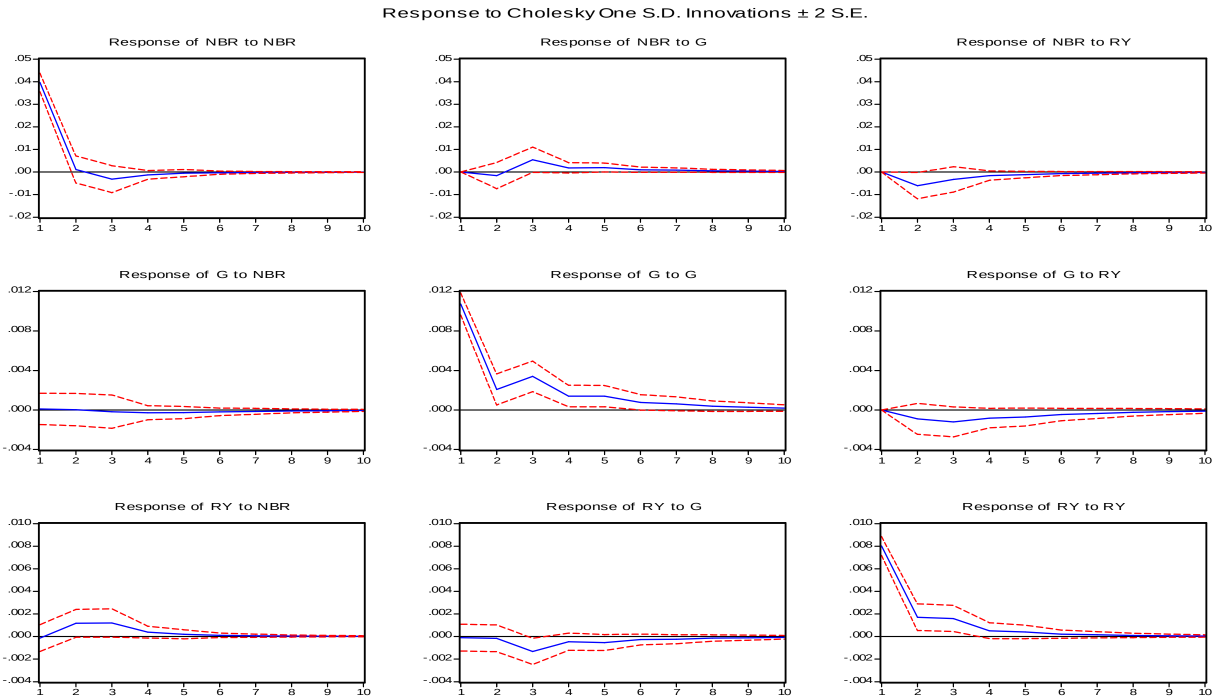


Figure 4: Impulse responses for the VAR model with real output (when NBR is the monetary policy measure).



The results from VDs are reported in Tables 4 through 7. Tables 4 and 5 show the VDs from the VAR model with nominal output when different measures of monetary policies are used. As shown in Table 4, in the longer horizon, 80 percent of the variation in nominal output is due to its own shocks. The rest 20 percent of the variation is accounted for the fiscal (13 percent) and monetary (7 percent) shocks, when we use FFR for monetary policy. Similarly, Table 5 indicates that 86 percent of the variation in nominal output is due to its own shocks, while the rest comes from fiscal (12 percent) and monetary (2 percent) shocks when NBR is used as a measure of monetary policy. However, the results of these policy shocks are not generally significant, especially when NBR is used as monetary policy measure. When the real output is considered, we see the same reversal of roles between the two policies (similar to that of the IRFs), monetary policy taking the lead.

Table 4: Variance decompositions from VAR with nominal output (when FFR is used as monetary policy) ordered as FFR, G, NY.

Variance Decomposition of NY

Forecast Horizon	Forecast SE	FFR	G	NY
1	0.01	1.90	2.50	95.60*
		(2.16)	(2.04)	(2.83)
8	0.01	7.39*	9.92*	82.69*
		(3.66)	(4.72)	(5.35)
16	0.01	7.40*	12.31	80.29*
		(3.60)	(6.27)	(6.79)
24	0.01	7.37	12.58	80.05*
		(3.76)	(6.98)	(7.54)
32	0.01	7.36	12.64	80.00*
		(3.89)	(7.39)	(8.02)

Notes: Numbers on parentheses are standard Errors: Monte Carlo (100 repetitions).
*Significant at 5 percent.

Table 5: Variance decompositions from VAR with nominal output (when NBR is used as monetary policy) ordered as NBR, G, NY.

Variance Decomposition of NY

Forecast Horizon	Forecast SE	NBR	G	NY
1	0.01	0.32	0.87	98.82*
		(1.10)	(1.53)	(1.79)
8	0.01	1.31	8.04	90.64*
		(1.96)	(4.62)	(5.09)
16	0.01	1.29	11.12	87.58*
		(1.84)	(6.81)	(7.20)
24	0.01	1.29	11.67	87.05*
		(1.83)	(7.77)	(8.13)
32	0.01	1.28	11.78	86.93*
		(1.83)	(8.25)	(8.60)

Notes: Numbers on parentheses are standard Errors: Monte Carlo (100 repetitions); *Significant at 5 percent.

Table 6: Variance decompositions from VAR with real output (when FFR is used as monetary policy) ordered as FFR, G, RY.

Variance Decomposition of RY

Forecast Horizon	Forecast SE	FFR	G	RY
1	0.01	0.85	0.63	98.53*
		(1.64)	(1.23)	(2.04)
8	0.01	18.74*	1.89	79.37*
		(5.54)	(2.29)	(5.29)
16	0.01	18.79*	1.96	79.25*
		(5.59)	(2.53)	(5.40)
24	0.01	18.83*	1.96	79.21*
		(5.69)	(2.54)	(5.50)
32	0.01	18.83*	1.96	79.21*
		(5.73)	(2.54)	(5.54)

Notes: Numbers on parentheses are Standard Errors: Monte Carlo (100 repetitions); *Significant at 5 percent.

Table 7: Variance decompositions from VAR with real output (when NBR is used as monetary policy) ordered as NBR, G, RY.

Variance Decomposition of RY

Forecast Horizon	Forecast SE	NBR	G	RY
1	0.01	0.03	0.01	99.96*
		(0.64)	(0.92)	(1.13)
8	0.01	3.99	3.22	92.78*
		(3.55)	(3.35)	(4.49)
16	0.01	3.99	3.25	92.75*
		(3.55)	(3.43)	(4.54)
24	0.01	3.99	3.25	92.75*
		(3.55)	(3.43)	(4.55)
32	0.01	3.99	3.25	92.75*
		(3.55)	(3.43)	(4.55)

Notes: Numbers on parentheses are Standard Errors: Monte Carlo (100 repetitions); *Significant at 5 percent.

From Table 6, while about 79 percent of the variation in real output is due to its own shocks, the rest almost goes to the monetary policy (as measured by FFR). About 19 percent is accounted for by the monetary policy, with significance even at 1 percent level, while the fiscal policy takes the share of only 2 percent. When we change the measure of monetary policy to NBR as in Table 7, about 93 percent of the variation in real output is accounted for by its own shocks, while the rest goes to monetary policy (4 percent) and fiscal policy (3 percent). However, these are not significant as in the case of monetary policy measured by FFR.

Overall, the results from the Granger causality test, impulse response functions and variance decompositions point to the same direction. Monetary policy is effective on real output and fiscal policy is not. Most impacts of the fiscal policy actions are reflected in nominal output with little or no impact on real output.

5. Conclusion

In this study, an attempt is made to make the empirical re-investigation of the relative importance of monetary versus fiscal policies using the Granger causality test and the VAR methodology. We used the Federal funds rate and non-borrowed reserves as a measure of monetary policy, and actual government expenditure as the measure of fiscal policy. In addition, we represent economic activity by nominal as well as real output. The method adopted in this study differs from other similar studies, which are mainly based on single reduced form equations. The VAR methodology captures the dynamics of the policies. It also solves the endogeneity problems of most similar studies in this area.

The results from the empirical analysis show that, monetary policy is relatively better than fiscal policy in affecting the real output - which is a better measure of economic activity. Fiscal policy, as measured by actual government current expenditure, failed to have significant impact on real output.

Competing Interests

The author declares that he has no competing interests.

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