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Monetary Policy in a Linearized DSGE Model

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ABSTRACT

The study is to estimate the endogenous variables of monetary policy to understand the response and interaction among the variables. I use the linearized DSGE model, and the findings suggest that the monetary policy shock leads inflation falls and interest rate rises but change in interest rate decreases output.

1. Introduction

This study estimates the endogenous component of monetary policy using a DSGE model. The idea behind using DSGE model is to get the better feedback from the key macroeconomic variables to the fiscal instruments. Understanding the endogenous response of monetary instruments is important because of endogenous movements in monetary and fiscal policy interact each other (Davig & Leeper [12]). Increases in government spending trigger substitution effects —both inter- and intra-temporal— and a wealth effect. The ultimate impacts on the economy hinge on current and expected monetary and fiscal policy behavior (Davig & Leeper [11]).

The literatures on estimating the economic effects of changes in monetary policy using a DSGE model are described in this section. In this study, I use a standard DSGE model and estimate to explain the behavior of output growth and inflation. Two features of the macro policy response have received little modeling attention, despite being central to the predictions of the impacts of the policy actions. First, monetary policy has reacted jointly to stimulate aggregate demand. A long line of research emphasizes that separating monetary and fiscal policies overlooks policy interactions that are important for determining equilibrium (Leeper [20]). Second, few economic observers expect that the current recession-fighting mix of macro policies will persist indefinitely; eventually, policies will return to “normal”. Because the impacts of current policies depend, in part, on expectations of possible future monetary-fiscal policy regimes, predictions need to condition on the current regime and incorporate prospective future regimes. Intertemporal aspects of monetary and fiscal policy interactions determine how any fiscal stimulus is expected to be financed, which theory suggests is a critical determinant of the efficacy of the stimulus (Leeper and Zha [21], Davig and Leeper [10], Chung et al. [8]).

This paper addresses these two features in a conventional dynamic stochastic general equilibrium (DSGE) model with nominal price rigidities and complete specifications of monetary policy. I use Fed interest rate and estimate monetary policy and inserted into the calibrated DSGE model.The rest of the study follows: Section 2

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presents the dataset, Section 3 presents the DSGE model used for the empirical analysis and discusses how I solve the model, Section 4 presents impulse responses to see unexpected change in interest rate on inflation and output gap.

2. The Dataset

The data is quarterly time series from 1947Q2 to 2020Q4. The data is seasonally adjustedfrom 1947Q2 to 2020Q4 in USA. The data is percentage change to make sure that it is stationary and taken from St. Louis Fred Website.

2.1. The model

The model has three sectors: households, firms, and monetary authority/federal reserve bank.

Households: Household's consumption depends on the future output and real interest rate that makes them enable in decision making based on current demand and expected future demand. The model equation is:

$$x_t = E_t(x_{t+1}) - \{r_t - E_t(\pi_{t+1}) - z_t\}\,. \tag{1}$$

The notation $x_t$denotes the output gap at time t, $E_t(x_{t+1})$ is the expected output gap in period $t+1$, r_t is the nominal interest rate and π_{t+1} is the inflation rate. The equation also states that the output gap is positively related to the future expected output gap, $E_t(x_{t+1})$ and negatively to the interest rate gap, $\{r_t - E_t(\pi_{t+1}) - z_t\}$.

Firms: The firms produce output and set prices to satisfy demand of households and the household's decision making is represented in a pricing equation that develop relation among current inflation, expected future inflation and current output demand. The model equation is:

$$\pi_t = \beta E_t(\pi_{t+1}) + kx_t\,. \tag{2}$$

The firms set prices and produce output to satisfy demand at the set price. Their decision making is summarized by a pricing equation that relates current inflation (that is, the change in prices) to expected future inflation and current demand. The parameter capturing the degree to which inflation depends on output demand plays a key role in the model. The parameter k determines the degree to which inflation depends on the output gap.

Federal reserve bank rules: Federal reserve bank sets the nominal interest rate in response to inflation. Fed increases the interest rate when inflation rises and reduces the interest rate when inflation falls. The model equation is:

$$r_t = 1/\beta\pi_t + u_t\,. \tag{3}$$

The endogenous variables x_t, π_t and r_t are driven by two exogenous variables, z_t and u_t.

Specifying the DSGE model: I fit the model using data on the US interest rate and inflation rates. In my small DSGE model, I have two control variables and two shocks. The DSGE model is linearized, and the variables are stationary. To run the model, I set the equation for STATA under the following way:

```
dsge(p=\{beta\}*E(F.p)+\{kappa\}*x)
(x=E(F.x)-(r-E(F.p)-g),unobserved)
(r=(1/\{beta\})*p+u)
(F.u=\{rhou\}*u,state)
(F.g=\{rhog\}*g,state)
```

The important parameter is kappa (k), which is estimated to be positive. This parameter k is related to the price friction in the model which means a one percentage point increases in the output gap, holding future expected inflation constant, leads to a 2.04 percentage point increase in inflation. The parameter beta (β) is estimated to be about 0.5, meaning that the coefficient on inflation (π) in the interest rate equation is about 2. So, the central

bank increases interest rate about 2 for almost one in response of movement of inflation rate. The state variables, with their autoregressive coefficients of 7.172 and 0.3214 respectively, are persistent.

Table 1
DSGE model output

	Coef.	Std. Err.	P
Beta	0.2974	0.3123	0.341
Kappa	2.0456	1.2770	0.109
Rhou	0.3463	0.1109	0.002
Rhog	0.9415	0.0369	0.000
Sd (e.u)	7.1713	7.6913	
Sd (e.g)	0.3214	0.1250	

3. Impulse-Responses

The model question is, “What is the effect of an unexpected change in the interest rate on inflation and the output gap?” This can be answered using the model and an unexpected change in the interest rate is modeled as a shock to the u_t equation. This shock represents a contraction in monetary policy in the language of the model. A shock to monetary policy leads inflation falls and interest rate rises but change in interest rate decreases output.

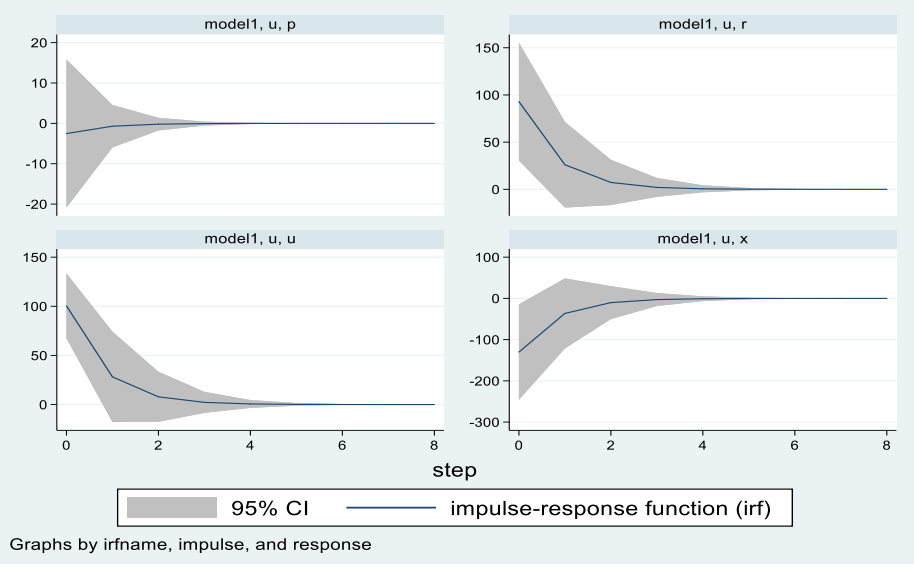

Figure 1:

4. Conclusion

The endogenous variables are output gap, interest rate and inflation. The model specification and estimated result gives the transmission channel of the monetary policy to prices. After the monetary policy shocks, the estimated results suggest that a decreasing weight of short run economic activity with inflation falls and output declines.

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