Model Setting with Variable Selection and Data Description

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Perspective

We use the Panel Vector Auto Regression (PVAR) model to test the spillover effect of the U.S. monetary policy normalization on BRICS countries. The PVAR model combines traditional VAR models with panel data, first proposed by Holtz-Eakin and later developed by Arellano and Bond. It has been widely used in many fields. Like the traditional VAR model, the PVAR model treats all variables in the system as endogenous variables. At the same time, it has the advantages of panel data analysis, which can control the unobserved individual heterogeneity. Therefore, the PVAR model can more objectively and accurately reflect the relationship among economic variables.

U.S. monetary policy variables: Interest rate variable (IR). In the previous literature, the federal fund rate was selected as the proxy variable of the U.S. monetary policy interest rate policy. Since the federal fund rate was at the zero lower bound during the unconventional monetary policy period, it could not really reflect the change in the interest rate. Therefore, this paper selects the shadow short rate constructed by Krippner as the proxy variable of interest rate in the period of the zero lower bound. After FOMC announced the interest rate hike in December 2015, the federal fund rate is selected as the proxy variable of the short-term interest rate.

Fed balance sheet variable (Fed asset)

We select the asset size of the Federal Reserve balance sheet as the proxy variable and add the original weekly data to monthly data.

BRICS macroeconomic variables:

Gross domestic product (GDP): We select the constant-price GDP of each country as an output proxy variable. For quarterly GDP data, this paper uses the quadratic-match average method to convert quarterly data into monthly data. **Inflation rate (CPI):** We select the year-on-year change rate of the consumer price index as a proxy variable of inflation rate.

Balance of trade (BOT): We select the trade balance measured by the local currency of each country as the proxy variable and adjust it to the real value by CPI.

Exchange rate (REER): We select the real effective exchange rate index based on 2010 as the proxy variable of the exchange rate. Before estimating the PVAR model, it is necessary to test the stability of the variables and select the optimal lag order of the model.

Stationarity is one of the key assumptions in time-series analysis. To avoid pseudo regression, we test the stationarity of all variables before PVAR analysis. As there are panel data and time series data in variables, we use three panel unit root tests for panel data and ADF unit root test for time-series data.

Before using the PVAR model for further analysis, we need to select the

optimal lag order of the PVAR model. Too large lag order may lead to the loss of a degree of freedom, increase variance decomposition error, and decrease estimation precision of impulse response function, while too small lag order may lead to autocorrelation error. In this paper, an optimal lag order is selected according to AIC, BIC, and HQIC information criteria. The test results are shown in Table 4. We find that AIC and HQIC have both chosen a model with eight lags, whereas BIC has selected a model with five lags. Based on various information criteria, the optimal lag order of the PVAR model is selected as eight.

The impulse response function reflects the effect of one standard deviation shock of the disturbance term on each variable in the model. In this paper, the impulse response function of the Fed's interest rate hike and balance sheet reduction on BRICS output, inflation rate, trade balance, and the real effective exchange rate is obtained by Monte Carlo simulations. The U.S. monetary policy shock is set as one standard deviation interest rate hike and Fed asset expansion. The response function is shown for a horizon of 12 months.

Using the PVAR model, this paper empirically analyses the spill over effects of the Fed's interest rate hike and balance sheet reduction on BRICS output, inflation rate, trade balance, and exchange rate. The main conclusions are as follows: first, the U.S. monetary policy has a significant spill over effect on the BRICS countries. The Fed's interest rate hike and shrinking its balance sheet will lead to the decline of output, inflation rate, trade balance deterioration, and currency depreciation in BRICS countries. Second, much more of output, inflation rate, trade balance, and exchange rate in BRICS countries can be explained by the U.S. interest rate shock, while the balance sheet shock explains a smaller proportion [1-5].

Based on the conclusions of this paper, BRICS countries can take different measures to mitigate the adverse effects of the U.S. monetary policy: first, BRICS countries should strengthen the supervision of international capital flow. In the context of the adjustment of the U.S. monetary policy, the change of interest rate spread will cause a fundamental change in international capital flow, and establish and improve the monitoring system of short-term international capital inflow and outflow, which can prevent the potential risks brought by international capital flow to the macroeconomy of each country. Second, BRICS countries should pay close attention to commodity prices, enhance their bargaining power over commodities in the international market, and prevent drastic fluctuations in domestic prices caused by commodity price fluctuations. Third, BRICS countries should appropriately use foreign exchange reserves to regulate exchange rates and improve their macroeconomic fundamentals such as economic growth so that the volatility of the exchange rate is reduced.

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