The Impact of Global and Domestic Volatility of Monetary Policy: A VAR-GARCH Approach

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Available at: https://works.bepress.com/reza_moosavi_mohseni/16/
The Impact of Global and Domestic Volatility of Monetary Policy:  
A VAR-GARCH Approach

Reza Moosavi Mohseni¹*, Jiling Cao*, and Wenjun Zhang*

Abstract:

This paper investigates the impact of the international and domestic volatility of monetary policy shocks using the GARCH-VAR model. We enrich the VAR model by adding time-varying volatility as endogenous variables. We consider three different types of shocks: internal (domestic), regional and global. For our empirical evidence we use quarterly data of Australia and New Zealand from 1988:1 to 2014:1. The data are collected from datastream. We employ the correlation of supply shocks between New Zealand/Australia and the USA, UK and the Euro area to find the main source of the global shocks. Results show that the supply shock correlation between New Zealand and UK is positive and of course bigger than the others. But for Australia the correlation of supply shocks by the United States are positive and bigger. This study assumes that the source of regional shocks is from Australian economy. We find a large amount of the volatility of monetary policy in New Zealand during period of 1988 to 2000 (Donald Brash’s period). Since then and in the Allain Bolard’s period, except in the current financial crisis (2008-2010)), New Zealand has experienced a period of tranquility. Australia shows more tranquility in the volatility of monetary policy in the period of study. The results also show that although monetary policy shocks have transient effect on real economy (neutrality of money), the impact of the volatility of monetary policy shocks on real part of the economy is permanent and significant.

Keywords: Structural VAR, GARCH, Volatility, Monetary Policy Shocks.

JEL Classification: C32, E52

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1. Introduction

In the past six decades a lot of research has been carried out to find the effect of monetary policy on real economy (Bayomi and Eichengreen; 1993, Eichenbaum and Evans; 1996, Kim; 2001, Sousa and Zaghini; 2007, Mumtaz and Surico; 2009, Moosavi et. al.; 2012). But, in most of these articles the effect of the volatility of monetary policy on the economies has been ignored. Recent financial world crisis has taught us that changing in the volatility of monetary policy can play a very important role in the transmission mechanism of monetary policy. It seems that an increase in the volatility of monetary policy can decrease the amount of investment and these changes in the policy uncertainty lead to a collapse in the real part of the economy (Fernandez-Villaverde, et. al.; 2011, Born and Pfifer; 2012, and Mumtaz and Zanetti, 2013).

In a small country where any kind of monetary policy rule is adopted, an increase in the volatility of monetary policy will result a decrease in the interest rate, which in turn will dictate the prices to decrease and this fall in the price level can change the expectation of the public and finally lead to a permanent decrease in the real output. Furthermore, if we regard an economy as a dynamical system, complexity and chaotic behavior can occur especially in an open economy (Moosavi and Kilicman; 2014), and thus the economy lose its stability.

The main objective of this paper is to analyze the impact of international and domestic volatility of monetary policy on a small economy. As done by Moosavi et. al. (2012), this study considers three different types of shocks: internal (domestic), regional and global. We employ a large scale SVAR model to find the dynamics of volatility changes.

This paper is organized as follows. Section 2 explains the econometrics methodology and the structure of the model. Section 3 describes the empirical results. The last section summarizes the results and exhibits the conclusion remarks.

2. Structure of the Model:

In order to capture the dynamics of international and domestic volatility of monetary policy and its effects on demand and supply sides of a small economy, we adopt the GARCH model to find the volatility and employ SVAR to study the impact of the monetary policy volatility on a small economy. This section briefly describes the structure of the model.
2.1. GARCH Approach

Since the ARCH approach was introduced in the seminal paper of Engle (1982), it is generally accepted that conditional forecast of the variance (the short run forecast of variance) can be superior to unconditional one. In 1986 Bollerslev proposed a generalized version of Engle’s ARCH model, namely the Generalized ARCH (GARCH) model. This model was designed to forecast the unconditional variance. Nowadays, the GARCH model is widely used in economics and finance for modelling volatility, as the economic and financial time series data show periods of relative tranquility followed by periods of volatility.

The representation of the GARCH(p, q) model is:

\[ X_t = \mu_t + \nu_t \]
\[ \nu_t \sim NID(0,1) \]  
(1)
\[ \sigma_t^2 = q(L)\sigma_{t-1}^2 + p(L)v_{t-1}^2 \]  
(2)

where \( \mu_t = \Gamma(L)Z_t \), is the conditional mean and \( Z_t \) denotes a set of exogenous variables. In variance equation \( q(L)\sigma_{t-1}^2 \) and \( p(L)v_{t-1}^2 \) denote the GARCH and ARCH terms, respectively.

This paper employs the GARCH(1, 1) process to estimate the monetary policy volatility. The model can be shown as follows:

\[ r_t = \alpha(L)r_{t-1} + \nu_t \]
\[ \nu_t \sim NID(0,1) \]  
(3)
\[ \sigma_t^2 = \gamma \sigma_{t-1}^2 + \rho v_{t-1}^2 \]  
(4)

where \( r_t \) denotes the monetary policy rate, i.e., the instrument of conduct of monetary policy.

2.2. Structural VAR:

Sims (1980) introduced the vector autoregressive (VAR) model as an alternative to the traditional simultaneous equation systems. Later, Milles (1998), Stock and Watson (2001), as well as others described that VAR provides a reasonable approach to summarize data, data description, forecasting and policy analysis. Now, the VAR model is a popular toolkit to analyze empirically multivariate time series, and can help to estimate the effect of unpredictable disturbances in an economy.

In response to some criticism to the VAR model (Cooley and LeRoy; 1985, Runkle; 1987) Sims (1986) and Bernanke (1986) introduced the structural VAR model simultaneously. Later, Blanchard and Quah (1989) employed the SVAR model to decompose the structural shocks into long run and short run, and Bayoumi and Echingreen (1993) employed a variant of this model to deal with the issue of macro disturbances through econometric estimations.

Note that in the literature of empirical studies, the transmission of shocks is mostly based on the small scale VARs. Stock and Watson (1996) argued that small-scale VARs are often unstable and provide poor prediction of the future. In this paper, we
employ a six-variable VAR model to examine the dynamic effects of international shocks on the New Zealand economy. In our study we consider three types of shocks: internal, regional and global. The regional shocks affect New Zealand from the inside of that area but the global shocks affect the countries from outside of the area. Thus our model can be written as:

\[ x_t = \Psi(L)y_{t-1} + \Phi(L)\vartheta_{t-1} + \xi_t \]  

(5)

where \( x_t = (y_t, \vartheta_t)' \), \( y = (gdp^d, p^d, er^d)' \) and \( \vartheta = (v^g, v^r, v^d)' \), \( gdp^d \) is the real output, \( p^d \) shows the price level, \( er^d \) indicates the real exchange rate and \( v \) shows the volatility of monetary policy. The superscripts \( g, r, d \) refer to global, regional and domestic, respectively. Our structural model can be written as:

\[ x_t = \Omega(L)\zeta_t \]  

(6)

where \( \zeta_t \) shows different types of serially uncorrelated and orthonormal shocks, and \( \Omega(L) = [\Omega_{ij}(L)] \) is a \( 6 \times 6 \) matrix that defines the impulse response of the endogenous variables to the structural shocks. To identify this model, we need to impose 15 contemporaneous restrictions on the coefficients of our structural model as follow:

\[ \Omega_{ij} = 0; \quad \forall i < j \]  

(7)

The reduced form of VAR model for estimation is given by:

\[ x_t = \Lambda(L)x_{t-1} + \zeta_t \]  

(8)

where \( \Lambda(L) = [\Psi(L)] \), and \( \zeta_t \) indicates the vector of reduced form error term.

3. Empirical Evidence:

This section uses the described models to estimate the volatility of monetary policy and analyze the impact of international and domestic volatilities on the economy of New Zealand. Kydland and Prescott (1990) argued that supply shocks must be responsible for any business cycle that happened in any economy. So, we employ the correlation of supply shocks between our sample countries and USA, UK and the Euro Area to find the main source of global shocks.

**Table 1: Correlation of Supply Shocks**

<table>
<thead>
<tr>
<th></th>
<th>USA</th>
<th>UK</th>
<th>Euro Area</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>0.2923</td>
<td>0.1964</td>
<td>0.2147</td>
<td>1.0000</td>
</tr>
<tr>
<td>New Zealand</td>
<td>0.1095</td>
<td>0.2028</td>
<td>-0.1164</td>
<td>0.1740</td>
</tr>
</tbody>
</table>

Table 1 shows that the correlation of supply shock between our sample countries and UK are positive and relatively bigger than the correlation by the United State.
and the Euro Area\textsuperscript{2}. This study assumes that the source of regional shocks is from Australian economy.

3.1. **Estimated Monetary Policy Volatility:**

Our estimation shows all estimated coefficients of conditional variance are positive and have all properties of a well-estimated time series model. Figures 1-3 show the estimated volatility of monetary policy for UK, Australia and New Zealand\textsuperscript{3}. During the period of this study the Reserve Bank of New Zealand has three different governors\textsuperscript{4}.

During Donald Brash’s period, a large amount of volatility can be seen, due to several external shocks: Persian Gulf War in early 1990s, inflation targeting adoption since 1990, increase in the house price inflation due to the jump in the migration to New Zealand and South East Asian Crisis. During the Bollard’s Period, New Zealand experienced a period of tranquility until the current financial crisis. Since then, again we can see a period of tranquility.

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\textsuperscript{2} Perhaps the most striking result of this table is the negative correlation between New Zealand and the Euro Area.

\textsuperscript{3} This paper uses the interest rate as an instrument of monetary policy, so, the innovation in this variable behaves as the measure of monetary policy action.

Furthermore, the results confirmed that the volatility of monetary policy in New Zealand is permanent. The estimated coefficient of ARCH and GARCH are 0.66 and 0.4 respectively. The sum of these two coefficients is almost equal to one, indicating that the volatility is quite persistent.

Figure 2: The Volatility of Monetary Policy in Australia

Figure 3: The Volatility of Monetary Policy in New Zealand

Figure 4 compares the global, regional and domestic volatilities of monetary policy during the period of this study.
3.2. **Results of SVAR Estimation:**

This section reports the empirical results of the estimation of SVAR. Quarterly data from 1988:Q1 to 2014:Q1 is used. The data are collected from IFS. The number of lags in the model is equal to two and based on the Shwarz Information Criterion. The stability test indicates that our VAR has fulfilled these properties. And finally the Eviews software is used for these estimations.

We report the results based on the impulse response and the variance decomposition. As we know the impulse response functions show the dynamic effect of shocks on the adjustment path of the variables. The variance decomposition measures the contribution of different type of shocks to the forecast error variables. The computation of these two measurements is useful in assessing how shocks to economic variables transmitted through a system.

**3.2.1. Impulse Response of the Volatility of Monetary Policy:**

i. **Australia:**

Figures 4 to 6 plot the impulse-response to one standard deviation in the variance of the volatility of global, regional and domestic monetary policy shocks, respectively. In all these three cases, the impact of the monetary policy volatility on real output and price level is fairly persistent and do not dissipate even after 70 quarters. So, the produced movements in the output and price level that come from the volatility of monetary policy never die out. The effect is small but permanent.
In particular, the impact of international volatility of monetary policy shocks on real output and price is negative and persistent. But domestic shocks have different story and show a puzzling result. Domestic shocks of the volatility of monetary policy have long run positive permanent impact on the output and price. At first it has a negative effect on price level, but after 20 quarters it becomes positive and stays positive permanently.

5 In this study the innovation in OCR (Official Cash Rate) that is the wholesale price of money, which is set by the Reserve Bank of New Zealand (RBN), uses as measure of monetary policy action.
ii. New Zealand:

It seems that the high level of migration (demand pressure) and the overvaluation of New Zealand dollar (since 2000) can be two main reasons for this puzzle. Figures 8 and 9, show the trend of OCR and exchange rate during the period of study.
3.2.2. The Forecast Error Variance Decomposition:

The variance decompositions of the SVAR model of New Zealand is given in Table 2. The ordering of variables in the VAR model is as follows: 

$v^g \rightarrow gdp^r \rightarrow p^r \rightarrow v^r \rightarrow er^r \rightarrow gdp^d \rightarrow p^d \rightarrow v^d \rightarrow er^d$
At first we consider the immediate reaction then analyze the long run effects. The forecast horizon is 12 years.

3.2.2.1. The Variance Decomposition of $gd{p}^d$:

First part of Table 2 shows the forecast variance decomposition of $gd{p}$ in New Zealand. In the first quarter 99 percent of the variance of $gd{p}$ is driven by its own innovation, and there are no significant instantaneous effects from other variables. But, during the time the share of exchange rate dramatically increased, for instance after 40 quarters, it reaches to near 35 percent. In the long run less than 50 percent of the variance of $gd{p}$ is driven by its own innovation and 8, 5, and 2 percent of the variance of $gd{p}$ are driven by domestic, global and regional volatilities of monetary policy, respectively. As we can see, the effect of exchange rate increases over time. This means that the New Zealand economy heavily depends on international trade.

3.2.2.2. The Variance Decomposition of $p^d$:

The
second part of Table 2 represents the forecast error variance decomposition of general price level in New Zealand. At the first quarter almost all of the variance driven by its own innovation. During the time the share of $gd_{d}^{d}$ and $er_{d}^{d}$ increased for instance after 40 quarters near 52 percent of the variance of the price level is driven by $gd_{d}^{d}$ and exchange rate. The share of innovations of domestic, global and international volatilities of monetary policy is 5.5, 3.7 and 1.6 percent, respectively.

3.2.2.3. The Variance Decomposition of $v_{d}^{d}$:

It can be seen that in the first quarter 74 percent of domestic volatility of monetary policy is driven by its own innovation. It means the instantaneous effect from other variables especially international volatility shocks is near 26 percent. In long run the effect of exchange rate increases to 15 percent.

3.2.2.4. The Variance Decomposition of $er_{d}^{d}$:

As is immediately evident, almost all of the forecast error variance of exchange rate is driven by its own innovation. During the time, the effect of global volatility shock increases to almost 15 percent. After 40 quarters $gd_{d}^{d}$ innovation is near 6 percent of the forecast error variance decomposition of exchange rate.

Overall, it can be seen that in the long run exchange rate has an important role in analyzing the forecast error variance decomposition in New Zealand.

4. Conclusion Remarks:

This paper applies a structural VAR to determine the interaction between international and domestic volatility of monetary policy shocks and the level of other endogenous variables. This dynamic interaction can show the impact of volatility shocks on real economy. We use a GARCH process to find the amount of volatility and employ a structural VAR to estimate the dynamic relations between volatility shocks and these variables.

Results indicate that the volatility of monetary policy shocks, in all levels, have permanent and significant effect on real variables. Although, there is a wide consensus in the literature that money has real effects in the short run and neutral in the long run, but the volatility of monetary policy shocks has permanent effect on real parts of the economy.

Results of forecasting variance decomposition confirm the findings of impulse response function and of course show that due to the fact that New Zealand
heavily depends on international markets, global and regional monetary shocks can have a permanent and significant impact on the local economy.

References:


