Chapter 1

MONETARY POLICY TRANSMISSION IN BRUNEI DARUSSALAM: A STUDY ON THE IMPACT OF EXCHANGE RATE SHOCKS ON BRUNEI'S CPI[1]

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1. Introduction

Understanding how monetary policy works remains a key issue for both policymakers and academic researchers. There have been ample studies done to study the effects of monetary policy on the real economy and yet no consensus has been reached on the exact functioning of a monetary policy transmission mechanism. In general, monetary policy transmission refers to the changes in a country's aggregate demand or inflation that stem from changes in monetary policy decisions such as changes on the interest rate, money supply or exchange rate. There are a number of transmission channels that have been identified in the past literature, including the interest rate channel, bank lending channel, asset prices channel and exchange rate channel. However, there is still a gap in the literature on how the monetary policy transmission works in countries with a currency board system.

Under a currency board arrangement (CBA), a country pegs its domestic currency to an anchor (foreign) currency. Such a system is popular in use by small and open economies such as Brunei Darussalam and Hong Kong. In the past, a CBA was adopted to address specific economic challenges such as hyperinflation (Argentina and Bulgaria) and to facilitate transition economies (Estonia and Lithuania). However, there are a few issues that arise when attempting to understand the dynamics of monetary policy transmission in a country with a currency board. This is because, under a currency board, the central bank does not make any independent monetary policy decisions, which consequently limits monetary policy exercises. Domestic interest rates and money

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supply are treated as endogenous while anchor-currency monetary policy is seen as an exogenous change in monetary policy stance.

This paper therefore attempts to address the gap in the literature on monetary policy transmission under a currency board arrangement, using Brunei Darussalam as a reference country. Brunei Darussalam is a small and open economy that is reliant on international trade. For over almost five decades now, Brunei has been operating a currency board arrangement and a Currency Interchangeability Agreement (CIA). Since the Autoriti Monetari Brunei Darussalam (AMBD) does not conduct active monetary policy due to the currency board arrangement, this paper thus focuses on the Singapore exchange rate as the main source of monetary policy shock.

The paper is organized as follows. Section 2 provides an overview of monetary policy in Brunei Darussalam and a brief insight on how decisions by the Monetary Authority of Singapore (MAS) on the Singapore Nominal Effective Exchange Rate (SNEER) could impact Brunei's real economy. Section 3 provides a brief literature review on monetary policy transmission in economies similar to Brunei's, focusing explicitly on the exchange rate channel. Section 4 explains the data and methodology used to assess monetary policy transmission in Brunei Darussalam while the empirical results are discussed in Section 5. Finally, Section 6 concludes with discussions of our results.

2. Overview of Monetary Policy and Monetary Transmission in Brunei Darussalam

As with other small and open economies such as Hong Kong, an exchange rate policy is the preferred choice for monetary policy in Brunei Darussalam. Ensuring exchange rate stability is vital for Brunei whose total exports account for approximately 60% of its Gross Domestic Product. Furthermore, 90% of these exports are attributed to the oil and gas sector.

For almost five decades now, Brunei Darussalam has operated a Currency Board Arrangement (CBA) with the Republic of Singapore, where the Brunei Dollar is at par with the Singapore Dollar whereby the currency in circulation must be backed up by not less than 100% with foreign assets, as stated in the Currency and Monetary (Amendment) Order, 2010. The Currency Interchangeability Agreement (CIA) between the two countries, which took effect on 12 June 1967, provides the basis for these arrangements. Under the CIA,

the domestic currencies in both countries are customary tender in the other country, where the monetary authorities and banks of each country are obliged to accept the currencies of the other country at par and without charge.

With the CIA in place, it does not only assist in encouraging bilateral trade, investment and tourism between Brunei and Singapore but it also promotes strong political cooperation between the two countries. In 2014, Singapore was the third largest trading partner for Brunei Darussalam, accounting for 21.7% of imports of goods (B$931.7 million) and 3.3% of exports of goods (B$446.1 million) (JPKE 2014). Singapore was also the source of 2.8% of total foreign direct investment (B$41.9 million) into Brunei Darussalam in 2011 (JPKE 2012). As of end 2013, banking institutions licensed in Brunei Darussalam had B$5.08 billion (26.3% of total assets) in investments and placements in Singapore.

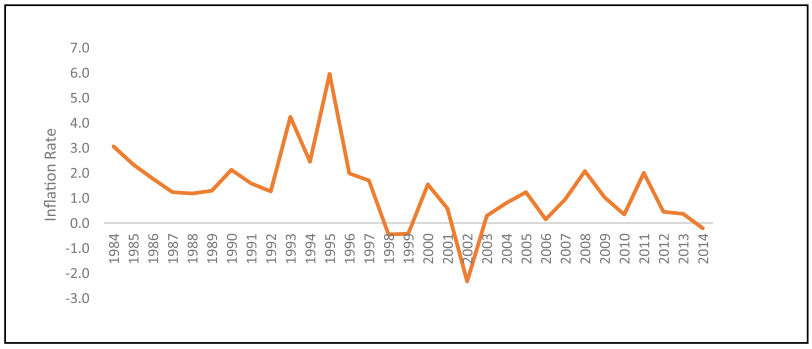
Due to the peg to the Singapore Dollar, the Brunei Dollar is directly affected by the decisions of Monetary Authority of Singapore on the conduct of its monetary policy. Unlike most central banks that choose the interest rate as its monetary policy instrument, the Monetary Authority of Singapore targets the Singapore Dollar Nominal Effective Exchange Rate (S$NEER) which is managed within a policy band. The slope and width of the exchange rate band, as well as the level at which the band is centered, are calibrated to attain the optimal monetary policy stance for the Singapore economy to ensure low and stable inflation over the medium-term.

This policy has boded well for Brunei, for which the monetary policy objective, among others, is to achieve and maintain domestic price stability. In fact, the International Monetary Fund (IMF) has commended the currency board arrangement and the Currency Interchangeability Agreement (CIA) as one of the key contributors to Brunei Darussalam's macroeconomic stability.

Apart from that, the Government of Brunei Darussalam has also implemented price controls and subsidies on several items to help ensure prices of necessities are affordable for the low-income group. The Price Control Act (Cap 142) commenced in 1974 but was revised further over the years. The Price Control Act Amendment Order 2012 caps the price of cars, rice, sugar, plain flour, baby milk powder, milk, petrol, automotive oil (diesel), dual purpose kerosene, bottled liquefied petroleum gas, cooking oil and construction materials such as sand, stone (aggregate 3/4), cement, bitumen, asphalt, ready-mix concrete and bricks (clay and concrete). In a study by Koh (2015), it was estimated that 31.9% of the total CPI is subject to subsidies and price controls.

Such measures along with the exchange rate policy have helped to keep the inflation rate in Brunei Darussalam at low levels over the years, as shown in Figure 1 below. The average inflation rate from 1984 until 2014 is about 1.2%.

Figure 1
Inflation Rate in Brunei Darussalam 1984-2014
(Annual % Change in CPI)



Source: World Development Indicators.

Furthermore, a major source of inflation in Brunei is assumed to stem from imported inflation as about 80% of its food requirements are imported from other countries (UNFAO, 2015). Food items, in turn, have the highest weight in the country's CPI basket of goods and services. The strong Singapore Dollar, has thus, helped to contain inflationary pressures from abroad.

3. Literature Review

Earlier research on monetary policy transmission largely involves the study of how an interest rate shock or a change in base money supply impacts the aggregate demand or the level of inflation in an economy. Under a currency board arrangement, however, due to the endogeneity of interest rate and money supply, the anchor currency monetary policy would instead play a more significant role. For Brunei Darussalam, this would imply that Singapore's monetary policy, which is its exchange rate policy of the SNEER, would have an impact on Brunei's economy through, presumably, the exchange rate channel. For this reason, this section will, therefore, solely concentrate on past literature on the exchange rate channel as a form of monetary policy transmission.

Mishkin (1996) previously highlighted the growing importance of the exchange rate channel in today's globalized economy. This channel operates through exchange rate effects on net exports where, in theory, changes in the exchange rate induce changes in relative prices of goods and services, and consequently, could lead to adjustments in the spending pattern by individuals and firms. For instance, an appreciation in the exchange rate will increase the relative prices of exports and make imported goods relatively cheaper to local residents in the country. Assuming that exports and imports are perfect substitutes and are price elastic, changes in their relative prices will lead to an increase in the consumption of imported goods by local residents and/or lower exports by foreign buyers. This could, therefore, lead to a fall in the country's output growth. Furthermore, an exchange rate appreciation could also translate into a decline in net wealth of a country, assuming that it has a significant level of wealth denominated in foreign currency. This could, in turn, lower the level of the country's expenditure.

Other past research also analyzed the exchange rate pass-through effect on domestic prices in a country. A 'complete' exchange rate pass-through occurs when the response of domestic prices to exchange rate changes is one for one. In other words, a complete exchange rate pass-through occurs when prices of imported goods, usually invoiced in foreign currency, are sold to consumers for local currency at the going market exchange rate.

Olivei (2002) and Campa and Goldberg (2005) argued that a few factors may determine the degree of exchange rate pass-through to domestic prices in a country. This includes the pricing behavior by exporters in the producer countries, the responsiveness of mark-ups to competitive conditions and the existence of distribution costs that may drive a wedge between import and retail prices. In fact, Mihaljek and Klau (2001) highlighted that, empirically, the measured pass-through is usually the highest for imported goods prices and lowest for consumer prices. This is reaffirmed with other past studies such as Burstein et al. (2005), Goldberg and Campa (2010) and Burstein and Gopinath (2014).

Apart from that, the composition of imports may also affect the extent of exchange rate pass-through to domestic prices. A complete pass-through was generally found for energy and raw materials and lower pass-through for food and manufactured items (Mihaljek and Klau, 2001). In addition, Gopinath (2015) argued that the exchange rate pass-through to CPI is considerably lower due to a lower import content in the consumption bundle compared to an exchange rate pass-through to the Import Price Index (IPI).

At the time of writing, there has not been any research done to study the monetary policy transmission mechanism in Brunei Darussalam. However, AMRO[4] (2013) analyzed the determinants of inflation in Brunei Darussalam using a VAR model and found that inflation was mostly determined by its own lag rather than on other foreign variables such as Singapore inflation, global oil prices or even Brunei M2 growth. In fact, global oil prices and Singapore inflation only accounted for 4.7% and 5.3% respectively, of Brunei's inflation, suggesting low pass-through of foreign variables into Brunei Darussalam's economy. Nevertheless, this study focused on the overall CPI rather than analyzing the imported component of CPI, where the presence of administrative price controls could have hindered the effect of foreign variables in Brunei's CPI.

Focusing on the earlier studies on monetary policy transmission in small and open economies, we have found ample evidence on the impact of exchange rate disturbances on the macroeconomy. Chew et al. (2009) attempted to study the exchange rate transmission channel in Singapore via the pass-through to import prices and domestic consumer price index (CPI) and they found that the exchange rate pass-through to CPI was fairly low. Their results showed that a 1% appreciation in the S$NEER led to a 0.1% decline in the domestic CPI in the short-run and a 0.4% decline in the long-run.

Similarly, Liu and Tsang (2008) found that a 1% depreciation of the Hong Kong NEER would lead to a range of 0.09-0.13% increase in domestic prices in the short-run and 0.13-0.25% increase in domestic prices in the medium-run. Comparing this to Singapore, we can see that the impact of exchange rate shocks to domestic CPI in the short-run effect is quite similar, although the long-run impact for Singapore is marginally higher. This may, in part, be due to the different components in the CPI basket and more importantly, the varying import content present. Singapore, in particular, has about 40% of imported items in their CPI (Loh, 2001) while Hong Kong has about 28.7% (Liu and Tsang, 2008). The higher import content in Singapore's CPI basket can, therefore, arguably explain the higher impact of exchange rate shock to the country's CPI.

Nevertheless, recent studies (Mihaljek and Klau, 2008) have questioned whether the exchange rate pass-through has declined in emerging market economies as central banks become more independent. Their findings showed that as nominal exchange rates became more volatile, the exchange rate pass-through also declined. Indeed, they noted in their study that countries with a

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fixed exchange rate such as Hong Kong as well as Malaysia and Thailand in the early periods of the 1990s, had fairly stable exchange rate pass-through in comparison to other countries with a floating exchange rate regime. However, it was also argued that other factors, apart from the choice of the exchange rate, could have also contributed to the declining exchange rate pass-through such as lower volatility of domestic inflation and foreign prices. The former was confirmed in a study by Gagnon and Ihrig (2001) who found that the decline in the strength of pass-through effects from exchange rate to inflation is commonly associated with countries that have low inflation levels.

Based on the literature review, we can therefore make an initial assumption that due to the currency board arrangement between Brunei Darussalam and Singapore, shocks to the S$NEER, the anchor currency in Brunei, could have an impact on the domestic CPI, through import prices. This is due to the high number of imported goods that are included in the CPI basket. The next section will present the methodology on how we test for these predictions, followed with a description on the data used.

4. Data and Research Methodology

To assess the impact of exchange rate to domestic CPI, this study uses a Vector Autoregressive (VAR) model. VAR modeling involves "estimating a system of equations for which each variable is expressed as a linear combination of lagged values of itself and all other variables in the system" (Weinhagen, 2002, p.4). We have constructed a VAR model consisting of four variables which includes inflation, import growth (in nominal and real terms) and exchange rate. We include both import growth in nominal and real terms to assess any impact of exchange rate changes to the volume of imports as well as the prices of imports. The exchange rate is the trade-weighted exchange rate of Singapore against its major trading partners while inflation is the consumer price index (CPI) sourced from the Department of Economic Planning and Development. Due to the currency board arrangement where the Brunei Dollar is pegged to the Singapore Dollar, we assume that any monetary policy shocks on the Singapore Dollar will be fully reflected on the Brunei Dollar. This study has also included three other variables including global oil prices, global food prices and world inflation which are assumed to be exogenous in the model. These variables are meant to capture inflationary pressures from abroad which could affect domestic inflation in Brunei. We use a VAR approach to estimate the following:

$$y_t = \alpha + A_1 y_{t-1} + \cdots A_k y_{t-k} + Bx_t + \varepsilon_t$$

for t=1,2…. T; where y is a vector of endogenous variables that includes SNEER, nominal import growth, real import growth, CPI and x includes global oil prices and world inflation sourced from Bloomberg as well as global food prices as found from the Food and Agriculture Organization of the United Nations. The model is estimated for the period beginning in January 2005 until December 2014 using monthly data. Due to the differences in the frequency of data, we have converted quarterly imports data to monthly data using E-Views.

In order to ensure the stationarity of the data, we applied the Augmented Dicky-Fuller unit root test on level forms for all variables described above. The test suggests that all variables have I(1) order of integration.

In order to choose the optimal lag length, the Schwarz information criteria suggests that 2 lags need to be included in the model. However, serial correlation is detected among the residuals when only 2 lags are included in the VAR model. Hence, we have included 8 lags to overcome this problem.

To assess the stability of the model, we applied the Roots of AR Characteristics Polynomial. The results show that our VAR model satisfies the stability condition. In addition, we also used the LM test to detect for autocorrelation which subsequently reveal that there was no serial correlation problem in our model.

5. Empirical Results and Case Study

5.1 Impulse Response Analysis

As discussed in the previous section, this study used a VAR model to assess the impact of the exchange rate to the real economy, particularly using the Singapore exchange rate as the policy shock and imports and inflation as the macroeconomic variables. Figures 2 to 4 below depict the impulse response functions to the exchange rate shock.

Figure 2
Response of Real Imports to SNEER

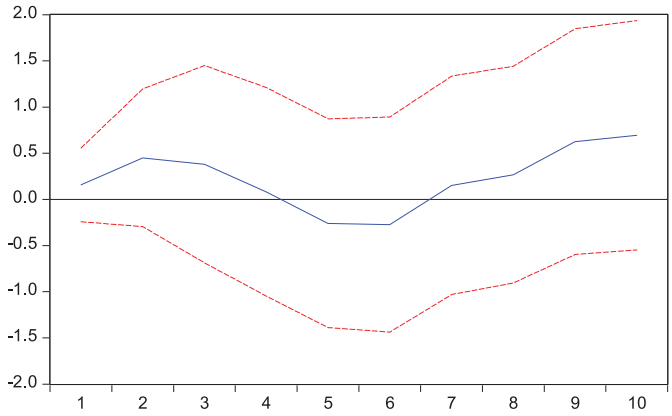


Figure 3
Response of Nominal Imports to SNEER

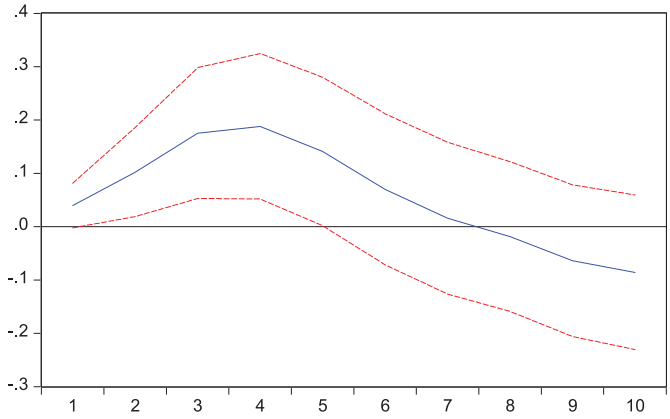


Figure 2 plots the response of real imports to exchange rate shocks while Figure 3 plots the response of nominal imports to exchange rate shocks. As seen from the graphs above, a positive exchange rate shock did not produce any statistically significant response to real imports, suggesting that volume of imports may not be affected by changes in the exchange rate. However, as seen from Figure 3, shocks to the SNEER led to a rise in nominal imports or presumably, import prices if, as implied from Figure 2, that volume of imports remains

unchanged. A 1% appreciation of the SNEER produced a 0.2% rise in nominal imports growth in the first three months. However, our results become statistically insignificant after five months.

Figure 4
Response of CPI to SNEER

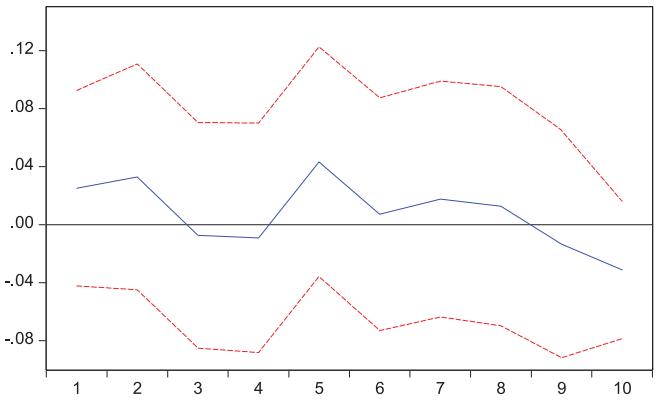


Figure 4, on the other hand, depicts the response of a positive exchange rate shock to domestic CPI where shocks to the exchange rate did not produce statistically significant responses to CPI. This implies that the exchange rate (SNEER) does not significantly affect domestic CPI and that there are other factors which could affect domestic CPI in Brunei.

5.2 Variance Decomposition Analysis

As previously mentioned, a variance decomposition analysis is used to determine the relative importance of exchange rate and imports on CPI as reported in Table 1 below.

Table 1
Variance Decomposition of CPI

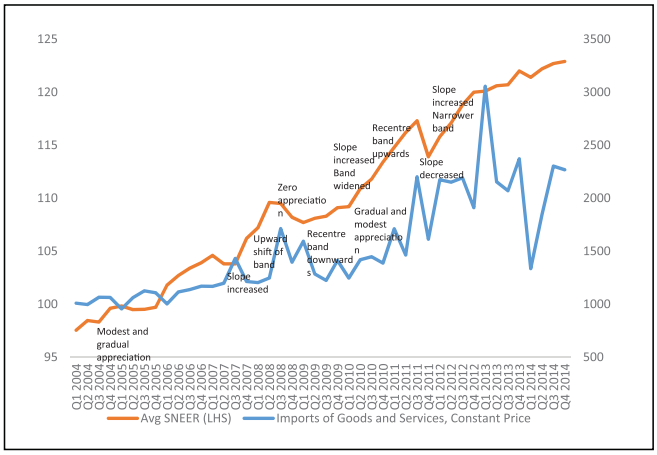
Horizon	Exchange Rate	Nominal Imports	Real Imports
6	2.37	3.25	2.49
12	3.07	4.65	5.17
18	3.06	4.53	6.28
24	3.22	4.41	6.17
30	3.15	4.68	6.09

For CPI, the percentage variance explained by the exchange rate and both nominal and real imports are very small, accounting for 2.37%, 3.25% and 2.49% respectively, in the first six months. The low values indicate that exchange rate disturbances do not pose a large impact on Brunei's domestic CPI.

5.3 Case Study: Singapore Exchange Rate Disturbances on Brunei's Economy

Apart from the empirical analysis above, we also created a simple case study to analyze the trends between the Singapore trade weighted exchange rate (SNEER) and real imports in Brunei Darussalam. As seen from Figure 5, the two variables tend to track one another, indicating high correlation (0.85) between the two. This suggests that an appreciation in the SNEER would lead to a rise in imports in Brunei Darussalam. This is because as the SNEER appreciates, prices of exports become more competitive relative to prices of imports. This in turn, would switch consumers' preferences to consume more imported goods.

Figure 5
Average SNEER and Total Real Imports

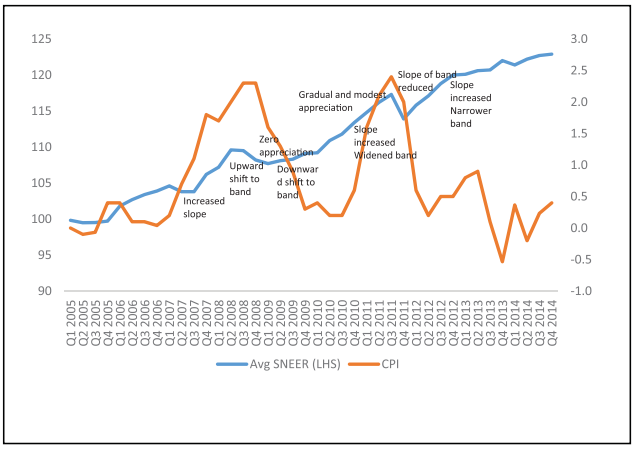


Source: JPKE and MAS.

In fact, as we can see from Figure 5, each time MAS announces a policy adjustment to the SNEER, this affects total imports in Brunei in almost all cases. For instance, a policy tightening by the MAS in Q2 2004 led to an upward trend in imports in the coming years. Similarly, when MAS announced a zero appreciation policy in Q4 2008, total imports started to decline, with the possibility of import prices becoming more competitive relative to prices of exports. This suggests that changes in the country's nominal exchange rate pose an impact to imports.

However, to assess whether these changes are transmitted to consumer prices, a simple analysis on the correlation of the SNEER and Brunei Darussalam's CPI was measured, as shown in Figure 6. As depicted in the graph, there is no significant correlation between the two (0.01). This suggests that any disturbances in the exchange rate will have no direct impact on domestic CPI. For instance, when the MAS tightened its policy beginning in Q4 2007, we would expect that the appreciation of the exchange rate would dampen inflationary pressures from abroad. However, as we can see from the graph, inflation actually rose in Brunei.

Figure 6
Average SNEER and CPI



Source: JPKE and MAS.

This finding, again, contrasts with our earlier assumption where we argued that due to the high number of imported items in the consumer basket included in the CPI, inflation in the country will be heavily influenced by exchange rate movements, or the SNEER. However, as evident from Figure 6, this is not the case. We assume that this may be due to the presence of government fiscal policies such as price controls and subsidies on selected imported items particularly food items. Furthermore, imported goods may not reflect their actual prices due to the importers' choice to retain their profit margins. If imported goods with high elasticity of demand were priced according to their true prices, any rise in prices from the depreciation of the exchange rate, may push consumers to demand other cheaper goods available in the market. In addition, some importers may choose to import more in times of an exchange rate appreciation for inventory purposes and to only sell these goods at a later stage. Such move, in turn, may explain the low exchange rate pass-through to CPI in Brunei. Additionally, some importers may have a fixed agreement on the pricing of their imported goods which limits the sensitivity of exchange rate changes to retail prices.

6. Conclusion

In this study, we have employed a VAR model to examine the impact of the Singapore exchange rate on the macroeconomic environment in Brunei Darussalam, particularly on domestic CPI. Our empirical findings from both the impulse response and variance decomposition analyses suggest that changes in the Singapore exchange rate do not significantly affect the domestic CPI. We attribute this to the existence of price controls and other government policies, particularly on food items in the country, which hamper the full transmission of the exchange rate to domestic prices. Nonetheless, we undertook a simple case study to assess the movements between the Singapore exchange rate and imports as well as CPI in Brunei. Our findings reveal that while imports and the Singapore exchange rate are highly correlated, there is no significant correlation between the exchange rate and the domestic CPI. This further implies that there is incomplete pass-through of exchange rate to domestic prices, which could be due to (i) administrative price controls; (ii) the choice of importers to adjust their profit margins rather than prices; (iii) the choice of importers to increase inventory of imported commodities without releasing it for sale to consumers; or (iv) importers having a fixed contract regarding the pricing of imported items which limit the sensitivity of any exchange rate shocks to the imported goods. Finally, we think that future research is needed to assess the domestic CPI, focusing particularly, on the imported CPI or with the elimination of the effects from fiscal policies such as subsidies and price controls.

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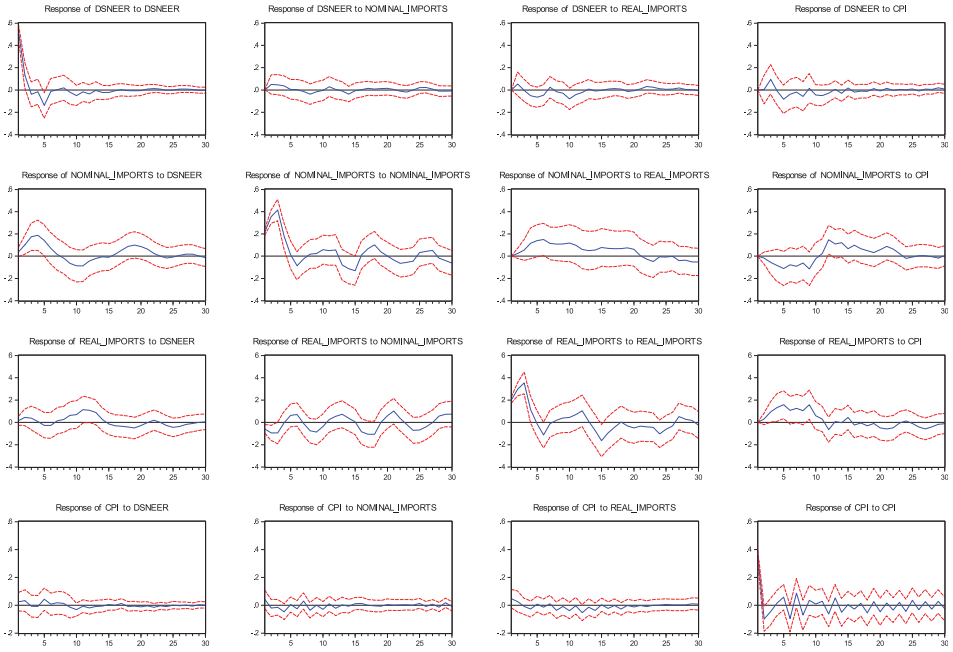
Appendices

Response to Cholesky One S.D. Innovations ± 2 S.E.



Variance Decomposition:

Period	S.E.	DSNEER	NOMINAL_ IMPORTS	REAL_ IMPORTS	CPI
1	0.515640	0.500383	1.348215	1.729901	96.42150
2	0.537341	1.242296	1.521918	2.082519	95.15327
3	0.549233	1.259203	1.654305	2.101963	94.98453
4	0.553113	1.287596	3.140105	2.588404	92.98389
5	0.579889	2.496676	3.045753	2.536227	91.92134
6	0.583098	2.369009	3.253482	2.491604	91.88590
7	0.584087	2.429331	3.601781	2.416721	91.55217
8	0.588659	2.412149	4.197105	3.048953	90.34179
9	0.590068	2.493842	4.163017	3.068538	90.27460
10	0.599242	2.986449	4.556325	3.834661	88.62257
11	0.603681	2.996301	4.581479	3.819990	88.60223
12	0.605767	3.065636	4.648842	5.168257	87.11727
13	0.605928	3.058560	4.580053	5.180515	87.18087
14	0.608206	3.012641	4.515881	5.814235	86.65724
15	0.608902	3.022607	4.578940	5.815906	86.58255
16	0.609293	2.999386	4.615416	6.053376	86.33182
17	0.609727	3.079608	4.607544	6.043789	86.26906
18	0.609957	3.057448	4.532968	6.284395	86.12519
19	0.610401	3.063510	4.540950	6.262975	86.13257
20	0.610687	3.088478	4.496428	6.256857	86.15824
21	0.611018	3.097033	4.490953	6.249195	86.16282
22	0.612072	3.188830	4.458136	6.247465	86.10557
23	0.612945	3.193521	4.453493	6.233201	86.11979
24	0.613073	3.215934	4.410656	6.173504	86.19991
25	0.613543	3.194229	4.462857	6.147227	86.19569
26	0.614148	3.182155	4.472233	6.116696	86.22891
27	0.614564	3.171025	4.481317	6.096094	86.25156
28	0.614720	3.175199	4.549049	6.068498	86.20725
29	0.615118	3.162091	4.664532	6.088002	86.08537
30	0.615265	3.151191	4.682298	6.091880	86.07463

Cholesky Ordering: DSNEER NOMINAL_IMPORTS REAL_IMPORTS CPI

Chapter 2

EVALUATING MONETARY TRANSMISSION MECHANISM IN INDONESIA USING A STRUCTURAL FAVAR APPROACH[1]

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1. Introduction

The monetary transmission mechanism is the process through which monetary policy decisions affect the economy in general and the price level in particular (ECB, 2015). Understanding how monetary policy affects the economy is essential for the central bank. To be able to design and implement its monetary policy properly, policymakers must have an accurate assessment of the timing and effects of their policies on the economy. To make this assessment, they need to understand the mechanisms through which monetary policy impacts real economic activity and inflation (Boivin et al., 2010).

Monetary policy works largely via its influence on aggregate demand in the economy. Nevertheless, the precise nature in which monetary policy is transmitted to the economy and price level is not easily determined as different channels work simultaneously with long, varying and uncertain time lags. Furthermore, the liberalization of trade, investment, and financial transactions can also have impacts on the transmission of monetary policy.

The monetary policy objectives or framework adopted in a country is closely related to the structural adjustment, degree of financial development, and the

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macroeconomic settings in which the monetary policy is implemented. In the case of Indonesia, some structural adjustments in economic sectors have occurred in the last few decades. The changes are strengthened by the faster pace in globalization and the financial crises of 1997/1998 and 2008/2009. These adjustments have major implications for monetary management and the transmission mechanism of monetary policy.

A major change in the conduct of monetary policy in Indonesia in the aftermath of the 1997– 2000 crises was the enactment of Act No. 23/1999 and its revision, Act No. 3/2004. The Act gives Bank Indonesia the single objective to achieve and maintain the stability of the rupiah. Bank Indonesia is also granted independence in formulating and implementing monetary policies. To achieve the objective, Bank Indonesia adopted a full-fledged inflation targeting framework (ITF) in July 2005.

The global financial crisis (GFC) in 2008/2009 also had an impact on monetary policy management in Indonesia. The GFC provided a lesson for central banks that while price stability should remain the primary goal, maintaining low inflation alone, without preserving financial stability, is insufficient to achieve macroeconomic stability (Juhro, 2014). The dynamic capital flows to emerging market like Indonesia also offers challenges for monetary policy implementation. More flexibility is required for monetary authorities to manage capital flows in the form of policy mixes between monetary and macroprudential policies. Furthermore for a small open economy like Indonesia, there is a case for managing the exchange rate to avoid excess volatility. Exchange rate and capital flow management play important roles in the inflation targeting framework in Indonesia.

The financial sector is also changing in Indonesia. The capital market as represented by the market capitalization/GDP ratio grew by 50% and the stock price index grew by 337% in the last decade (June 2005 to June 2015). Although the banking sector still dominates financing activities in Indonesia, the changing financial landscape also raises questions as to whether monetary transmission, especially through the banking channel or asset channel, has changed.

There have been many studies conducted in Bank Indonesia to assess the monetary transmission mechanism. The studies mainly use VAR and SVAR to evaluate whether monetary policy is transmitted in each channel. To complement the previous studies, the objective of this paper is to reinvestigate the effectiveness

of the monetary policy transmission in all the channels and identify the relative importance of the channels using Structural Factor-Augmented VAR (SFAVAR).

Factor-Augmented VAR (FAVAR), proposed by Bernanke, Boivin and Eliasz (2005) combines standard VARs with factor analysis to exploit large data sets. This approach allows a better identification of the monetary policy shock as it enables the use of unlimited variables to proxy theoretical constructs, such as the real activity, inflation and others. FAVAR thus eliminates the necessity of arbitrarily choosing a specific variable to represent an economic concept. Furthermore, with the flexibility of using many variables, this approach allows the study of all the channels and measure the relative importance of each transmission channel. We believe this research would contribute to the existing research on monetary policy transmission in Bank Indonesia.

The rest of the paper is organized as follows. Section 2 discusses the monetary policy and operations in Indonesia and assesses the transmission mechanism of monetary policy through various channels. The literature review is presented in Section 3. Section 4 discusses the methodology and data used in the empirical study. The empirical findings are discussed in Section 5 while Section 6 concludes the study.

2. Overview of Monetary Policy and Monetary Transmission

2.1 Overview of Monetary Policy Framework in Indonesia

Bank Indonesia was established in 1953 following the nationalization of the Javasche Bank NV and further regulated by the Central Bank Act Number 13 of 1968. Under the said Act, Bank Indonesia had multiple objectives of maintaining price stability and stimulating economic growth and employment. Bank Indonesia also served as a development bank.

During this time, Indonesia adopted foreign exchange controls under Act No. 32/1964 on Foreign Exchange Regulation. Under this regulation, foreign exchange obtained from natural resources and business operations in Indonesia is controlled by the state. Consequently, exporters must sell foreign exchange from their export proceeds in foreign exchange banks, which were subsequently sold again to Bank Indonesia. Also, residents and firms are required to register and store foreign-currency securities or bonds in government foreign banks. This policy, on the one hand, was quite successful in isolating the national economy against external influences, but on the other hand, created a black market for foreign exchange.

Therefore, since 1967, the stringency of the exchange controls was gradually reduced through Act No. 1/1967 on Foreign Direct Investment (FDI). The purpose of this Act was to attract capital inflows to finance domestic investments. In 1970, the government declared the rupiah a fully convertible currency (free foreign exchange regime), with no restrictions on the flow of foreign exchange into or out of Indonesia. Credit reform began in 1983 when the artificial restrictions on bank credit and the state bank interest rate were eliminated. Bank Indonesia reduced its significant role in refinancing bank loans and introduced Bank Indonesia Certificates (SBI) and money market securities which were issued and endorsed by banks. Subsequently, Bank Indonesia adopted indirect monetary policy to reduce the supply of reserve money, under which monetary policy transmission is viewed to run from monetary base (operating target) through monetary aggregate (intermediate target) to output and inflation (ultimate target).

Financial sector reform was taken further in 1988 when restrictions on the operations of foreign banks were eased, and the procedures for establishing branch banks were simplified. The bank reserve requirement was lowered successfully, reducing the spread between borrowing and loan rates. The re-utilization of the reserve requirement as an indirect instrument of monetary policy is intended to control bank credit in the light of the surge in capital inflows.

The economic and financial crisis in Indonesia in 1997 resulted in the worst recession the economy had ever experienced. One outcome was that the Government finally allowed the exchange rate to float freely in mid-August 1997. A major change in the conduct of monetary policy in the aftermath of the crisis was the new Bank Indonesia Act that gives the Bank full autonomy in formulating and implementing policies. Under this Act, Bank Indonesia has a single objective to achieve and maintain the stability of the rupiah (currency) value, meaning inflation and exchange rate. The Act also grants independence for the central bank in both setting the inflation target (goal independence) and conducting its monetary policy (instrument independence). After the amendment of the Central Bank Act of 1999, the new Act in early 2004 states that the inflation target is set by the Government, in consultation with Bank Indonesia. This stipulation implies that in conducting monetary policy, Bank Indonesia has only instrument independence and no longer goal independence.

Implicitly, the Act mandates the central bank to implement the monetary policy framework based on interest rates replacing the previous monetary targeting. The monetary targeting is considered no longer suitable for the development of the financial market, especially after the crisis period. The most dominant change is the increasingly important role of interest rates, compared

to the money supply, to monetary stabilization. The rapid development and innovation in the financial markets, the integration of the domestic financial market with the global market, as well as the development of financial market instruments that are sensitive to interest rates such as bonds and mutual funds contribute to the changes in the role of interest rate. Because these factors, Bank Indonesia adopted a full-fledged inflation targeting framework (ITF) in July 2005 (Goeltom, 2008). With the ITF, the inflation target is the overriding objective and nominal anchor of monetary policy. In this regard, Bank Indonesia will apply a forward-looking strategy to steer present monetary policy towards the achievement of the medium-term inflation target.

The inflation targets are set by the Government in coordination with Bank Indonesia. For 2015-2017, the Government has set the CPI inflation target at 4% with a deviation of ± 1% and for 2018, the target is 3.5± 1%. These targets are consistent with the process of gradual disinflation towards a medium- to long-term inflation target of around 2-4%, comparable to other economies.

The BI rate is the policy rate that is used to convey the monetary policy stance. This rate is determined in monthly meetings of the Board of Governors and announced openly to the public. The monetary policy stance would consist of change or no change of BI Rate. The BI rate is translated into the operational target - the overnight interbank money-market rate (O/N interbank rates).

The monetary operations aim to keep the movement of O/N interbank rates around the BI rate. If movements in the overnight interbank rate do not deviate far from the anchor (the BI rate), Bank Indonesia will work consistently to safeguard and fulfil the liquidity needs of the banking system while maintaining the equilibrium for formation of fair, stable interest rates.

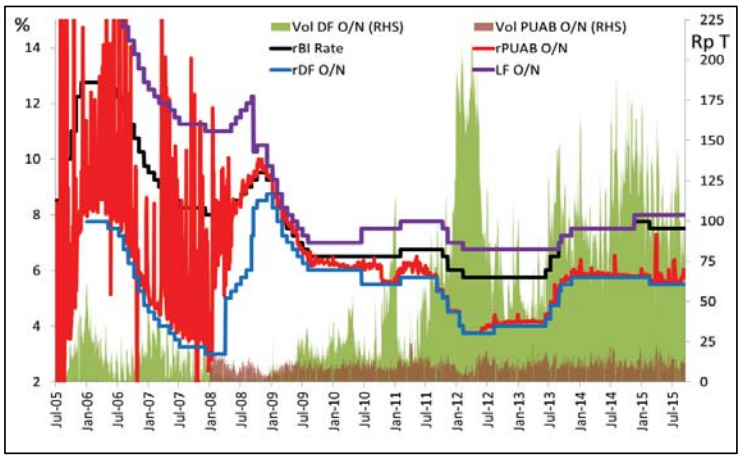
The operational target is attained by monetary operation through Open Market Operations (OMO) and the Standing Facility. Activities of OMO consist of the issuance of Bank Indonesia Certificates (SBI), repo and reverse repo transactions, term deposits, securities trading, and intervention in the foreign currency market. Eligible assets for repo and reverse repo transactions are SBI and Government Securities. The Standing Facility consists of the lending facility and deposit facility.

The full implementation of the monetary policy framework with the BI rate as the target for O/N interbank rates started on 9 June 2008. However, since the third quarter 2009, the implementation faced new challenges. The monetary easing measures by the Fed. Reserve resulted in surges of capital flows into

emerging markets, including Indonesia. Consequently, the pressure of exchange rate appreciation and overshooting of financial asset prices could not be avoided. The decision to cut the BI rate was insufficient to withstand the rapid capital inflows. To mitigate these risks, Bank Indonesia sterilized the market by increasing the accumulation of foreign exchange reserves, on the one hand, and adding to the excess liquidity and increases the monetary burden, on the other.

Bank Indonesia responded to the situation by modifying the monetary operations since October 2010. Since that period, Bank Indonesia maintains an asymmetrical corridor and, as a result, the O/N interbank rates tend to move closer to the Deposit Facility rate (Figure 1).

Figure 1
Policy Rate and O/N Interbank Rate



2.2 Main Monetary Policy Transmission Channels in Indonesia

The financial structure in Indonesia is more bank-oriented than capital market oriented. The banking system dominates 70-80% of assets in the financial system. Bank credit also dominates financing activities to the amount of US$ 40.74 bn or a share of 83% in 2014 (Figure 2). In terms of outstanding credit (Figure 3), the ratio of bank credit in 2014 was approximately 74.12%, which is higher than the previous year (73.17%) and the 4-year average (71.59%). The increasing share of credit banking is mainly due to slow growth of financing from the bonds market and Non-Bank Financial Institution (NBFI) credit.

Figure 2
Financing Activity (Flow in US$ bn)

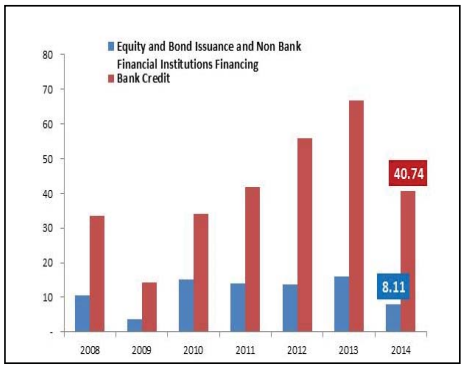
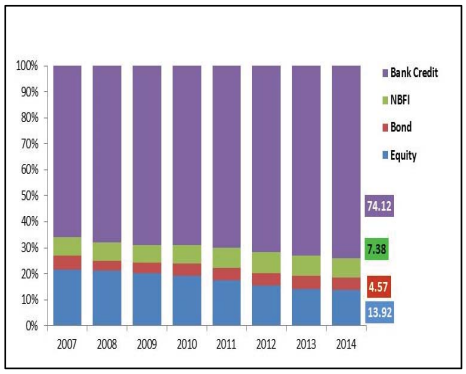


Figure 3
Financing Structure (Position %)



Given the dominance of banking system, the interest rate and banking lending channels are assumed to play important roles in monetary transmission. Under the ITF era, transmission mechanism through the interest rate channel appears to work. As shown in Figure 4, the BI rate movement is followed closely by the Indonesia Deposit Insurance Corporation (IDIC) rate. The 1-month deposit rate and the loan rate also appear to follow the BI rate. Credit growth seems to respond to the loan rate. As the loan rate increases, credit growth is slowing down (Figure 5).

Figure 4
Bank Interest Rate and Policy Rate

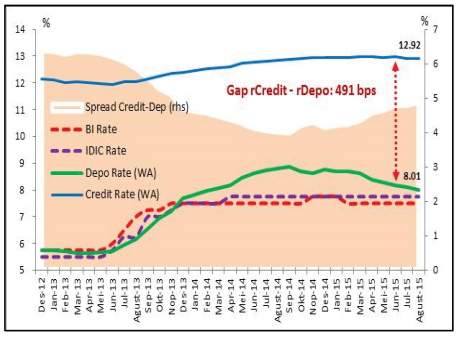
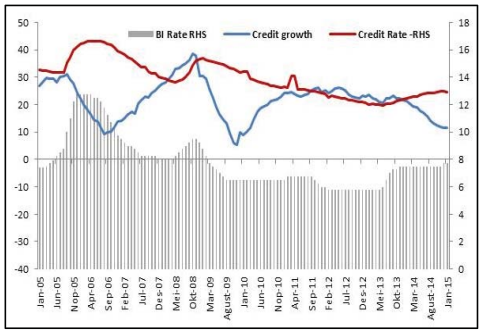


Figure 5
Loan Rate and Credit Growth



The money and credit growths appear to follow a similar pattern and have impacts on inflation (Figure 6). The average duration impact of M1 growth on inflation is 5-6 quarters, and credit growth to inflation is around three months

(Juhro, 2010). In a small open economy like Indonesia, the exchange rate also has an important role in transmitting monetary policy, in that exchange rate movements significantly influence the development of aggregate demand and supply, and thus output and prices. As shown in Figure 7 before the GFC, there was a significant pass-through effect of the exchange rate to inflation implying that depreciation leads to inflation, but the impact appears to have weakened in recent periods.

Figure 6
Monetary Aggregates and Inflation

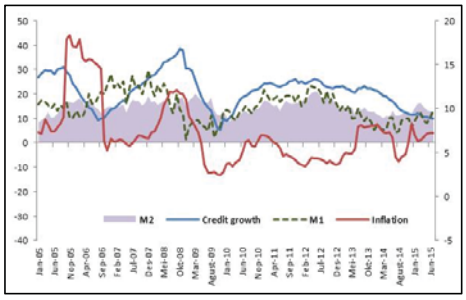
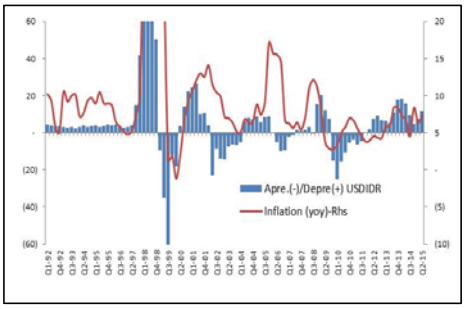


Figure 7
Exchange Rate and Inflation



We also conduct event analysis to see whether the market rates respond to a monetary policy shock. Figure 8 depicts the response of the different maturities of deposit rates following the 25-bp increase of BI rate in the year 2005-2014. There are 12 episodes of 25-bp BI rate increase in the year 2005-2014. The lines in the graph depict the average of the deposit rates at four occasions namely the day of the Board of Governors' (BoG) meeting, one day after BoG, seven days after BoG, and a day before the next BoG. The blue panel is the difference between the deposit rate of 1 day before the next BoG and on the day of BoG.

Following the increase of the BI rate by 25-bps, the deposit rates also increase during the absorption period where the rates keep increasing until one day before the next BoG meeting. The blue panels show that the increase in deposit rates is smaller for the longer maturity of deposits. Government bonds also show a similar response as can be seen in Figure 9. For different maturities of government bonds, the yields increase following the BI rate increase. The yields keep increasing until the day before the next BoG meeting. This analysis shows that the monetary policy appears to be transmitted to the banking and capital market.

Figure 8
Bank Deposit Rates

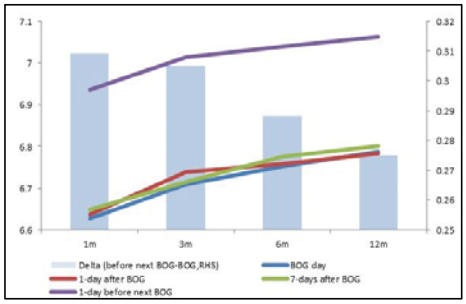
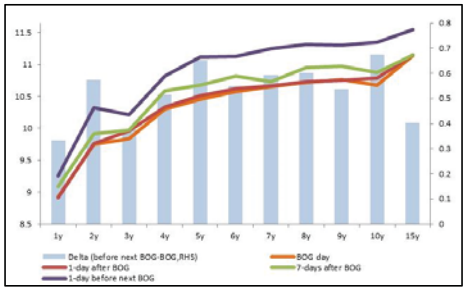


Figure 9
Government Bond Yields



3. Literature Review

There have been several studies on monetary transmission in Indonesia. A study by Warjiyo and Agung (2002) compiled the research for every transmission channel conducted in early 2000. Goeltom (2008) summarized the same studies with several additional research conducted after 2002. Further studies in 2009 and post-GFC usually focused on specific channels to answer specific questions.

The studies usually use VAR/SVAR methodology to account for endogenous relationships and summarize the empirical relationships without placing too many restrictions on the data (Berkelmans, 2005). While a SVAR model is compatible with many different economic theories, the estimates can be sensitive to the set-up of the model. Previous studies using SVAR usually employ different sets of variables in the model and thus a comparison between the studies is not easy. Furthermore, the study of the individual or specific channel does not allow the identification of the relative importance of the transmission channels. This information is relevant given the change in the economy and financial system. For example, a growing capital market and surging capital inflows could imply that the asset price channel is stronger than before (Tahir, 2012). Another situation is when the foreign banks' share of the domestic financing is dominant. This situation may imply that the bank lending channel could be weaker as foreign banks are less affected by the domestic monetary policy. The information of relative importance of the channels is naturally relevant for the central bank in its design of monetary operations and effective implementation of monetary policy.

In general, all studies find that the interest rate and credit channels appear to work in Indonesia. The exchange rate channel was very weak before the 1997 crisis because the monetary authorities' action to maintain exchange rate variability within a certain band, which had kept the exchange rate relatively stable and predictable. Post-1997, the exchange rate channel appears to work in transmitting monetary policy, but in the aftermath of GFC in 2008/2009, the channel does not appear to respond as strongly. For the asset price and inflation expectation channels, early studies reveal little evidence of their presence, although more recent studies have started to find evidence of their existence.

3.1 Interest Rate Channel

Studies about the interest rate channel typically analyze the first stage of transmission by determining the way the policy rate affects loan and deposit rates. The next stage of determining whether the interest rate would affect investment or consumption would depend on the purpose of the study and the variables they use in the model. Some studies include economic activity variables and try uncover whether the policy rate affects target variables such as investment, consumption, and inflation. Other studies do not include the target variables in their specification and assess only the interest rate transmission.

Kusmiarso et al. (2002) study the interest channel for the period from January 1989 to December 2000. They divide the study into the pre- and post-1997 crisis. Empirical evidence from the VAR analysis reveals that before the crisis, the transmission channel appears to work effectively. The real deposit rate and investment credit rate were strongly influenced by the interbank rate. However, the rates do not appear to have any impact on investment and consumption. Investment growth was influenced more by the high access to foreign borrowing than the real investment credit rate. After the crisis, the transmission channel appears to be less effective than before. The responses of the real deposit rate and real investment credit rate to the interbank rate were weaker than those previously. However, investment growth has been significantly influenced by the real investment credit rate since investors have limited access to other sources of financing. Using the least square methodology, Kusmiarso et al. (2002) identified the determinants of the interbank, deposit and loan rate. The result is that SBI rate is significant in explaining the interbank rate. Subsequently, the interbank rate is significant in explaining the deposit rate, and the deposit rate is significant in explaining the loan rate. This finding implies that the interest rate channel appears to work. The result is supported by the survey of banks, companies, and households which reveal that banks and companies have a significant response to substantial changes in policy rates.

Dewati, Suryaningsih and Chawwa (2009) investigate the interest channel using VAR with data from 2000q1 to 2009q1. Their result is similar to Kusmiarso et al. (2001) which asserts that an increase of the BI rate will cause loan rates and deposit rates to increase. Consumption seems to be affected by the deposit rate, although investment does not seem to be affected by real loan rates. They also employ panel data to study the determinants of bank loan rates. Using individual bank data from January 2002 to April 2009, they find that the BI rate significantly affects loan rates, implying that the interest channel works. Furthermore, they find banks with higher assets, liquidity and capital tend to be less responsive to a change in the BI rate.

Another study by Wimanda et al. (2013) investigates the interest rate channel in the aftermath of GFC. The study attempts to answer the question as to whether a modification in monetary operations where the interbank rates move closer to the deposit facility rate than to the BI rate, has any impact on the monetary transmission. Employing VAR for data from July 2005 to April 2013, the study finds that the interbank, IDIC[5], deposit and loan rate, increase in response to an increase in BI rates. This finding confirms the first-stage transmission from policy rate to banking interest rates. Further investigation by using the Granger Causality test finds that the policy rate is transmitted to the banking rate through the IDIC rate and not through the interbank rate.

Similar to Wimanda (2013), Juhro et al. (2014) try to identify the transmission of the BI rate to the banking rate after the GFC. Using monthly data from July 2009 to June 2013, they derive a similar result to Wimanda (2013) where the transmission of the BI rate to deposit and credit rate is through the IDIC rate. The policy rate (as represented by the deposit facility rate) plays a role in the exchange rate channel, serving as a signal of monetary management (liquidity management). The increase of the deposit facility rate can affect the overnight interbank market and influence financial market indicators, namely, the yield on government bonds. The increase in government bond yields would cause a appreciation in the exchange rate, influencing the inflation rate.

A study using FAVAR by Harahap et al. (2013) find that the interest rate channel appears to work, with an increase in the BI rate causing significant increase in the loan and deposit rates as well as government bond yield.

5. Indonesian Deposit Insurance Corporation.

3.2 Credit Channel

The credit channel appears to transmit monetary policy even though the intensity varies across time. Pre-1997 crisis, bank lending was almost unaffected by monetary policy but post-crisis, there was a discernible impact. The studies also identify the balance sheet channel, where monetary policy affects the firms' balance sheets and external financing costs which finally impact the investment activity of firms.

3.2.1 Bank Lending Channel

Agung et al. (2002) study the credit channel using monthly data from January 1991 to December 2000. The results from VAR analysis show that bank lending in the pre-1997 crisis period was almost unaffected by monetary policy as the access of domestic commercial banks to international sources of funds was relatively easy. Post-crisis, however, the study reveals a "credit crunch" where tight money policy exacerbated the unwillingness of banks to lend. This result is supported by another finding using the VECM approach. In the short-run, the credit market is more dominated by supply rather than demand. They also use panel data to investigate the determinants of bank lending. They find that pre-crisis, the policy rate does not seem to affect bank lending but post-crisis, bank lending is significantly affected by monetary policy. The sensitivity of lending to the policy rate increases for banks with low capital. This result is also supported by the bank survey that finds that the majority of banks will reduce the loan supply in the case of tight money policy. This finding is especially true for banks, which have limited access to other sources of funds.

Dewati, Suryaningsih and Chawwa (2009) employed VAR and panel data to study the bank lending channel for the period 2000q1 to 2009q1. They find that an increase in the Bank Indonesia Certificate rate would reduce credit even though lower credit does not seem to affect investment growth. Using panel data of individual banks from 2002 to 2009, they find that the policy rate is significant in explaining bank lending. Similar to Agung et al. (2001), the sensitivity of bank lending to the policy rate decreases as the bank's asset, liquidity or capitalization increases.

Another study by Wimanda et al. (2013) using VAR for data from 2006 to 2013 is also supportive of the existence of the credit channel. The study concludes that BI rates can affect aggregate demand through bank lending as the banks' credit-to-asset ratio decrease to a positive shock of the BI rate. This finding is similar to Juhro et al. (2014) who find a BI rate hike cause the credit gap and

inflation to decline. Harahap et al. (2013) using FAVAR also finds the existence of a credit channel, although post-GFC, the impact is not as strong as the previous period due to the excess liquidity.

3.2.2 Balance Sheet Channel

The study on the balance sheet channel using individual firms' data was first conducted by Agung et al. (2002). They use data from 219 non-financial companies listed on the Indonesian Stock Exchange for the period 1992-1999. The study attempts to answer two questions - first, whether a firm's balance sheet indicator affects a firm decision to invest. Then they try to answer the question of whether monetary policy affects the sensitivity of firms' investment to the balance sheet indicator. For the balance sheet indicator, they use variables of cash flows, total debt and short debt ratio. Their study finds that that the balance sheet indicator affects the firms' decision to invest. For the second question, they find that during the tight monetary policy, the sensitivity of investment to balance sheet indicator (total debt and short debt ratio) increases, implying that tight monetary policy cause firms to face a premium cost for external financing. Thus, firms find it more difficult to obtain external financing, thus affecting their investment. This finding proves the existence of a balance sheet channel although no clear evidence was found for financially constrained firms to be more affected by monetary policy than large firms, as predicted by the theory.

A recent study of the balance sheet channel is conducted by Wimanda et al. (2014), using data of 185 non-financial companies listed on the Jakarta Stock Exchange from 2000 to 2013. The empirical results show that the balance sheet channel transmits monetary policy, in particular, through companies that have financial constraints. The coefficient of the balance sheet indicator (cash flow, total debt and short debt ratio) for small firms becomes more sensitive to tight monetary policy, implying that the reliance on internal funds for investment increases as external funds become scarce. The opposite is true for loose monetary policy with investment becoming less sensitive to internal funds as the premium cost of external financing decreases, and easier access to external funds.

3.3 Exchange Rate Channel

Siswanto et al. (2002) conduct a study on the exchange rate channel using monthly data from January 1990 to April 2001. The study employs SVAR, which seeks to detect the transmission of exchange rate changes on the inflation rate

both directly, through price (direct pass-through effect), and indirectly, through the output (indirect pass-through effect). The findings from the SVAR analysis reveal that during the pre-1997 crisis period, monetary policy transmission through the exchange rate channel was very weak. Monetary authorities' action to maintain exchange rate variability within a certain band has kept the exchange rate relatively stable and predictable. Under such conditions, the interest rate on the SBI instrument did not have a significant impact on the exchange rate, and the exchange rate was not an important determinant of inflation. Post-crisis, the study finds that direct pass-through effect of the exchange rate to consumer prices is larger than the indirect, implying that an appreciation of the exchange rate will boost GDP. This finding is in contrast to the expectation where an exchange rate appreciation could make exports less competitive and contract GDP. The relatively high pass-through effect of the exchange rate on the domestic economy is caused by the high import content of capital goods and raw materials in investment and production activity, as well as to the considerable amount of external debt. Also, the appreciation of the exchange rate could generate higher GDP growth through indirect pass-through as an appreciation will encourage consumption and investment. Indeed, at a certain level, an exchange rate appreciation would support exports of manufacturing products with high import content.

A recent study by Harahap et al. (2013) using FAVAR finds the existence of the exchange rate channel where the increase of the policy rate is followed by the appreciation of Rupiah, although the impact after the GFC in 2008/2009 is less responsive compared to previous periods. Juhro et al. (2014) find that the exchange rates channel transmits monetary policy through the policy rate's impact on the financial market indicator such as government bond yields.

3.4 Asset Price Channel

Idris et al. (2002) analyze the asset price channel using monthly data from January 1989 to 2001. Employing SVAR and using stock prices as a proxy for asset prices, they find little evidence of the asset price channel. They suspect that the absence of the channel owes to the use of stock prices as a proxy for asset prices, as the Jakarta Stock Exchange (JSX) index cannot properly reflect the wealth of the economy. This finding is similar to the study by Dewati, Suryaningsih and Chawwa (2009). Employing VAR with quarterly data from 2000 to 2009, they find that a monetary policy shock does not seem to affect the asset price proxied by stock and property prices. A study by Harahap et al. (2013) also finds that before the Inflation Targeting Framework (ITF) (or before

2005), the asset price channel does not seem to transmit monetary policy significantly.

3.5 Expectation Channel

The study on the expectation channel was first conducted by Wuryandani et al. (2002). Using monthly data from July 1997 to December 2000, the analysis with SVAR reveals that there is monetary transmission through the expected inflation channel. The inflation expectation itself is mainly determined by the exchange rate, past inflation (inertia), and the interest rate. The result confirms that expected inflation plays a role in inflation formation although it is not as strong as other variables such as inertia (past inflation). The significant effect of past inflation indicates that monetary authority credibility is factored in when forming the expectation. In turn, the credibility will determine the effectiveness of inflation targeting. This finding is similar to the study by Dewati, Suryaningsih and Chawwa (2009) which finds that inflation expectation is backward looking because the actual inflation influences it. The inflation expectations have a significant effect on inflation, but not on domestic demand. The VAR impulse response shows that there is no significant impact of a SBI shock on inflation through this channel. A recent study by Harahap et al. (2013) finds the existence of an expectation channel, where a monetary shock appears to have an effect on the inflation expectation.

4. Data and Research Methodology

4.1 Methodology

VAR models are widely used to identify and examine the impact of monetary policy innovation on macroeconomic variables. The VAR approach has advantages in its ability to produce a credible empirical response of macroeconomic variables to monetary policy without having to apply an excessive restriction on the dynamic structure of the model (Soares, 2011). However, VAR is a small-scale model with a limited set of information. Bernanke et al. (2005) argues that VAR models rarely used more than 6 to 8 variables. Thus, the number of variables that can be included in the VAR model is unlikely to represent the whole set of information monitored and used by the central bank when formulating policy. Eliminating a lot of relevant information in the analysis of VAR has a risk of omitted-variable which can lead to biased estimates of VAR coefficients. Furthermore, the limited number of variables can cause the selection of variables to represent the economic concepts, seem arbitrary.

Based on the above-mentioned problems, Bernanke et al. (2005) proposed the Factor-Augmented VAR (FAVAR) which combined standard VARs with factor analysis to exploit large data sets in the study of monetary policy. Research on the dynamic factor model argues that the information contained in a large dataset can be summarized in a small number of "latent" factors. Bernanke et al. (2005) argues that if the factors can effectively summarize information from the large data, then the natural solution to the problem of degree of freedom in the VAR analysis is to use a factor in the VAR model. FAVARs allow a better identification of the monetary policy shock as it permits the use of unlimited variables to proxy theoretical constructs, such as the real activity, inflation, and others. This approach thus eliminates the necessity of arbitrarily choosing a specific variable to represent an economic concept. FAVAR also allows researchers to compute impulse responses for hundreds of variables.

The shortcoming, however, is that the factors are not identified and, therefore, lack any economic interpretation (Belvisio and Milani, 2006). They propose to set restrictions in the formation of factors so that it is possible to attribute the economic interpretation to the common factors. For example, the inflation factor is only formed by the inflation variables while real activity is only formed by the GDP or industrial production data. This approach ensures that the factor formed has economic meaning.

The original FAVAR model has the following structure. Let Y_t be a M x 1 vector of observed economic variables and F_t a K x 1 vector of unobserved factors which captured most of the information on X_t and represent generic economic concepts like "economic activity" or "inflation". According to Bernanke et al. (2005), the dynamic relationship (F_t, Y_t) can be represented by the following equation:

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Phi^*(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + v_t, \leftrightarrow \Phi(\mathrm{L}) \begin{bmatrix} F_t \\ Y_t \end{bmatrix} = v_t \qquad (1)$$

where $\Phi(\mathrm{L})$ is an order-d polynomial that has the usual restrictions present and error v_t term with zero mean and covariance matrix Q. If the coefficients of $\Phi(\mathrm{L})$ in (1) that link Y_t and $F_{t\text{-}1}$ are equal to zero, then this system reduces to a standard VAR in Y_t; otherwise, the system expressed in (1) is a VAR in terms of (Y_t,F_t) or as Bernanke et al. (2005) label it, a factor-augmented vector autoregression (FAVAR).

Since the factors are unobservable, Equation (1) cannot be estimated directly. However, once the factors interpreted as forces that affect many economic variables, factor model techniques allow them to be inferred indirectly through a dataset of an observed series. Let X_t be a N x 1 vector containing observed economic variables (usually called the informational series), with N being sufficiently large (at least larger than the number of periods T, and much larger than the number of factors $K + M << N$). Bernanke et al. (2005) propose that the non-observed factors F_t can be related to the informational series throughout the following observation equation:

$$X_t = \Lambda^f F_t + \Lambda^y Y_t + \varepsilon_t \quad (2)$$

where Λ^f is a N x K loading matrix, Λ^y is a N x K matrix of coefficients, and ε_t is a N x K error vector with a zero mean.

According to Equation (2), the series in X_t can be interpreted as stochastic means of the factors contained in F_t conditioned on Y_t which can also include lags in the fundamental factors. Because of that, this equation without the observed factors Y_t is referred as a dynamic factor model.

The contribution of the FAVAR model given by Equations (1) and (2), is as Bernanke et al. (2005) emphasize - if central banks and the private sector had information beyond that included in the VAR, the measurement of the unsystematic part of monetary policy would be incorrect. FAVARs allow a better identification of the monetary policy shock, since they employ a more realistic information set and permit observation of impulse responses for shocks on all the economic series included in the factors.

To identify and give economic interpretation to the factor, Belviso and Milani (2006) set restrictions in the formation of factors as follows. Take a partition $X_t^1, X_t^2, \ldots, X_t^I$ from X_t, where X_t^i is a $N^i \times 1$ vector, I represents the number of different economic concepts present in the dataset, and $\sum_{i=1}^{I} N^i = N$. Assume now that each X_t^i is explained exclusively by one "economic concept." That is, there is a correspondent partition of the F_t vector given by $F_t^1, F_t^2, \ldots, F_t^I$ where F_t^i is such that it explains the dynamics of X_t^i exclusively, for all i (and conversely, X_t^i is a uniquely explained by F_t^i). Then, the system of Equations (1) and (2) can be written as follows:

$$\begin{bmatrix} F_t^1 \\ F_t^2 \\ \vdots \\ F_t^i \\ Y_t \end{bmatrix} = \Phi(L) \begin{bmatrix} F_{t-1}^1 \\ F_{t-1}^2 \\ \vdots \\ F_{t-1}^i \\ Y_{t-1} \end{bmatrix} + v_t \tag{3}$$

$$\begin{bmatrix} X_t^1 \\ X_t^2 \\ \vdots \\ X_t^I \end{bmatrix} = \begin{bmatrix} \Lambda_1^f & 0 & \dots & 0 \\ 0 & \Lambda_2^f & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & \Lambda_I^f \end{bmatrix} \cdot \begin{bmatrix} F_t^1 \\ F_t^2 \\ \vdots \\ F_t^I \end{bmatrix} + \varepsilon_t \tag{4}$$

where $E\left(\varepsilon_t^i \varepsilon_t^j\right) = 0$ for all $i, j = 1, \dots, I$ and $i \neq j$.

With the above set of restriction, if the vector X_t is divided into subsets of variables that have the same "economic concept", the common force that drives each subset now has an economic meaning. For example, the common factor built from the variables like industrial production, sales index, and capacity utilization can be interpreted as the factor of "economic activity".

To estimate the SFAVAR model as outlined in the system of Equations (3) and (4), Bernanke et al. (2005) present two different strategies, namely, a Bayesian estimation approach and a two-step procedure based on Principal Component Analysis (PCA). The Bayesian approach has the benefit of accounting for the structure of the transition equation in the estimation of the factors. However, the computation of this approach is more complicated, and it does not seem to have a meaningful or practical advantage. Belviso and Milani (2006) show that both methods generate highly correlated factors, while Bernanke et al. (2005) state that some outcomes from the Bayesian estimations are at odds with economic theory.

This study follows Bernanke et al. (2005) and Fonseca and Pereira (2014) which employ a two-step approach with PCA. Based on the two-step approach, the first step is to estimate factors $\widehat{F_t^1}, \widehat{F_t^2}, \dots, \widehat{F_t^I}$ which are the first principal components obtained from each group of a series that forms an economic concept. The second step, the estimated factors are used within the VAR represented by Equation (3) to estimate $\Phi(L)$.

To derive the objective of this study, we construct a structural form model. Structural VAR is a multivariate, linear representation of a vector of observable variables on its lag. These models are called structural because of their economic interpretation. In these models, the identification restrictions are used according to some economic theory that use the non-recursive structure while still imposing

restrictions only on contemporaneous structural parameters. We employ the Impulse Response Functions (IRF) to give the visual representation of the behavior of observed series in response to a structural shock. The IRF also allows the computation of the forecast error variance decomposition that can be used to rank the monetary transmission channels according to their relative importance (Tahir, 2012). The variable that explains larger variations in the target variables such as GDP and inflation will be ranked higher and assumed as more important channels.

4.2 Data

The data used in this study consist of a balanced panel of 148 macroeconomic variables with a monthly frequency from January 2006 to March 2015. The data represents several economic concepts, namely, economic activity, inflation, interest rate, credit, exchange rate, asset price, inflation expectation and global financial factor. Economic activity and inflation factors are target variables while the interest rate, credit, exchange rate, asset price, inflation expectation are intermediate targets representing the transmission channels of monetary policy onto the economy. The BI rate is the policy rate representing the central bank monetary stance.

The economic activity dataset contains variables of industrial production index, real GDP (interpolated monthly), capacity utilization, retail sales index and consumption and sales data. The economic series used to explain inflation consists of consumer price index and wholesale price index with their components. Interest rate factor is estimated from credit rate, deposit rate, overnight interbank rate, and Jakarta Interbank Offer Rate data with different time horizon. For the credit factor, the volume of investment, consumption, and working capital credits are used. The exchange rate factor is constructed from bilateral exchange rates of the Indonesian rupiah to major currencies. For the asset factors, data on the stock price index, price earning ratio, and government bond yields for different maturities are used. The inflation expectation factor comprises datasets of producer and consumer price expectations. Lastly, for the global economic condition, the dataset includes the S&P index, VIX index, USD Basket Index, commodity price index and various financial variables from advanced economy such as monetary policy rate, total assets of central banks, government bond yield, and corporate bond yield.

Unit root tests were applied, and the data is transformed to ensure stationarity. Usually, interest rates variables are stationary and, therefore, are not transformed while other variables are transformed into the first differenced in the log to ensure stationarity. The lag length selection is based on several criteria: sequential modified LR test statistic (LR, LR, Final prediction error (FPE), Akaike Information Criterion (AIC), Schwarz Bayesian Information Criterion (SBIC), and Hannan-Quinn information criterion (HQ). For the LR, a lag length of 4 was selected, FPE 2 lags, AIC 8 lags while the other two criteria (SC and HQ) indicate one lag. For two lags, the result of the serial correlation LM test shows that there is no serial correlation at 5% level, and there is no hint of heteroskedasticity at 2-lag model. We use the lag chosen by FPE.

The restrictions are short-term and contemporaneous on the structural parameters of A_0 and no restrictions on lagged parameters. The contemporaneous restrictions enable us to derive reasonable economic structure.

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & a_{43} & 1 & 0 & 0 & 0 & 0 \\ a_{51} & 0 & 0 & a_{54} & 1 & 0 & 0 & 0 \\ 0 & 0 & a_{63} & a_{64} & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & a_{74} & 0 & a_{76} & 1 & 0 \\ 0 & 0 & a_{83} & 0 & 0 & a_{86} & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} u_{Activity} \\ u_{Inflation} \\ u_{BI\ Rate} \\ u_{Interest\ Rate} \\ u_{Credit} \\ u_{NER} \\ u_{Asset\ Price} \\ u_{Expectation} \end{bmatrix}$$

$$= \begin{bmatrix} b_1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_2 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_3 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_4 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_7 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_8 \end{bmatrix} \cdot \begin{bmatrix} e_{Activity} \\ e_{Inflation} \\ e_{BI\ Rate} \\ e_{Interest\ Rate} \\ e_{Credit} \\ e_{NER} \\ e_{Asset\ Price} \\ e_{Expectation} \end{bmatrix}$$

The first and second equations are real activity and inflation equations. We follow Brischetto and Voss (1999) and Tahir (2012) and assume they will only adjust slowly to the financial variables in the model. One reason is that we use monthly data, and therefore, it is intuitive to assume that the GDP or inflation are not instantaneously responding to the other variables. The third equation is the policy reaction function of the central bank. We assume the policy rate to depend contemporaneously on the inflation and activity following Tahir (2012). As Indonesia is an inflation targeting country, it is reasonable to assume that the

central bank is forward looking and forecast the gaps of the output and inflation and thus responds contemporaneously to the current month inflation and industrial production index.

The fourth equation is the interest rate that is assumed to respond contemporaneously to the policy rate. The fifth equation is the response of credit. We follow Berkelmans (2005) and Tahir (2012) and assume that the credit responds contemporaneously to interest rate and output. The contemporaneous interaction of credit with the interest rate is justified by the perception that borrowers and potential borrowers will respond quickly to the cost of credit. Furthermore, we assume that there is a certain percentage of loans on flexible interest rate, thus causing credit to respond quickly to interest rate. As for response of credit to the output, as argued by Berkelmans (2005), the expectation of future activity is an important determinant of credit demand. Current activity, as observed by individual agents, and interest rates should give some indication of what future conditions hold.

In the sixth equation, we assume that the exchange rate depends contemporaneously on the policy rate and interest rate. As the exchange rate is a financial variable, we assume it reacts quickly to all information. The response of asset price is quite similar to the exchange rate's, which is assumed to respond contemporaneously to the interest rate and exchange rate. The last equation is the inflation expectation that responds contemporaneously to the policy rate and exchange rate. As inflation targeting framework has been implemented in Indonesia since 2005, it is realistic to assume that both the producer and consumer form their expectations, relatively quickly, based on the policy rate.

Table 1 shows the estimated contemporaneous coefficients in the structural model. The identifying restrictions are not rejected at 5% significance level as shown by the likelihood test of over-identifying restrictions at the bottom of the table.

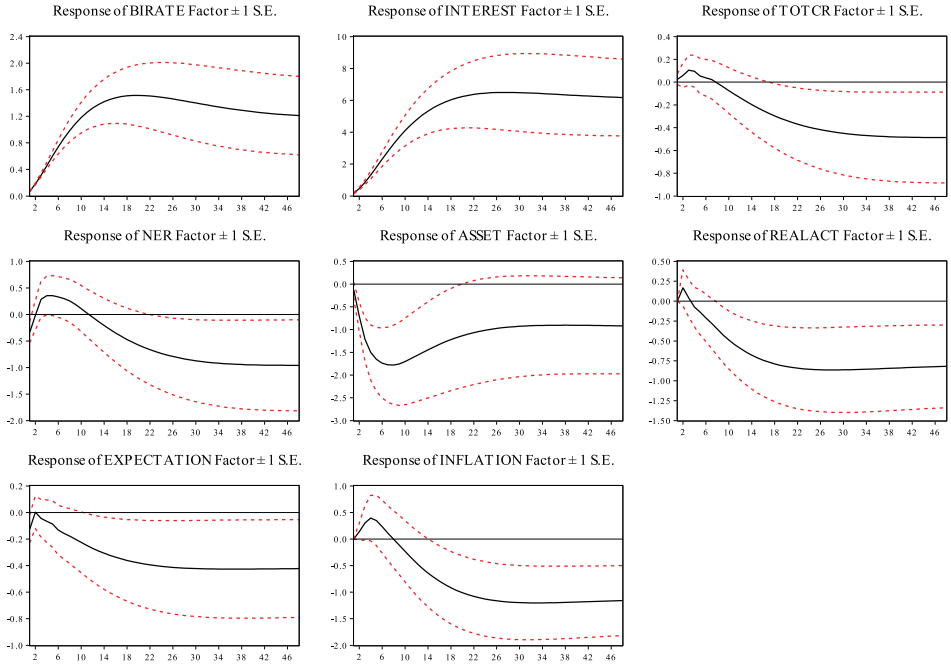
Table 1
Contemporaneous Coefficients

	Coefficient	Std. Error	z-Statistic	Prob.
A_{31}	0.0006	0.0027	0.2136	0.8309
A_{51}	-0.0935	0.0421	-2.2222	0.0263
A_{32}	-0.0101	0.0039	-2.5826	0.0098
A_{43}	-2.3724	0.4777	-4.9660	0.0000
A_{63}	4.9676	3.1354	1.5843	0.1131
A_{83}	1.5721	1.5163	1.0368	0.2998
A_{54}	-0.1523	0.2843	-0.5357	0.5921
A_{64}	-0.0959	0.5855	-0.1639	0.8698
A_{74}	1.7791	0.6256	2.8439	0.0045
A_{76}	0.5197	0.1169	4.4445	0.0000
A_{86}	-0.0400	0.0529	-0.7563	0.4494
Likelihood test χ^2 (17)		19.33		
Significance level		0.3100		

5. Empirical Results

The estimated impulse response of the factors is shown in Figure 10. Each figure shows the impulse response for each macroeconomic factor to a one-standard deviation positive shock to monetary policy. The confidence interval band in each graph is one-standard-error.

Figure 10
Cumulative Impulse-response Functions of Factors Due to Shocks of the BI Rate



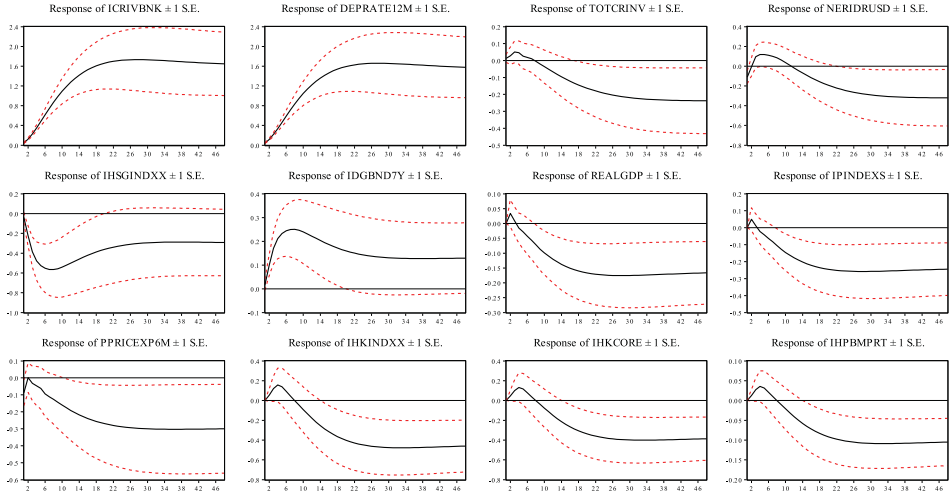
The responses are generally of the expected sign and magnitude and statistically significant. Following the increase of the BI rate, interest rates increase immediately. The increase of the BI rate is then followed by the decrease of credits (TOTCR) as predicted by the financial accelerator and bank lending channel theoretical model. The rise in uncertainty about the credit quality of firms and households makes financial institutions more cautious about lending loans which then translate into higher interest rates and tighter standards for lending. The increase in the BI rate also decreases financial institutions' liquidity and capital buffers, thus reducing their ability to lend. The ultimate impact is the decline in new loans.

The exchange rate (NER) appreciates as the domestic interest rate increases. When asset prices go down, inflation expectation also decline. The real activity measures decline, as expected, eight months after the initial shock. Inflation eventually declines after approximately 16 months. There is no "price puzzle"

found, where monetary policy tightening is followed by a rise in inflation, an outcome at odds with conventional monetary policy theory.

With the FAVAR approach, the response of every variable in the model can also be extracted. The estimated impulse response of a selection of key macroeconomic variables to a monetary policy shock is shown in Figure 11.

Figure 11
Cumulative Impulse-response Functions of Variables Due to Shocks of the BI Rate



Similar to the response of the factors, the responses of the variables are as expected. The first two graphs are the investment credit interest rate and 12-month deposit rate that immediately increase after a contractionary monetary policy. The BI rate increase is then translated into the decline in credit represented by the investment credit volume (TOTCRINV). The exchange rate factor is represented by the nominal exchange rate of Indonesian Rupiah to US Dollar (NERIDRUSD), which appreciates following a tightening of the monetary stance. Asset prices decrease as shown by the declining stock index (IHSGINDXX) and the increasing yield of government bond (IDGBND7Y). Real activity declines as represented by the real GDP and Industrial Production Index (IPINDEXS). Inflation expectation goes down as shown by the producer price expectation (PPRICEXP6M). Inflation eventually declines as represented by the consumer price index (IHKINDXX), core CPI (IHK CORE), and wholesale price (IHPBMPRT).

To measure the relative importance of the monetary transmission channels, we use the Variance Decomposition Approach following Tahir (2012). Variance decomposition can provide complementary information for the better understanding of the dynamic relationship between variables jointly analyzed in a VAR model. This tool is an approach to determine the fraction of the forecasting error of a variable, at a given horizon, attributable to a particular shock. Thus, it allows a comparison of the role of different variables in explaining the variation in a certain variable, namely, the relative importance. The target variables are Real Activity and Inflation. To assess the relative importance of each monetary transmission channel represented by the factors, we use the share of variation of the channel variable in explaining the fluctuation in the target variables.

The variance decomposition of inflation and real activity caused by the shocks, with each of the shocks representing a transmission channel, is presented in Table 2 and Table 3. The numerical figure indicates the percentage fluctuation in the inflation and real activity caused respectively, by the intermediate variables representing the transmission channel. The higher the number, the higher the relative importance of that variable.

Table 2
Variance Decomposition of Inflation

Inflation					
Period	**Interest Rate**	**Credit**	**Asset Price**	**Inflation Expectation**	**Exchange Rate**
12	3.03	2.51	2.22	1.79	0.99
24	3.05	2.48	2.22	1.77	1.02
36	3.08	2.48	2.22	1.77	1.02
48	3.09	2.48	2.22	1.77	1.02

Table 3
Variance Decomposition of Real Activity

Real Activity					
Period	**Credit**	**Asset Price**	**Inflation Expectation**	**Interest Rate**	**Exchange Rate**
12	2.00	1.07	0.70	0.57	0.21
24	2.00	1.07	0.70	0.58	0.21
36	2.00	1.08	0.70	0.59	0.21
48	2.00	1.08	0.70	0.59	0.21

For inflation, the interest rate channel appears to be the most dominant channel followed by the credit channel. This finding seems plausible, given the inflation targeting framework in Indonesia and the dominance of the banking sector in the financial system. It is based on the assumption that the banking sector translates the policy interest rate into bank lending rate and credit efficiently, thus making the interest rate and credit, the most important channels. The asset price, inflation expectation, and exchange rate also transmit monetary policy although they are less dominant than the interest rate and credit channel. For real activity, the credit channel appears to be the most dominant, followed by the asset price channel. The results appear to be relatively consistent using different forecast horizons.

6. Conclusion and Policy Implications

Monetary policy, in this case, represented by the policy rate, BI rate, appears to empirically affect real activity and inflation through every channel (interest rate, credit, exchange rate, asset price and inflation expectations). However, there is a lag of approximately 16 months in the transmission of monetary policy on inflation. The most important channel for transmitting monetary policy to inflation is the interest rate and credit channel. This finding is consistent with the inflation targeting framework and the importance of the banking sector in the financial system. This research contributes to the existingresearch on monetary policy transmission of Bank Indonesia in that it takes into account all the channels simultaneously, by using the Structural FAVAR and ranking the transmission channels according to their impact on variation in the GDP and inflation.

From this research, we can glean that there is room for improving the effectiveness of the inflation expectation channel. As the impact of inflation targeting on inflation and other macroeconomic variables may rise through its effects on inflation expectations and on the expectations formation process, the inflation expectation channel is expected to play a more important role in the transmission of monetary policy. One strategy is to improve communication between the monetary authority and economic agents that could lead to less dispersion of expectations. The fall in the dispersion may enhance the effectiveness of the expectations channel of monetary transmission which, in turn, can reduce the level of inflation (Martinez, 2011). Another strategy is to prove to the public that the central bank has been succeeding in achieving the inflation target for several occasions. This is very challenging for Bank Indonesia since the inflation target set by the government is quite low while many administered price components are adjusted, for example, fuel, gas, and electricity.

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Appendices

Data Sets

No	Factor	Source	Units	Definition	Transformation
1	Real Activity	CEIC, Interpolated	Miliar Rupiah (2000p)	Gross Domestic Product	3
2	Real Activity	CEIC, Interpolated	Miliar Rupiah (2000p)	Consumption Expenditure: Private	3
3	Real Activity	CEIC, Interpolated	Miliar Rupiah (2000p)	Consumption Expenditure:Government	3
4	Real Activity	CEIC, Interpolated	Miliar Rupiah (2000p)	Gross Fixed Capital Formation	3
5	Real Activity	CEIC, Interpolated	Miliar Rupiah (2000p)	Total Export: Goods	3
6	Real Activity	CEIC - DBARBA	2000 = 100	Industrial Production Index	3
7	Real Activity	CEIC - DBARBAC	2000 = 100	Industrial Production IndexTextiles	3
8	Real Activity	CEIC - DBAZABD	2000 = 100	Industrial Production Index Wearing Apparel	3
9	Real Activity	CEIC - DBAZABR	2000 = 100	Industrial Production Index Motor vehicles, Trailers and Semitrailers	3
10	Real Activity	CEIC - DBARBAM	2000 = 100	Industrial Production Index Metals	3
11	Real Activity	CEIC - DBARBAN	2000 = 100	Industrial Production Index Fabricated Metal	3
12	Real Activity	CEIC - DBARBAK	2000 = 100	Industrial Production Index Rubbers and Plastics	3
13	Real Activity	CEIC - DBARBAG	2000 = 100	Industrial Production IndexPaper and Paper products	3
14	Real Activity	CEIC - DBARBAJ	2000 = 100	Industrial Production IndexChemicals and Chemical Products	3
15	Real Activity	Bank Indonesia	% of capacity	Capacity Utilization Rate: Food	1
16	Real Activity	Bank Indonesia	% of capacity	Capacity Utilization Rate: Textile	1
17	Real Activity	Bank Indonesia	% of capacity	Capacity Utilization Rate: Wood	1
18	Real Activity	Bank Indonesia	% of capacity	Capacity Utilization Rate: Paper	1
19	Real Activity	Bank Indonesia	% of capacity	Capacity Utilization Rate: Chemicals	1

No	Factor	Source	Units	Definition	Transformation
20	Real Activity	Bank Indonesia	% of capacity	Capacity Utilization Rate: Non Metal	1
21	Real Activity	Bank Indonesia	% of capacity	Capacity Utilization Rate: Metal	1
22	Real Activity	Bank Indonesia	% of capacity	Capacity Utilization Rate: Machinary	1
23	Real Activity	Bank Indonesia	% of capacity	Capacity Utilization Rate: Other Industry	1
24	Real Activity	CEIC - DBKA	Units	Motor Vehicle Production GAIKINDO	3
25	Real Activity	CEIC - DHCA	Units	Motor Vehicle Sales GAIKINDO	3
26	Real Activity	CEIC - DHBB	Units	Motorcycle Sales	3
27	Real Activity	CEIC - DBJB	Thousand Ton	Total Cement Consumption: Domestic	3
28	Real Activity	CEIC - DBJA	Thousand Ton	Total Cement Sales: Commercial	3
29	Real Activity	CEIC - DHDEAB	Oct 2000=100	Retail Sales Index: Sparepart	3
30	Real Activity	CEIC - DHDEAE	Oct 2000=100	Retail Sales Index: Food, Drinks, and Tobacco	3
31	Real Activity	CEIC - DHDEAH	Oct 2000=100	Retail Sales Index: Fuels	3
32	Real Activity	CEIC - DHDEAI	Oct 2000=100	Retail Sales Index: Writing Equipments	3
33	Real Activity	CEIC - DHDEAF	Oct 2000=100	Retail Sales Index: Apparels	3
34	Real Activity	Bank Indonesia		Consumer Confidence Index: Current Economic Condition	3
35	Inflation	Bank Indonesia	2007 = 100	Consumer Price Index	3
36	Inflation	Bank Indonesia	2007 = 100	Consumer Price Index: Core	3
37	Inflation	Bank Indonesia	2007 = 100	Consumer Price Index: Administered Price	3
38	Inflation	Bank Indonesia	2007 = 100	Consumer Price Index: Food	3
39	Inflation	Bank Indonesia	2007 = 100	Consumer Price Index: Processed Food, Beverages, Tobacco (BF)	3
40	Inflation	Bank Indonesia	2007 = 100	Consumer Price Index: Housing, Electricity, Gas and Fuel	3
41	Inflation	Bank Indonesia	2007 = 100	Consumer Price Index: Clothing	3
42	Inflation	Bank Indonesia	2007 = 100	Consumer Price Index: Health	3
43	Inflation	Bank Indonesia	2007 = 100	Consumer Price Index: Education, Recreation and	3

No	Factor	Source	Units	Definition	Transformation
				Sports (ER)	
44	Inflation	Bank Indonesia	2007 = 100	Consumer Price Index: Transportation, Communication and Finance (TC)	3
45	Inflation	CEIC	2000 = 100	IHPB: Agriculture	3
46	Inflation	CEIC	2000 = 100	IHPB: Mining and Quarrying	3
47	Inflation	CEIC	2000 = 100	IHPB: Manufacturing	3
48	Inflation	CEIC	2000 = 100	IHPB: Imports	3
49	Inflation	CEIC	2000 = 100	IHPB: Exports	3
50	Asset Price	CEIC - DZEA	10/08/82 = 100	IHSG (Stock Index)	3
51	Asset Price	CEIC - DZEB	28/12/95 = 100	IHSG: Agriculture	3
52	Asset Price	CEIC - DZEC	28/12/95 = 100	IHSG: Mining	3
53	Asset Price	CEIC - DZED	28/12/95 = 100	IHSG: Property	3
54	Asset Price	CEIC - DZEE	28/12/95 = 100	IHSG: Finance	3
55	Asset Price	CEIC - DZEF	28/12/95 = 100	IHSG: Trade	3
56	Asset Price	CEIC - DZEG	28/12/95 = 100	IHSG: Basic Industry	3
57	Asset Price	CEIC - DZEH	28/12/95 = 100	IHSG: Miscellaneous	3
58	Asset Price	CEIC - DZEI	28/12/95 = 100	IHSG: Consumer Goods	3
59	Asset Price	CEIC - DZEJ	28/12/95 = 100	IHSG: Manufacture	3
60	Asset Price	CEIC - DZEK	28/12/95 = 100	IHSG: Infrastructure	3
61	Asset Price	CEIC - DZEL	13/07/94 = 100	IHSG: LQ45	3
62	Asset Price	CEIC	%	IHSG Price Earning Ratio: Agriculture	1
63	Asset Price	CEIC	%	IHSG Price Earning Ratio: Mining	1
64	Asset Price	CEIC	%	IHSG Price Earning Ratio: Property	1
65	Asset Price	CEIC	%	IHSG Price Earning Ratio: Finance	1
66	Asset Price	CEIC	%	IHSG Price Earning Ratio: Trade	1
67	Asset Price	CEIC	%	IHSG Price Earning Ratio: Basic Industry	1
68	Asset Price	CEIC	%	IHSG Price Earning Ratio: Miscellaneous	1
69	Asset Price	CEIC	%	IHSG Price Earning Ratio: Consumer Goods	1
70	Asset Price	CEIC	%	IHSG Price Earning Ratio: Infrastructure	1
71	Asset Price	Bloomberg -	%	Indonesia Government Bond	1

No	Factor	Source	Units	Definition	Transformation
		GIDN2YR Index		Yields: 2 Years	
72	Asset Price	Bloomberg - GIDN3YR Index	%	Indonesia Government Bond Yields: 3 Years	1
73	Asset Price	Bloomberg - GIDN5YR Index	%	Indonesia Government Bond Yields: 5 Years	1
74	Asset Price	Bloomberg - GIDN7YR Index	%	Indonesia Government Bond Yields: 7 Years	1
75	Asset Price	Bloomberg - GIDN10YR Index	%	Indonesia Government Bond Yields: 10 Years	1
76	Asset Price	Bloomberg - GIDN15YR Index	%	Indonesia Government Bond Yields: 15 Years	1
77	Interest Rate	Bank Indonesia	% p.a.	Interest rate: Working Capital Credit	1
78	Interest Rate	Bank Indonesia	% p.a.	Interest rate : Investment Credit	1
79	Interest Rate	Bank Indonesia	% p.a.	Interest rate: Consumption Credit	1
80	Credit Volume	Bank Indonesia	Miliar Rp	Total Credit: Working Capital	3
81	Credit Volume	Bank Indonesia	Miliar Rp	Total Credit: Investment	3
82	Credit Volume	Bank Indonesia	Miliar Rp	Total Credit: Consumption	3
83	Exchange Rate	CEIC - DMAAAAAZAB	IDR/USD	Exchange Rate against US Dollar Monthly Average	3
84	Exchange Rate	CEIC	IDR/100 JPY	Spot FX Rate BI: IDR/100 JPY	3
85	Exchange Rate	CEIC	IDR/GBP	Spot FX Rate BI: IDR/GBP	3
86	Exchange Rate	CEIC	IDR/SGD	Spot FX Rate BI: IDR/SGD	3
87	Exchange Rate	CEIC	IDR/MYR	Spot FX Rate BI: IDR/MYR	3
88	Exchange Rate	CEIC	IDR/HKD	Spot FX Rate BI: IDR/HKD	3
89	Exchange Rate	CEIC	IDR/AUD	Spot FX Rate BI: IDR/AUD	3
90	Exchange Rate	CEIC	IDR/CAD	Spot FX Rate BI: IDR/CAD	3
91	Expectation	Bank Indonesia		Producer Price Expectation: 3 month hence	3
92	Expectation	Bank Indonesia		Producer Price Expectation: 6 month hence	3
93	Expectation	Bank Indonesia		Consumer Price Expectation: 6 month hence	3
94	Interest Rate	Bank Indonesia	% p.a.	PUAB Rate: Overnight Interbank Rate	1
95	Interest Rate	Bank Indonesia	% p.a.	Time Deposit Rate: 1 months	1
96	Interest Rate	Bank Indonesia	% p.a.	Time Deposit Rate: 3 months	1
97	Interest Rate	Bank Indonesia	% p.a.	Time Deposit Rate: 6 months	1
98	Interest Rate	Bank Indonesia	% p.a.	Time Deposit Rate: 12 months	1

No	Factor	Source	Units	Definition	Transformation
99	Interest Rate	Bank Indonesia	% p.a.	Time Deposit Rate: 24 months	1
100	Interest Rate	Bank Indonesia	% p.a.	Saving Rate	1
101	Interest Rate	Bank Indonesia	% p.a.	Jakarta Interbank Offer Rate: Overnight	1
102	Interest Rate	Bank Indonesia	% p.a.	Jakarta Interbank Offer Rate: 7 days	1
103	Interest Rate	Bank Indonesia	% p.a.	Jakarta Interbank Offer Rate: 1 months	1
104	Interest Rate	CEIC - DMAAAAAZA	% p.a.	Jakarta Interbank Offer Rate: 3 months	1
105	Interest Rate	IFS	% p.a.	Call Money Rate	1
106	Global Financial	Bloomberg - SPX Index		S&P 500 Index	3
107	Global Financial	Bloomberg - VIX INDEX		Volatility Index	3
108	Global Financial	Bloomberg - DXY Curncy		USD Basket Index	3
109	Global Financial	Bloomberg - FDTR Index	% p.a.	Federal Fund Rate: Target Rate	1
110	Global Financial	Bank of Japan - BJ'MADR1M	% p.a.	BOJ: Basic Discount Rate and Basic Loan Rate	1
111	Global Financial	Bloomberg - CNDR1Y Index	% p.a.	PCB: Policy Rate	1
112	Global Financial	Bloomberg - GUKG1 INDEX	% p.a.	UK Govt Bond Yield: 1 Years	1
113	Global Financial	Bloomberg - GUKG2 Index	% p.a.	UK Govt Bond Yield: 2 Years	1
114	Global Financial	Bloomberg - GUKG30 Index	% p.a.	UK Govt Bond Yield: 30 Years	1
115	Global Financial	Bloomberg - GJGB1 INDEX	% p.a.	JP Govt Bond Yield: 1 Years	1
116	Global Financial	Bloomberg - GJGB2 Index	% p.a.	JP Govt Bond Yield: 2 Years	1
117	Global Financial	Bloomberg - GJGB5 Index	% p.a.	JP Govt Bond Yield: 5 Years	1
118	Global Financial	Bloomberg - GJGB10 Index	% p.a.	JP Govt Bond Yield: 10 Years	1
119	Global Financial	Bloomberg - GJGB30 Index	% p.a.	JP Govt Bond Yield: 30 Years	1
120	Global Financial	IFS	2010 = 100	Commodity Prices: Food	3
121	Global	IFS	2010 = 100	Commodity Prices: Beverages	3

No	Factor	Source	Units	Definition	Transformation
	Financial				
122	Global Financial	IFS	2010 = 100	Commodity Prices: Agricultural Raw Materials	3
123	Global Financial	IFS	2011 = 100	Commodity Prices: Metals	3
124	Global Financial	IFS	2012 = 100	Commodity Prices: Energy Index	3
125	Global Financial	Fed St. Louis	Juta Euro	Total Aset Bank Sentral: ECB	3
126	Global Financial	Fed St. Louis	100 Juta Yen	Total Aset Bank Sentral: BOJ	3
127	Global Financial	CEIC - GMAA	% p.a.	BOE: Policy Rate	1
128	Global Financial	CEIC - EUMGCAA	% p.a.	ECB: Policy Rate	1
129	Global Financial	CEIC	% p.a.	US Treasury Bills Yield: 1 Months	1
130	Global Financial	CEIC	% p.a.	US Treasury Bills Yield: 3 Months	1
131	Global Financial	CEIC	% p.a.	US Treasury Bills Yield: 6 Months	1
132	Global Financial	CEIC	% p.a.	US Treasury Bills Yield: 1 Years	1
133	Global Financial	CEIC	% p.a.	US Treasury Bills Yield: 2 Years	1
134	Global Financial	CEIC	% p.a.	US Treasury Bills Yield: 3 Years	1
135	Global Financial	CEIC	% p.a.	US Treasury Bills Yield: 5 Years	1
136	Global Financial	CEIC	% p.a.	US Treasury Bills Yield: 7 Years	1
137	Global Financial	CEIC	% p.a.	US Treasury Bills Yield: 10 Years	1
138	Global Financial	CEIC	% p.a.	US Treasury Bills Yield: 20 Years	1
139	Global Financial	CEIC	% p.a.	US Treasury Bills Yield: 30 Years	1
140	Global Financial	CEIC - EUMCBA	% p.a.	EU Govt Bond Yield: 2 Years	1
141	Global Financial	CEIC - EUMCBB	% p.a.	EU Govt Bond Yield: 5 Years	1
142	Global	CEIC - EUMCBC	% p.a.	EU Govt Bond Yield: 7 Years	1

No	Factor	Source	Units	Definition	Transformation
	Financial				
143	Global Financial	CEIC - EUMCBD	% p.a.	EU Govt Bond Yield: 10 Years	1
144	Global Financial	CEIC - EUMCBE	% p.a.	EU Govt Bond Yield: 30 Years	1
145	Global Financial	CEIC	Miliar Reminbi	Total Aset Bank Sentral: PCB	3
146	Global Financial	CEIC	% p.a.	US Corporate Bond Yield: AAA Rated	1
147	Global Financial	CEIC	% p.a.	US Corporate Bond Yield: BAA Rated	1
148	Policy Rate	Bank Indonesia	% p.a.	BI Rate	1

VAR Lag Order Selection Criteria Data

Endogenous variables: FCTR_REALACT FCTR_INFLATION SD_BIRATE FCTR_INTEREST FCTR_TOTCR FCTR_NER FCTR_ASSET FCTR_EXPECTATION
Exogenous variables: C FCTR_GLOBALFIN
Sample: 2006M01 2015M03
Included observations: 95

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1385.592		901.6587	29.5072	29.93733	29.68101
1	-1016.377	660.6999	1.469433	23.08163	25.23226*	23.95065*
2	-949.5643	108.3077	1.428278*	23.02241	26.89355	24.58664
3	-916.8257	47.55714	2.980375	23.68054	29.27219	25.93999
4	-846.0581	90.88053*	3.004888	23.53806	30.85022	26.49272
5	-787.4445	65.40041	4.359138	23.65146	32.68412	27.30133
6	-709.7029	73.6499	4.946438	23.36217	34.11533	27.70725
7	-617.49	71.829	5.222276	22.76821	35.24188	27.80851
8	-526.8776	55.32127	8.182614	22.20795*	36.40213	27.94346

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Sample: 2006M01 2015M03
Included observations: 101

Lags	LM-Stat	Prob
1	56.21336	0.745
2	53.86615	0.8128

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Sample: 2006M01 2015M03
Included observations: 101
Joint test:

Chi-sq	df	Prob.
1266.53	1224	0.194

Chapter 3

UNDERSTANDING THE EVOLUTION OF THE MONETARY POLICY TRANSMISSION MECHANISM IN MALAYSIA[1]

By
Daniel Khaw[2]
Rubin Sivabalan[3]

1. Introduction

Over the past two decades, the balance of risks to growth and inflation in emerging economies has shifted frequently, necessitating continued reassessments of the stance of monetary policy. During these times, understanding the monetary policy transmission mechanism is pivotal for the successful conduct of policy. Since the last comprehensive monetary policy transmission mechanism (MTM) study by Tang (2006) on Malaysia ten years ago which detailed the impact of policy rate changes on economic growth and inflation, many features of the economic landscape have changed. Notable changes in policy and economic trends include the move from a fixed to floating exchange rate regime, the introduction of a market-based interest rate framework, the higher integration with the global financial system, the rise in financing from the capital markets and the diversification of the domestic economy.

Against this backdrop, we investigate the monetary transmission mechanism for Malaysia in order to understand its evolution, dynamics and implication for policy makers. Our paper aims to answer two questions. First, has the transmission of monetary policy to growth and inflation in Malaysia strengthened or weakened over the past decade? Second, what are the factors that have driven these changes?

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1. This paper presents research in progress of the staff members at Bank Negara Malaysia (BNM) and is disseminated to elicit comments and to further debate. Any views expressed are solely of the author(s) and should not be taken to represent those of BNM. The authors would like to thank Dr. Norhana Endut, Dr. Ahmad Razi, Nozlan Khadri, Allen Ng, Tng Boon Hwa and Dr. Chuah Kue Peng for their valuable comments.

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We approach the first question empirically to examine the magnitude and speed of impact from a policy rate shock to the real economy using a vector autoregression (VAR) model from 1990 to 2015. Our results indicate that over time, the transmission mechanism to output and inflation has weakened and strengthened, respectively. In addition, the relative importance of the individual channels of the MTM has changed. The asset price channel and credit channel have gained some significance in accounting for the pass-through to output, while the interest rate channel and exchange rate channel have weakened over time. On the whole, the uncertainty surrounding the transmission has reduced, and the impact of policy rate changes on growth and inflation has become more predictable.

To answer the second question, we turn to some stylized economic facts and trends globally and domestically. In particular, we focus our analysis on the evolution of the three factors that influence monetary policy, namely, the monetary policy framework, the structure of the financial sector and the structure of the economy to explain the changes in the monetary transmission mechanism in Malaysia. Our findings suggest while changes in the monetary policy framework have improved monetary transmission, the gains have been offset by changes in the financial sector and structural shifts in the economy.

The rest of the paper is organized as follows. Section 2 reviews the existing literature on the transmission mechanism for Malaysia. Section 3 describes the empirical methodology. Section 4 presents the empirical results, while Section 5 discusses the results and implications for policy. Section 6 concludes.

2. Literature Review

This section provides a brief literature review on the MTM in Malaysia. The most recent comprehensive empirical study on the overall transmission mechanism on Malaysia was conducted by Tang (2006), whose paper we extend in our study. His paper examined the relative strength of the different channels of monetary transmission in Malaysia, concluding the interest rate channel to be the most significant in influencing output and inflation in a two-year horizon, with the credit channel beyond that. The asset price channel is also found to be relevant in the shorter horizon, while the exchange rate channel did not play an important role in transmission.

Other transmission mechanism studies in Malaysia have focused on individual channels. Goh, Chong and Yong (2007) investigate the bank lending channel

using an autoregressive-distributed lag (ARDL) model and find that the bank lending channel may not be effective in Malaysia as banks are able to cushion a fall in deposits through adjustments in liquid financial instruments. In terms of the interest rate channel, Tai, Sek and Har (2012) show that post-Asian Financial Crisis in 1997, the pass-through from a policy shock to lending rates and deposit rates in Malaysia has increased significantly.

Evidence from literature suggests that policy shocks result in a heterogenous impact on investment in different sectors and on consumption of certain goods (see Erceg and Levin, 2005; Peersman and Smets, 2002). For the case of Malaysia, Ibrahim (2005) finds that the manufacturing, construction, finance, insurance, real estate and business services sectors decline more than aggregate demand in response to a monetary policy tightening, suggesting that these sectors may be more interest rate-sensitive.

Past studies also suggest that key developments in the domestic economic and financial landscape have impacted the MTM in Malaysia. We discuss some of these evolutions and their impact on the effectiveness of monetary policy in greater detail later in the paper. Broadly, Cheong (2004) notes the introduction of market-based monetary policy procedures has made monetary policy transmission more effective, attributing it to BNM's efforts to enhance the transparency, to improve the payment and settlement arrangements and to accelerate prudential reforms. Ooi (2008) also argues that with better banking system efficiency in Malaysia, the speed and size of the interest rate pass-through from policy rates to interbank and retail rates have increased. In addition, Tan and Goh (2007) show that increased financial disintermediation activities in the early 1990s have contributed to the reduction of the effectiveness of the MTM in Malaysia.

In recent years, the link between global factors and the effectiveness of domestic monetary policy has been of increasing interest, especially among policy makers. Using a dynamic factor model and a structural vector autoregression (SVAR) model, Jain-Chandra and Unsal (2012) suggest that long-term interest rates in Asia are increasingly driven by global factors. In particular, the authors find that the contribution of U.S. interest rates to domestic bond yields is higher in countries with a large foreign presence in domestic government bond markets, such as Malaysia and Indonesia. In addition, the surge in global liquidity after the global financial crisis (GFC) has exerted a stronger influence on domestic financial conditions and therefore, on the conduct of monetary policy. In the

face of these challenges, Singh (2014) notes that, in Malaysia, the effectiveness of the MTM is bolstered by the floating exchange rate regime and also expanded monetary policy toolkit employed by the central bank.

3. Methodology

Our empirical methodology follows closely from Tang (2006). Where Tang's sample ends in 2004 (spanning 23 years from 1981), our study extends the sample period to 2015 from 1990. We compare the evolution of the monetary policy transmission mechanism by contrasting both the short sample (1990 to 2004) and the full sample (1990 to 2015).[4] The sample is divided as such to capture pronounced shifts in the monetary policy framework, namely the move to a market-based interest rate framework and the removal of the ringgit peg to the U.S. dollar.[5] As in Tang's study, we use a vector autoregression (VAR) model to examine the transmission mechanism over time, employing the shutdown technique to understand the relative strength of the transmission channels.

3.1 Data Collection and Transformation

The data used in our study are quarterly, spanning from the first quarter of 1990 to the first quarter of 2015. We divide the variables in our estimation into a foreign block and a domestic block to correctly capture identification of contemporaneous relationships and to capture impulse responses of the domestic variables to exogenous external shocks. Our foreign block consists of the U.S. output gap (YUS), U.S. consumer price index (INFUS), and U.S. Federal Funds Rate (FFR). In addition, we use the world commodity price index (WCOM) to account for supply driven inflationary pressures. The foreign block in our model is completely exogenized, reflecting the fact that domestic variables do not affect U.S. real variables in a material manner.

4. A number of studies examine potential structural breaks by splitting their sample. A selection of these studies on Malaysia includes Fung (2002), Tai, Sek and Har (2012) and Raghavan et al. (2012).

5. BNM implemented the New Interest Rate Framework (NIRF) with the introduction of the Overnight Policy Rate (OPR) on 26 April 2004. On 21 July 2005, the ringgit peg to the USD was replaced with a managed float system.

The domestic block includes six variables that describe the Malaysian economy. Our target variables of monetary policy are Malaysia's real GDP (Y) and core inflation (INF), while we use the 3-month Kuala Lumpur Interbank Offered Rate (KLIBOR) (I) as the policy instrument. We chose the KLIBOR as the proxy for the policy rate as it provides a robust alternative to the OPR, which only starts in mid-2004. The remaining three variables represent the three individual channels of monetary policy. We use the USD/MYR spot exchange rate (EXR) to account for the exchange rate channel, given the significant position of the US as Malaysia's trade partner.[6] To proxy for the asset price channel (AP), we use the Kuala Lumpur Composite Index (KLCI), a capitalization-weighted stock market index comprising of the 30 largest companies on the Bursa Malaysia.[7] While we considered the Malaysian House Price Index (MHPI)[8] as an alternative variable for the asset price channel, we were not able to use it as the series only started in the early 2000s. We use total loans outstanding to represent the credit channel (CRE). Unlike Tang (2006), we used the residual impact that is unexplained by the other channels of monetary policy as a proxy for the direct interest rate channel. While several studies have used this method to estimate the interest rate channel (see Disyatat and Vongsinsirikul, 2003 and Khundrakpam and Jain, 2002), we acknowledge that the results could also include other non-interest rate channel effects, such as the risk-taking channel or the expectation channel of monetary policy. All our variables are transformed into natural logarithm, and detrended using the Hodrick-Prescott (HP) filter[9] to estimate the data in gap terms. We use the Census X-12 method to adjust for seasonality.

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6. For robustness, we also ran the model with alternate proxies for the exchange rate (NEER and REER), inflation (headline), and global inflation (IMF commodity price index) and dummy to capture a break post Asian financial crisis. None of the alternate specifications changed the results of the finding save for the post Asian financial crisis dummy.

7. Previously known as the Kuala Lumpur Stock Exchange (KLSE), Bursa Malaysia refers to the Malaysian stock exchange.

8. The Malaysian House Price Index (MHPI) is compiled by the National Property Information Centre (NAPIC), under the Valuation and Property Services Department of Malaysia (JPPH).

9. The HP-filter is a widely used statistical technique to estimate potential output by fitting a trend to an economic time series (see Hodrick and Prescott, 1997). Chuah and Shahrier (2014) show that for Malaysian data, the HP-filter is able to consistently pick up important

3.2 Model Specification

Our study relies on the use of VAR models to understand the dynamics of the MTM in Malaysia. First introduced by Sims (1980), VAR models are dynamic systems of equations that are used to characterize the behavior of the economy by capturing the interdependencies between multiple time series. Unlike other macroeconomic models, VAR models make few *a priori* assumptions about the economy, instead, allowing the data to determine the dynamics of the model. As in Tang's (2006) study, we use a reduced form VAR model[10] to examine the transmission mechanism in Malaysia. We estimate our VAR using one lag, as suggested by the Schwarz information criterion (SIC).

An important consideration in VAR studies is the ordering of variables using the 'recursive' Choleski decomposition. The ordering of the variables is important as it reflects an implicit assumption about the dynamics between the variables in the economy. In our model, the variables in the domestic block are ordered as follows: Y, INF, I, EXR, AP, CRE. Y and INF are ordered before I, output and inflation only react to shocks to interest rate after a lag. As the financial market variables react almost contemporaneously to real and monetary developments, the asset price (AP), the credit (CRE) and the exchange rate (EXR) channel variables are ordered last.

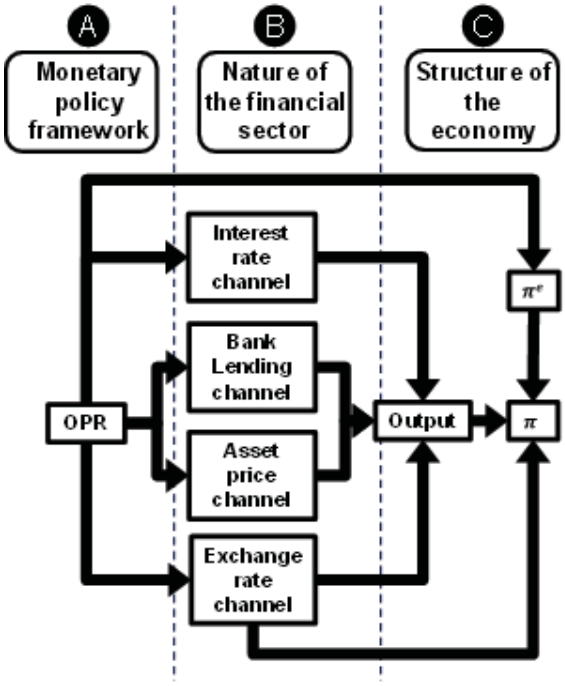
3.3 Model Estimation

We estimate two baseline VAR models incorporating all the variables in the foreign and domestic blocks, one for the short sample (1990 – 2004) and a second for the full sample (1990 – 2015). To examine the relative strength of individual channels, we use the shutdown methodology seen in Tang (2006). The broad idea behind the shutdown methodology is to compare the impulse responses of the target variables (output and inflation) to a policy shock under two scenarios. In the first (unconstrained) case, the VAR model is run with all channels operating. In the second scenario (constrained), the channel variable of interest is "turned off" by exogenizing the channel variable. Both impulse responses are identified for each scenario. The difference between impulse response of the unconstrained and constrained model provides an indication of the strength of the channel of interest. Further details on the model specification can be found in Appendix 1.

10. A reduced form VAR expresses each variable as a linear function of its own past values, the past values of other variables in the system, and a serially uncorrelated error term.

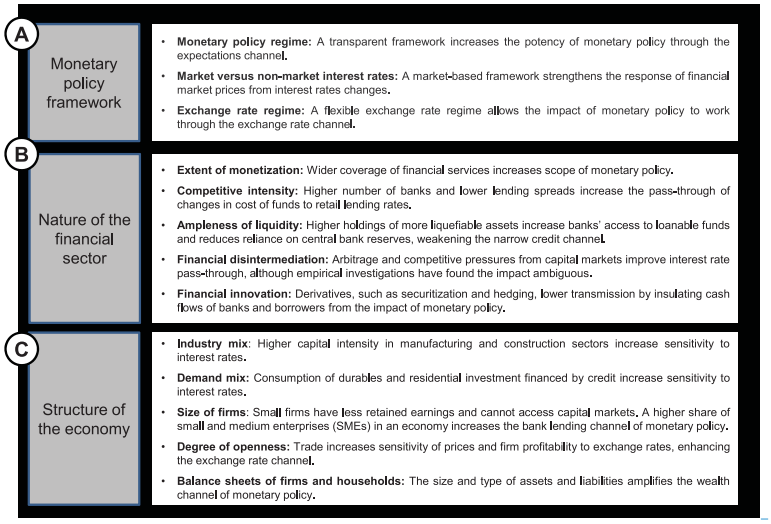
3.4 Qualitative Assessment

Figure 1
Flow Diagram of Monetary Policy Transmission to Output and Inflation



We subject our empirical findings to the stylized facts and the economic trends in Malaysia over the past few years to understand the reasons underlying the changes in the MTM. To ensure a systematic and comprehensive approach towards examining the MTM, we focus on the three areas that determine the efficacy of the transmission process, that is, the monetary policy framework, the nature of the financial system and the structure of the economy (see Figure 1). Delving into each of these areas, we proceed to identify, based on existing literature, attributes that would help explain the shifts uncovered in the empirical investigation (see Table 1). The analysis in this section is mainly descriptive and comparative as it is intended to support the empirical findings in the previous section.

Table 1
Factors that Influence the Transmission of Monetary Policy



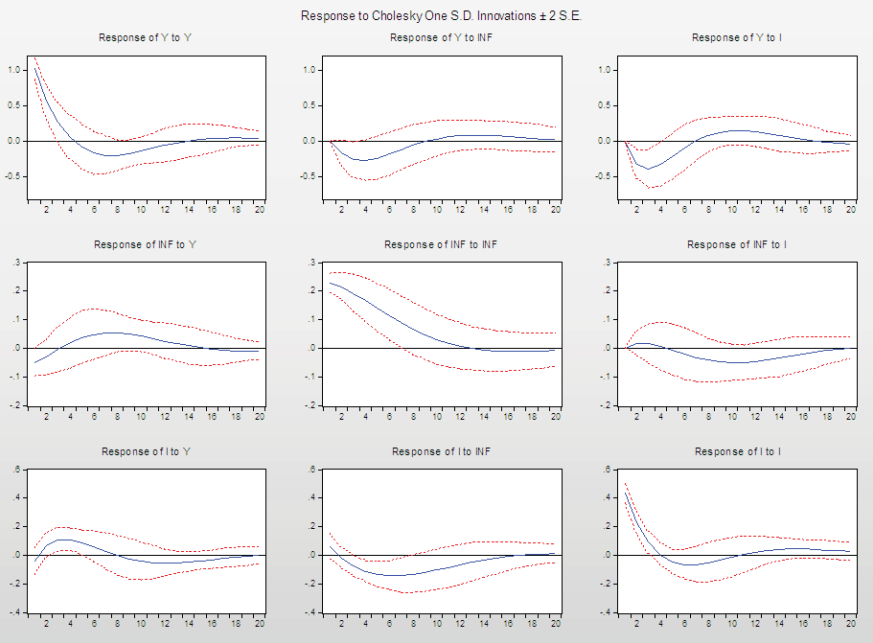
4. Results

4.1 Empirical Results

Figure 2 shows the impulse responses of both the domestic intermediate and target variables in response to a one standard deviation shock in interest rates, using the 2015 base model. Broadly, the domestic variables respond in a way consistent with economic intuition. Following a one standard deviation tightening of monetary policy – corresponding to approximately 40 bps increase – output reduces by 30 bps after three periods with a persistence of about seven quarters. Prices increase slightly, indicating some evidence of the price puzzle[11] before falling to 5 bps below the baseline after nine quarters.

11. The price puzzle refers to the positive relationship between interest rates and inflation. It is a puzzle because an unexpected tightening of monetary policy is typically expected to be followed by a decrease in the price level, instead of an increase. The price puzzle was initially described by Sims (1992).

Figure 2
Factors that Influence the Transmission of Monetary Policy

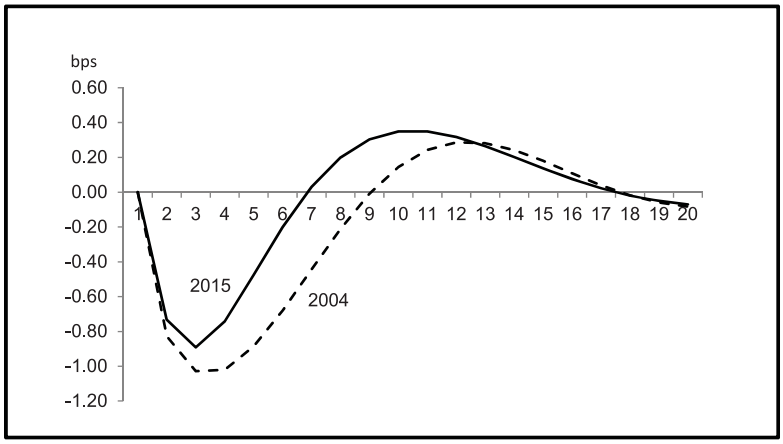


The channel variables also generally respond as expected, with asset prices and bank loans falling in response to an interest rate increase. However, contrary to conventional theory, a hike in the policy rate counter-intuitively leads to a contemporaneous depreciation in the ringgit (increase in USDMYR), a result that is also observed in various countries including Brazil, Mexico and Chile (see Kolscheen, 2011).

We take away a few main conclusions from our empirical model. First, we find that over time, the transmission mechanism to output has weakened slightly with a shorter persistence in recent years (see Figure 3). Our impulse response function indicates that the transmission to output has decreased by about 10%, taking approximately three periods for maximum impact with the effect on output dissipating after six quarters. A 100 bps positive shock to the policy rate results in a decrease in output of about 90 bps in the full sample compared to about 100 bps in the short sample, indicating lower monetary policy pass-through in recent years. However, the pass-through to output has marginally increased in speed over time. In addition, we find that the standard error bands around our impulse response functions for the transmission to output and inflation have

narrowed, implying a decreased in variability of monetary policy's impact on economic activity over time.

Figure 3
Impulse Response Function of Output (Y) to a 100 bps Policy Rate Shock for the Samples from 1990 to 2004 and 2015



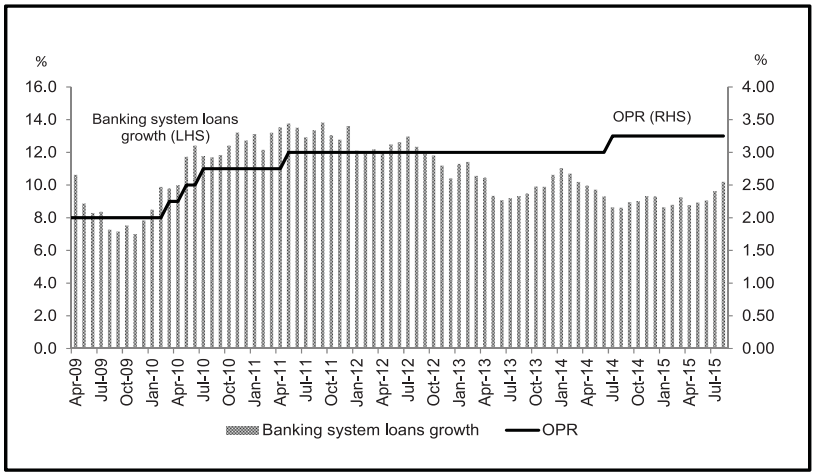
The weakening of the overall transmission mechanism can be attributed to the decrease in strength of the exchange rate and interest rate channel as the deviation between the impulse response functions with these channels exogenized, and that of the baseline, yields a smaller difference over time. The exchange rate channel has also slowed the overall pass-through to output to three quarters compared to two quarters previously. The slight decrease in strength of the interest rate channel, proxied by the residual impact unexplained by the other channels, is likely to have caused the overall weakening given its importance to the transmission mechanism.[12]

In the short sample, our results indicate a counter-intuitive response of the credit channel in transmitting policy shocks to output. According to the credit channel, credit should decline when monetary policy is tightened, constraining growth and inflation. However, in the short sample, our results indicate that blocking the credit channel leads to a stronger effect to output from a policy rate hike. In other words, the presence of the credit channel inhibits the full

12. Please refer to Appendix 1B for further details on the impulse response functions of the individual channels.

transmission of a policy rate shock to output. A plausible reason for this result is if, in response to an unanticipated monetary policy shock, borrowers increase demand for credit (instead of decreasing demand) in order to hedge against potential rate increases in the future. Figure 4 shows that during the policy rate tightening cycle in 2010, banking system loans growth rose contemporaneously, in line with expectations of higher interest rates.

Figure 4
Banking System Loans Growth and the Overnight Policy Rate (OPR)

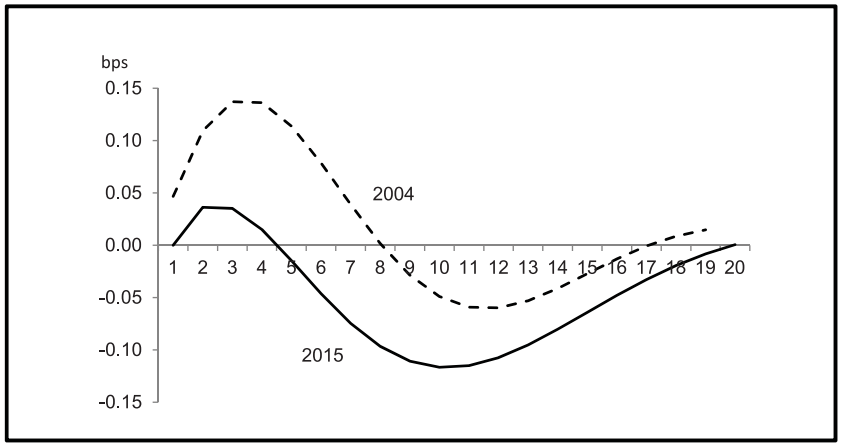


However, in the full sample we find that this effect has declined significantly, as observed by the close tracking of the impulse response function of output with the credit channel exogenized and that of the baseline model for the first four quarters. Beyond the fourth quarter, the credit channel begins to have a positive impact on the transmission channel before tapering off after nine quarters. Although most of the channels have gotten weaker over time, we find that these effects are offset by the gains in strength of the asset price channel, which now account for about 45% of the total transmission to output. However, we note that the share of the asset price channel may be slightly overstated in our results for two reasons, especially as the equity holdings as a share of household wealth in Malaysia is only at around 11%. First, as asset prices are a leading indicator of economic conditions, the asset price channel may be capturing general consumer expectations about the future state of the economy, in addition to the direct wealth effects in response to a monetary policy shock. Second, as the correlation between the KLCI and the Malaysian House Price Index (MHPI)

from 2005 to 2010 is high at 0.93, we anticipate that a sizeable portion of the asset price channel may be derived from the effects from higher housing wealth in recent years, in addition to that of equity holdings.

The speed and persistence of the transmission with the asset price channel exogenized and endogenized remain broadly similar, with output hitting its trough by two quarters and lasting for five quarters.

Figure 5
Impulse Response Function of Inflation (INF) to a 100 bps Policy Rate Shock for the Samples from 1990 to 2004 and 2015



In terms of transmission to inflation, Figure 5 shows that the pass-through has both strengthened and increased in speed over the two samples. A 100 bps increase in the policy rate results in a maximum decline in inflation of about 12 bps after ten quarters in the full sample, compared to 6 bps after twelve quarters in the short sample. The pass-through to inflation is also more persistent, lasting for about nineteen quarters compared to sixteen quarters previously. It is also worth noting that the price puzzle has declined significantly in recent years.

4.2 Evolution of the Factors of Monetary Policy Transmission

What are the factors that have driven these changes in the transmission mechanism for Malaysia over time? To answer this question, we identify the three factors that influence the effectiveness of the MTM for a particular country, that is, the monetary policy framework, the structure of the financial sector and

the structure of the economy (See Table 2). These factors have evolved over time and we look to stylized facts and trends to explain our empirical results. Overall, the analyses in this section appear to concur with the empirical findings of a slightly weaker transmission to output. While the MTM in Malaysia has increased in potency due to the changes in the monetary policy framework, its gains have been offset by the evolution of the financial sector and developments in the structure of the economy.

Table 2
Evolution of Factors Influencing the Monetary Transmission Mechanism

		Strengthen	Weaken	Ambiguous	Overall
Monetary policy framework	Monetary policy framework	✓			• **Shift in monetary policy framework is likely to have intensified transmission** by strengthening impulses to bond markets and exchange rates.
	Market versus non-market interest rates	✓			
	Exchange rate regime	✓			
Nature of the financial sector	Extent of monetization	✓			• **The impact of financial sector development is mixed** as stronger transmission by banks may be countered by weakened transmission via bond markets.
	Competitive intensity			✓	
	Ampleness of liquidity		✓		
	Financial disintermediation			✓	
	Financial innovation		✓		
Structure of the economy	Industry mix		✓		• **Changes in the economic structure** of demand, movements away from capital intensive industries and lower export share is **likely to have reduced sensitivity to monetary policy.**
	Demand mix		✓		
	Size of firms	✓			
	Degree of openness		✓		
	Balance Sheets	✓			

The monetary policy framework plays a central role in the MTM of an economy as it is the source of monetary impulses to the economy. In April 2004, BNM introduced the New Interest Rate Framework (NIRF), transitioning towards a market-based interest rate-targeting framework. In financial systems where intermediation is organized around banks and capital markets, the use of market based monetary instruments can increase the pass-through of monetary policy as the setting of short-term interbank rates influences the funding costs of banks and the prices and returns in the financial markets.[13] The shifts in the monetary policy framework resulted in greater emphasis on the role of communications in shaping expectations, such as through the publication of a Monetary Policy

13. In comparison, the use of non-market based monetary instrument such as credit ceilings, reserve requirements and moral suasion is likely to be more limited as its effects are focused mainly on lending conditions within the banking system.

Statement (MPS) following monetary policy meetings. Central bank communication plays an important role in the transmission mechanism by increasing the potency of the expectations channel. By shaping expectations about the future path of the policy rate, central banks have greater influence on longer term financial market prices, as well as, expected prices of goods, services and factors of production. Indeed, Ooi (2008) shows that the new monetary policy regime resulted in faster and more complete pass-through from the policy rate to interbank rates and retail lending rates. In terms of the exchange rate regime, Malaysia removed its currency peg to the U.S. dollar, moving to a floating rate regime in July 2005.[14] This shift in exchange rate regime opened up an additional channel of monetary policy transmission through the exchange rate channel. As a whole, we summarize the developments of the monetary policy framework as having increased the strength of the MTM, in particular, along the interest rate and exchange rate channels.

The structure of the financial system is another important factor that influences the effectiveness of the MTM, as it constitutes the environment that monetary policy operates in. An increase in the number of business and households that have exposure to financial services, products or assets is likely to increase the influence of monetary policy.[15] In the case of Malaysia, significant gains in financial inclusion have been made; according to the World Bank's 2014 Global Financial Index (Global Findex), 81% of adults had access to an account at a financial institution in Malaysia, up from 66% in 2011. High financial inclusion in Malaysia is also evidenced by a high degree of monetization, as proxied by the ratio of M3 to GDP. According to studies (see Kokoszczyñski, Łyziak and Wróbel, 2002), a high degree of monetization improves the pass-through of monetary policy.

From the perspective of the banking system, balance sheets play a role in the transmission of monetary policy. For example, banks that hold adequate amounts of liquid assets on their balance sheets are able to draw down on these assets during policy tightening cycles, meeting demand for credit despite lower

14. The currency peg was introduced in September 1998 to stem short-term capital outflows and to stabilize the currency during the 1997 Asian Financial Crisis (AFC).

15. According to Mehrotra and Yetman (2015), the increase in financial inclusion in countries amplifies the transmission channels by significantly changing the behaviour of firms and consumers.

supply of loanable funds. This trend could weaken the narrow credit channel.[16] We observe this scenario in the Malaysia, as the share of liquid assets as a ratio of total asset holdings of commercial banks in Malaysia is high at 42% (see Figure 6). Counterbalancing this impact, however, is the increasingly competitive banking landscape as evidenced by the tightening lending spread of banks. Higher competition to lend amid compressed lending spreads is likely to result in greater pass-through from changes in banks' funding costs to retail lending rates.[17]

In terms of the financial markets, the increasing trend of financial disintermediation has resulted in structural changes in the functioning of the financial system as borrowers are able to tap into capital markets for their funding needs. To the extent that the rise in financial disintermediation drives financing activity towards markets such as the shadow banking system and the markets for securitized assets, which are further removed from the direct effect of monetary policy, this trend could reduce the strength of the transmission mechanism (see Estrella, 2002). In the case of Malaysia, we observe a strong trend of financial disintermediation from the bank based financing toward lending activity that is bond market-based. Figure 7 shows that in 2014, the share of capital market financing out of the total private sector financing in Malaysia was 34%, compared to only 21% in 1996. The pass-through of monetary policy changes to the cost of borrowing in the bond market is also found to be less complete than the high transmission observed in retail lending rates of the banking system (see Figure 8). In addition, certain types of financial innovation such as hedging instruments may weaken the MTM by insulating borrower cash flow from the effects of monetary policy shocks. The development of markets such as the KLIBOR futures market, the interest rate swap market and the equity futures market in Malaysia may have contributed towards the weakening MTM.

16. The narrow credit channel (also known as the bank lending channel) works through the banking system. If the supply of bank loans is disrupted due to a monetary tightening, bank-dependent borrowers may find it more difficult to obtain credit, thus reducing real activity (see Bernanke and Gertler, 1995) for further details.

17. We note however that in the short-run, higher competition could also result in a weaker pass-through of increases in the policy interest rate to retail lending rates, if banks compress margins to retain market share.

Figure 6
Share of Liquid and Non-liquid Asset Holdings of Commercial Banks

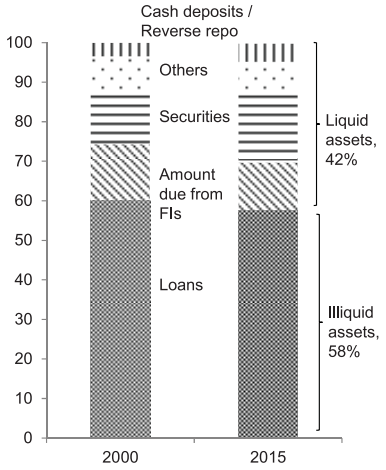


Figure 7
Share of Capital Market Financing to the Private Sector

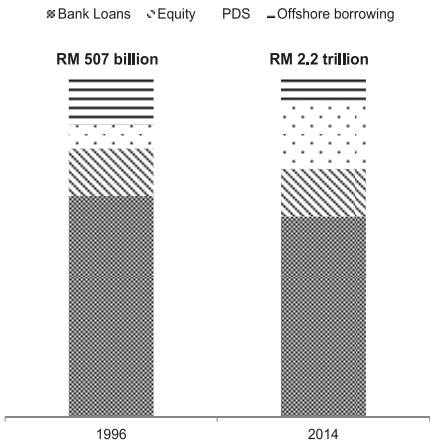
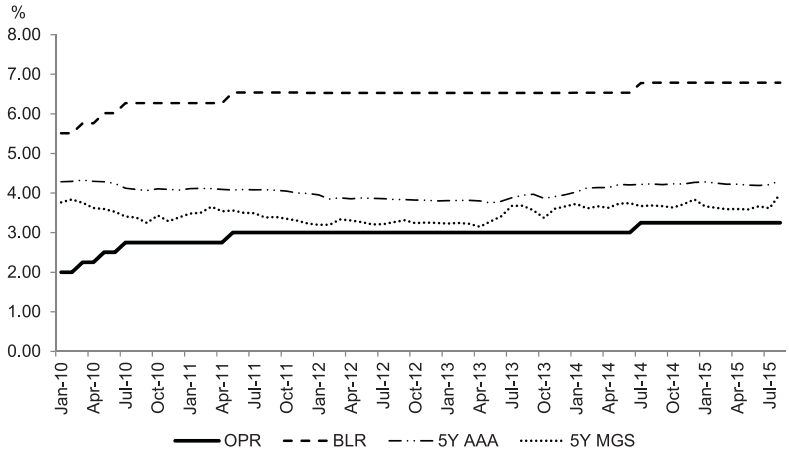


Figure 8
Interest Rate Pass-through to Bond Market Rates and Retail Lending Rates



Note: Up till 2 January 2015, the Base Lending Rate (BLR) served as the main reference rate on retail floating rate loans in Malaysia, until it was superseded by the Base Rate (BR). Corporate bond yields are proxied by 5-year AAA bonds, while government bonds yields are proxied by 5-year Malaysian Government Securities (MGS).

In the context of a highly open economy, greater integration between domestic financial markets with the global financial system has important implications for the MTM. Measures of cross-border financial transactions for Malaysia indicate greater two-way movement of capital and a sharp increase in domestic assets owned by foreign investors. Rey (2015) argues that increased global financial integration can render national monetary policies less effective, as domestic monetary conditions become overwhelmed by shifts in the global financial cycle. In addition, Jain-Chandra and Unsal (2012) find that large capital inflows weaken the link between the policy rate and lending rates, resulting in long-term interest rates being largely determined by global factors. We also find closer synchronization of domestic bond market yields with global bond yields, as shown by a higher correlation between the two rates (2011-2015: 0.71; 2004-2010: 0.34). This finding is in line with other studies on Malaysia. For example, Singh (2014) shows how, despite an unchanged monetary policy stance, large capital inflows impacted the Malaysian economy through direct and indirect effects, by boosting domestic equity prices, and exerting downward pressure on financial and bank interest rates.

As a whole, we observe that evolving developments to the structure of the financial sector appear to have a mixed impact on the MTM. Some developments, such as greater financial inclusion, is likely to have strengthened the pass-through, while other developments, including increasingly integrated global capital and financial markets, appear to have weakened the MTM. Putting these findings together with the empirical results, on balance, we conclude that changes in the financial sector have most likely resulted in weakening of the MTM, in particular along the interest rate and exchange rate channel.

As the target variables of monetary policy are real variables, changes to the nature of the economy would naturally affect the transmission mechanism. A number of studies find that economies with a higher concentration of consumption of durables and residential investment (demand mix) are more sensitive to interest rate changes, as the spending on these items are typically financed through credit. As shown in Figure 9 and 10, the share of consumption of durables and residential housing compared to the past decade has declined, implying reduced sensitivity of consumption and investment to interest rate changes. Closely related to the demand mix is the industry mix, whereby economies with larger manufacturing and construction sectors also display higher sensitivity to interest rate changes, in part due to the high capital intensity of these sectors.

Figure 9
Share of Durables over Total Private Consumption

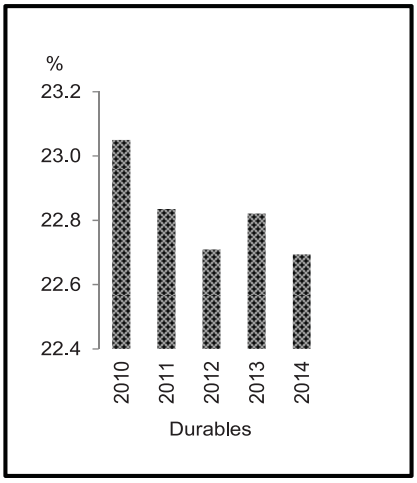


Figure 10
Share of Residential Housing over Total Private Investment

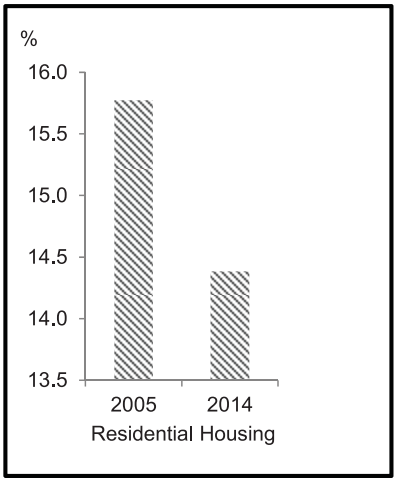


Figure 11 shows that the manufacturing sector as a share of total private investment has decreased substantially over time from 38% to 24%. The manufacturing sector is one of the sectors in Malaysia that is most interest rate-sensitive (see Ibrahim, 2005). However, the decline may be partially offset by slight gains in the share of the construction sector, which is another interest-rate sensitive sector. Turning from the domestic economy to the external sector, the level of trade openness of a country can also affect the transmission mechanism by increasing the importance of the exchange rate channel. The smaller size of the external sector, as reflected by the decline of exports as a share of GDP from 92% to 76% suggests a lower impact of monetary policy from the exchange rate channel (see Figure 12).

Figure 11
Share of Manufacturing over Total Private Investment

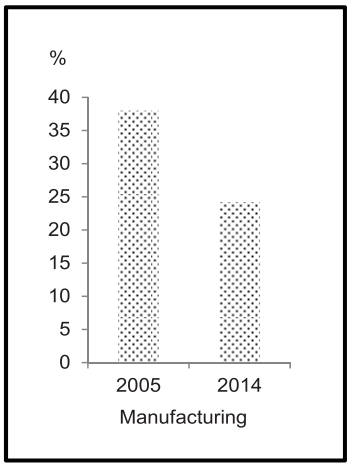
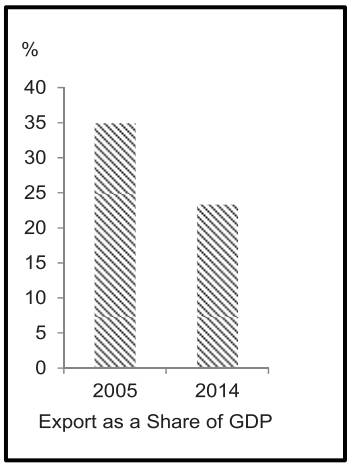


Figure 12
Export as a Share of GDP



While patterns of demand may have weakened the channels, we find that the trend of household asset holdings, including the size and the type of asset holdings may explain the increased potency of the asset price channel. Over the past decade, the household balance sheet has grown in size, both in terms of assets and debt.[18] From 2003-2013, total household assets grew at an annual rate of 10.4% to 321.6% of GDP as at end-2013. Housing wealth, while remaining the largest component of household assets, has increased significantly as a share of GDP over time (2005: 102%; 2013: 160%) as reflected by the MHPI more than doubling since 2000. Although we did not include the MHPI in our estimates, the high correlation between equity prices and housing prices indicate that housing prices is likely to play an important role in the asset price channel (see Figure 13). These trends suggest the strengthening of the asset price channel, as a reversal in price gains is like to lead to a larger reduction in wealth, causing a scale-back in household spending. In addition, the composition of household assets has become more diversified over time with an increase in accumulation of unit trusts and equities, increasing the speed and magnitude of policy shocks to consumption in the real economy through changes in asset prices (see Figure 14).

18. Bank Negara Malaysia Annual Report 2013.

Figure 13
Malaysia House Price Index (MHPI) and Kuala Lumpur Composite Index (KLCI)

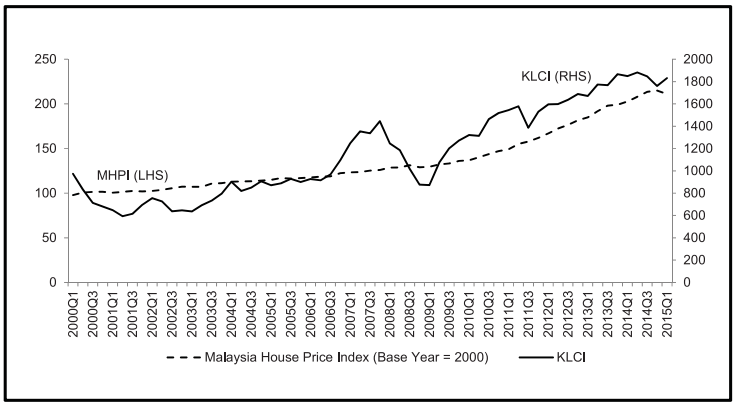
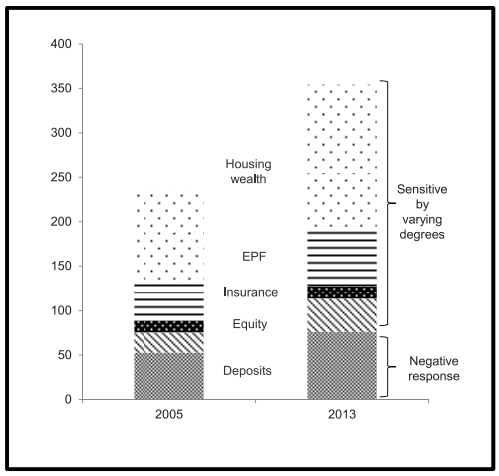


Figure 14
Household Assets as a Ratio to GDP



Broadly, we observe that the evolution in the structure of the economy, as reflected by the domestic demand and supply factors and also the developments in the external sector, has reduced the sensitivity of economy activity to monetary policy impulses. In contrast, within the household sector, we find that the cash flow and wealth effects are becoming more sensitive to policy movements, supporting the finding of increased potency of the asset price channel uncovered in our empirical analysis.

5. Policy Implications

Our empirical results and analysis provide some insight to the conduct of monetary policy. First, as the transmission mechanism to output has weakened slightly over the past decade, for the same type of shocks to growth, the OPR would have to be adjusted by a larger magnitude than before to have the same offsetting impact on aggregate demand. In contrast, our results indicate that the transmission mechanism to inflation has strengthened, implying that to offset inflationary impact from movements in the policy rate, the OPR would need to be adjusted by a lesser magnitude compared to before to achieve the same results.

These trends indicate that BNM faces a lower sacrifice ratio[19] compared to before when it contemplates raising rates to rein in inflation. Due to the lower sacrifice ratio, BNM has greater policy space to adjust rates as the costs to growth are more muted. The empirical results, however, indicate that the cost to economic activity will be in the near terms, while the benefit of lower inflation is only likely to materialize over the longer term. Nevertheless, the improved capacity to deal with inflation shocks will strengthen monetary policy at a time when the on-going removal of domestic price subsidies and controls, as well as, other structural shifts in the labor market are likely to increase the variability of inflation going forward.

The results of the channel study confirm that in recent years, a sizeable portion of monetary policy effects occur outside the traditional interest rate and bank lending channels. This underscores the continued need for close surveillance of the capital and foreign exchange markets to ensure that monetary policy is having the expected impact. The formulation of policy will also need to account for how dynamic changes in the structure of Malaysia's economy and financial may alter the functioning of certain channels, resulting in weakened or impaired transmission. The experience of the U.S. during the subprime crisis provides a clear example of how extreme financial instability can impair specific channels of monetary policy transmission. Although the Federal Reserve lowered the Federal Funds Rate to near zero levels, demand for credit was muted due to severe household balance sheet damage during the crisis, nullifying the transmission through the interest rate channel. In the banking system, the bank lending component of the credit channel was also weakened as banks preferred

19. An economic ratio that measures the costs associated with slowing down output to change inflationary trends.

to hoard capital instead of lending to borrowers to hedge against potential credit risks at a time of high default rates. These disruptions to the transmission channels during the subprime crisis rendered the transmission mechanism of the U.S. largely impotent until financial stability was restored.

Lastly, the results also indicate that the uncertainty surrounding the effects of OPR changes on the economy has reduced. The reduction in uncertainty provides scope for less gradualism[20] in monetary policy adjustments. While in the past, policy adjustments have been undertaken in a measured pace, evidenced by the normalization cycle that began in 2010 and continued up until 2014, the reduction in instrument uncertainty may enable more decisive adjustments to counter higher-than-anticipated inflationary pressures or asset price increases, given the reduced risk of such an adjustment inadvertently dampening economic growth. However, we emphasize that this finding does not suggest the elimination of uncertainty surrounding the transmission of monetary policy in Malaysia. For this reason, continued monitoring of the factors surrounding transmission coupled with a measured approach to policy adjustments remains appropriate.

6. Conclusions

The aim of this paper was to answer two questions about the transmission mechanism in Malaysia. First, has the transmission of monetary policy to growth and inflation in Malaysia strengthened or weakened over the past decade? Second, what are the factors that have driven these changes?

Through our quantitative results and qualitative assessments, our key findings are as follows:

1. The monetary transmission mechanism to output has weakened over the past decade.
2. However, the monetary transmission mechanism to inflation has increased.
3. In terms of the transmission to output, the interest rate channel and exchange rate channel has declined in strength. The credit channel does not seem to

20. This strategy follows from Brainard's principle of attenuation (Brainard, 1967), which says that if the central bank is unsure of the magnitude of the effect on the real economy from a change in the monetary policy instrument, it should adjust the instrument by a lesser degree than if it were to be sure. Indeed, there are gains to this strategy, as it reduces the risk of reversing policy decisions should economic data show an unexpected turnaround and it lowers financial market disruptions and policy mistakes in an uncertain environment.

have a material impact in transmitting policy impulses to output, while the asset price channel has gained in significance.

4. The overall monetary policy transmission mechanism has become less uncertain in terms of its impact on the targeted real variables.

5. While changes in the monetary policy framework have improved the transmission of monetary policy to output, the gains have been blunted by changes in the financial sector and structural shifts in the economy.

While this study has provided some insight into the MTM for Malaysia and implications for policy, we note that the nature of the transmission mechanism is a dynamic system that is constantly evolving. As such, continued monitoring of the developments and greater research on the MTM are important in order to deepen the understanding for effective policy making in Malaysia.

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Appendices

Appendix 1: Shutdown Methodology and Estimation Results

A. Introduction to the Shutdown Methodology

We investigate the individual strength of each transmission channel by comparing the impulse responses of both the target variables of output and inflation in response to a monetary policy shock under two scenarios: a baseline VAR model that includes all the channels and a constrained model that excludes the channel of interest.

The operation of such a procedure is as follows. First, the baseline model is run, and the impulse response function for output and inflation in response to a monetary policy tightening is identified. Next, a transmission channel is shut down by exogenizing the associated variable. A similar impulse response function is then plotted and compared to the baseline. By exogenizing the variable that proxies for the channel of interest, we are effectively blocking off any response that passes through the VAR through the said variable.

The difference between the impulse response of the baseline (unconstrained) model and that of the constrained model provides a measure of the strength of the channel of interest. The greater the deviation of the impulse response function of the constrained model from the baseline for a particular channel of interest, the higher its significance in the transmission mechanism. Conversely, the closer the impulse response function of the constrained model tracks that of the baseline, the lower the importance of the associated channel.

Similar counterfactual experiment methodologies, pioneered by Ramey (1993), have been employed in various monetary transmission mechanism studies in a variety of contexts. Disyatat and Vongsinsirikul (2003) examine the degree and channels of pass-through from money market rates to retail rates by shutting down the asset price channel, exchange rate channel, and credit channels. Endut, Morley and Tien (2014) perform a similar study on the US transmission channels using a structural VAR (SVAR) approach. Closer to home, Tang (2006) employs this technique to gauge the strength of the interest rate, exchange rate, credit and asset price channels to monetary policy. It is with his study that ours most closely relates to, and we compare some of the broad results with that of his study.

B. Impulse Response of the Individual Channels

Figure 1
Impulse Response Function of Individual Channels for a Response of Output (Y) to a Policy Rate Shock (1990-2004)

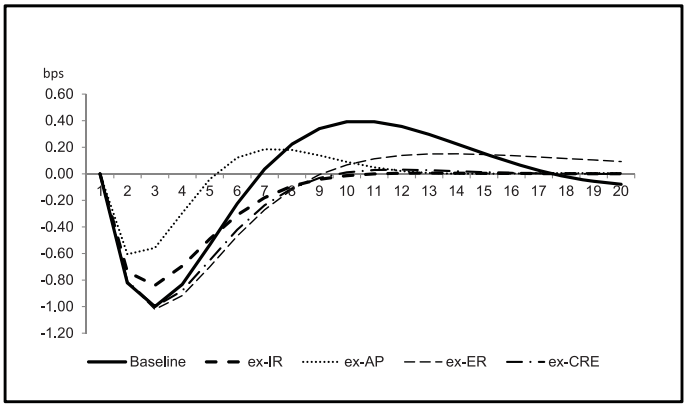
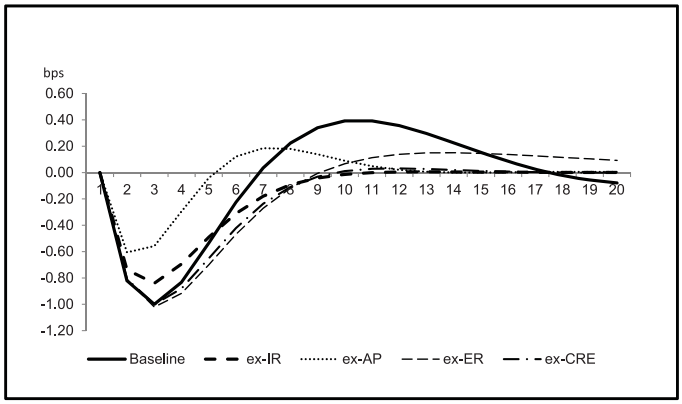


Figure 2
Impulse Response Function of Individual Channels for a Response of Output (Y) to a Policy Rate Shock (1990-2014)



Chapter 4

MONETARY POLICY TRANSMISSION IN MONGOLIA[1]

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1. Introduction - Goal of the Paper

Like most of emerging and developing economies, Mongolia is not unfamiliar with the difficulties arising from the ambiguity of monetary policy transmission mechanism. Not to mention the fact that both structural and institutional changes in the economy does not make it an easier task to assess the transmission channels.

Following the adoption of the democratic regime and the shift to a market-based economy in early 1990's, the Mongolian economy has been evolving continuously over time, in terms of the structure of production, development of financial sector and trade openness etc. The number of trade partners and the volume of trade turnover widened tremendously. Moreover, the giant project of Turquoise Hill for the mining of copper and other coal projects have made Mongolia very attractive for foreign investors. Needless to say, the mining sector has become one the economic drivers in a very short period. Following the real sector, raising funds in international financial markets via initial public offerings (IPOs) and other forms of debt securities have become increasingly popular among major banks, corporates and even for the government. In a nutshell, the Mongolian economy has received a significant amount of capital inflows in the last half decade.

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1. This paper was written for the SEACEN Research Project "The Monetary Policy Transmission Mechanism." The views expressed in this paper are the only authors' and do not necessarily reflect the Bank of Mongolia and The SEACEN Centre.
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One of the most recent and extremely debated shifts in monetary policy was the injection of public money into the credit market by both the central bank and the Development Bank of Mongolia, under the direct lending program to targeted sectors in line with the government's development plan for 2012-2014. Consequently, domestically issued public debt increased by more than 50% in the past 5 years. Since investment expenditure by the Development Bank of Mongolia is similar to fiscal expenditure, it amplified the fiscal dominance and its pro-cyclicality. Unfortunately, fiscal dominance and pro-cyclical fiscal policy tend to blur the effectiveness of monetary policy and exacerbates economic vulnerability.

Although the financial intermediary is deepening, with the increased financing from both domestic and foreign sources, the Mongolian financial sector was not entirely insulated from the Global Financial Crisis (GFC) as both banking and non-banking sector suffered drastically.

Every structural shift or major change in "the way things work" raises the questions "How do these developments affect the transmission mechanism of monetary policy? How should the Bank of Mongolia (BOM) respond to shocks in different economic environments? What would be the appropriate monetary policy responses?" These developments do not only have lasting impacts on the evolution of the transmission mechanism, but also on the framework of monetary policy. For instance, the monetary targeting framework based on strong lending channel was effective at curbing hyper-inflation until the mid-2000s. However, financial deepening, fiscal dominance and significant monetization process resulted in the unstable relationship between broad money and reserve money, hence hindering the central bank's ability to steer domestic demand in its desired direction. Since then, the evolution of the monetary policy framework at the Bank of Mongolia has shifted from monetary targeting to an eclectic strategic framework with inflation as the primary target and from then, to a more forward looking framework after the Global Financial Crisis. This framework is close to inflation targeting and proposes a complete system of forecast based monetary policy decision making and policy formulation. Needless to say, it is very important to have a good idea about the monetary policy transmission mechanism while making macroeconomic forecasts, formulating and implementing monetary policy under the new framework. In other words, it is hard to use your tool, if you do not know how it works.

This study will focus on determining the relative strength of each monetary policy transmission channel in accordance to recent shifts in economic and financial environment. The results of this study may provide constructive

implications on the selection of appropriate monetary policy instruments and operational target.

The rest of this paper is organized as follows. Section 2 discusses the monetary policy framework and transmission channels in the Mongolian economy by assessing economic and financial factors that may play an active role in determining relative strength and weakness of each channel. Section 3 briefly reviews the literature on transmission mechanism of Mongolia. Sections 4 and 5 discuss data and methodology and the empirical results. The final section concludes the research.

2. Overview of Monetary Policy and Monetary Transmission

2.1 Overview of Monetary Policy Framework

2.1.1 Institutional Framework

Institutional and operational affairs of the Bank of Mongolia (BOM) are regulated under the Central Banking Act as declared by the Parliament of Mongolia. The Act states that BOM is responsible for formulating and implementing monetary policy; issuing the national currency; acting as the Government's fiscal intermediary; supervising banking activities; arranging interbank payments and settlements; and managing the State's international reserves. As specified in the legislation, the primary objective of monetary policy is to promote stability of the national currency. Within the boundaries of its primary objective, BOM may take actions for fostering the balanced and sustained development of the national economy, through maintaining stable financial and money market.

2.1.2 Strategic Framework

According to the Central Banking Act, BOM is responsible for drafting and submitting the "Monetary Policy Guideline" including inflation target for the following year, by October 1 of each year to the Parliament for its approval. Although the guideline is approved by the Parliament, BOM has the liberty to formulate its own policy measures and define its own strategic framework. Throughout its history, BOM has had several shifts in its strategic framework.

2.1.2.1 Monetary Targeting (1995-2006)

The Bank of Mongolia has had a monetary aggregate targeting framework since the mid-1990s, with reserve money as the operational target and M2 as

the intermediate target. In practice, however, BOM had not been strictly adhering to its monetary targets (Table 1). Data on monetary aggregates indicate that since the mid-2000s, the relationship between reserve money and broad money, the money multiplier, had become unstable and the impact of M2 on inflation had become ambiguous.

Table 1
Statistics on Money Growth and Inflation

	M0 Growth		M2 Growth		Inflation
	Target	Actual	Target	Actual	
1995		28.7	38.3	32.9	53.1
1996		36.5	31.7	25.8	44.6
1997		23.1	19.8	32.5	20.5
1998		18.7	4.4	-1.7	6
1999		49.9	10.8	31.6	10
2000		18.6	11.2	17.6	8.1
2001	11.1	8.2	13.6	27.9	8
2002	21.5	21.9	35.8	42	1.6
2003	13.9	14.5	15.2	49.6	4.7
2004	20	17	18	20.4	11
2005	15	19.7	20	34.6	9.5
2006	15	15	25	39.6	6

Source: Bank of Mongolia.

2.1.2.2 Eclectic (2007-2009-2011)

Considering the difficulties of targeting monetary aggregates, BOM with the technical assistance of IMF, initiated an eclectic anchoring strategy that sets inflation as a goal and monitors a broad range of financial (exchange rate, money and credit growth, interest rates) and real indicators (domestic demand, current account, production, labor markets). Under the new framework the BOM introduced the Policy Rate as the main policy instrument to impact the market and the ultimate intention was to shift to inflation targeting framework in the future. Unfortunately, before BOM could complete the transition, the Mongolian economy was sharply hit by the wave of GFC in 2009. In order to safeguard the foreign exchange reserves and relieve immediate pressure on the exchange rate, BOM accepted the IMF Stand-by program in 2009. The program's terms required BOM to target the monetary aggregate by placing a ceiling on net domestic assets and setting a floor for net foreign assets. In 2011, BOM successfully completed the 18-month Stand-by program.

2.1.2.3 Transition to Forward Looking Framework (2011-Present)

Since 2011, BOM has been laying out the groundwork for a more forward looking monetary policy framework, namely, the Forecasting and Policy Analysis System (FPAS), which is a complete scheme that maps several aspects of monetary policy, such as forecast-based policy formulation and decision making, and effective communication with the public. Once fully developed, the FPAS is expected to strengthen monetary policy transmission in the economy. In other words, the desired outcome of FPAS is to reinforce the link between the policy rate, short-term market rate, long-term rate and ultimately inflation expectations. Yet, currently BOM lacks a well-defined operational target and anchor for inflation expectations, which are considered the foundational bricks of the FPAS system. Hence, it is not an easy task for BOM to maneuver the longer term rate in the desired direction, and it often misses the inflation target and consequently issues for credibility arise. In this regard, for the last couple of years, the BOM is working to make a phased transition to a medium- and long-term program, to improve monetary policy implementation and to adopt a formal forecasting framework.

2.1.3 Operational Framework

In-line with the Monetary Policy Guideline, given the numerical target on inflation rate for the following year, the BOM formulates its monetary policy and implements it using several direct tools, such as reserve requirement, policy rate, standing facilities and foreign exchange deals.

2.1.3.1 Reserve Requirement

BOM currently imposes a minimum reserve requirement of 12% of liabilities on banks, with the double purpose of affecting the supply of base money and managing liquidity in the system. Banks must comply with the requirement, on average, over a two-week reserve maintenance period and must hold a minimum of 50% of the reserve requirement daily. Banks' demand deposit at the Central Bank is considered eligible and counted as the compliance measure of reserve requirement. The liability base includes practically all deposits in both domestic and foreign currencies by nonbanks.

2.1.3.2 Policy Rate

In 2007, BOM introduced the policy rate (7-day central bank bill rate) to maneuver short-term rates on the interbank market. However, the transmission

from policy rate to banks' deposit/ lending rates remains problematic because of the shallow bond and interbank market and strong exchange rate channel.

2.1.3.3 Standing Facilities

BOM employs two standing facilities - the overnight repo and overnight deposit. The overnight repo facility is fully collateralized, priced at 2 percentage points above the policy rate while the overnight deposit facility is priced at 2 percentage points below the policy rate. The overnight repo and overnight deposit facilities are the last transactions approved on a business day and matures the first on the following business day. The rationale behind these tools is to provide a corridor around the policy rate, so that the interbank interest rate floats within 2 percentage point of the policy rate.

2.1.3.4 Open Market Operations

BOM issues and trades Central Bank Bills (CBB) with maturities of 1-52 weeks with banks to absorb excess liquidity from the interbank market. As a result of BOM's liquidity management, short-term interest rate at the interbank market is maintained close to BOM's target level.

2.1.3.5 Foreign Exchange Deals

In order to reduce excess volatility in the exchange rate and align exchange rate movements with macroeconomic fundamentals, BOM engages in foreign exchange deals with commercial banks. These foreign exchange deals vary from simple spot trading of foreign exchange to forward and swap deals with commercial banks in order to reduce foreign exchange risk of banks as well as non-banks.

2.1.3.6 Unorthodox Tools

Over the past three years, BOM has attempted to reduce inflation and spur economic growth using unconventional methods. To cushion the impact of declining FDI on economic growth, BOM initiated substantial direct lending to banks at below-market rates, under the Price Stabilization Program, Mortgage Program as well as direct lending to banks. The total planned allocation under these programs is equivalent to 19% of GDP in 2013. In the same year, central bank claims on banks increased by more than 10 times and reserve money grew by 54% compared to end of 2012.

2.1.3.7 Price Stabilization Program (PSP)

The PSP was launched in late-2012. Under the program, BOM provides low-cost funding to corporations for which the price-setting behavior has a significant impact on inflation (e.g. corporates in the business of wholesale distribution of meat, flour, imported petroleum products, construction, coal production and other agricultural products).

In August 2013, the Bank of Mongolia injected liquidity of MNT 900 billion into the banking system, in the form of one-year time deposit at 7% interest rate to reverse the downward trend in lending growth.

In mid-June 2013, BOM launched a 1.1 trillion MNT mortgage lending program, aimed at providing low-cost mortgage loans to qualified debtors. Funding under this program was provided to banks at 4% interest rate and on-lent by banks through 20-year mortgages at 8% interest.

2.2 Main Monetary Policy Transmission Channels of Mongolia

In this section, we discuss factors that affect transmission mechanism of monetary policy in the Mongolian economy. The relative strength or weakness of each monetary policy transmission channel can be explained in part, by economic factors such as economic structure, financial market development, monetary policy decision making process and etc.

2.2.1 Interest Rate Channel

Due to some characteristics of small and open emerging economies such as underdevelopment of securities and interbank market, lower credibility of monetary policy, heavy concentration of banking sector and small share of the industrial sector, the conventional transmission channel of interest rate is unlikely to work efficiently.

One of the reasons behind the weak interest rate channel of monetary policy transmission in Mongolia is poor development of the interbank and securities market. Change in the short-term rate should transmit to longer-term bond rate, since the expected short-term rate determines the long-term bond rate. However, this channel is not discernible because of the unavailability of a yield curve for government securities and corporate debt, resulting in asymmetric information for investors and banks. Although the Mongolian government is attempting to develop the government securities market, the secondary market for domestic

government bonds is still shallow and illiquid. Moreover, most non-major domestic firms have limited opportunities to raise additional funds by issuing corporate debt. Moreover, raising capital in the domestic equity market via IPO and secondary public offerings (SPO) is constrained by the shallow investor base and illiquid market. This slow development of the stock market can be clearly seen from its main stock market indicators compared to that of the world and its peers.

Table 2
Stock Market Indicators as of 2012

	Indicators	Mongolia	World	Low & Middle income	East Asia & Pacific
1	Market capitalization (% of GDP)	12.5%	74.2%	47.9%	51.5%
2	Market liquidity (Value of shares traded % of GDP)	0.4%	69.4%	40.5%	61.9%
3	Turnover ratio (Value of shares traded % of market capitalization)	2.8%	99.8%	90.4%	127.7%

Source: World Bank, Available at: http://wdi.worldbank.org/table/5.4

As a market for short-term liquidity, the money market plays an important role for the pass-through of the short-term rates to long-term rates. The money market serves as a base platform where financial institutions can easily fulfill their short-term liquidity needs at a competitive cost. As the size of money market widens, the pass-through of the short-term rates to longer term rates becomes stronger. However, in the Mongolian economy, the size of interbank market and banks' funding from the interbank market are marginal. For instance, banks' funds raised at the interbank market are below 4% of banks' total equity and liability. Moreover, most of the transactions at the interbank market are settled among only five to six large banks and the total monthly turnover in the interbank market is usually less than 5% of total asset in banking sector.

Although the effect of the interbank market rate on the bank lending rate is generally referred to as the bank lending channel, one part of a broader bank credit channel, this channel is described in detail in the following sections[5]. The central bank maintains the interbank market rate around its desired level by employing the policy rate and interest rate corridor of 2 percentage points around

5. Due to the common understanding of economics, this may be referred to as the bank lending channel.

the policy rate. Since the interbank market is a potential source of funding for banks, the short-term rate of banks should not deviate far from the interbank market rate. This short-term rate is expected to affect the banks' deposit and lending rate. Banks set their lending rates based on the sum of the deposit rate, which can be translated as banks' cost of funding, and other factors such as its operational expenses, opportunity cost and profit margin. In the case of Mongolia, since a major portion of banks' funding is comprised of deposits, the transmission from policy rate to deposit rate is considered important for monetary policy implementation.[6] However, Mongolia has to contend with challenges of an emerging economy which has led to a weak interest rate channel.

In Mongolia, although the link between the lending and long-term deposit rate and household consumption and capital formation may still be intact, the transmission of the pass-through of the short-term rate to the long-term deposit and lending rate may be the point of breakdown.

One of the reasons behind the weak transmission of the policy rate to deposit rate may be related to the credibility of monetary policy and the history of high and volatile inflation. Inflation surveys conducted by the Monetary Policy and Research Department of the Bank of Mongolia, show that inflation expectation is not well anchored and tends to be based on actual inflation rather than anticipated inflation. Therefore, a change in the nominal deposit rate may be affected by the risk premium of backward looking inflation expectation rather than a forward looking change in policy rate, especially in the case of large depositors.

Another factor is competition in the banking sector. Competition among the three major banks for large depositors is fierce and this fierce competition for depositors and lenders has resulted in the reticence of the three major banks to decrease their deposit rates or increase their corporate lending rate when there is a change in the policy rate. In the case of relatively smaller banks, there is an institutional factor that creates a buffer for their deposit rates against the policy rate. In 2011, the government introduced a guarantee on deposits up to 20 million MNT and since then, banks' risk profiles became less important relative to the interest rate differential. Hence, in case of a reduction in the policy rate, a single small bank cannot reduce its deposit rate accordingly, in the fear of

6. For instance, at the end of 2010 and 2014, deposits comprised 75% and 44% of total bank liabilities, respectively. The reduction of share of deposits in total liabilities can be mainly explained by the increased direct lending operations by the central bank and the Development Bank of Mongolia, which are intermediated through the banking sector.

losing its depositors to a different bank offering higher deposit rates, regardless of its risk profile.

Moreover, subsidized loans from the central bank and the Development Bank of Mongolia (DBM) have blurred the signal of the policy rate. In order to stabilize inflationary pressure induced by a shortage in supply, the central bank provided direct lending to targeted sectors at subsidized interest rate between 0.89% and 4.5% per annum while the average market lending rate and policy rate were at 18% and 13%, respectively. In addition, the DBM provided significant amounts of funding to large mining, construction and infrastructure projects at 7.5%[7] per annum in 2012[8], using its funds raised through securities issued at the international market. Since most of these direct lending and financing were charged at fixed rates under the contract period, it is naïve to assume any interest rate shock would have significant impact on the lending rate.

2.2.2 Exchange Rate Channel

According to the classic uncovered interest rate parity condition, the short-term interest rate can affect the nominal exchange rate and consequently, the real effective exchange rate under the assumption of price-stickiness. With different interest rate and real exchange rate condition, a change in external and domestic demand should follow. For instance, a real depreciation of the domestic currency can improve the position of the current account balance while nominal depreciation can increase prices of consumer goods, comprising 30% of imported goods in Mongolia (Bhattacharya, 2011).

The effectiveness of this channel depends on the central bank's willingness to allow the fluctuation of the exchange rate or what is referred to as a "fear of floating". The degree of "fear of floating" and central bank interventions in the foreign exchange market can be assessed in relation to the balance sheet effect. For instance, exchange rate fluctuations negatively affect the balance sheet of unhedged borrowers and investors. The gravity of this issue depends on the degree of dollarization and its unhedged open position in the balance sheet of economic agents such as the government, financial institutions, firms and households. In the Mongolian banking system, around 30% of total loans and deposits are held in foreign currency. Due to the absence of relevant restrictions on the conversion of deposits from domestic currency to foreign

7. Calculated as interest income over loans outstanding.
8. http://www.dbm.mn

currency or vice-versa, a change in the depositors' expectation on the stability of domestic currency may result in deposit conversions that can have potential hazardous effects on the banking system and increase the risk of currency mismatches. Following a nominal depreciation, this adverse effect of the balance sheet may discourage households and investors' willingness to consume and invest, hence may even offset the positive effect of improved competitiveness on aggregate demand. During the GFC and the recent economic downturn, a significant amount of conversion from domestic currency to foreign currency deposits was observed in the banking system.

Furthermore, in the recent decade, Mongolian banks, corporations and the Government have been actively participating in the international financial market, to raise funds to meet their financing needs. A bank that raises funds in the international market is normally forced to issue foreign currency dominated loans to domestic borrowers, so as to hedge their currency risks and to fulfill prudential regulation on foreign exchange open positions[9]. Since interest rates on foreign currency denominated loans are relatively lower compared to domestic currency denominated loans, it attracts unhedged borrowers and further exacerbates the risk of exchange rate fluctuations on banking sector.

Moreover, the Bank of Mongolia cannot adopt a full-fledged flexible exchange rate regime because of the high dollarization and balance sheet effect. Also, the stability of the domestic currency is an important indicator for the credibility of the Bank of Mongolia and the confidence of economic agents in domestic economy. The general public and politicians still tend to see the exchange rate as a main indicator while assessing the effectiveness of monetary policy and economic condition, although complete exchange rate stability is not the primary objective of monetary policy. Not to mention that exchange rate fluctuation has a lot of significance on domestic economic development and macroeconomic stability, considering the increasing size of foreign trade in recent years.

Capital mobility is another factor that determines the strength of the exchange rate transmission channel. In an economy where capital mobility is relatively high due to the change in the short-term domestic rate, great amounts of capital transfer tends to create large fluctuations on the exchange rate. In other words, control and restrictions on capital movements can discourage capital mobility and hence, reduce the significance of the exchange rate channel. Although

9. In Mongolia, the limit for FX net open position is 12% of capital.

Mongolia does not impose any restrictions or controls on capital mobility such as taxes or tariffs, akin to those of emerging economies in the 1980s, it still faces difficulties in attracting capital flows. It is becoming apparent that just the differential between domestic and foreign interest rates is not sufficient. It seems obvious that while making decisions on their investments, in addition to the interest rate differentials, investors put significant weight on other factors such as uncertainty over exchange rate fluctuations, capital productivity, legal framework, regulatory and institutional risks, capital and labor productivity and the cost and development of financial intermediation and etc.

Last but not least, the higher pass-through of exchange rate to inflation plays a significant role on the relative strength of the nominal exchange rate transmission to aggregate demand. The greater the pass-through, the greater the impact of exchange rate on inflation and consequently domestic demand. Doojav (2009[c]) has estimated the coefficient of exchange rate pass-through to be approximately 50% in the third quarter of an initial shock. This is consistent with the fact that a third of goods in the consumer basket and around half of intermediate goods in production sector are imported.

2.2.3 Bank Lending Channel

In the literature, the traditional bank lending channel of monetary policy is described as follows. Expansionary monetary policy increases bank reserves and deposits, resulting in available funds for issuing credit, and with improved liquidity conditions, interest rates should decline. Since households and non-corporate firms are highly dependent on bank lending compared to large corporates, a rise in credit at relatively lower pricing would result in the expected increase in private consumption and private investment. In other words, expansionary monetary policy prompts higher domestic demand by encouraging banks to issue more credit at lower interest rates.

There are several monetary tools that can stimulate the lending channel. For instance, the central bank may either decrease the short-term interest rate and increase banks' profit margin, or reduce reserve requirements and impose a charge on banks' capital or increase remuneration for required reserves that would increase available funds for lending activity. Macroprudential measures such as capital adequacy requirement may also put a limit on the available funds. One of the most popular tools of the last decade has been priority sector lending or stylized quantitative easing programs which also serve as instruments which transmit the effect of monetary policy through the lending channel.

The Bank of Mongolia has several policy instruments in its arsenal and has taken both orthodox and unorthodox measures through the years since its establishment. For instance, in order to anchor the short-term rate through the interbank market rate, the Bank of Mongolia introduced the policy rate in 2007 and interest rate corridor with overnight deposit and lending rates in 2012. As highlighted above, expansionary monetary policy via a decrease in the policy rate should reduce the cost of funding for banks and increase their margins, which in turn, lead to higher credit supply.

In addition to the interest rate instruments, the Bank of Mongolia imposes a minimum reserve requirement of 12% on banks' liabilities. This instrument was first introduced in 1993 and serves the double purpose of managing money supply as well as providing liquidity to the banking system. For instance, by reducing liquidity in the system, the central bank implements contractionary monetary policy and consequently, discourages credit supply and domestic demand. Over the years, a few modifications were made on the imposition of reserve requirement and it is of vital importance to keep in mind, while assessing its effect on lending activity. For instance, the Bank of Mongolia used to pay remuneration on the banks' deposit at the central bank under the reserve requirement, equivalent to a quarter of the policy rate in 2009. Starting from 2015, the Bank of Mongolia pays a remuneration equivalent to one half of the overnight deposit rate. In 2014, in order to encourage foreign exchange inflows, the Bank of Mongolia removed the minimum requirement on banks' liabilities of foreign origin with maturities of 3 years or more.

Parallel to traditional monetary policy instruments, in order to maintain the stability of financial system, the Bank of Mongolia employs several macroprudential measures as well. For example, a high capital adequacy ratio may decrease banks' funds and liquidity available for lending activity and hence put cap on the credit supply. Implemented properly, the timing and magnitude of these measures may play significant role in smoothening irregularities in the lending channel to increase its effectiveness.

In recent years, the Bank of Mongolia has been actively engaged in unorthodox monetary policy measures or stylized quantitative easing programs. Starting late 2012, in cooperation with the Government of Mongolia, the central bank introduced the direct lending program to prioritized sectors in line with the government's development goals. Under the program, over a course of 3 years, a total of 5 trillion MNT was provided to the agriculture, construction, mining, real estate and banking sectors and the year-on-year growth of credit, base money and M2 money supply reached 58%, 36% and 54%, respectively. Currently,

many of the programs have been completed and a significant portion of the initial funding has been retracted from the system. This direct increase in credit supply must be taken into account while assessing the bank lending channel.

According to Barran et al. (1996), the bank lending channel depends on the central bank's influence over the banking system and the availability of lending sources other than banks. Similarly, Cecchetti (1999) and Mihov (2001) found that the bank lending channel is likely to be stronger in countries where small banks are relatively important and firms have little access to nonbank financing sources. In case of Mongolia, the banking sector comprises over 95% of the financial sector and there is little substitutability of financing sources for households and nonbank corporates. Superficial judgment based on this statistics alone would suggest that the lending channel is strong in Mongolia's case.

In a similar vein, Ehrmann et al. (2001), in a comprehensive study of the structure of banking and financial markets in the euro area, find that the effect of monetary policy on credit supply is most dependent on the liquidity of individual banks, although the size of banks is not a significant determinant. Similarly, Mishra et al. (2010) have found that the banking sectors of many low-income countries (LICs) tend to maintain high levels of liquidity, compared with those of banks of higher-income countries. In the case of Mongolia, Demid E. (2011) has found that banks decide on credit supply based on its reserves and equity. Hence, it is better to look at the size of the liquid assets of banks while studying the strength of the credit channel.

Either strong or weak, literature asserts that effect of monetary policy through the lending channel may have an asymmetric impact on the end-users. In case of contractionary monetary policy, banks become reluctant to issue credit and are likely to withdraw their exposure to the credit market. However, the way banks reduce their credit may not be symmetric across all types of debtors. It may be that banks have more negotiating power over SMEs and households over the large corporates. Hence, this channel may cause asymmetric reduction in credit growth across different types of debtors.

2.2.4 Asset Price Channel

As described in literature and textbooks, the effect of monetary policy may feed into a change of asset prices and equity prices through several channels. First, lower short-term interest rate is translated as lower discount factor in the valuation of business projects and companies. With a lower discount factor, the net worth of business projects and companies, increases and thus causes a rise

in their stock prices at the market with investors receiving higher dividends, leading to higher domestic demand. Second, expansionary monetary policy raises investor's expectation of a future prosperous growth in the economy. With elevated expectation of future cash flows, asset prices tends to increase.

Mishkin (1996) explains the asset price channel through stock prices, also known as the Tobin's Q channel, via two main links. First, higher stock prices increase the market value of a firm relative to the replacement cost of capital. Consequently, the firm can buy more investment goods and can implement new investment projects at cheaper cost, having less need to issue additional stocks in the market. However, in the case of Mongolia, immaturity of the domestic capital market has resulted in the firm's very limited opportunity to raise additional funds through IPOs and SPOs thus diminishing the significance of the Tobin's Q channel.

Second, higher stock prices makes households richer in terms of their holdings of total wealth such as housing, shares of companies and land, etc. As a result, households have the impression that they have become less vulnerable to the risk of sudden drops in their future consumption and can boost their current consumption without having to reduce their future expenditure. In most cases, consumption of durable goods tends to increase more than nondurable goods. However, in Mongolia, a larger share of household wealth is in the form of housing, residential real estate and land, rather than shares of companies. Thus, housing and land prices play a more significant role in the asset price channel rather than the Tobin's Q and discount rate channel.

One of the factors behind the strong housing price channel may be the increasing share of housing in the wealth of households recently. In the last few years, following state development programs such as "Housing Program for Civil Servants", "Program on 40000 Housing" and "Long-term Stable Residential Real Estate Financing Program," households invested heavily in housing and residential real estate. The most recent program, "Long-term Stable Housing Financing Program" made mortgage lending more affordable for middle income households, by fixing the interest rate at 8%[10] per annum. Consequently, in the past 2 years, more than 50,000 new housing and apartments were supplied to the market; more than 80,000 housing and residential real estate were sold; and housing prices increased by more than 30%[11]. This increase in housing prices

10. Market rate for mortgage loan was around 16%-17%.

11. www.nso.mn

not only elevated the wealth of home owners, but also caused a surge in construction and real estate investments. However, it is important to bear in mind that these programs increased household indebtedness which negatively affected the household's disposable income and current consumption expenditure. Over the past 2 years, mortgage loans increased by 3.4 times to finance around 44% of houses sold in the market. As mentioned above, it may negatively impact the current consumption of households who are first-time homeowners. Yet, the same cannot be said for those who already own housing before the program.

Although Tobin's Q channel may seem insignificant in Mongolia, it is important to emphasize the combined effect of the asset price channel and the credit channel. Since banks usually request for land, residential or non-residential real estate and factory buildings as collaterals for issuing either new loans or refinancing existing loans; increases in the prices of real estate or the valuation of a company project would be translated as higher opportunities for s to borrow from banks.

3. Literature Review - Some Studies on Monetary Policy Transmission

3.1 Literature Review on Ordering of Monetary Policy Shock

Although numerous studies and research have been conducted on measuring the effectiveness of monetary policy transmissions, only a few of them have focused empirically, on the transmission channel of an emerging market, low income economy. It is safe to assume the literature is in its infancy in this area. Before looking at previous studies on Mongolia, it is constructive to look at the technical overview of these studies on monetary policy transmission in emerging economies.

The overall technique employed in most of the monetary policy transmission studies, is the recursive Vector Autoregressive Approach with Choleski decomposition, where monetary policy is assumed as exogenous and ordered at the beginning of the Choleski exogeneity list. Hence, it is assumed that the shocks of monetary policy have contemporaneous impact on the rest of the variables. For example, Choleski ordering in a simple three variable system which consists of monetary policy (often monetary base M), real output (Y) and price (P) variables, would be go as the following: monetary policy, real output and price (M, Y, and P). Here, monetary policy does not respond to contemporaneous shocks in the other two variables, and the price level shocks do not have contemporaneous effect on real output. However, this way of ordering neglects the possibility where monetary policymakers can observe the shock in other

macro-variables and respond in the same period. Assuming that the contemporaneous shocks are included in the information set of policymakers and that policymakers can take policy actions in the same period as the shock, where the impact of the policy action is observed with a lag, Bernanke and Blinder (1992) propose the recursive identification scheme where monetary policy variable is ordered last in the Choleski exogeneity ordering. As opposed to the initial suggestion, a simple illustration of the scheme would have a Choleski ordering of real output, price level and monetary policy variable (Y, P, M).

In 1995, Bernanke and Gertler further advanced the structure by adding commodity price to the system and including the federal funds rate as a monetary policy variable instead of the monetary base. This well-known application proposed a Choleski ordering of real output, price level, commodity price and Federal funds rate (Y, P, CP, R). Here, the pitch assumption was that the Federal Reserve makes its policy decision by observing the Y, P, CP variables, but the federal funds rate did not have any impact on these variables within the same period.

Unlike the previous studies, the monetary policy variable was not always ordered last in the Choleski ordering. Peersman and Smets (2001) estimated the monetary transmission mechanism in the euro area by using a Choleski ordering of real GDP, consumer prices, short-term nominal interest rate and real exchange rate (Y, P, R, RER). In this case, they assumed that the European Central Bank observed real GDP and price level but not exchange rate in making its policy decisions. In the short-term, this approach assumes that the monetary policy shock has no impact on real output and price level and at the same time, shocks in other variables have no impact on the monetary policy variable, contemporaneously. One pitfall of this type of approach is that the central bank may respond, that is change its monetary policy variable, if it expects a shock in non-predetermined variables. For instance, if the central bank foresees a nominal exchange rate depreciation in the current period would cause increasing pressure on the price level, then it would respond by tightening its monetary policy in the same period. Hence, whenever a non-predetermined variable enter the information set, the recursiveness assumption fails. So, in order to avoid this problem, the VAR scheme can be converted into a simultaneous system. For example, Gordon and Leeper (1994) included intermediate target variables and estimated a structural model that includes real output (Y), price level (P), long-term interest rate (R_{10}), commodity prices (CP), the stock of reserves (M) and federal funds rate (R). They tried to extract the structural monetary policy shocks and then designed the following model for the reserves market: (e^d and e^s are structural shocks to the demand and supply of reserves).

$M = a_1R + a_2P + a_3Y + e^d$ (Demand for reserves)

$R = a_4M + a_5R_{10} + a_6CP + e^s$ (Supply of reserves)

Bernanke and Mihov (1998) adopted a different model of the reserves market with a similar approach. Sims and Zha (1998) developed another influential approach to identify structural shocks. They extended the four-variable model of Peersman and Smets, with money as a stock variable and imposed several specific restrictions. In the model, exchange rate is allowed to respond to all other variables in a contemporaneous manner. Kim and Roubini (2000) extended the Sims-Zha framework with inclusion of a world commodity price and world short-term interest rate, and it is often used to identify structural shifts in low-income countries.

Table 3
Papers on Monetary Transmission

Authors	Country	VAR (order)	Policy Variable
Bernanke and Blinder (1992)	United States	Y, P, R	R
Bernanke and Gertler (1995)	United States	Y, P, CP, R	R
Peersman and Smets (2001)	Euro Area	Y, P, R, RER	R
Central Asian Economies			
Isakova (2008)	Kazakhstan, Kyrgyz Republic and Tajikistan	Y, P, M, R, S	R
Samkharadze (2008) (Structural identification)	Georgia		M
Dabla-Norris and Floermeier (2006)	Armenia	Y, P, R, M, S	M
Samkharadze (2008)	Georgia		M
Bordon and Weber (2010)	Armenia		M, R
Bakradze and Billmeier (2007)	Georgia	Y, P, M, FX, S	M

Several other studies were conducted on transitional economies in Central Asia, where characteristics such as low-income, weak institutions, low degree of integration into the international financial market and heavy intervention on foreign exchange market are common. For instance, Isakova (2008) estimated

effects of policy changes in several countries (Kazakhstan, Kyrgyz Republic and Tajikistan) with a five-variable VAR in the order of Y, P, M, R and S (nominal exchange rate). Samkharadze (2008) also estimated a five-variable VAR of similar order with Isakova, but with structural identifications. There are also several other works with a five-variable VAR in the order of Y, P, R, M, S. For example, Dabla-Norris and Floerkemeier (2006) estimated the VAR model on the Armenian economy, Samkharadze (2008) on the Georgian economy, Bordon and Weber (2010) on the Armenian economy, Bakradze and Billmeier (2007) on the Georgian economy. Although the variables are similar (Y, P, M, FX, S), where FX is the stock of foreign exchange reserves, the ordering is slightly different across these studies.

3.2 Literature Review on Monetary Policy Transmission in Mongolian Economy

In literature, there are few papers that directly focus on the monetary policy transmission mechanism in Mongolia. However, several Bank of Mongolia research studies provide indirect information on the subject. For instance, a few researchers studied the lagged effects of monetary policy on inflation and the bond market, credit channel of monetary policy, factors determining lending and deposit rates, cost factors of lending rate and exchange pass-through to inflation. For the purpose of furthering the research of the monetary policy transmission mechanism in Mongolia, this section briefly reviews the common methodologies and outcome of the studies and attempts to provide an overview of monetary policy effectiveness. In addition, drawing from the historical course that monetary policy has taken and its impact on the financial market as well as real economy will provide significant explanatory power for this research paper.

One of the earliest studies on monetary policy and inflation in the 2000s is by Luvsannyam (2004) who looked at the lagged effect of money supply, central bank bill's rate and exchange rate on inflation during 1996 and 2004, using the recursive VAR method. According to the study, the effect of the exchange rate on inflation starts in the third month of a nominal shock and peaks in the fifth to sixth month. Whereas, the effect of money supply or central bank bill's rate were observed only after the seventh month of the shock and were not statistically significant. Hence, the study concludes that the exchange rate channel is the most significant channel of monetary policy in the Mongolian context.

A later study on the same topic, where Doojav, G. (2004) used the Granger causality and VAR analysis over data on different monetary aggregates, reinforces the result of the previous study. Doojav and Borkhuu (2004) have found that

exchange rate and central bank bill rate both have a 4 month lagged effect on inflation. Yet the exchange rate channel was still the strongest. In the case of monetary aggregates, M1 and M2, both had similar effects on inflation with 4 and 8 month lags. In 2009[b], Doojav, G. further narrowed his study by eliminating the central bank bill rate and M2 monetary aggregate and distinguished monetary policy and exchange rate impact in the longer term and shorter term. The paper concludes that a 1% increase in M1 supply increased CPI by 1% in the long-term and 0.05-0.06% in the short-term (6-7 months after the initial shock). In the short-term, the exchange rate had a faster and larger effect on CPI. A 10% depreciation increased CPI by 0.37-0.41% 3 months after the shock. However in the longer term, the same shock had 0.31% effect on CPI. The study also analyzed the relation with core inflation. The only difference observed is for the exchange rate shock. A 1% depreciation increases core CPI by 0.4% in the longer term.

Studies paraphrased above suggest that the exchange rate has the strongest impact on inflation compared to the interest rate and money supply. Hence, several studies on the exchange rate pass-through to inflation have been conducted, for instance by using the recursive VAR method, (Doojav, 2009[c]) with results showing that the exchange rate pass–through in Mongolia rises from 10% in the fifth month of a shock to 55% in nine months after the shock.

(Doojav, 2010) further widened his research by studying symmetry of exchange rate fluctuations on inflation. According to him, nominal depreciation has a stronger effect on inflation compared to nominal appreciation. Hence, the study suggests that in case of a significant depreciation that may potentially cause high first and second round pressure on inflation, it is better to control the monetary balance with other monetary instruments such as foreign exchange interventions rather than to wait for the impact of a policy rate change.

In the literature, there are some studies that look at different areas compared to those discussed above. For instance in 2007, Doojav G. et al. studied the impact of monetary policy on the stock market during 1998 and 2007, using the VAR methodology. Although the results suggest that the short-term CBB rate has a 1-3 month lagged effect on stock prices, it found that money supply has insignificant effects on stock prices, hence concluding that Tobin's Q channel of monetary policy is weak or not effective in Mongolia. The paper asserts that the shallow or underdeveloped bond market is the main cause of the weakness. Moreover, the authors suggest that stock market development is lagged because of banking sector dominance in the financial sector.

In 2011, Demid E. studied the lending channel of monetary policy with the VECM approach. She used co-integration restrictions on credit supply and demand by assuming that GDP has no effect on credit supply; central bank bill rate and lending rates have opposing impact on credit supply but of same magnitude, and central bank bill rate, banks' reserves and equity have no impact on credit demand. For the sample period between 2004 and 2011, estimation results suggest that for a 1% increase in banks' reserves, credit supply increases by 0.2% after 1 quarter, for a 1% increase on equity, credit increases by 0.1%. However, for a 1% increase in lending rate, lending activity declines by 0.02% only. Hence, it concludes that banks decide on credit supply mostly by observing its reserves and equity, rather than the increased opportunity to exploit the central bank bill rate. The credit channel is thus strong in Mongolia. For the credit demand side, its elasticity from lending rate is 0.1 and elasticity from GDP is 1.3. Since the income effect is stronger than the cost effect, the study concludes that the interest rate channel of monetary policy is weak.

Doojav (2009[a]) looks at the opportunity cost of reserve requirement imposed by the central bank, and its impact on the difference between lending and deposit rates. While doing so, he found evidence that the reserve requirement widened the interest rate gap at 1% significance level. The paper proposes that the interest rate differential between lending and deposit has narrowed until the first half of 2008, due to lower reserve requirement and higher growth of M2. His findings also showed that the interbank market rate has significant effect on bank's excess reserves and consequently interest rate differential. Doojav (2009[a]) asserts that if the Bank of Mongolia is successful in maneuvering the interbank market rate, the interest rate channel of monetary policy would be stronger.

In 2012, Demid et al. (2012) indirectly measured the cost channel of monetary policy by estimating the opportunity cost of banks' lending activity and lending rate based on banks' cost calculations. Based on its assumptions the paper arrives at the following conclusions:

- Banks pay dividends to its owners by the shares of their equity. However, owners have the choice to invest their equity in central bank bills or earn interest income of at least the policy rate. So, by not investing in central bank bills, the owners are incurring opportunity costs and they are compensated by the banks' equity cost, which is incorporated in the lending rate. According to Demid et al. (2012), out of a lending rate of 17.43% as of September 2012, 0.27 percentage point was contributed by the cost of equity. That is 1.5% of lending rate is channeled through the opportunity cost of equity.

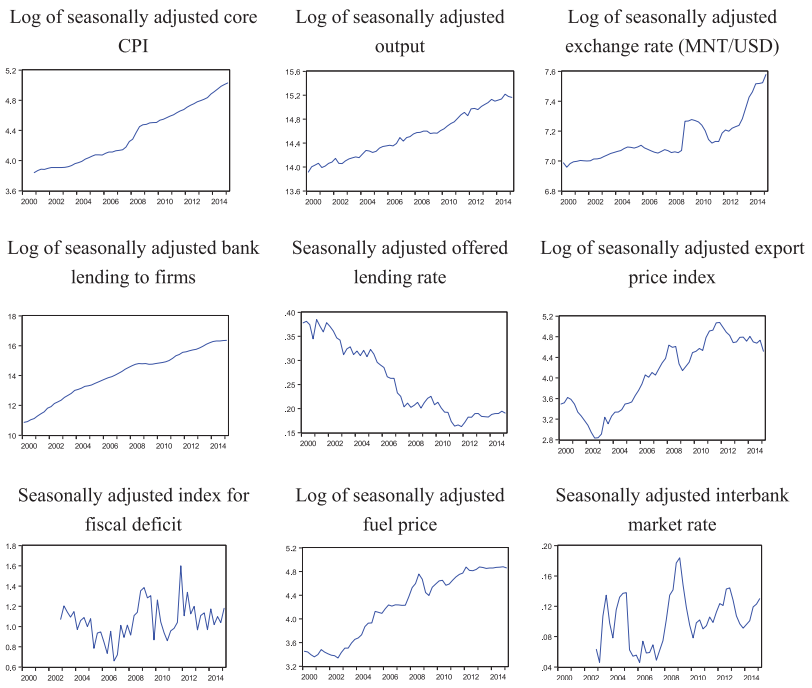
- Banks are obligated to hold a certain amount of liquid assets at the central bank as required reserves. Had the requirement ratio been zero, banks could have made "profit bearing" use of the fund portion or at least invested in central bank bills and earned interest profits at the policy rate. Here, banks incur costs on the required reserve as a lost opportunity to earn interest income and it must be incorporated into its lending rate. The paper estimated that this opportunity cost is 1.33 percentage point of the total lending rate of 17.43%. In other words, 7.6% of the cost estimated lending rate is channeled through the reserve requirement.

The results are confirmed by the outcome of the "Lending Rate Survey", in which banks suggested that policy makers could create a stable macroeconomic environment and reduce financial sector risk by the reduction of inflation, matching policy rate with inflation, reducing the RRR and keeping the foreign exchange market stable.

4. Data and Research Methodology

4.1 Data Plot

We construct a quarterly dataset from 2002 to 2015. Our dataset for domestic variables is sourced from the National Statistical Office (NSO), WDI (World Development Indicator) of The World Bank and the Bank of Mongolia (BOM) database.



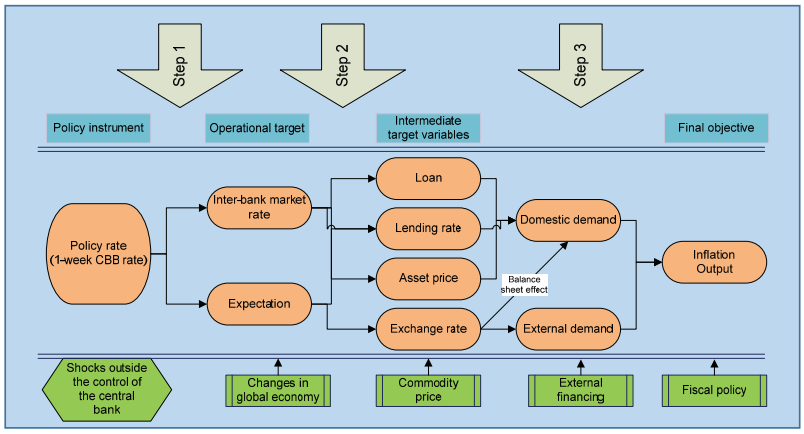
Source: The National Statistical Office of Mongolia and The Bank of Mongolia.

The price series is the core Consumer Price Index (CPI, pc_sa), output series is the quarterly real Gross Domestic Product (GDP, y_sa), the exchange rate is measured by the price of US dollar per national currency MNT (e_sa), and we used the total outstanding loans (l_sa) from banks to private sectors. Analysis of monetary policy transmission requires a careful choice of the interest rate that sufficiently captures the true nature of monetary policy stance. We analyzed several short-term interest rate variables viz the interbank market interest rate (weighted average rate, ibr_sa) and central bank bill rate and decided to use the interbank market rate as a proxy for the policy stance. As for the long-term rate, due to the limited time series length of available choices, we used the offered lending rate (lr_avg_sa). All the variables are seasonally adjusted and are in log form; unless otherwise indicated.

Variable	Details	Source
pc_sa	Core Consumer Price Index	NSO
y_sa	Gross Domestic Product	NSO
e_sa	Price of US dollar per national currency MNT	BOM
l_sa	Total outstanding loan	BOM
ibr_sa	Interbank market weighted average interest rate	BOM
lr_avg_sa	Weighted average lending rate, domestic currency, Average of Period	BOM
l_xpi_sa	Export price index	BOM
fis_sa	Fiscal deficit=Fiscal Expenditure/Fiscal Revenue*	MOF
l_fuel_sa	Gasoline price index from consumer basket*	NSO
dum_gfc	Dummy variable, Global financial crisis*	
dum_qe	Dummy variable, Quantitative easing program by Central bank*	
dum_crunch	Dummy variable, credit crunch during global financial crisis*	
dum_cor	Dummy variable, introduction of symmetric corridor for interbank market rate*	

4.2 Empirical Methodology and Strategy

We define the monetary policy transmission mechanism as follows:



The Bank of Mongolia sets a target interbank market rate known as the policy rate, namely the 1-week central bank bill (CBB). Central bank bills are the main instrument for absorbing excess liquidity from the interbank market and steering the interbank rate. The policy rate also signals to market participants, the monetary policy stance and future development of inflation. The interbank rate and expectations further affect the intermediate-targets such as the lending rate, bank credit to the private sector, the exchange rate and etc. These changes are further transmitted to inflation and output through domestic and external demand. However, there are several shocks beyond the BoM's control such as commodity prices, fiscal policy, financial linkages between domestic banks and corporates and international financial institutions, etc.

The empirical analysis covers three steps. First, we define and extract unanticipated or structural monetary policy shocks, using the VAR approach. Second, by estimating the ordinary least squares (OLS), we examine the effect of unanticipated policy shocks on intermediate macroeconomic and financial variables.[12] Third, the VAR model is estimated to determine the impact of intermediate variables on inflation and output.

Determining Unanticipated Policy Shock: Changes in policy action tend to reflect policy action responding to development of the economic state. We define unanticipated policy shocks as movements in policy instruments that are not explained by variables that central banks consider in changing policy stance. These variables are found in monetary policy rules that central banks implicitly or explicitly follow. Although central banks do not explicitly announce policy rules, they do announce their primary objective of monetary policy and this partially reveals the implicit rule of monetary policy. In practice, inflation and output are the most common indicators that central banks take into account to change the policy stance. Also, it has been observed that emerging economies such as Korea, Thailand, the Philippines, etc., tend to consider the movements of exchange rate, reacting to sharp depreciations by increasing the policy rate in the short- term during GFC-08/09. In the case of the Mongolian currency, stability is set as a primary objective of monetary policy, while output and inflation are included in the policy rule of the main forecasting model. However, BoM characterizes currency stability as price stability.

12. Loan outstanding to the private sector from banks, nominal exchange rate and lending rate.

L.J. Christiano et al. (1999) identifies monetary policy shock as a disturbance term of following equation:

$$S_t = f(\Omega_t) + \sigma_s \varepsilon_t$$

Here S_t represents the main instrument of monetary policy, f is a linear function of S_t to information set, Ω_t, The random disturbance, $\sigma_s \varepsilon_t$, represents a monetary policy shock. In addition, f and Ω_t reflect policy rule and information set that central bank considers, respectively.

L.J. Christiano et al. (1999) provides three possible explanation for ε_t. First, it reflects the exogenous shock to the preference of monetary authority for unemployment and inflation. Second, it reflects Federal Reserve's desire to avoid the social costs of disappointing private agents' expectations of Ball (1995) and Chari, Christiano and Eichenbaum (1998)). Third, it reflects technical factors that represent the measurement error in the preliminary data available to the Federal Open Market Committee (FOMC) at the time it makes its decision (Hamilton (1997) and Bernanke and Mihov (1995)).

Therefore, in order to determine unanticipated monetary policy shocks, we estimate the VAR model that controls output and inflation as the main information that an agent can consider to predict policy changes. Also, the VAR includes the interbank market rate as a policy variable. It means that unexpected policy shock is determined by movements in the interbank market rate that is not explained by output and inflation and is measured by the residual of the equation for the interbank market rate in the VAR system. Moreover, information about output and inflation is not directly observable when central banks change the policy rate. Consequently, these variables do not react to policy shock contemporaneously.

Vector Autoregressive (VAR) Model: we have mentioned above that the VAR approach is used in Steps 1 and 3. The general form of the VAR(p) model with deterministic terms and exogenous variables is given by following equation:

$$Y_t = \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + \cdots + \Pi_p Y_{t-p} + \Phi D_t + G X_t + \varepsilon_t \qquad t = 1, \ldots, T$$

where $Y_t = (Y_{1t}, Y_{2t}, Y_{3t}, \cdots, Y_{nt},)'$ denotes an (nx1) vector of time series variables, D_t represents an (I × 1) matrix of deterministic components, X_t represents an (m × 1) matrix of exogenous variables, and Π_i , Φ and G are parameter matrices. ε_t is an (n × 1) unobservable zero mean white noise vector process (serially uncorrelated or independent) with time invariant covariance matrix Σ_t.

In Step 1, the VAR model includes the log of output, log of CPI and the interbank market rate[13] as endogenous variables and the log of net international reserves for external shocks, log of petrol price index for supply shocks for inflation and for "price puzzle," fiscal deficit index for fiscal dominance and dummy variables for change in macroeconomic policy and economic structure. Under the Choleski ordering scheme, policy shock is ordered as the most exogenous variable and output and price are ordered in 2nd and 3rd in our VAR system. It implies that price is not affected by output and price, contemporaneously. In Step 3, the VAR model is estimated to determine the effects of intermediate variables which are bank loans to private sector, lending rate and the exchange rate. It includes the log of output, log of core CPI, log of loan to private sector, log of nominal exchange rate and lending rate. Also, it includes other exogenous and dummy variables from Step 1. The model was estimated over the period 2002Q4-2015Q1 and the selection of lag length was based on the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Hannan-Quinn Information Criterion (HQ), Final Prediction Error (FPE) and Sequential Modified LR Test Statistic (LR). Furthermore, the stability of the estimated model was checked using roots of the AR characteristics Polynomial. For the robustness check, impulse response functions are applied to trace out the time path of the effect of structural shocks on the endogenous variables in the VAR system. In order to determine the impulse response functions, the VAR model is transformed into a VMA representation:

$$Y_t = \mu + \psi(L)\varepsilon_t = \mu + \varepsilon_t + \psi_1\varepsilon_{t-1} + \psi_2\varepsilon_{t-2} + \psi_3\varepsilon_{t-3} + \cdots$$

where ψ_s are the (n x n) matrices for moving average components and are determined recursive substitution of VAR. The $(i,j)^{th}$ element, ψ_{ij}, of the matrix ψ_s indicates the dynamic multiplier or impulse response of i^{th} variable to j^{th} structural shock.

$$\psi_{ij}^{s} = \frac{\partial y_{i,t+s}}{\partial \varepsilon_{j,t}} = \frac{\partial y_{i,t}}{\partial \varepsilon_{j,t-s}}, \qquad i,j = 1, \ldots, n$$

OLS Technique: Jorda (2005) proposes the alternative methods to compute impulse responses without specification and estimation of the underlying multivariate dynamic system such as VAR. It has several advantages as it can be estimated using simple least squares and it is robust to misspecification of

13. Bernanke and Blinder (1992) point out that in order to identify unanticipated policy shocks, it is sufficient to assume that policy shocks do not contemporaneously affect other variables.

the DGP. It is also easily applicable for non-linear specification and etc. This approach has also been used in Vargas, González and Lozano (2012). They estimate the impulse responses of GDP to fiscal shock and those of the public bond rate and market rates to an unexpected monetary policy shock. Following along the same line, Kilian (2009) using the OLS, examines the effect of oil specific structural shocks extracted from SVAR on US GDP growth and inflation. The assumption is that within the quarter, there is no feedback effect from GDP and inflation on an unexpected policy shock and this shock can be treated as predetermined.

Following this idea and approach, we examine the effect of unanticipated monetary policy shocks on intermediate target variables. We assume that an unexpected monetary policy shock cannot be affected by intermediate target variables such as the exchange rate, lending rate or bank loans to the private sector. Hence, we use the following equation:

$$X_t = c_0 + \sum_{h=0}^{12} \psi_h \cdot \varepsilon_{t-h} + u_t$$

where X_t represents an intermediate target variable, μ_t a potentially serially correlated error term, ε_t an unanticipated monetary policy shock which is extracted from the VAR model in Step 1. In this model, ψ_h represents the impulse response coefficients at horizon h. Therefore, the number of lags is determined by the maximum horizon of the impulse response function and set to 12 quarters in our case.

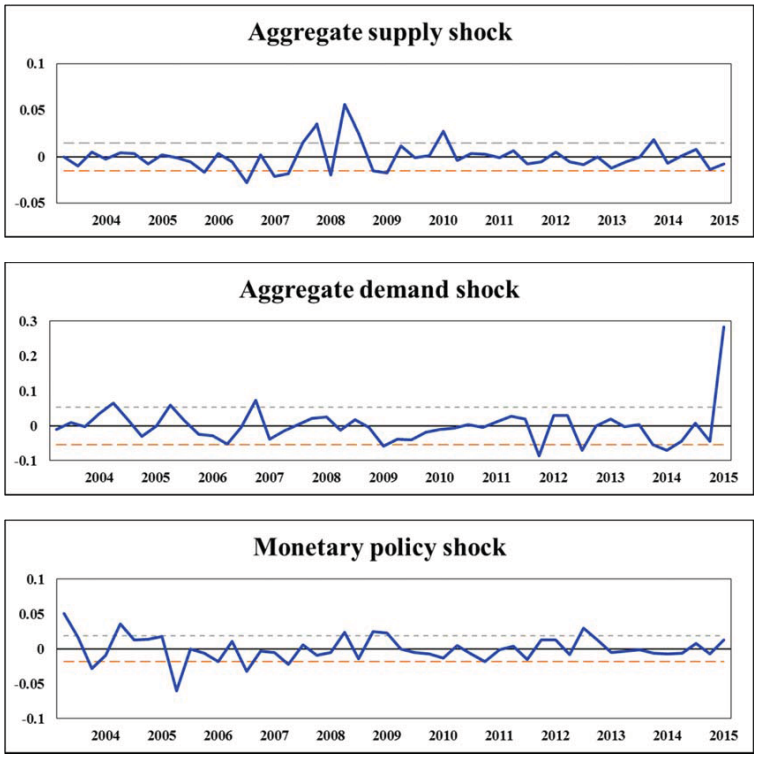
5. Empirical Results

Macroeconomic indicators that are used to make a diagnosis on the general "well-being" of the economy are prone to numerous external and internal shocks such as economic policy shocks, not to mention the fact that policy indicators are intertwined in the system so deeply that it is difficult to identify exactly through which channel the policy shock transmits to macroeconomic indicators. Hence, for the sake simplicity in both the estimation and interpretation of the results, we examined the significance of transmission channels in the following three steps. First, as described in the methodology section, a reduced form of the VAR model is initially estimated on CPI, nominal GDP and interbank market rate (*pc_sa, y_sa, ibr_sa*) in order to isolate the unanticipated supply induced

price shock, aggregate demand and interest rate specific shocks in the system.[14] The extraction of unanticipated monetary policy shock is the main purpose of this step. Second**,** using the OLS technique, we estimate the significance of the policy shock on intermediate targets such as the exchange rate, lending rate, and credit issued by banks to private sector. Third, we estimate a reduced form of the VAR model with inflation, output, exchange rate, lending rate, and credit issued to examine the significance of each transmission channel.

Step 1- Identifying Policy Shock

Figure 1
Historical Evolution of Structural Shocks (2003Q2-2015Q1)



In this model, the interbank market rate is considered as a proxy for monetary policy instrument and the reduced form VAR suggests that an unanticipated change in monetary policy has a negative impact on both output and inflation.

14. These shocks are considered mutually uncorrelated structural innovations. See estimation results in Appendix A.

However, the effect of monetary policy change on inflation is delayed by 6-8 quarters. Aside from the shocks in late 2003 and 2005, the model does not imply significant (more than one standard deviation) monetary policy shock over the course of history. Yet, since the size and the sign of the monetary policy shock are consistent with the literature, we proceed to analyze the impact on intermediate targets (transmission channels) in the following steps.

Step 2 – Estimating transmission to Intermediate Targets

In this step, we checked the significance of a policy shock on intermediate targets, which are the "starting points" of the exchange rate, interest rate and lending channel of monetary policy by estimating 3 independent equations as follows: [15]

$$Eq\ 1:\ lr\_avg\_sa_t = c_0 + \sum_{i=0}^{12} c_{i+1}\varepsilon_{t-i} + AR(1) + e_t^{lr}$$

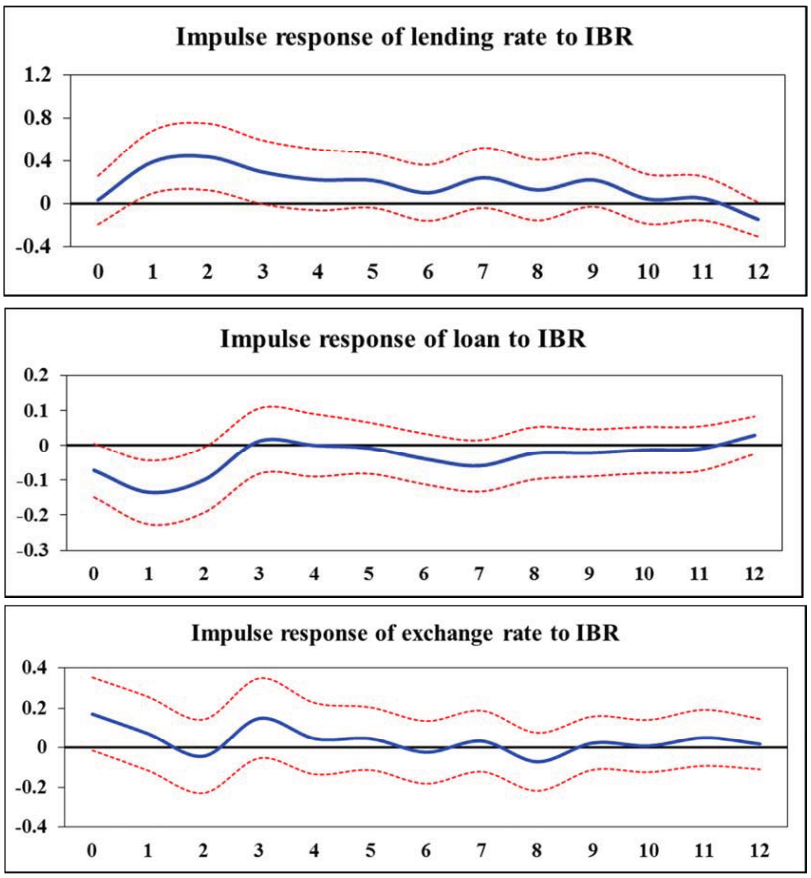
$$Eq\ 2:\ l\_sa_t = b_0 + \sum_{i=0}^{12} b_{i+1}\varepsilon_{t-i} + AR(1) + e_t^{l}$$

$$Eq\ 3:\ e\_sa_t = a_0 + \sum_{i=0}^{12} a_{i+1}\varepsilon_{t-i} + AR(1) + e_t^{er}$$

where ε_t is unanticipated monetary policy shock obtained from VAR estimation in Step 1 while c, a and b represent the impulse response of intermediate variables, respectively. The OLS estimation result of *Eq 1 su*ggests that the impact of an unanticipated policy shock on lending rate is stronger within 1-3 quarters of the initial shock. Moreover, signs of the estimated policy coefficients are positive, meaning that an increase in the interbank market rate leads to a higher lending rate. In the case of the second equation, although the goodness of fit is not as appropriate as the first equation, the impact of an unanticipated policy shock on lending is stronger within 2 quarters of the initial shock with theoretically correct signs. In the last equation where the exchange rate is regressed on an unanticipated policy shock, the effect of change in the interbank market rate is not statistically significant.

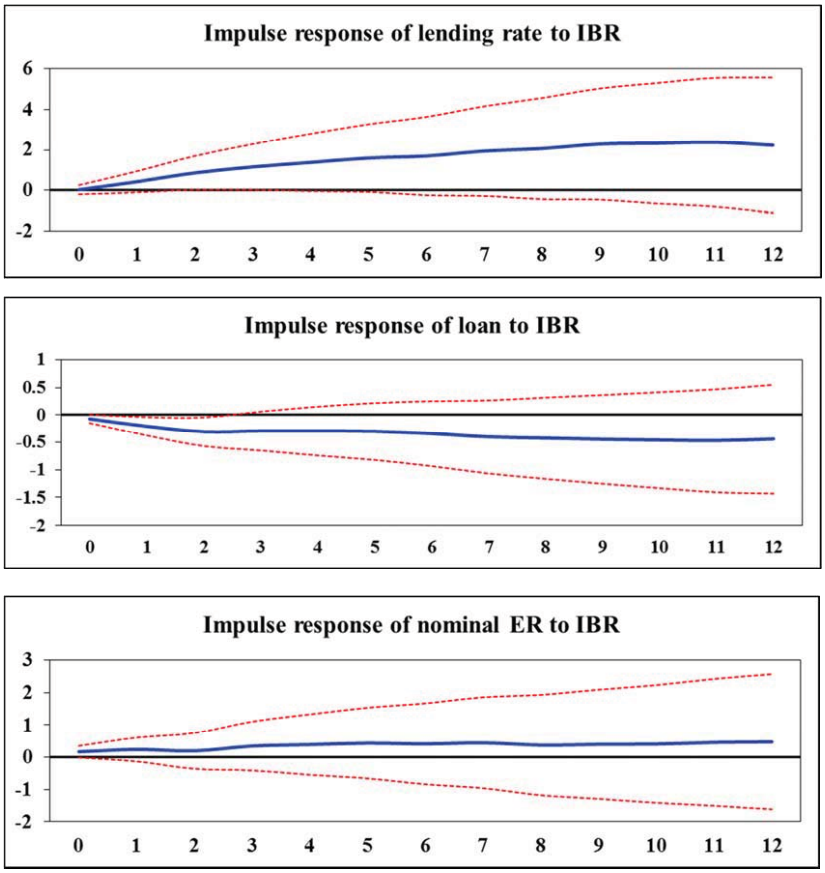
15. Estimation results are shown in Appendix B1-B3.

Figure 2
Impulse Responses to a 1% Unanticipated Shock of the Interbank Market Rate



If we look at the accumulated impulse response functions of the lending rate, loan and exchange rate to a 1% unanticipated policy shock, the lending rate increases by approximately 2%, while the quarter on quarter growth decreases by 0.5 percentage points and the exchange rate appreciates by 0.5% within 12 quarters of the initial shock.

Figure 3
Accumulated Impulse Responses to 1% Unanticipated Shock of Interbank Market Rate

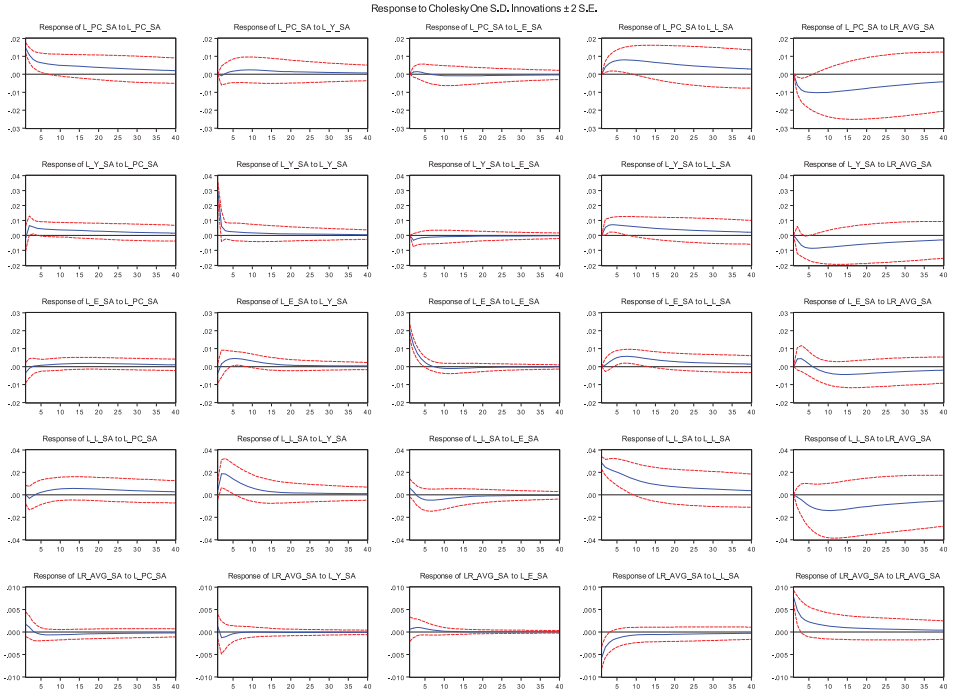


At an initial glimpse, out of the three equations estimated, the equation for exchange rate seems inferior and that of the exchange rate is dull in response to a policy shock. However, if we consider the extent of foreign exchange intervention conducted by the central bank, the effect of an interest rate change on the exchange rate may be offset by counterbalancing foreign exchange interventions such as spot, swap and forward deals.

Step 3 – Testing for Significance of Transmission Channels

Now that we have established the link between unanticipated policy shock and intermediate targets, the following step is to estimate the significance of each channel on final targeted variables of inflation and output. As mentioned

in the methodology section, we estimated a reduced form structural VAR model on CPI, output, exchange rate, loan and lending rate (*l_pc_sa, l_y_sa, l_e_sa, l_l_sa, lr_avg_sa*). In order to account for structural shifts and other externalities, we used dummies for the GFC, Quantitative Easing Program by the central bank, credit crunch during GFC, introduction of symmetric corridor for interbank market rate, export prices, fiscal dominance and gasoline prices (dum_gfc, dum_qe, dum_crunch, dum_cor, l_xpi_sa, fis_sa, l_fuel_sa).[16]



One Unit of Lending Rate Shock: Transmission of the lending rate to inflation is strongest within 4-6 quarters of the shock and in first 6 quarters, is statistically significant. For the response of output, it is theoretically consistent and its magnitude is significant between the 4th and 5th quarter of the shock.

One Unit of Loan: The lending to the private sector from banks has a positive impact on inflation and output with a delay of a number of quarters. The response of inflation is statistically significant at 10 quarters after the shock

16. See estimation output in Appendix C.

and the strongest impact is observed in the 6-8th quarters. The transmission to output is statistically significant at 9 quarters after the shock.

The loan and lending rate channel have statistically significant impact on both of inflation and output while the exchange rate channel does not have statistically significant impact on the final targeted variables. Comparing the two effective channels, the impact of the lending channel on inflation is marginally stronger than that of the lending rate channel while the lending rate channel has a slightly stronger impact on output.

Due to the forecast error variance decomposition, the contribution of the shock from loans and the lending rate to error variance of inflation is almost 27% and 50% at a longer horizon, respectively. For output, loan and lending rate, the shocks account for around 22% and 38% of the error variance, respectively.

Surprisingly enough, in contrast with several studies, we find that the exchange rate is not significant on price and output in Mongolia. One plausible explanation is that the effect of the exchange rate is captured by private loans. This is because the level of outstanding loans and the exchange rate are highly correlated. Secondly, the causality test shows that loans and the lending rate cause the exchange rate without a reverse effect. This correlation seems plausible. Pro-cyclical bank lending tends to amplify economic boom and bust cycles. Thus, during boom periods, banks tend to issue more loans, adding to higher current account deficits and depreciations in the medium-term. Impulse response functions show exchange rate depreciation from the 5th quarter after the lending shock, lasting for long horizon, while response of the exchange rate to the lending shock is not significant. In addition, the substantial amount of BoM's intervention in the foreign exchange market is another reason that makes exchange rate muted. BoM tends to be unwilling to allow the exchange rate to depreciate because of the high dollarization in bank deposits and lending and the traditional view of the general public on the exchange rate.

Overall, the impulse response analysis finds bank lending as the most effective monetary policy channel in Mongolia. Bank lending to non-financial firms can affect output and price. Conceptually, it is supposed to be transmitted through changes in firms' investment and households' consumption expenditure. In Mongolia, bank lending to household for consumption purposes accounts for a quarter of total outstanding bank lending.[17] According to the impulse analysis,

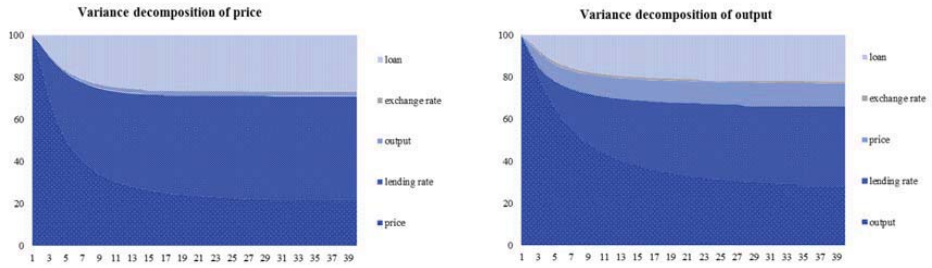
17. This consumption loan is determined as a loan that is issued to households, not including mortgage and SME loans.

the supply of bank lending immediately leads to a decline in the offered lending rate. It also leads to a depreciation of domestic currency, starting from the 5th quarter till 13th quarter. The offered lending rate then affects price and output which is consistent with theoretical concepts, whereas the effect of the exchange rate shock on other variables within the VAR system is not statistically significant. Following softer credit condition, higher output leads to an increase in loan demand at the later stage and it is seen from the statistically significant impulse response of bank loans to shock of output. Also, greater output affects the depreciation of the domestic currency in the medium-term. It seems that the supply of bank lending driven usually by fiscal deficit, capital inflows and/or favorable conditions of terms of trade (with resulting higher liquidity in the banking system) boost the economy and exert pressure on inflation during the boom period. It then drives the economy to overheating and higher current account deficits which cause the exchange rate to depreciate.

It may be necessary to note that all variables except for the lending rate in the VAR system are unit root at level and they are I(1). This implies that the impulse response of some variables to some shocks takes long periods to converge after the shock. For instance, the impulse responses of price to lending rate and loan outstanding are still different from zero even after 40 quarters. However, the stability of the estimated model was proven by the roots of the AR characteristic. The polynomial and the null hypothesis of the multivariate normality of the VAR residual are not rejected by the normality test. Also, the LM test did not reject the null hypothesis of no serial correlation of the VAR residual.

Figure 5 shows the contribution of the three intermediate target variables shocks to the variance of the forecast error of price and output. The forecast error variance decomposition of two target variables provides the total proportion of their forecast errors attributed to their own and other variables' innovations. Due to the result of forecast error variance decomposition, the loan and lending rate shocks have the dominant sources of variation in the forecast errors of both price and output whereas their own innovations explain only 21% of the price variation and 28% of the output variations, respectively, in the 40th quarter although they started from 85% and 90%, respectively. On the contrary, the lending rate shock starting from 9.8% of the price variation in second quarter converges to 49.8% in the 40th quarter. In addition, the proportion of the lending rate shock in the output variation increases from 1% in the 2nd quarter to 38.2% in the 40th quarter.

Figure 5
Forecast Error Variance Decomposition



6. Conclusion and Policy Implications

This paper aims to draw an overview of the channels of monetary policy shock on inflation and output. However, our conclusion is limited by our assumption that there is no misspecification problem in our statistical model. Macroeconomic variables are closely related and affect one another through a sophisticated unidentified system. Hence, it is not easy to pinpoint the true data generation process of macroeconomic variables. Therefore, it is important to bear in mind that there may be misspecification problems although several statistical methods i.e., VAR were used and which have been applied extensively in empirical research to identify true DGP.

Instead of a structural model that could have incorporated the behavioral relationships of agents, the VAR and OLS techniques are applied using three steps. In the first step, using VAR estimation, we isolated the unexpected/structural shock of monetary policy controlling two main considerable variables for central bank, output and inflation. The shock was within the bound of one standard deviation in most of the estimation period. In the second step, the estimation to identify the impact of unexpected monetary policy shock on the intermediate target variables shows that the shock are transmitted significantly to bank loans, lending rate and exchange rate. The lending rate responds in the 1st and 2nd quarter after the shock while amount of loans also reacts to the shock in the 1st and 2nd quarter. In contrast, the response of the exchange rate is within the quarter of the shock but it is only significant at 10%. Consequently, the results of the VAR model show that the lending rate and bank credit to private sector can affect both inflation and output after a delay of 3 and 5 quarters, respectively. In case of the exogenous variables, export price leads to exchange rate appreciation whereas fiscal deficit leads to depreciation. Furthermore, gasoline price was helpful to solve the problem of “price puzzle”.

As mentioned above, the effect of the exchange rate on inflation and output are statistically insignificant. Unfortunately, we are not able to establish a solid argument to defend our results. However, one plausible explanation may be that the effect of the exchange rate is captured by private loans. This is supported by the unidirectional granger cause of lending rate for exchange rate and significant impulse response of exchange rate to lending shock. Although it seems that lending activity leads to exchange rate volatility, this hypothesis needs to be substantiated by further research.

In any case, this study shows that the bank lending channel is relatively stronger in Mongolia's economy while the impact of the exchange rate channel is somewhat overshadowed by both endogenous and exogenous variables. Hence, our study suggests that monetary policy aimed at inflation and output should focus more on the bank lending activities.

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Appendix A

Vector Autoregression Estimates
Date: 07/08/15 Time: 16:52
Sample (adjusted): 2003Q2 2015Q1
Included observations: 48 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	LOG(PC_SA)	LOG(Y_SA)	IBR_SA
LOG(PC_SA(-1))	1.320507	-0.161801	0.402717
	(0.14504)	(0.53157)	(0.18140)
	[9.10475]	[-0.30438]	[2.22007]
LOG(PC_SA(-2))	-0.383741	0.311550	-0.355000
	(0.13478)	(0.49399)	(0.16858)
	[-2.84711]	[0.63068]	[-2.10588]
LOG(Y_SA(-1))	0.027403	0.344978	0.025980
	(0.07340)	(0.26903)	(0.09181)
	[0.37332]	[1.28229]	[0.28298]
LOG(Y_SA(-2))	0.045128	0.565078	-0.069817
	(0.07171)	(0.26283)	(0.08969)
	[0.62931]	[2.15000]	[-0.77843]
IBR_SA(-1)	0.135889	-0.462021	0.899641
	(0.11769)	(0.43133)	(0.14719)
	[1.15467]	[-1.07115]	[6.11202]
IBR_SA(-2)	-0.174450	-0.012198	-0.320512
	(0.11959)	(0.43833)	(0.14958)
	[-1.45868]	[-0.02783]	[-2.14276]
C	-0.763071	0.753632	0.465775
	(0.47566)	(1.74336)	(0.59492)
	[-1.60422]	[0.43229]	[0.78292]
R-squared	0.998117	0.974732	0.676214
Adj. R-squared	0.997841	0.971034	0.628831
Sum sq. resids	0.010341	0.138905	0.016176
S.E. equation	0.015881	0.058206	0.019863
F-statistic	3621.804	263.5990	14.27115
Log likelihood	134.5200	72.17486	123.7814
Akaike AIC	-5.313335	-2.715619	-4.865892
Schwarz SC	-5.040451	-2.442736	-4.593009
Mean dependent	4.434725	14.66168	0.104414
S.D. dependent	0.341806	0.341998	0.032603
Determinant resid covariance (dof adj.)		3.35E-10	

Determinant resid covariance	2.09E-10
Log likelihood	330.6422
Akaike information criterion	-12.90176
Schwarz criterion	-12.08311

Appendix B1

Dependent Variable: LR_AVG_SA
Method: Least Squares
Date: 07/08/15 Time: 16:38
Sample (adjusted): 2006Q3 2015Q1
Included observations: 35 after adjustments
Convergence achieved after 6 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.184010	0.012327	14.92781	0.0000
RESID03	0.034157	0.115357	0.296095	0.7702
RESID03(-1)	0.391938	0.149964	2.613550	0.0166
RESID03(-2)	0.438499	0.159488	2.749421	0.0124
RESID03(-3)	0.294352	0.152321	1.932439	0.0676
RESID03(-4)	0.223052	0.145408	1.533966	0.1407
RESID03(-5)	0.216986	0.129958	1.669655	0.1106
RESID03(-6)	0.101719	0.133607	0.761329	0.4553
RESID03(-7)	0.242703	0.143293	1.693748	0.1058
RESID03(-8)	0.127575	0.144461	0.883110	0.3877
RESID03(-9)	0.222119	0.126557	1.755097	0.0946
RESID03(-10)	0.042604	0.117839	0.361542	0.7215
RESID03(-11)	0.049755	0.104148	0.477730	0.6380
RESID03(-12)	-0.145784	0.081200	-1.795362	0.0877
AR(1)	0.877639	0.050496	17.38042	0.0000

R-squared	0.948113	Mean dependent var	0.199219
Adjusted R-squared	0.911791	S.D. dependent var	0.023787
S.E. of regression	0.007065	Akaike info criterion	-6.769892
Sum squared resid	0.000998	Schwarz criterion	-6.103314
Log likelihood	133.4731	Hannan-Quinn criter.	-6.539789
F-statistic	26.10355	Durbin-Watson stat	2.475533
Prob(F-statistic)	0.000000		

Inverted AR Roots	.88

Appendix B2

Dependent Variable: DLOG(L_L_SA)
Method: Least Squares
Date: 07/08/15 Time: 16:35
Sample (adjusted): 2006Q3 2015Q1
Included observations: 35 after adjustments
Convergence achieved after 5 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003946	0.001291	3.057012	0.0062
RESID03	-0.072073	0.039058	-1.845260	0.0799
RESID03(-1)	-0.135066	0.046613	-2.897604	0.0089
RESID03(-2)	-0.099160	0.047702	-2.078736	0.0507
RESID03(-3)	0.012209	0.047925	0.254745	0.8015
RESID03(-4)	4.00E-05	0.045927	0.000870	0.9993
RESID03(-5)	-0.007995	0.037501	-0.213205	0.8333
RESID03(-6)	-0.038971	0.037143	-1.049203	0.3066
RESID03(-7)	-0.059147	0.037735	-1.567410	0.1327
RESID03(-8)	-0.022721	0.038199	-0.594799	0.5586
RESID03(-9)	-0.021729	0.034475	-0.630291	0.5356
RESID03(-10)	-0.013423	0.033779	-0.397381	0.6953
RESID03(-11)	-0.009963	0.032740	-0.304300	0.7640
RESID03(-12)	0.029091	0.027566	1.055316	0.3039
AR(1)	0.660289	0.177177	3.726720	0.0013

R-squared	0.721733	Mean dependent var	0.004735
Adjusted R-squared	0.526946	S.D. dependent var	0.003531
S.E. of regression	0.002429	Akaike info criterion	-8.905497
Sum squared resid	0.000118	Schwarz criterion	-8.238919
Log likelihood	170.8462	Hannan-Quinn criter.	-8.675394
F-statistic	3.705245	Durbin-Watson stat	2.227561
Prob(F-statistic)	0.003933		

Inverted AR Roots	.66

Appendix B3

Dependent Variable: DLOG(L_E_SA)
Method: Least Squares
Date: 07/08/15 Time: 17:11
Sample (adjusted): 2006Q2 2015Q1
Included observations: 36 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.002647	0.001104	2.398530	0.0254
RESID03	0.170123	0.093913	1.811507	0.0837
RESID03(-1)	0.071040	0.094931	0.748328	0.4622
RESID03(-2)	-0.042764	0.094700	-0.451577	0.6560
RESID03(-3)	0.148454	0.102798	1.444127	0.1628
RESID03(-4)	0.045778	0.092022	0.497463	0.6238
RESID03(-5)	0.045813	0.080807	0.566944	0.5765
RESID03(-6)	-0.023082	0.080708	-0.285997	0.7776
RESID03(-7)	0.033190	0.078653	0.421980	0.6771
RESID03(-8)	-0.070955	0.074653	-0.950464	0.3522
RESID03(-9)	0.023513	0.068802	0.341752	0.7358
RESID03(-10)	0.008736	0.067409	0.129600	0.8981
RESID03(-11)	0.050323	0.072290	0.696120	0.4936
RESID03(-12)	0.018189	0.065114	0.279346	0.7826

R-squared	0.371224	Mean dependent var	0.001858
Adjusted R-squared	-0.000326	S.D. dependent var	0.005855
S.E. of regression	0.005856	Akaike info criterion	-7.157496
Sum squared resid	0.000754	Schwarz criterion	-6.541683
Log likelihood	142.8349	Hannan-Quinn criter.	-6.942561
F-statistic	0.999124	Durbin-Watson stat	1.480832
Prob(F-statistic)	0.483644		

Appendix C

Vector Autoregression Estimates
Date: 07/20/15 Time: 14:35
Sample (adjusted): 2002Q4 2015Q1
Included observations: 50 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	L_PC_SA	L_Y_SA	L_E_SA	L_L_SA	LR_AVG_SA
L_PC_SA(-1)	0.848120	0.475184	0.009550	-0.141739	-0.003815
	(0.05697)	(0.11537)	(0.07810)	(0.11366)	(0.03809)
	[14.8867]	[4.11870]	[0.12228]	[-1.24709]	[-0.10017]
L_Y_SA(-1)	0.019294	0.181730	0.076357	0.509650	-0.066073
	(0.09120)	(0.18469)	(0.12503)	(0.18194)	(0.06097)
	[0.21156]	[0.98397]	[0.61072]	[2.80116]	[-1.08373]
L_E_SA(-1)	0.096216	-0.185138	0.558591	-0.102563	0.022103
	(0.06051)	(0.12253)	(0.08295)	(0.12071)	(0.04045)
	[1.59012]	[-1.51090]	[6.73399]	[-0.84965]	[0.54643]
L_L_SA(-1)	-0.013888	0.112420	0.143444	0.808284	0.006119
	(0.03426)	(0.06938)	(0.04696)	(0.06834)	(0.02290)
	[-0.40540]	[1.62046]	[3.05431]	[11.8268]	[0.26717]
LR_AVG_SA(-1)	-0.800088	-0.411300	0.559355	-0.286409	0.627175
	(0.29346)	(0.59428)	(0.40230)	(0.58543)	(0.19618)
	[-2.72642]	[-0.69210]	[1.39039]	[-0.48923]	[3.19701]
C	-0.097040	10.21006	0.561825	-3.578879	0.843702
	(1.09320)	(2.21382)	(1.49866)	(2.18087)	(0.73080)
	[-0.08877]	[4.61197]	[0.37488]	[-1.64103]	[1.15449]
DUM_GFC	-0.003836	-0.036456	0.109054	0.034366	0.014781
	(0.01886)	(0.03819)	(0.02585)	(0.03762)	(0.01261)
	[-0.20338]	[-0.95459]	[4.21823]	[0.91346]	[1.17246]
DUM_QE	0.014455	0.027106	0.029129	0.082687	0.000284
	(0.01342)	(0.02717)	(0.01839)	(0.02676)	(0.00897)
	[1.07747]	[0.99774]	[1.58389]	[3.08963]	[0.03162]
DUM_CRUNCH	-0.022157	-0.055991	-0.074066	-0.028092	-0.022926
	(0.01939)	(0.03927)	(0.02659)	(0.03869)	(0.01296)
	[-1.14253]	[-1.42568]	[-2.78586]	[-0.72610]	[-1.76839]

DUM_COR	-0.000149	0.043146	-0.067419	-0.004599	0.012830
	(0.01456)	(0.02949)	(0.01996)	(0.02905)	(0.00974)
	[-0.01021]	[1.46304]	[-3.37703]	[-0.15832]	[1.31792]
L_XPI_SA	-0.053344	0.020742	-0.119513	0.120001	-0.025876
	(0.02910)	(0.05893)	(0.03989)	(0.05805)	(0.01945)
	[-1.83316]	[0.35199]	[-2.99589]	[2.06713]	[-1.33017]
FIS_SA	0.020928	-0.085079	0.055543	0.002827	0.018315
	(0.01672)	(0.03387)	(0.02293)	(0.03336)	(0.01118)
	[1.25146]	[-2.51225]	[2.42274]	[0.08475]	[1.63834]
L_FUEL_SA	0.092916	-0.121452	-0.069053	-0.022195	0.014524
	(0.04454)	(0.09019)	(0.06105)	(0.08885)	(0.02977)
	[2.08633]	[-1.34665]	[-1.13102]	[-0.24982]	[0.48785]
R-squared	0.998682	0.994076	0.986131	0.999511	0.976874
Adj. R-squared	0.998255	0.992154	0.981633	0.999352	0.969374
Sum sq. resids	0.007933	0.032532	0.014909	0.031571	0.003545
S.E. equation	0.014642	0.029652	0.020073	0.029211	0.009788
F-statistic	2337.009	517.3727	219.2412	6302.231	130.2439
Log likelihood	147.7723	112.4916	131.9989	113.2413	167.9085
Akaike AIC	-5.390890	-3.979666	-4.759958	-4.009652	-6.196339
Schwarz SC	-4.893764	-3.482540	-4.262832	-3.512526	-5.699213
Mean dependent	4.413718	14.63203	7.178883	14.61842	0.232468
S.D. dependent	0.350528	0.334766	0.148117	1.147867	0.055933

Determinant resid covariance (dof adj.)	3.35E-18
Determinant resid covariance	7.44E-19
Log likelihood	688.8130
Akaike information criterion	-24.95252
Schwarz criterion	-22.46689

VAR Lag Order Selection Criteria
Endogenous variables: L_PC_SA L_Y_SA L_E_SA L_L_SA
LR_AVG_SA
Exogenous variables: C DUM_GFC DUM_QE DUM_CRUNCH DUM_COR L_XPI_SA
FIS_SA L_FUEL_SA
Date: 07/20/15 Time: 17:17
Sample: 2000Q1 2015Q1
Included observations: 50

Lag	LogL	LR	FPE	AIC	SC	HQ
0	475.8255	NA	1.87e-14	-17.43302	-15.90340	-16.85053
1	688.8130	315.2214*	1.07e-17	-24.95252	-22.46689*	-24.00598*
2	717.4125	36.60738	1.03e-17*	-25.09650	-21.65486	-23.78590
3	743.5867	28.26818	1.20e-17	-25.14347	-20.74582	-23.46882
4	779.0982	31.25006	1.13e-17	-25.56393*	-20.21026	-23.52522

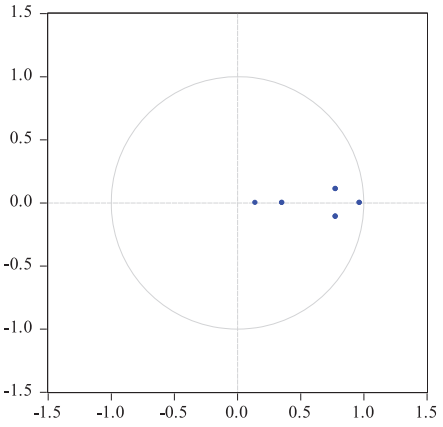
* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 07/20/15 Time: 17:18
Sample: 2000Q1 2015Q1
Included observations: 50

Lags	LM-Stat	Prob
1	36.60151	0.0630
2	25.07039	0.4584
3	32.27192	0.1503
4	24.15526	0.5104
5	27.26085	0.3430
6	26.63047	0.3746
7	22.42188	0.6113
8	29.62460	0.2387

Probs from chi-square with 25 df.

Inverse Roots of AR Characteristic Polynomial



VAR Residual Normality Tests

Orthogonalization: Cholesky (Lutkepohl)

Null Hypothesis: residuals are multivariate normal

Date: 07/20/15 Time: 17:18

Sample: 2000Q1 2015Q1

Included observations: 50

Component	Skewness	Chi-sq	df	Prob.
1	0.193766	0.312878	1	0.5759
2	0.616760	3.169940	1	0.0750
3	-0.154730	0.199510	1	0.6551
4	0.386383	1.244101	1	0.2647
5	-0.196970	0.323310	1	0.5696
Joint		5.249740	5	0.3862

Component	Kurtosis	Chi-sq	df	Prob.
1	4.352064	3.808496	1	0.0510
2	3.096835	0.019535	1	0.8888
3	3.892092	1.657974	1	0.1979
4	3.454586	0.430517	1	0.5117
5	3.615986	0.790498	1	0.3739
Joint		6.707021	5	0.2434

Component	Jarque-Bera	df	Prob.
1	4.121374	2	0.1274
2	3.189475	2	0.2030
3	1.857484	2	0.3951
4	1.674618	2	0.4329
5	1.113808	2	0.5730
Joint	11.95676	10	0.2880

Chapter 5

REVISITING THE TRANSMISSION MECHANISMS OF MONETARY POLICY IN THE PHILIPPINES

By
Eloisa T. Glindro
Vic K. Delloro
Christofer A. Martin
Joan Christine S. Allon[1]

1. Introduction

The central banks of industrial and emerging market economies face the challenge of implementing monetary policy in an ever-changing economic environment. The emergence of more globally integrated financial systems, the liberalization of capital accounts, greater exchange rate flexibility, and the introduction of increasingly sophisticated products tested the ability of monetary policy and efficacy of financial regulations. Amidst these changes, central banking in the Philippines has also substantially evolved. It is not remote, therefore, that the traditional transmission mechanisms of monetary policy could have also undergone changes alongside structural transformation and policy regime shifts.

This research seeks to examine the relevance of the traditional channels in explaining the response of key macroeconomic variables to monetary policy shock even with the spate of external shocks such as the 2008 global financial crisis. Specifically, it measures and compares the magnitude of the traditional channels of monetary policy, namely, interest rate channel, exchange rate channel, and credit channel in the Philippines during the inflation targeting (IT) period.

This research adopts a Bayesian vector autoregression approach in analyzing the transmission of mechanisms of monetary policy. In addition, changes in inflation persistence and exchange rate pass-through are also analyzed using an autoregressive distributed lag (ARDL) model. This is in consideration of the

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1. Eloisa T. Glindro and Vic K. Delloro (Bank Officers V), Christofer A. Martin (Bank Officer II), and Joan Christine S. Allon (Research Analyst) at the Department of Economic Research, Bangko Sentral ng Pilipinas. The authors are thankful to former Assistant Governor Cyd N. Tuaño-Amador for her initiative to update the 2009 research paper. Nonetheless, the views expressed herein do not represent the views of the BSP. Errors and omissions are sole responsibilities of the authors.

greater exchange rate flexibility, financial reforms, and economic transformation during the inflation targeting period. The specification by Edwards (2005) and Siregar & Goo (2008) has been modified by controlling for output gap and by replacing world inflation with two major sources of external price shocks, namely, world oil inflation and world food inflation.

2. Review of Related Literature

Monetary policy transmission mechanism is characterized as a set of channels of monetary policy impulse propagation, through which the central bank affects aggregate demand and overall level of prices in the economy (Demchuk, £yziak, Przystupa, Sznajderska, and Wróbel, 2012). The literature identifies and focuses on several channels of transmission either through the traditional channels (i.e., market interest rates, the foreign exchange rate, the volume and allocation of credit) or through non-traditional channels (i.e., portfolio effects induced by asset price and economic agents' expectations). These channels are interdependent and could shift with changes in economic structure and policy landscape.

There are important aspects in evaluating and analyzing the transmission of monetary policy. The first is the transmission from the instruments directly under the central bank's control (e.g., short-term interest rates or reserve requirements) to variables that most directly affect conditions in the financial sector (loan rates, deposit rates, asset prices, and the exchange rate). The second is the link between financial conditions and the spending decisions of both households and firms. Third is the incorporation of asymmetric and non-linear relationships in examining the transmission of monetary policy.

Many studies on monetary policy transmission are usually applications to the cases of specific countries or regions. Bernanke & Gertler (1995) quantitatively measured the traditional channels of monetary policy transmission in the United States. These studies typically update the magnitude and timing by which policy actions translate to changes in economic variables and examine the relative strengths of conventional channels. Such works were usually undertaken in the aftermath of significant disruptions in a country's real, financial and regulatory environments, such as the 1980-1984 Volcker disinflation (Biovin, Kiley, Mishkin, 2010) or the 2008 global financial crisis (Demchuck et al., 2012).

In Biovin et al. (2010), the effect of monetary policy on aggregate real activity was shown to have become smaller and more persistent after 1984 – that is, after the Volcker disinflation and the numerous regulatory changes that occurred in the late 1970's and early 1980s. In another study, Demchuk et al.

(2012) determined the impact of the 2008 global financial crisis on Poland's policy transmission mechanism. By separating the identification of the key features of the analyzed relationships from their crisis-induced distortions, the paper found that the financial crisis has led to significant disturbances in the interest rate channel. Many long-term relationships between interbank market rates and deposit and loan rates were broken off and loans response with respect to loans to individual entrepreneurs had longer lags.

Research in the field of monetary transmission mechanism has also advanced from the usual study of the timing and magnitude of the macroeconomic responses through traditional channels towards less conventional transmission channels. Borio & Zhu (2008) explored a unique transmission channel – the "risk taking channel," defined as the impact of changes in policy rates on the degree of risk in the portfolios, on the pricing of assets, as well as non-price prospects. The paper showed the increasing interaction among capital regulation, the business cycle, and transmission mechanism.

Another strand of literature focuses on new or existing market players. Tobias and Shin (2008) examined the role of the broker-dealer in the asset and credit channels. In their analysis, they found out that broker-dealer balance sheet holds potentially more information on underlying financial conditions as they are the marginal suppliers of credit and their balance sheets reflect the financing constraints of the market-based financial system. Meanwhile, Iacoviello & Minetti (2008) presented results that suggest the presence of a bank-lending channel for households in countries where mortgage finance is more bank-dependent. However, little work has been done on the overall assessment of the macroeconomic importance of this channel.

The literature on the role of non-neoclassical channels (i.e. credit, bank-based and balance sheet) remains thin, reflecting difficulty in specifying the relevant mechanisms and finding the supporting empirical evidence. This is currently a very active research area that is expected to yield significant insights in the future (e.g., Meh & Moran, 2008; Angeloni & Faia, 2009; and Gertler & Kiyotaki, 2010).

There are also studies that look into the fundamental differences in the financial, economic, and institutional structures of advanced, emerging, and low-income economies. Although banks are dominant formal financial intermediaries in developing countries, the formal financial system tends to be very small relative to the size of the economy. Oftentimes, their links with the private international

capital markets are imperfect, necessitating more involved participation of their central banks in the foreign exchange markets (Mishra & Montiel, 2012).

In the Philippines, BSP researchers have undertaken studies to assess the relative strength of transmission channels of monetary policy and the magnitude of the impact of policy instruments on transmission channels.

Results of vector autoregression exercises by Dakila & Claveria (2006) showed that the BSP retains its capability to influence market interest rates through the adjustment of the policy rate.[2] The study showed that apart from the past trend in the T-bill rate itself, the policy rate is the most significant determinant of the T-bill rate over the very near term (within three months). Beyond this period, exchange rate changes begin to dominate the policy rate in influencing the T-bill rate.

Guinigundo (2008) observed that, with the shift to inflation targeting, expectations channel has taken a more important role in the transmission of monetary policy in the Philippines. The enhanced transparency associated with inflation targeting has increased policymakers' awareness of the importance of gauging public inflation expectations in the conduct of monetary policy. While the expectations channel has strengthened during the inflation targeting period, the effect of inflation targeting on the interest rate channel, specifically the correlation between the policy rate and the 91-day T-bill rate, has weakened. Meanwhile, the credit availability channel and the asset price channel remain closely linked due to the dominant role of the banking system in the Philippine financial system.

Monetary policy simulations using the BSP's Dynamic Stochastic General Equilibrium (DSGE) model for the Philippine economy showed that an adjustment in the BSP's reverse repurchase (RRP) rate was also found to significantly affect price levels, cost and volume of credit, nominal and real exchange rates and, eventually, output (McNelis, Dakila, Glindro, and Co, 2009).

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2. In their study, an impulse response analysis of the reverse repurchase (RRP) rate and the 91-day T-bill rate from a vector autoregression (VAR) of the RRP rate, month-on-month change in the exchange rate, 91-day T-bill rate, real money supply and deviation of gross domestic product (GDP) from trend showed that a one-time shock in the RRP rate by one percentage point leads to a maximum increase in the 91-day T-bill rate of 0.70 percentage point in the second month and dissipates thereafter.

Amador, Glindro, and Claveria (2010) offered some views on the extent to which monetary policy actions have worked through the interest rate channel, the exchange rate channel, and the bank lending channel during the period 1986 - 2008. The paper found evidence of lower exchange rate pass-through and improved yet relatively weak interest rate and bank lending channels when monetary policy shifted emphasis towards the control and management of inflation. Nonetheless, the study maintained that there remained substantial scope for strengthening the interest rate and bank lending transmission channels of monetary policy. The authors conjectured that structural factors may have limited the strength of the monetary policy transmission channels – these include, among others, relative shallowness of financial markets, comparatively high reserve requirements, and susceptibility to shifts in investor sentiment could have also hindered stronger monetary policy transmission through the interest rate channel during the period of review.

Using dynamic, structural, macro econometric model, Bayangos (2010) affirmed the importance of bank credit channel in Philippine monetary transmission mechanism. Evidence of the existence of a bank credit channel was obtained by estimating changes in bank credit relative to monetary policy indicators and specific banking indicators such as bank capital. The impact of a monetary policy tightening on output was shown to be relatively moderate and quite long when realized through the credit channel.

Guinigundo (2015) examines the impact of increasing financial intermediation in the Philippines on monetary policy transmission. Using a two-step Engle Granger Error Correction Model, the study shows evidence of stronger pass-through and faster adjustments towards the long-run impact of monetary policy, especially during the IT period. The study also shows evidence of weaker immediate monetary pass-through as a consequence of well-anchored inflation expectations and strong linkages between long-term bond rates across countries.

3. Philippine Monetary Policy Framework

The 1990s was a critical juncture in the conduct of monetary policy in the Philippines. The BSP was granted greater autonomy in carrying out its mandate.[3] The BSP was granted greater autonomy in carrying out its mandate. Within the

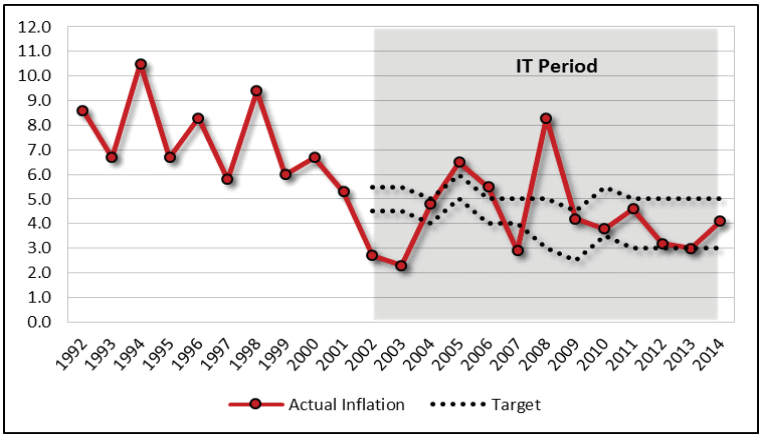
3. Republic Act No. 7653 or the *New Central Bank Act*, which created the independent Bangko Sentral ng Pilipinas, came into force in 1993.

same period, the liberalization of the Philippine financial system began. The subsequent developments in the financial sector contributed to the weakening of the traditional link among money, economic output, and inflation, as embodied in a monetary aggregate targeting framework.

The ensuing unpredictability in the relationship between monetary aggregates and real side of the economy led to difficulties in attaining the BSP's monetary targets. Thus, beginning mid-1990s, the BSP adopted some form of quasi-inflation targeting – it modified its monetary targeting approach by allowing flexibility in attaining monetary targets and increasingly prioritized price stability. It fully shifted to inflation targeting as the framework for monetary policy in 2002, with explicit pronouncement on the primacy of price stability objective of monetary policy and less weight on intermediate monetary targets. Notwithstanding the initial birth pains in achieving the inflation target, the Philippine IT period has generally been characterized by disinflation (Figure 1) and greater exchange rate flexibility.

Figure 1

Figure 1. Actual vs. Target Inflation (2006 = 100)[4]



Source of Basic Data: BSP.

As a forward-looking framework, the success of IT depends largely on anchoring of public's expectations on the central bank's inflation target. This would require public's deeper understanding and appreciation of the IT framework

4. In December 2006, the Government's inflation target was re-specified from a 1 percentage-point range target to a point target with a tolerance interval of ±1 percentage point starting in the target for 2008.

for monetary policy. Thus, the BSP undertook institutional capacity building and developed information campaign programs aimed at educating the public about the rationale behind the BSP's mandate to promote price stability and the supporting framework that would help it realize its objectives. The BSP's information campaigns eventually led to the institutionalization of the economic and financial learning program that caters not only to the sophisticated corporate sector but also to the working class, students and faculty, and overseas Filipinos.[5]

There have been tangible proofs of inflation stabilization since the BSP adopted inflation targeting as the framework of monetary policy. Average inflation as well as inflation volatility have been on a relative trend decline (Figure 2). The lowest average inflation was posted for the inflation targeting period even with the disruption caused by the global commodity price shock in 2008-2009 (Figure 3).

Figure 2
Mean and Standard Deviation of Inflation 1980 – Q1 2015

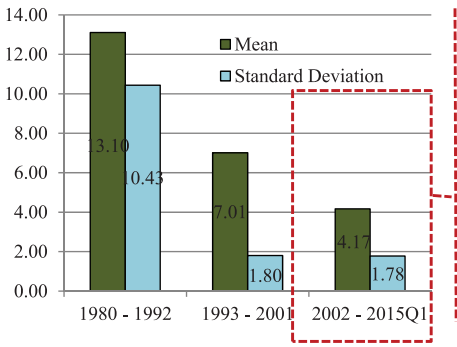
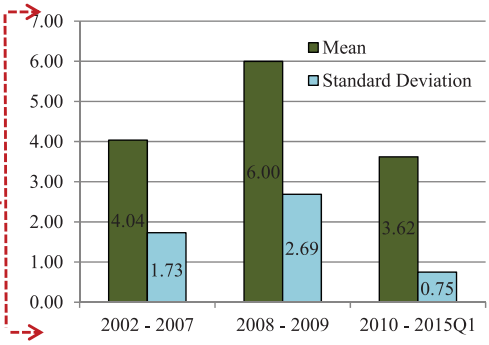


Figure 3
Mean and Standard Deviation of Inflation 2002 – Q1 2015



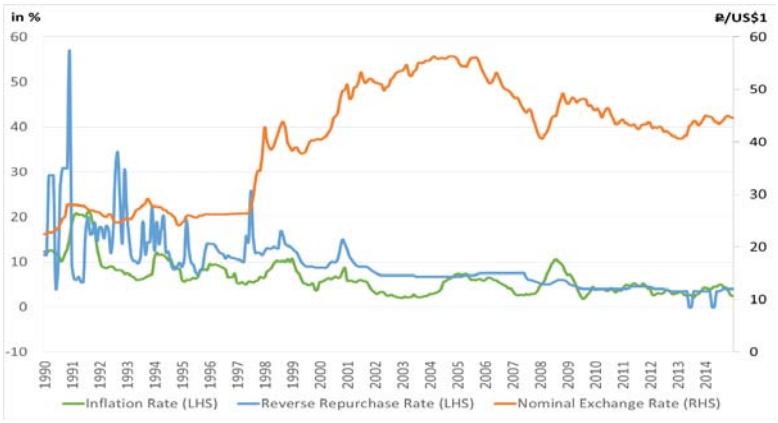
Source of Basic Data: BSP.

There have also been corresponding adjustments in exchange rate policy with the change in monetary policy framework. Greater exchange rate flexibility has become more apparent after the 1997 Asian financial crisis and the

5. The Bangko Sentral ng Pilipinas (BSP) won the 2015 Global Forum on Remittances and Development (GFRD) Public Sector Award from the International Fund for Agricultural Development of the United Nations, the World Bank, and the European Commission for its Economic and Financial Learning Program (EFLP) that educates overseas Filipino workers and their beneficiaries on the importance of, and methods for using remittances to build savings and invest productively.

subsequent implementation of financial sector reforms (Figure 4). The greater policy space provided by the improvement in the country's macroeconomic fundamentals means that the burden of the adjustments (in exchange rate policy and monetary policy framework) is not borne by exchange rate alone. The weight that the BSP places on exchange rate developments is largely determined by its impact on inflation and inflation expectations, conditional on other factors. The BSP intervenes occasionally in the foreign exchange market to temper excessive exchange rate volatility.

Figure 4
Historical Trends: Exchange Rate, Reverse Repurchase Rate, and Inflation Rate in the Philippines (1990 – 2014)

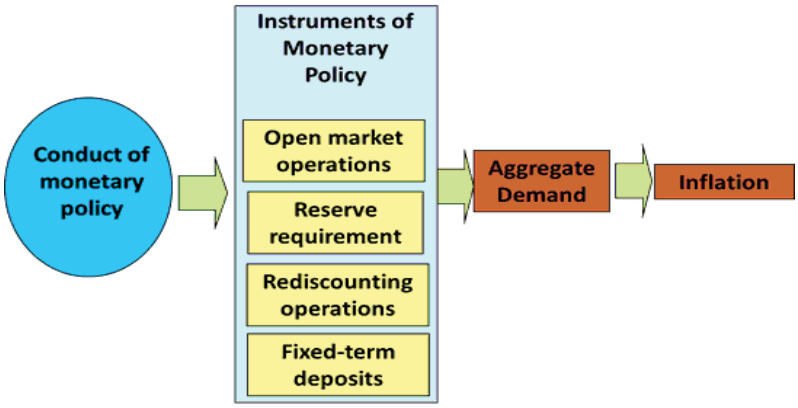


Source of Basic Data: BSP.

To achieve the inflation target, the BSP uses a suite of monetary policy instruments (Figure 5) in implementing the desired monetary policy stance. The repurchase rate (RP) or lending rate and the RRP or borrowing rate are the primary monetary policy instruments of the BSP's open market operations. Other monetary policy instruments include (a) reserve requirements; (b) rediscount rate on loans extended to banking institutions on a short-term basis against eligible collateral of banks' borrowers; (c) outward sales/purchases of the BSP's holdings of government securities; and (d) special deposit account (SDA) facility by banks and trust entities of BSP-supervised financial institutions.[6]

6. For description of each policy instrument, see http://www.bsp.gov.ph/monetary/targeting.asp

Figure 5
BSP's Monetary Policy Instruments



4. Data and Research Methodology

4.1 Methodology

In analyzing the transmission mechanisms of monetary policy in the Philippines, an integrative analysis is undertaken using Bayesian Vector Autoregression (BVAR) method. This is complemented by (i) Autoregressive Distributed Lag (ARDL) model to examine inflation persistence and exchange rate pass-through and (ii) Ordinary least squares to examine determinants of credit to the private sector.

4.1.1 Bayesian Vector Autoregression

Traditional VARs are confronted with the problem of over-parameterization and hence, the consequent loss of degrees of freedom with the use of unrestricted VARs. The number of coefficients to be estimated can easily expand, imposing limits on the number of variables that can be included in the system as well as on the precision of the coefficient estimates with limited data set.

One approach in solving these problems is shrinkage, where restrictions are imposed on parameters to reduce the parameter set. Bayesian VAR (BVAR) methods are one popular approach for achieving shrinkage, since Bayesian priors

provide a logical and consistent method of imposing parameter restrictions (Eviews 9). With limited macroeconomic datasets, as often the case, Bayesian methods are increasingly used to deal with the problem of over-parameterization (Litterman, 1986; Doan, Litterman, and Sims, 1984; Sims & Zha, 1998). The following description draws from Ciccarelli & Rebucci (2003), which provides a coherent and cohesive explanation of the BVAR.

The principle behind BVAR is the recognition of parameter uncertainty, thus, parameters are treated as random variables to which a probability distribution is assigned. In this aspect, modelers can impose own beliefs on the prior distribution of the parameters, which, in turn, can be modified by information contained in the data to produce posterior distribution. The general idea is to use informative priors to transform the unrestricted model to a more parsimonious model. In this way, parameter uncertainty is reduced. As long as the prior information is not too vague, only the signal (and not the noise) from the data will be used to adjust the prior (Eviews 9).

A BVAR in a compact form is given by $Y_t = X_t\beta + \varepsilon_t$

such that $X_t = I_n \otimes W_{t-1}$ is n x nk; $W_{t-1} = (Y'_{t-1}, \dots Y'_{t-p}, Z'_t)'$ is a k x 1; and $\beta = vec(\beta 1, \beta 2, \beta t\text{-}p, D)$ is a nk x 1 parameter space; n is the number of observations and k is the number of regressors. The unknown parameters are β and Σ.

Given the likelihood function,

$L(Y|\beta,\Sigma) \propto |\Sigma|^{-T/2} exp\{-1/2 \sum (Y_t - X_t\beta)'\Sigma^{-1}(Y_t - X_t\beta)\}$ and a joint prior distribution on the parameters, $\beta b, \Sigma Y$, the joint posterior distribution of the parameters conditional on the data is derived following Bayes law:

$$p\beta,\Sigma Y = p\beta,\Sigma L(Y|\beta,\Sigma)p(Y)$$

$$\propto p(\beta,\Sigma)L(Y|\beta,\Sigma)$$

The choice of prior distribution for the parameter space ($\beta,\Sigma/Y$) is an essential building block for the specification. For this study, the BVAR analysis used the standard Litterman/Minnesotta priors, which assume that the Σ_t is known by using estimate, $\widehat{\Sigma_t}$.

Complementing the Bayesian VAR are (i) autoregressive distributed lag (ARDL) model for measuring inflation persistence and exchange rate pass-through and (ii) simple ordinary least squares (OLS) method in analyzing some macroeconomic determinants of credit channel of monetary policy.

4.1.2 Autoregressive Distributed Lag (ARDL) Model

To analyze exchange rate pass-through and inflation persistence, an ARDL model is applied on augmented Phillips curve as done by Xie (2014) in the IMF Country Report No. 14/246. It has the following specification:

$$\pi_t = \beta_0 + \sum_{i=1}^{p} \beta_1 \pi_{t-i} + \sum_{i=0}^{q} \beta_2 ygap_{t-i} + \sum_{i=0}^{q} \beta_3 \pi woil_{t-i} + \sum_{t=0}^{q} \beta_4 \pi wrice_{t-i} + \sum_{i=0}^{q} \beta_5 er_{t-i} + \varepsilon_t$$

Unlike the specification made by Edwards (2005) and Siregar & Goo (2008) that used a composite world inflation, the new specification controls for two principal sources of imported inflation, i.e., global oil inflation *(woil)* and global rice inflation *(wrice)* as well as nominal peso-dollar exchange rate *(er)*. The model also controls for effect of excess demand *(ygap)*, which indirectly embodies the domestic component of real marginal cost that is influenced by the impact of interest rate and fiscal policies. Inflation persistence *(π_{t-1})*, in a limited way, captures the indexation of wages to inflation.

5. Empirical Results

5.1 Transmission Channels of Monetary Policy: Small-Scale Bayesian Vector Autoregression (BVAR)

To gauge the relative strength of different channels of monetary policy during inflation targeting, BVAR was undertaken. The BVAR system consists of nominal exchange rate, 91-day secondary Treasury bill rate, weighted average lending rate of universal/commercial banks, growth rate of nominal credit to the private sector, growth rate of real household consumption, growth rate of investment, inflation rate, and weighted average of BSP's overnight RRP rate and SDA rate.[7]

The study adopted Litterman-Minnesota priors. Prior mean (μ_1) is set at zero since all the variables used are stationary. In the specification, trend and Federal Funds rate are included as exogenous variables in the BVAR system. The variance-covariance matrix of standard classical VAR is used as initial estimate. Lambda 1 (λ_1), which controls for overall tightness of the variance is set at 0.10. Lambda 2 (λ_2), which controls for the relative tightness of the variance of other dependent variables, is set at 0.99.[8] Generalized impulse response functions, which are invariant to the ordering of variables, are reported.[9]

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7. SDA and RRP are weighted by their respective volumes of transactions.

8. The IRFs are deemed reasonable based on different values for l1 and l2 that were tested.

9. The mean and standard deviation of the variables in the BVAR system with different prior assumptions used are reported in Appendix 2.

Figure 6
Data Presentation

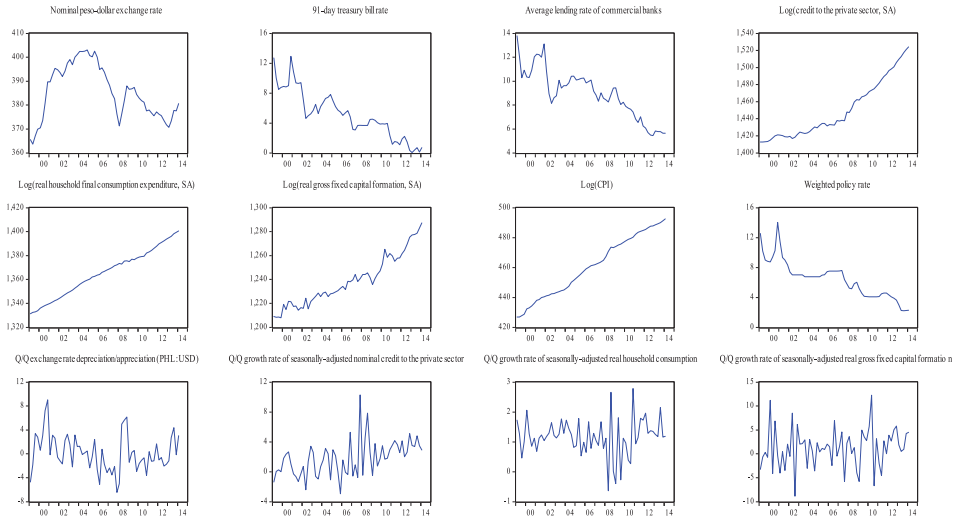


Table 1
Unit Root Test Results

Variables	Level of Integration	p-value of ADF test-statistic	
		Log(level)	First difference
Log(nominal exchange rate)	I(1)	0.08	0.00
91-day Treasury bill rate	I(1)	0.02	0.00
Average bank lending rate	I(1)	0.07	0.00
Log(credit to the private sector, SA)	I(1)	0.99	0.00
Log(household final consumption expenditure, SA)	I(1)	0.49	0.00
Log(gross fixed capital formation, SA)	I(1)	0.37	0.00
Log(CPI)	I(1)	0.40	0.00
Policy rate	I(1)	0.02	0.00

To make the estimated impact of policy rate shock, inflation shock, and exchange rate shock comparable, the estimated responses are scaled by the one-standard deviation shock to the variable of interest.[10] The reported figures (Table 2) pertain to cumulative impact of shocks. As such, the cumulative impact in the second year is the sum of the responses from the first-period shock, thereby, providing a gauge of how much of the initial shock has waned.

Table 2
Estimated Cumulative Impact of Policy Rate, Inflation, and Exchange Rate Shocks (in ppt)

	CUMULATIVE IMPACT					
	Inflation Shock		Exchange Rate Shock		Policy Rate Shock	
	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr
Nominal exchange rate (q/q g.r.)	1.35	1.19	1.19	1.14	0.67	0.35
91-day Treasury bill rate	0.71	0.74	0.23	0.24	1.18	1.08
Average bank lending rate	0.42	0.48	0.07	0.08	0.68	0.72
Credit to the private sector (q/q gr)	0.44	0.34	0.03	0.01	-0.54	-0.52
Real personal consumption expenditure (q/q g.r.)	-0.13	-0.14	-0.01	-0.01	-0.04	-0.03
Real fixed capital formation (q/q g.r)	-0.50	-0.48	-0.23	-0.19	-1.19	-0.96
Inflation (q/q)	0.97	0.96	-0.01	-0.01	-0.15	-0.12
Weighted policy rate	0.16	0.15	0.15	0.14	1.43	1.32
Implied real credit	-0.53	-0.62	0.04	0.02	-0.39	-0.41

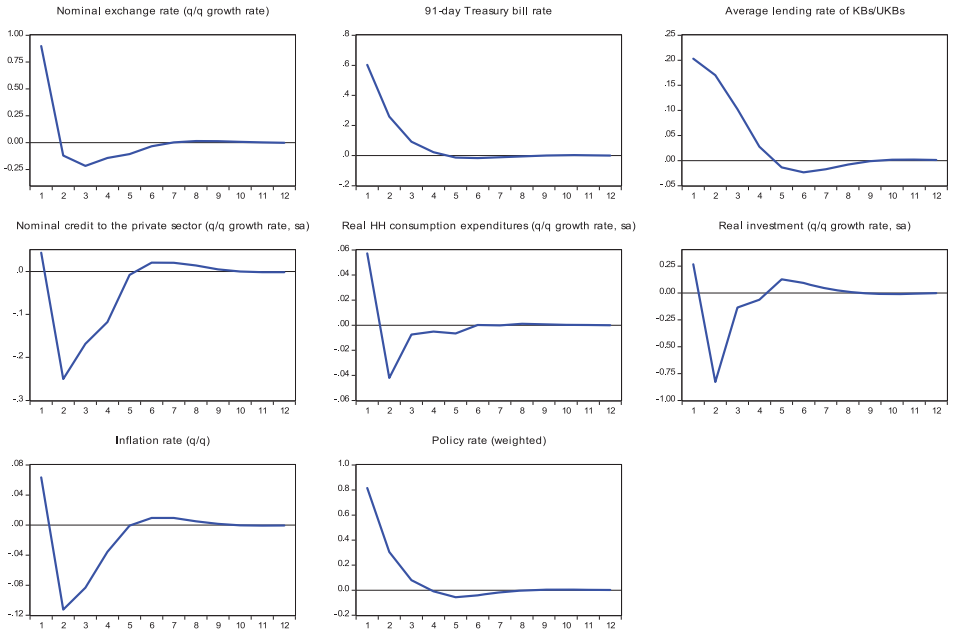
N.B. All the responses are multiplied by (1/standard deviation of the shock).

5.1.1 Interest Rate Pass-through

Compared to exchange rate and inflation shocks, the cumulative first-year impact of a policy rate shock has the strongest effect on market rates (i.e., 1-day Treasury bill rate and average bank lending rate). After a year, the initial one ppt increase in policy rate is fully transmitted into the 91-day T-bill rate and about 2/3 in the case of lending rate. These are close to estimates of Guinigundo (2015) on long-run pass-through to 91-day Treasury bill rate (0.84 ppt) and bank lending rate (0.67 ppt), using an error correction method.

10. This is equivalent to multiplying all the responses by (1/standard deviation of the shock). For example, if the one standard deviation shock to policy rate is 0.92, all the responses are multiplied by (1/0.92). Thus, own shock would be 1 ppt in first period.

Figure 7a
Response of Selected Macroeconomic Indicators to Generalized One S.D. Innovation to Weighted Policy Rate



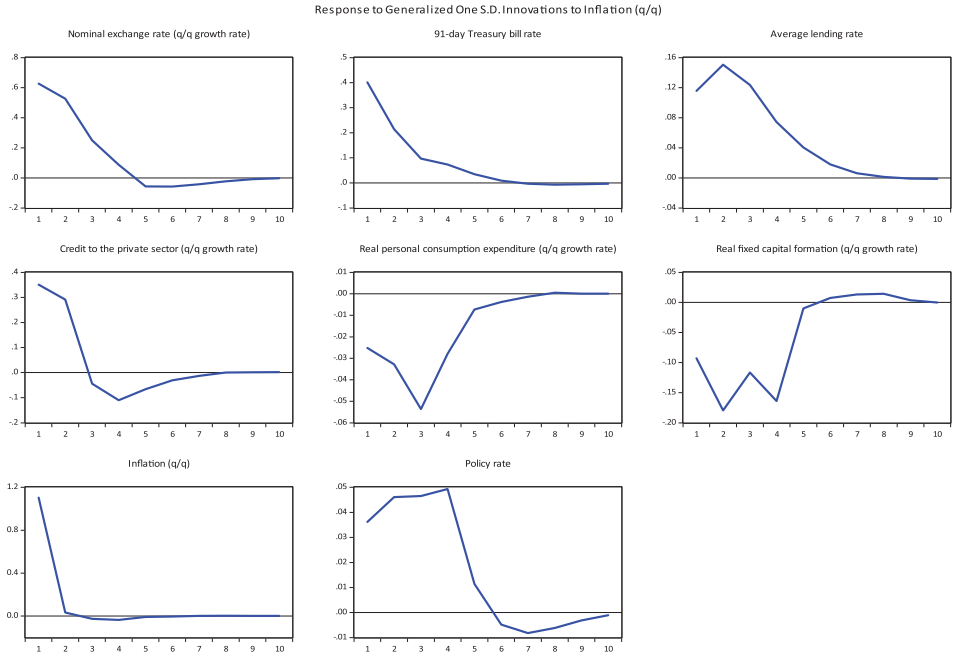
Exchange rate initially depreciates but appreciates thereafter. The finding of contemporaneous depreciation is supported by the positive correlation during the estimation period of 1999 – 2015Q2. The cumulative impact in the first year is still a depreciation, possibly indicating that the one ppt policy rate shock is initially seen as a deterioration in the economic outlook.

Demand indicators respond with a lag, as expected. With the implied real lending rate rising by a bigger magnitude in the second quarter, nominal credit to the private sector starts to contract, bottoming out in the fifth quarter – this corresponds to an average decline of 0.14 ppt. The cumulative decline after four quarters is only about half a percentage point. Real consumption and real investment decline beginning second quarter, with the latter falling by a much larger scale. Since consumption marginally goes down, the slowdown in real activity leads to modest deceleration in inflation.

5.1.2 Inflation Shock

Among the three shocks, inflation shock exerts the most impact on real household consumption. Policy rate response exhibits inertia in the face of supply shock. From the policy perspective, the nature of the initial supply shock could have just been a temporary one such that policy rate need not immediately respond one-for-one, lest it induces volatility in the economy. This may also be explained by the fact that historically, inflationary episodes in the Philippines were driven by supply shocks. With regard to credit to the private sector, even if nominal credit growth remains positive, the higher inflationary impulse and the consequent impact on exchange rate and market rate dent real credit to the private sector, thus, affecting real investment in the process.

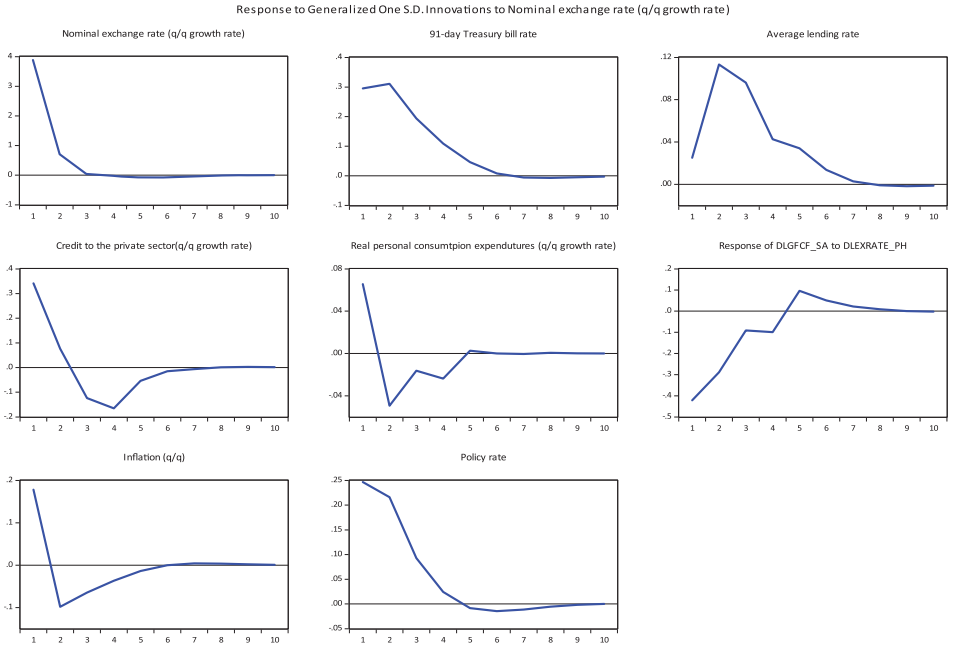
Figure 7b
Response of Selected Macroeconomic Indicators to Generalized One S.D. Innovation to Inflation



5.1.3 Exchange Rate Shock

Market interest rates react the least to exchange rate shock. Relative to inflation and policy rate shocks, the impact on both nominal and real credit, and hence, real investment is positive yet minimal. As a result, the pass-through of exchange rate shock to inflation is equally small.

Figure 7c
Response of Selected Macroeconomic Indicators to Generalized One S.D. Innovation to Exchange Rate



5.2 Determinants of Credit to the Private Sector

As a validation exercise, simple OLS regression is undertaken to further identify determinants of credit to the private sector. Lagged value of the endogenous variable is included to capture inherent persistence in the behavior of credit to the private sector. The preferred specification controls for GDP growth, fiscal condition indicator (represented by the ratio of national government

(NG) gross domestic borrowings-to-revenue), and stock market price index (Table 3). The results confirm the BVAR results on the muted response of nominal credit to policy rate adjustment. The estimated coefficients of the preferred model exhibit theoretically predicted signs. Model simulation indicates that a one ppt increase in policy rate leads to a modest average decline of 0.14 ppt in the growth rate of credit to the private sector, a finding that is consistent with the average decline estimated in the BVAR model.

Nominal credit growth exhibits high degree of persistence. It is inversely related to fiscal condition indicator. The latter implies crowding-out effect on private credit of higher government borrowings relative to its capacity to generate income. However, the extent of crowding out is limited, owing to the fiscal consolidation and debt reduction program by the national government.

Higher economic activity, represented by nominal GDP growth rate, positively impacts on the growth of credit to the private sector. The positive association with stock market returns suggests that, at the macro level, it acts as a complement to credit. The positive relationship between the credit to the private sector and the stock price index can be attested by the marked steepening of the slope of the Philippine Stock Exchange index (PSEi) in the post-GFC period, when the economy and credit started growing above their historical average growth rates.

The impact of monetary policy tightening on credit growth, however, remains quite modest. The strength of the balance sheet of Philippine banks may have helped shield their loan portfolios from changes in monetary policy, thus, explaining the small response of credit growth to interest rate adjustment. While capital adequacy ratio and non-performing loans ratio at the macro level did not turn out to be significant in explaining the growth of nominal credit to the private sector in this study, the results of a separate research that uses bank-level data to examine the responsiveness of bank loan supply of universal and commercial banks to monetary policy indicate that the capital-to-asset ratio is the most significant loan supply predictor that cushions the effect of restrictive monetary policy (Glindro, Lemence, & Sabuga, 2015). The study by Aban (2013), which differentiates universal and commercial banks according to asset size, shows that loan supply of larger banks are insensitive to monetary policy while the loan supply of banks belonging to the smallest category are responsive to changes in monetary policy stance, signifying differential effect of monetary policy.

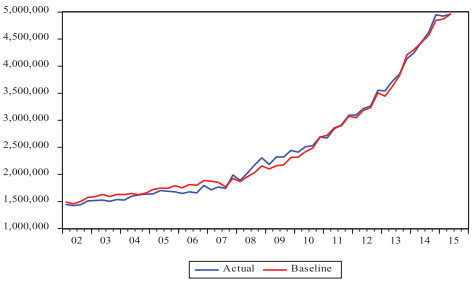
Table 3
Macroeconomic Determinants of Credit to the Private Sector

Dependent Variable : Credit to the private sector (log) Date: 10/26/15 Time: 09:27 Sample: 1995Q1 2015Q1 Included observations: 81 HAC standard errors and covariance (Bartlett kernel, Newey west fixed bandwidth = 4.0000		
Variable	Coefficient	Centered Variance Inflation Factor
Constant	0.679 (0.000)	NA
Credit to the private sector $_{t-1,}$ (log)	0.931 (0.000)	4.802
NG gross domestic borrowings/NG revenue	-0.036 (0.010)	2.012
Policy rate $_{t-1}$	-0.004 (0.003)	3.173
Stock price index $_{t-1}$ (log)	0.047 (0.0000)	7.342
Growth rate (Q/Q) of Nominal GDP	0.204 (0.0000)	1.114

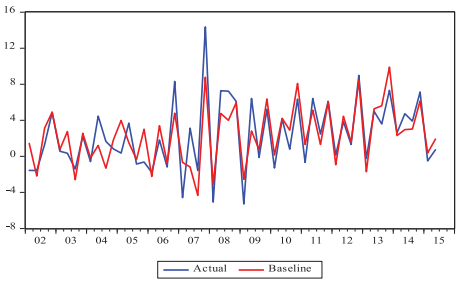
Adjusted R2 = 0.997; In parenthesis are p-values; VIF > 10 is considered evidence of severe multicollinearity.
The estimation is undertaken with Newey-West covariance method.
Variables are log transformed. Exceptions are rate variables and those expressed as ratios.

Figure 8
Forecasting Performance of the Model

Credit to the Private Sector
(in Million Pesos)

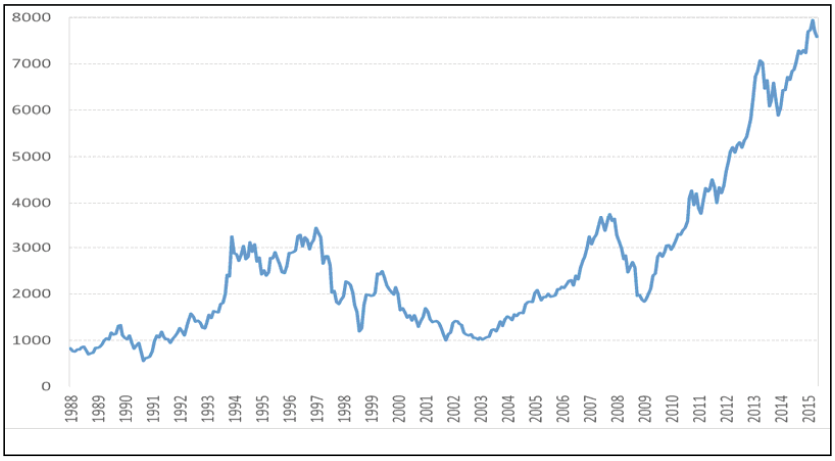


Credit to the Private Sector
(q/q Growth Rate)



RMSE = 4.59; MAPE = 0.25; Theil = 0.002; Covariance proportion = 0.97

Figure 9
Philippine Stock Exchange Index
(January 1988- March 2015)



Source of basic data: Bloomberg.

5.3 Inflation Persistence and Exchange Rate Pass-through

The BSP adheres to its policy of allowing exchange rate flexibility even as it occasionally participates in the foreign exchange market when there is excessive volatility. It responds more to instability in speculative or "hot money" flows than to structural flows such as remittances, exports, and foreign direct investment. The structure and nature of foreign exchange inflows into the Philippines have changed significantly over the years, with overseas Filipino remittances accounting for the bulk of the country's current account receipts. Since remittances are relatively more stable inflows, this may have partly contributed to general trend appreciation of the peso in recent years.

To measure inflation persistence and pass-through effects of exchange rate and global commodity price inflation on domestic headline inflation, an ARDL model was applied on augmented Phillips Curve. The specification is patterned after the IMF Country Report.[11]

11. "Philippine Inflation: Home Grown or Imported?" IMF Country Report No. 14/246, Selected Issues, August 2014. The model appears in Ssection D of the report "Modeling Inflation in the Philippines: A Single Country, Single Equation Approach".

Over the years, the ability of the domestic economy to accommodate supply shocks has improved (Table 4). While there can be no clear mapping of measures of persistence vis-à-vis monetary policy regime (Gali, 2004), there appears to be some congruence between lower inflation persistence and lower exchange rate pass-through in the case of the Philippines.

Estimates indicate that both intrinsic inflation persistence and exchange rate pass-through coefficients have gone down during the inflation targeting (IT) period. The estimated lower inflation persistence and lower exchange rate pass-through in the IT period coincided with the general disinflation during the IT period. Mean quarter-on-quarter inflation as captured by the constant term also went down.

The coefficient of the output gap slightly increased in the IT period. This may imply that in the presence of a demand shock, interest rate adjustment will have to be relatively stronger. With a supply shock, however, interest rate adjustment may be relatively less aggressive since the higher coefficient of aggregate demand in the Phillips curve means the reduction in output, following an interest rate adjustment, will have a stronger dampening impact on inflation. However, an important caveat should be put in order. The estimated higher coefficient of output gap from the ARDL specification should not be interpreted as an evidence of structural change in the sensitivity of inflation to demand conditions, for four reasons: first, output gap, which is an unobservable variable, may not be the best indicator of the domestic component of real marginal cost; second, output gap is derived simply by univariate filtering method; third, the difference in the estimated coefficients over three decades' worth of data (interspersed with crisis episodes) is small; and fourth, the specification does not control for credibility.

In terms of external shocks, the pass-through of global oil inflation rose while the pass-through of global rice inflation significantly declined. It appears that lower exchange rate pass-through combined with lower external indebtedness during the IT period could have attenuated disruptive exchange rate movements and external supply shocks on domestic inflation. Prior to IT period, the coefficient

of global oil price inflation was insignificant, perhaps reflecting the oil price subsidy.[12]

Table 4
Estimated Inflation Persistence and Exchange Rate Pass-through from Augmented Phillips Curve

	Inflation Persistence	Output Gap	World Rice Inflation	World Oil Inflation	Exchange Rate	Constant
1982Q1 2001Q4	0.45	0.25	0.22	0.03	0.36	1.99
	-	*(0.009)*	*(0.003)*	*(0.129)*	*(0.045)*	*(0.000)*
2002Q1 2015Q2	0.36	0.29	0.04	0.06	0.15	0.87
	-	*(0.014)*	*(0.010)*	*(0.000)*	*(0.029)*	*(0.000)*

Variables (all are stationary) in the ARDL model are in quarter-on-quarter growth rates. Reported coefficients correspond to long-run coefficients with p-values in parenthesis. Results of residual diagnostics based on correlogram of Q-statistics do not reject the null hypothesis that the errors from residuals of the models are not serially independent (no evidence of autocorrelation). ARDL bounds test rejects the null of no long-run relationship. Output gap is estimated using Hodrick-Prescott filter.[13]

The sustained improvement in the BSP's inflation-fighting credentials may have facilitated more anchored inflation expectations. In Dincer & Eichengreen's (2014) study on central bank transparency and independence, the Philippines has the second highest transparency index among economies in Central, Eastern, Southern, and Southeast Asia, with Japan being the highest. In Southeast Asia

12. The Oil Price Stabilization Fund (OPSF) is a budgetary allocation maintained by the government with the purpose of reimbursing the oil companies for cost increases on crude oil and imported petroleum products resulting from exchange rate adjustment and/or increase in world market prices. The use of the OPSF was meant to stabilize the prices of petroleum products for a longer period despite exchange rate adjustments or world market price changes. However, recurring deficits (most prominent of which occurred in 1995) threatened the fiscal stability of the economy. The OPSF was in effect from October 1984 upon the passage of Presidential Decree No. 1956, until February 1998 when Republic Act 8479, Downstream Oil Industry Deregulation Act of 1998, was signed into law (Philippine Institute for Development Studies (2000). "Oil Deregulation." Economic Issue of the Day, February No. 2 and Executive Order No. 137).

13. We also tried a specification wherein we replaced world rice inflation and world oil inflation with implicit price index of imports (seasonally adjusted) and added seasonally adjusted producer price index for the manufacturing sector. However, the ARDL model, which runs only from 2001Q1 to 2015Q4 (since data on producer price index is only available from 2001), suffers from autocorrelation. Hence, parameter estimates from the said model are not consistent (because of the lagged values of the values of the dependent variable that appear as regressors in the model.

alone, it ranks the highest, followed by other inflation targeting central banks of Thailand and Indonesia (Table 5). The study further indicates that the "central banks for which the index rose the most were those of Hungary, Thailand, Turkey, and the Philippines." For the economies included in the study, the report remarks that the most increase among the components of the index was in the area of economic and policy transparency.

Table 5
Selected Transparency Indices (Unweighted)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Central Asia	2.7	2.7	2.7	3.0	3.0	2.7	3.3	4.5	4.5	4.7	4.7	4.7	4.7
Southern Asia	2.3	2.3	2.3	2.5	2.9	3.3	3.4	3.4	3.9	3.9	3.9	3.6	3.9
Eastern Asia	4.3	4.4	4.8	4.9	5.3	6.1	6.3	6.3	6.3	6.3	6.7	6.7	6.7
o.w. China	1.0	1.0	1.0	1.0	1.5	4.5	4.5	4.5	4.5	4.0	4.0	4.0	4.0
Hong Kong SAR	5.0	6.0	6.0	6.0	7.0	7.0	7.0	7.0	7.5	7.5	7.5	7.5	7.5
South Korea	6.5	6.5	8.0	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Japan	8.0	8.0	8.5	8.0	8.0	8.0	9.5	9.5	9.0	9.0	10.5	10.5	10.5
Southeast Asia	2.5	3.1	4.1	4.3	5.0	5.6	5.8	5.9	6.0	5.9	5.9	6.0	6.2
o.w. Indonesia	3.0	4.5	4.5	4.5	4.5	7.0	8.0	8.0	8.5	8.5	8.5	8.5	9.0
Malaysia	4.5	4.5	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Philippines	3.5	5.0	5.0	6.0	10.0	10.0	10.0	10.0	10.0	9.0	9.0	9.0	10.0
Singapore	2.5	4.0	4.0	4.0	3.0	4.5	4.5	5.5	5.5	5.5	5.5	5.5	5.5
Thailand	2.0	2.0	6.0	6.5	8.0	8.0	8.0	8.0	8.0	8.0	8.5	9.0	9.0

N.B. The indices range from 0 to 15. The most transparent central banks are the Swedish Riksbank, the Reserve Bank of New Zealand, the Central Bank of Hungary, the Czech National Bank, the Bank of England, and the Bank of Israel.

Inflation stabilization objective can also be compromised by sharp exchange rate volatility. The typical response would be to intervene in the market through sterilization strategy. This greatly affects the degree to which exchange rate influences inflation since shocks are pre-empted and smoothed out to manageable levels before it can be passed through to inflation. Sterilization, however, causes distortions in the economy. In buying foreign currency, an equivalent amount of pesos will be released into the economy. This leads to excess money in circulation and, consequently, higher inflation. The pesos released will then have to be siphoned off using monetary policy instruments (e.g., policy rates and liquidity reserve requirements).

The BSP recognizes that the strategy of full sterilization could result in higher interest rates that could potentially encourage more of the interest-rate sensitive foreign exchange flows. Higher interest rate could also affect the BSP's financial position. This could be difficult to sustain over prolonged period given the profile of BSP balance sheet – assets are predominantly foreign assets that earn lower global interest rate while bulk of liabilities are in domestic currency with relatively higher interest rate.

Consistent with the advent of policies towards greater exchange rate flexibility and the recognition of limits of central bank intervention, the sterilization coefficient, on average, has declined during the IT period (Table 6). Ordinary least squares (OLS) regression using monthly data was undertaken for the periods 1990 – 2001 and 2002 – March 2015 with the following specification:

$$\Delta NDA/RM_{t-12} = \alpha + \beta \Delta NFA/RM_{t-12} + \varepsilon_t$$

where:

- ΔNDA is the change in net domestic assets divided by reserve money stock 12 months ago
- ΔNFA is the change in net foreign assets divided by reserve money stock 12 months ago
- Change (Δ) is measured over 12 months. Using the 12-month changes helps smooth the data by eliminating much of the month-on-month noise. The final specification includes an AR(1) term to account for first-order serial correlation.

Table 6
Estimated Sterilization Coefficients

	Sterilization Coefficient	Adjusted R2	D.W. Statistic
1990 – 2001	-0.70	0.95	1.67
2002 – 2015 March	-0.47	0.89	2.15

The coefficient is a measure of the extent of sterilization where â= -1 represents full monetary sterilization of reserve changes and â = 0 implies no sterilization. A value of the sterilization coefficient between these levels, -1 < â < 0, indicates partial sterilization.

The decline in the sterilization coefficient during the IT period is consistent with the estimated lower exchange rate pass-through. Since exchange rate shocks are less strongly transmitted to domestic inflation, the BSP has less motivation to conduct sterilization given the massive costs it will have to incur. During the IT period, the BSP has also implemented other policy measures to help temper exchange rate volatility resulting from cyclical or non-structural capital flows.[14] In doing so, the burden of adjustment is not borne by the policy rate alone. For instance, prudential measures were further strengthened to mitigate potential build-up of systemic risks. In particular, the BSP undertook reserve accumulation and associated liquidity management operations during periods of high capital inflows. These were intended to limit potential inflation pressures from increase in money supply. The BSP also pursued further liberalization of foreign exchange regulations to give corporations and individuals wider opportunities to diversify outward investments. Rising foreign exchange reserves have also provided sufficient buffers for the prepayment of external obligations. Further, carefully-planned, well-timed, and clear communications with the market helped in managing sentiment and avoiding self-perpetuating expectations. This approach to foreign exchange flows could help explain why even with lower sterilization during the IT period, inflation was not severely affected.[15]

14. Other measures to discourage speculative activity have included increasing capital charges (in January 2012) and introducing limits on banks' non-deliverable forward (NDF) positions (in March 2013); prohibiting (since end-2013) external funds and direct placements by non-banks in the SDA and gradually lowering the interest rate (by 50 bps each in January, March and April 2013) to 2 percent; and curtailing (beginning in late 2010) its foreign exchange forward book (counterpart to one leg of banks' forward positions, used for hedging). The BSP also lowered its policy rate by 100 bps in 2012, partly to reduce the incentive for foreigners to hold peso-denominated fixed income securities.

15. Amador et al. (2009).

6. Conclusion and Policy Implications

The paper provides more recent estimates of the magnitude of the traditional transmission channels of monetary policy in the Philippines, namely interest rate channel, exchange rate channel, and credit channel. Empirical results indicate that the interest rate, credit, and exchange rate channels remain relevant and active channels for aggregate demand stabilization even with the spate of external shocks.

Policy rate shock has the strongest impact on market interest rates. The initial one ppt increase in policy rate is fully transmitted into the 91-day T-bill rate and about 2/3 in the case of lending rate after four quarters. Relative to policy rate shock and inflation shock, market interest rates react the least to exchange rate shock.

With regard to the components of demand, the effect of policy rate shock is most pronounced on investment but less so on consumption. Inflation shock, on the other hand, exerts the biggest impact on real household consumption. However, policy rate response exhibits inertia in the face of inflation shock, possibly due to uncertainty in the nature of supply shock. So as not to be an undue source of volatility, policy responds only when there are second-round effects.

Exchange rate shock has the smallest impact on market rates and components of demand. As a result, the pass-through of exchange rate shock to inflation is equally small. The modest response of inflation to policy rate shock could have also been partly moderated by lower sensitivity to imported inflation and exchange rate, as borne by the ARDL estimates. Lower inflation persistence affirms Dincer & Eichengreen's (2014) finding of enhanced credibility of the BSP in anchoring inflation expectations.

With regard to growth of credit, its response to policy rate adjustment remains relatively modest. This may be partly due to strong balance sheet position of the Philippine banking system. Such strength, however, may also imply greater conservatism and higher risk aversion among banks, with natural preference for safer investments. This partly explains the phenomenon of banks' substantial cash holdings and deposits with the BSP.

The BSP recognizes that facilitating credit to productive sectors, particularly small and medium-sized enterprises, is vital for investment and growth. The

current BSP programs on financial inclusion and microfinance[16] are essential complements to existing macroprudential regulations and ongoing efforts to finetune monetary policy operations. While macroprudential measures are intended to check excessive risk-taking in the financial system, inclusive finance programs are designed to expand the reach of credit to small entrepreneurs and hence, provide effective intervention for poverty alleviation and promote economic stability.

Despite the creditable strength of the domestic economy, the investment requirements remain huge. An economy that is in the process of growth convergence would require positive real returns to sustain investment and consumption. Thus, the interest rate channel of monetary policy will have to be gain further traction. As the economy moves in the direction of higher growth, the BSP's planned shift to an interest rate corridor (IRC) system is envisioned to strengthen the BSP's capacity to guide the market interest rate towards the BSP's target policy rate for better aggregate demand stabilization consistent with its inflation objective. In the process, improved price discovery mechanism in the capital markets would also be facilitated.

Some of the monetary transmission channels remain unexplored due to lack of appropriate data or sufficiently long data series. An example is the asset price channel, in particular, real estate prices. Currently, the BSP is spearheading the development of real estate price index. Other issues that are currently being examined by BSP researchers include: 1) the risk-taking channel of monetary policy transmission in the Philippines, the relevance of which has drawn special attention since the outbreak of recent financial crises; 2) possible non-linearities in the exchange rate pass-through; 3) bank lending channel using bank-level data to assess the responsiveness of bank loan supply to monetary policy; 4) financial-macro inter-linkages using financial computable general equilibrium model, among others. Another fertile area of future research is an assessment of the nexus between microfinance policies and efficacy of monetary policy.

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16. The National Strategy envisions a viable and sustainable microfinancial market that will help provide poor households and microentrepreneurs with greater access to microfinancial services. It emphasizes the adoption of market-oriented financial and credit policies to ensure viability and sustainability. It also rationalizes the government financing programs such that instead of engaging in direct lending, government line agencies will focus on capacity building, social preparation and business support services and government financing programs will focus on providing wholesale funds to retail institutions. Regulations, on the other hand, focus on portfolio quality, outreach, efficient and sustainable operations and transparent information.
(Source: http://www.bsp.gov.ph/about/advocacies_micro_facts.asp#10)

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Appendix 1

Definition of Technical Terms

Bank Lending Rate – is the lower band of the lending rates of interest charged on loans by commercial banks to private individuals and companies.

Business Expectations Survey – is a quarterly survey of firms drawn at random from the combined list of the Securities and Exchange Commission's Top 7,000 Corporations in 2010 and Business World's Top 1,000 Corporations in 2013. Results of the BES provide advance indication of the direction of the change in overall business activity in the economy and in the various measures of companies' operations as well as in selected economic indicators.

Capital Adequacy Ratio – is the ratio of a bank's capital in relation to its risk weighted assets and current liabilities. It is decided by central banks and bank regulators to prevent commercial banks from taking excess leverage and becoming insolvent in the process.

Consumer Price Index (**CPI**) - measures changes in the prices paid by consumers for a basket of goods and services.

Domestic Liquidity (M3) – refers to M2 (currency in circulation, demand deposits with banks, savings and time deposits) plus deposit substitutes, or short-term borrowings other than deposits.

Exchange Rate – The exchange rate is the price of a unit of foreign currency in terms of the domestic currency. In the Philippines, for instance, the exchange rate is conventionally expressed as the value of one US dollar in peso equivalent. For example, US$1 = ₱44.00.

Government Final Consumption Expenditures (GFCE) – includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defense and security, but excludes government military expenditures that are part of government capital formation.

Gross Domestic Product (GDP) – measures of national income and output for a given country's economy. The GDP is equal to the total expenditures for all final goods and services produced within the country in a stipulated period of time.

Gross Fixed Capital Formation (GFCF) – includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.

Household Final Consumption Expenditures (HFCE) – is the market value of all goods and services, including durable products (such as cars, washing machines, and home computers), purchased by households. It excludes purchases of dwellings but includes imputed rent for owner-occupied dwellings. It also includes payments and fees to governments to obtain permits and licenses. Household consumption expenditure includes the expenditures of nonprofit institutions serving households, even when reported separately by the country.

Net Domestic Assets (NDA, SRF-based) – includes only Domestic Claims which consists of Net Claims on Central Government and Claims on Other Sectors.

Net Foreign Assets (NFA, SRF-based) – presented as Claims On Non-residents less: Liabilities to Non-Residents.

Non-performing Loans (NPLs) – Loans Classified as Past Due and Already Non-Performing + Items in Litigation

Philippine Stock Exchange Index (PSEI) – is a capitalization-weighted index composed of stocks representative of the Industrial, Properties, Services, Holding Firms, Financial and Mining & Oil Sectors of the Philippine Stock Exchange.

Producer's Price Index (PPI) – measures the average change in price of goods and services sold by manufacturers and producers in the wholesale market during a given period.

Real Effective Exchange Rate (REER) – is a weighted average of inflation- or price-adjusted bilateral exchange rates with currencies of trading partners. It takes into account not only nominal exchange rate but also inflation differentials with trading partners, and is a measure of external price competitiveness. An increase in the REER means that the peso could buy more imported goods and services while foreign currencies could buy fewer Philippine exports. Conversely, a decrease in the REER index would yield the opposite results.

Reserve Money (SRF-based) – includes currency issue, liabilities to other depository corporations, and liabilities to other sectors.

Reserve Requirement – refer to the percentage of bank deposits and deposit substitute liabilities that banks must set aside in deposits with the BSP which they cannot lend out, or where available through reserve-eligible government securities. Changes in reserve requirements have a significant effect on money supply in the banking system, making them a powerful means of liquidity management by the BSP.

Reverse Repurchase (RRP) rate – is the primary monetary policy instrument of the BSP and is the rate at which banks can borrow money from the BSP.

Special Deposit Accounts (SDAs) – are fixed-term deposits by banks and trust entities of BSP-supervised financial institutions with the BSP.

Treasury Bills – are short-term debt obligations backed by the Philippine government with maturities of less than 1 year.

US Federal Funds Rate – is the cost/interest rate at which depository institutions (banks and credit unions) actively trade balances held at the **Federal Reserve**, called **federal funds**, with each other, usually overnight, on an uncollateralized basis.

Value of Manufacturing Production Index (VaPI) – is defined as the monthly change of production values in selected manufacturing enterprises. It is used for the analysis of production trend in the manufacturing sector.

Volume of Manufacturing Production index (VoPI) – is derived by dividing VAPI by the Producer's Price Index (PPI), with 1992 as the base year. The index is a measure of change in the volume of manufacturing production.

Appendix 2

Diagnostic Results

Table 7
Comparison of Mean and Standard Deviation with Different Priors

Comparison of Mean and Standard Deviation

	Actual	Version 1	Version 2	Version 3	Version 4	Version 5
Exchange rate	0.17	0.41	0.38	0.42	0.38	0.41
	[3.07]	[1.92]	[1.93]	[1.9]	[1.93]	[1.95]
91-day Treasury bill rate	5.11	5.27	5.27	5.26	5.27	5.25
	[3.14]	[3.12]	[3.08]	[3.12]	[3.07]	[3.07]
Lending rate	8.98	9.03	9.03	9.02	9.03	9.14
	[2.05]	[1.95]	[1.96]	[1.96]	[1.96]	[2.03]
Credit to the private sector	1.80	1.81	1.79	1.81	1.79	1.73
	[2.37]	[1.29]	[1.3]	[1.29]	[1.3]	[1.28]
Personal consumption expenditures	1.17	1.16	1.16	1.67	1.16	1.16
	[0.63]	[0.19]	[0.2]	[0.19]	[0.2]	[0.19]
Gross fixed capital formation	1.23	1.27	1.27	1.27	1.27	1.43
	[4.11]	[2.06]	[2.09]	[2.06]	[2.09]	[2.09]
Inflation rate	1.11	1.13	1.13	1.13	1.13	1.12
	[0.77]	[0.45]	[0.45]	[0.45]	[0.45]	[0.45]
Policy rate	6.42	6.48	6.48	6.48	6.48	6.43
	[2.49]	[2.51]	[2.51]	[2.52]	[2.51]	[2.52]

Except for the rate variables, all the other variables in the BVAR system are expressed in quarter-on-quarter growth rates
Standard deviation in brackets
Version 1: mu1 = 0; lambda1 = 0.1; lambda2 = 1.0; lambda3 = 1; initial residual covariance : diagonal
Version 2: mu1 = 0; lambda1 = 0.2; lambda2 = 1.0; lambda3 = 1; initial residual covariance : diagonal
Version 3: mu1 = 0; lambda1 = 0.1; lambda2 = 1.0; lambda3 = 1; initial residual covariance : full VAR
Version 4: mu1 = 0; lambda1 = 0.2; lambda2 = 1.0; lambda3 = 1; initial residual covariance : full VAR
Version 5: Sims-Zha diagonal default

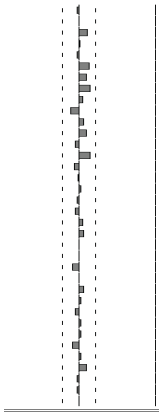
Table 8
Results of Residual Diagnostics for the OLS Equation on Determinants of Credit to the Private Sector

	Heteroskedasticity Test: Breusch-Pagan-Godfrey	Breusch-Godfrey Serial Correlation LM Test	Ramsey RESET Test	Cointegration Test
	Ho: there is no heteroskedastcity	Ho: there is no serial correlation	Ho: there is no mis-specification	Ho: series are not cointegrated
F-Stat	1.466935 (0.2107)	0.170632 (0.8435)	1.663174 (0.2012)	
nR2	7.215779 (0.2051)	0.376901 (0.8282)	-	
Engle-Granger tau-statistic	-	-	-	-9.047823 (0.0000)
Engle-Granger z-statistic	-	-	-	-81.42478 (0.0000)
Phillips-Ouliaris tau-statistic	-	-	-	-8.537307 (0.0000)
Phillips-Ouliaris tau-statistic	-	-	-	-77.4632 (0.0000)

Figure 10a
Results of Residual Diagnostics Based on Correlogram - Q-Statistics
ARDL Inflation Model, 1982Q1-2001Q4

Ho: there is no autocorrelation
Ha: there is autocorrelation

Date: 09/01/15 Time: 00:01
Sample: 1982Q1 2001Q4
Included observations: 80
Q-statistic probabilities adjusted for 3 dynamic regressors



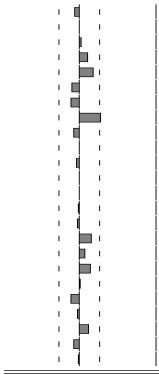
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.019	-0.019	0.0292	0.864
		2	-0.007	-0.008	0.0335	0.983
		3	0.121	0.121	1.2818	0.733
		4	0.016	0.020	1.3030	0.861
		5	-0.029	-0.027	1.3762	0.927
		6	0.145	0.131	3.2302	0.779
		7	0.093	0.096	4.0038	0.779
		8	0.150	0.169	6.0526	0.641
		9	0.043	0.027	6.2257	0.717
		10	-0.112	-0.140	7.3968	0.688
		11	0.060	0.023	7.7403	0.736
		12	0.100	0.084	8.7008	0.728
		13	-0.053	-0.037	8.9735	0.775
		14	0.151	0.101	11.246	0.667
		15	-0.062	-0.139	11.633	0.707
		16	-0.013	-0.006	11.651	0.768
		17	0.018	0.007	11.683	0.819
		18	-0.027	-0.011	11.758	0.859
		19	-0.049	-0.051	12.021	0.885
		20	0.044	-0.045	12.234	0.908
		21	0.060	0.088	12.638	0.921
		22	-0.008	0.023	12.646	0.943
		23	-0.002	-0.001	12.646	0.959
		24	-0.082	-0.079	13.436	0.958
		25	-0.004	-0.027	13.437	0.971
		26	0.059	0.080	13.863	0.975
		27	0.031	0.098	13.978	0.981
		28	-0.052	-0.105	14.318	0.985
		29	0.025	-0.022	14.397	0.989
		30	0.018	0.024	14.439	0.993
		31	-0.084	-0.009	15.385	0.991
		32	0.021	0.043	15.445	0.994
		33	0.105	0.062	16.972	0.991
		34	-0.023	-0.058	17.049	0.993
		35	-0.033	-0.057	17.204	0.995
		36	-0.004	0.037	17.206	0.997

*Probabilities may not be valid for this equation specification.

Figure 10b
Results of Residual Diagnostics Based on Correlogram - Q-Statistics
ARDL Inflation Model, 2002Q1-2001Q4

Ho: there is no autocorrelation
Ha: there is autocorrelation

Date: 09/01/15 Time: 00:03
Sample: 2002Q1 2015Q4
Included observations: 54
Q-statistic probabilities adjusted for 4 dynamic regressors

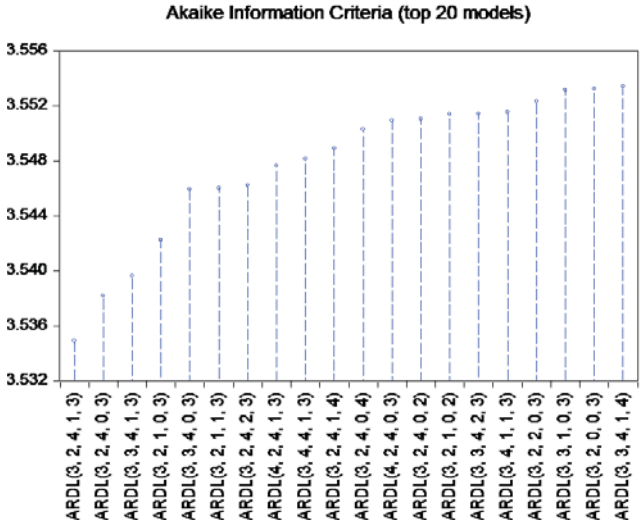


Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.058	-0.058	0.1901	0.663
		2	0.004	0.001	0.1911	0.909
		3	0.019	0.019	0.2126	0.976
		4	0.120	0.123	1.0850	0.897
		5	0.193	0.211	3.3883	0.640
		6	-0.105	-0.082	4.0844	0.665
		7	-0.116	-0.146	4.9437	0.667
		8	0.285	0.265	10.267	0.247
		9	-0.082	-0.104	10.715	0.296
		10	0.001	-0.041	10.715	0.380
		11	-0.033	0.047	10.794	0.461
		12	0.008	-0.023	10.798	0.546
		13	-0.007	-0.143	10.802	0.627
		14	-0.014	0.085	10.817	0.700
		15	-0.025	0.044	10.865	0.762
		16	0.169	0.070	13.147	0.662
		17	0.076	0.184	13.614	0.694
		18	0.151	0.215	15.533	0.625
		19	0.009	-0.033	15.540	0.688
		20	-0.113	-0.211	16.668	0.674
		21	-0.031	-0.102	16.754	0.726
		22	0.129	0.059	18.318	0.687
		23	-0.074	-0.126	18.845	0.710
		24	-0.011	0.005	18.857	0.760

*Probabilities may not be valid for this equation specification.

Figure 10c
ARDL Model Selection Summary Based on Akaike Information Criteria (top 20 models)

1982Q1-2001Q4



2002Q1-2015Q2

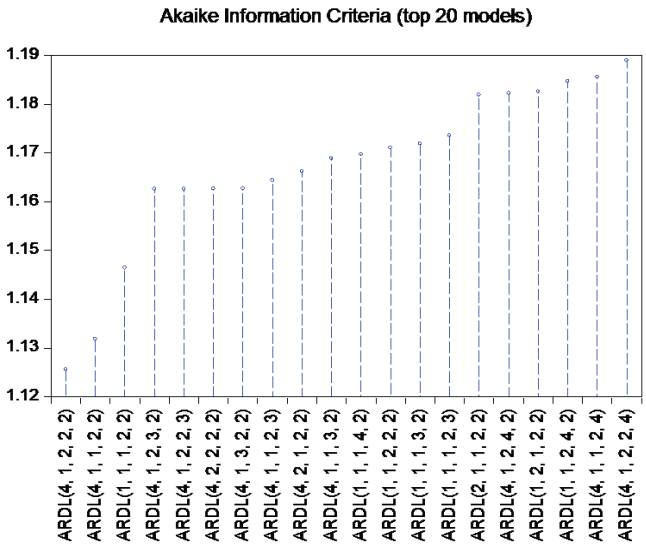


Table 10
Results of ARDL Bounds Test

Sample: 1982Q1-2001Q4

ARDL Bounds Test
Date: 09/01/15 Time: 00:14
Sample: 1982Q1 2001Q4
Included observations: 80
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	6.636571	4

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.2	3.09
5%	2.56	3.49
2.5%	2.88	3.87
1%	3.29	4.37

Sample: 2002Q1-2015Q2

ARDL Bounds Test
Date: 09/01/15 Time: 00:10
Sample: 2002Q1 2015Q2
Included observations: 54
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	8.777460	4

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.2	3.09
5%	2.56	3.49
2.5%	2.88	3.87
1%	3.29	4.37

Chapter 6

THE RELEVENCE OF THE BANK LENDING CHANNEL IN SRI LANKA – A STRUCTURAL VECTOR ERROR CORRECTION MODEL APPROACH

By
Kanchana Tennekoon[1]

1. Introduction

An understanding of the monetary transmission mechanism (MTM) is essential to gauge the effects of monetary policy on target variables such as output and inflation. MTM is therefore defined as the transmission of central bank policy action through interest rates, exchange rates, loans, asset prices, aggregate supply and demand to ultimately impact on prices and output. Mishkin (1995) categorized these transmission channels of monetary policy broadly into the market interest rate channel, the credit availability channel, the exchange rate channel, asset prices channel, and the expectations channel. Given that previous research on the MTM in Sri Lanka has established the importance of the interest rate channel (Amarasekara, 2003; Perera and Wickramanayaka, 2012; Gharzanchyan, 2014), the focus of this paper is confined to assessing the relative importance of the bank lending channel (or the narrow credit channel) of the transmission mechanism in Sri Lanka. An emphasis on the bank lending channel is justified given that banks are the dominant financial intermediaries in Sri Lanka. According to Schmidt-Hebbel (2003), certain conditions must be satisfied for the bank lending channel to exist in a country: bank loans must be an important source of funds for firms; the Central Bank is able to constrain bank lending; bank dependent borrowers should exist; and imperfect price adjustments are necessary for monetary policy to affect real variables. In Sri Lanka, in the absence of developed capital markets, it is believed that at least

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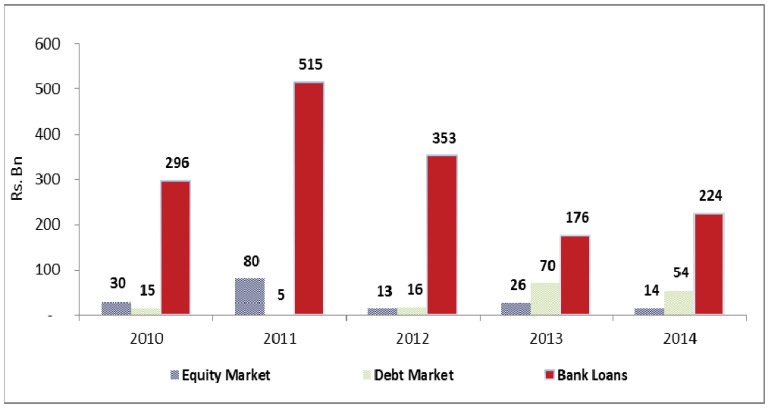
two conditions, the importance of bank lending as a funding source for corporates, and the existence of bank dependent borrowers is satisfied for the bank lending channel to play a complementary role to the interest rate channel.

As seen in Chart 1, credit granted to the private sector by both domestic and overseas banking units has consistently exceeded funds raised from the equity and debt markets. This trend has continued in spite of a significant rise in the market capitalization of the Colombo Stock Exchange after the conclusion of the war in 2009. In 2014, total credit granted by commercial banks amounted to Rs. 224 billion compared to Rs. 54 billion and Rs. 14 billion raised from the debt and equity market, respectively. This is an indication that bank financing is the dominant form of financing for the private sector in Sri Lanka.

Chart 1
Financing the Private Sector (a) (b) (c)



a. Equity market includes IPO's and Rights Issues during the year.
b. Debt market includes corporate debentures issued during the year.
c. Bank loans includes credit extended by Domestic and Overseas Banking Units to the private sector.

The licensed commercial banks accounts for 48.9% of the total assets of the financial sector at end 2014, and since the conclusion of the war in 2009, the banking sector in Sri Lanka has undergone rapid growth resulting in improved access to finance, a process known as "democratization of credit." The relative importance of banks in extending credit to the private sector is also augmented by limited opportunities in raising capital in equity markets and through other alternative financing arrangements.

Chart 2
Coverage of Financial Services

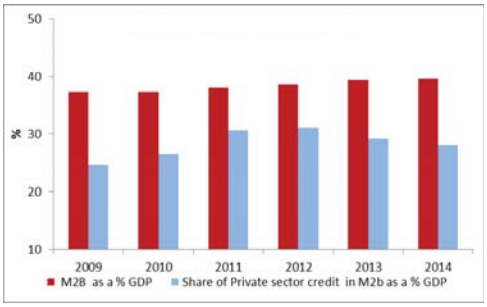
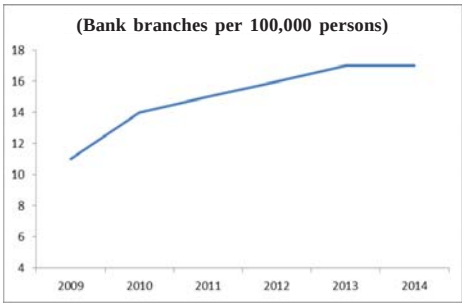


Chart 3
Banking Density



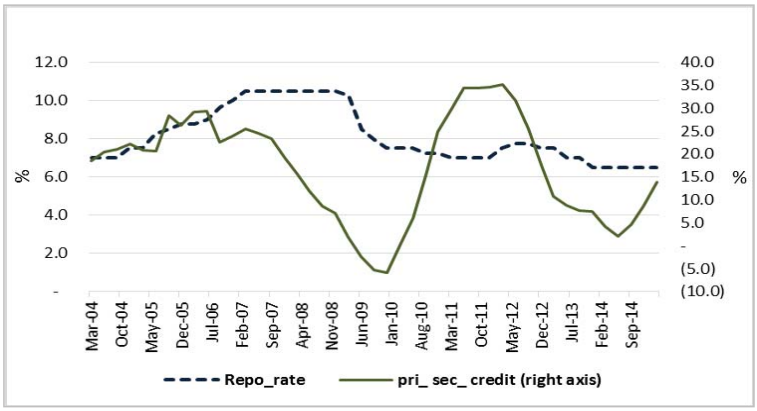
As a result, it appears that the bank lending channel could act as an important conduit for monetary policy to affect output and prices. However, there exist several factors that could hinder the operation of the bank lending channel in Sri Lanka. For example, the lack of competitiveness in the banking sector and the high degree of liquid assets in the banks' asset composition could weaken the transmission of monetary policy signals through the banking sector. Further, Sri Lanka's low credit to GDP[2] ratio at around 28% is another factor that could dampen the effectiveness of the bank lending channel although empirical evidence to date indicate that a low credit to GDP ratio does not hinder the effectiveness of the bank lending channel (De Mello and Pisu, 2009).

The emergence of shadow banking is another characteristic that could pose important considerations for the bank lending channel in Sri Lanka. The growth of the non-banking financial sector such as the emergence of non-bank financial institutions, unit trusts, insurance companies, the growth of the stock exchange and the corporate bond market as alternative sources of financing could diminish the importance of the credit channel compared to other channels of monetary transmission. Martin (2007) states that the higher weight of financial and non-financial assets in the firms and households' balance sheets could enhance the effects of monetary policy through asset prices and related wealth effects while weakening the bank lending channel. Therefore, given the rapid changes in the financial sector and the relative importance of banks as a source of funding, it is important to ascertain whether bank lending is a significant channel of monetary

2. Credit to the private sector in M2b as a percent of GDP at end 2014. Domestic credit in M2b as a percent of GDP is 47.4. Credit to the private sector and domestic credit in M4 as a percent to GDP is 39.2% and 64.3%, respectively at end 2014.

transmission in Sri Lanka. This paper is also motivated by the fact that loans to the private sector failed to respond sufficiently to the relaxed monetary policy stance of the Central Bank since December 2012, prompting some to question whether the transmission of monetary policy has weakened in Sri Lanka. As seen in the Chart 4, credit growth declined sharply from about October 2011 mainly due to the imposition of a credit ceiling to stabilize credit growth at more sustainable levels. However, credit growth was unresponsive to the subsequent monetary policy relaxation of the Central Bank and remained at low levels for a considerable period of time. The lack of credit growth in spite of the relaxed monetary policy stance was partly due to the contraction in gold backed lending by commercial banks with the collapse of gold prices and the subsequent impairment of commercial banks' gold backed loan portfolio. Similarly, during the global financial crisis, the significant impairing of balance sheets of commercial banks forced banks to limit their supply of credit at a time when central banks of advanced economies were easing monetary policy. Therefore, under financial duress and under conditions of a liquidity trap, channels of monetary transmission could become ineffective.

Chart 4
Policy Rate Changes and Private Sector Credit Growth



Against this backdrop, this paper attempts to analyze the existence of a bank lending channel in Sri Lanka. This paper employs a Vector Error Correction Model (VECM) to estimate the demand for and the supply of bank loans in the context of aggregate data for Sri Lanka. The VECM postulated by Johansen (1988, 1995) allows for endogeneity and non-stationarity of time series. Since monetary policy shocks can simultaneously affect demand as well as the supply of bank loans, testing for the relevance of the bank lending channel raises a key

identification problem. The failure to differentiate the demand and supply effects results in the overestimation of the loan supply response to monetary policy shocks as highlighted in past literature (Bernanke and Blinder, 1992; Kashyap and Stein, 1993). Two alternative methods have been used extensively in previous literature to overcome the identification problem. The first is the use of bank-wise data to assess individual responses of banks with different characteristics to a change in monetary policy. The second is the use of aggregate data to overcome the identification problem inherent in the study of the bank lending channel. Empirical estimation of aggregate data by De Mello and Pisu (2009) and Hülsewig et al. (2001), which employed an identification strategy based on simultaneous estimation of loan demand and supply with a number of restrictions on cointegrating parameters is the basis for this study. The quarterly data on Bank Loans, the Repurchase Rate, the Average Weighted Lending Rate (AWLR), CPI Inflation, Bank Capital and GDP are included in the VECM. The Repurchase Rate of the Central Bank is the main monetary policy instrument.[3]

Based on the empirical findings, two cointegrating vectors were found on the basis of the Johansen trace test. These two cointegrating vectors were identified as the long-term demand and the supply of bank loans. Based on the identification strategy, the long-term demand for credit is positively related to economic activity. The estimated parameter indicates that economic activity is a strong determinant of demand for bank loans. The long-term supply of loans is negatively related to the policy rate and positively related to the lending rate, thus confirming the relevance of the bank lending channel in Sri Lanka. However, the resulting policy rate elasticity of credit supply seems to suggest that the bank lending channel may not be a significant channel of monetary transmission in Sri Lanka.

This paper is structured as follows. Section 2 reviews the relevant literature on the MTM of Sri Lanka and the empirical literature with respect to the bank lending channel. Section 3 provides an overview of the monetary policy framework in Sri Lanka. Section 4 presents the data and its time series properties and Section 5 describes the methodology and the estimation results. Section 6 concludes.

3. In January 2014, the Central Bank renamed its policy interest rates, the Repurchase Rate and the Reverse Repurchase Rate as the Standing Deposit Facility Rate (SDFR) and the Standing Lending Facility Rate (SLFR), respectively.

2. A Survey of Literature

The MTM in Sri Lanka has been analyzed at different times in several studies in the past. Jayamaha (1989) stated that the most effective channel through which monetary policy is transmitted to real variables was the interest rate channel during the period 1977-1985. Thenuwara (1998) established a close relationship between changes in policy interest rates and the call money rate, highlighting the importance of the interest rate channel, although he failed to establish a similar link between call money rates and other market interest rates. The IMF (1998) stated that interventions in the determination of market interest rates impose significant distortions to the MTM in Sri Lanka and inhibits the pass-through of policy rates to market interest rates. They highlighted that the two state banks tend to increase market lending rates due to the significant non-performing loan portfolio that these two banks carry in their balance sheets. Research conducted on the MTM prior to 2003 may have been constrained by the fact that the Central Bank was less reliant on market-based instruments for its conduct of monetary policy. However, the Central Bank graduated to a more market-based active open market operations (OMO) framework for its conduct of monetary policy since 2003, relying more on maintaining short-term interest rates within the policy rate corridor.

On more recent studies, Amarasekera (2005) examined the size and the speed of the pass-through from policy interest rates to short-term call money market rates and from call market rates to retail interest rates of commercial banks. He observed an almost complete pass-through of policy interest rates to call market rates indicating the potency of the interest rate channel. However, he failed to establish a similar pass-through from call market interest rates to retail interest rates of commercial banks. He concluded that a lack of competition in the financial system, collusive behavior of banks and adverse selection and moral hazard problems among others, as reasons for the sluggish and incomplete pass-through of policy rates to retail interest rates of commercial banks.

Perera and Wickramanayaka (2013) assessed the effectiveness and the relative importance of different transmission channels in Sri Lanka. Based on monthly and quarterly aggregate and disaggregate data, they observed that monetary policy is effective in influencing output and inflation and changes to monetary policy affect target variables through intermediate transmission channels such as exchange rates, asset prices as well as bank credit. Based on bank-wise data, the authors found that small financial institutions found it more difficult to shield their activity against a monetary policy shock than large institutions, confirming the relevance of the bank lending channel. As per the relative

importance of transmission channels, the authors observed that the interest rate channel is the most important transmission channel in Sri Lanka while other channels display various levels of significance.

Ghazanchyan (2014) examined the channels through which policy interest rates or monetary aggregates affect macroeconomic variables such as output and inflation in Sri Lanka. The VAR model he employed found that the interest rate channel was the strongest channel through which policy interest rates are transmitted into real variables while the bank lending channel was also statistically significant in affecting both output and prices, albeit weakly and with a significant lag. He concludes that the weak reaction of the supply of bank loans in response to monetary policy shocks was conditioned upon the banks' ability to attract external funds. He further stated that banks display a tendency to purchase more government securities than undertaking higher lending to the private sector in response to a policy rate changes indicating risk adverse behavior of commercial banks.

Wimalasuriya (2007) examined the impact of the exchange rate on import prices, wholesale and retail prices. She observed that import prices increased by around 0.5% as a result of 1.0% depreciation in the nominal effective exchange rate while consumer prices rose by around 0.3% in response to a 1.0% depreciation of the nominal effective exchange rate. She concludes that the exchange rate pass-through should necessarily be given due consideration in the formulation of monetary policy in Sri Lanka.

On empirical literature on the bank lending channel in other economies, Bernanke and Blinder (1992) argued that in response to a tight monetary policy, banks are not able to completely offset a decline in liquid funds with alternative sources of funding without incurring additional costs. The non-substitutability between loans and bonds forces banks to reduce their lending under a restrictive monetary policy regime, thereby resulting in a decline in aggregate demand and economic activity in the United States. Subsequently, Kashyap and Stein (2000) commented that the above results do not conclusively prove the existence of the bank lending channel as the decline in output as a result of monetary tightening can also be explained by the interest rate channel. In order to correct this identification problem, several subsequent studies used both aggregate and disaggregate data. Kashyap and Stein (1995, 2000) used quarterly data at the individual bank level as a strategy to isolate the loan supply movement. They concluded that the impact of monetary policy on loans is stronger for smaller banks with less liquid balance sheets than for larger banks, confirming the existence of the bank lending channel. Hülsewig et al. (2001) used aggregate

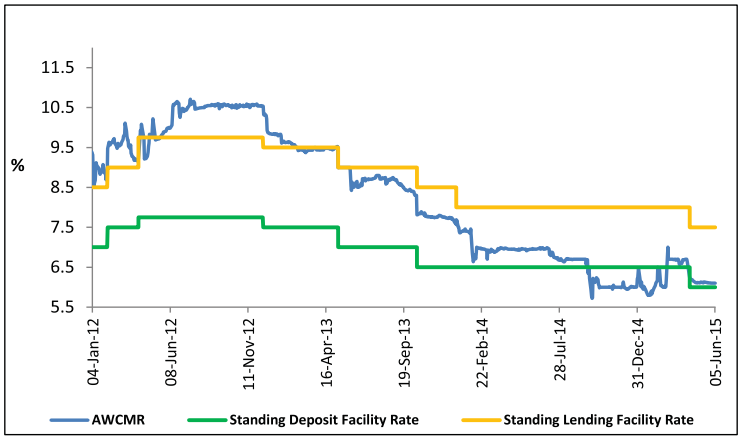
quarterly data on the German economy and estimated a loan demand equation, loan supply equation and a bank equity equation via a VECM analysis. They concluded that the bank lending channel is effective through both loan demand and the supply of loans. In a similar study with Brazilian data, De Mello and Pisu (2009) concluded that loan supply is negatively related to a short-term money market rate, confirming the relevance of the bank lending channel even for a country that is characterized with a low credit to GDP ratio.

3. Overview of the Monetary Policy and Implementation Process in Sri Lanka

The Central Bank of Sri Lanka has been conducting monetary policy under a monetary targeting framework under the National Credit Plan since 1980. Under this framework, reserve money is the operating target while broad money serves as the intermediate target. The final objectives of the Central Bank as redefined in 2002 are economic and price stability and financial system stability. The Monetary Law Act No. 58 of 1949 provides the necessary legal provisions for the Central Bank to conduct monetary operations to achieve its objectives. Under the monetary targeting framework, a monetary program is prepared annually by the Central Bank, taking into account key economic factors such as the expected fiscal and balance of payments developments, desired levels of economic growth and inflation. Based on expected developments, the monetary program sets out a desired path for key monetary aggregates. The Central Bank would then conduct its Open Market Operations (OMO) within the policy rate corridor to achieve the reserve money target.

The key monetary policy instrument and the signaling mechanism of the policy direction of the Central Bank are the policy interest rates of the Central Bank. The Repurchase Rate, renamed as the Standing Deposit Facility Rate (SDFR), is the rate at which commercial banks could invest their surplus funds mainly in government securities while the Reverse Repurchase Rate, renamed the Standing Lending Facility Rate (SLFR), is the rate at which commercial banks can obtain funds from the Central Bank pledging their stock of government securities to the Central Bank. Under its OMO, the SDFR and the SLFR forms the Standing Rate Corridor (SRC) in which the overnight call market interest rate varies. OMOs are conducted to maintain liquidity at adequate levels, thereby maintaining stability in the overnight call market rates. Chart 5 displays the behavior of the Average Weighted Call Money Rate (AWCMR) and the movement of policy rates of the Central Bank.

Chart 5
AWCMR and Policy Interest Rates



Under active OMO, standing facilities are available for market participants at both the SDFR and the SLFR rate in order to prevent excess volatility arising from excess or short liquidity positions of market participants while regular auctions are conducted to provide or absorb liquidity as necessary. Changes to policy interest rates of the Central Bank are expected to be reflected in short-term interest rates and after a time lag, other market interest rates are also expected to adjust in line with the changes in policy interest rates. The Central Bank can also use the Bank Rate[4] and the Statutory Reserve Ratio (SRR)[5] as monetary policy instruments although their relative importance as regular monetary policy instruments has diminished somewhat since the Central Bank graduated to a more market-based active OMOs in 2003.

Although Sri Lanka currently conducts its monetary policy under a monetary targeting framework, the Central Bank has identified the necessity to move from the current framework to a more forward looking framework for the conduct of monetary policy. This line of reasoning is strengthened by the fact that the stable relationship between broad money and inflation, which is required for an effective monetary targeting framework may have weakened due to the increased sophistication of the financial markets. Further, the ongoing fiscal consolidation

4. The rate at which the Central Bank grants advances to commercial banks for their temporary liquidity purposes, as stipulated under section 87 of the Monetary Law Act.

5. The proportion of rupee deposit liabilities that commercial banks are required to maintain as a deposit with the Central Bank.

process has removed an impediment for Central Bank to move towards a forward looking monetary policy framework in the future. In the "Road Map 2015: Monetary and Financial Sector Policies for 2015 and Beyond", the Central Bank commenced announcing a targeted inflation range for the medium-term, thereby anchoring inflation expectations on an inflation target range. In the meantime, the Central Bank has embarked on strengthening its technical capabilities in macro-econometric/structural and Dynamic Stochastic General Equilibrium (DSGE) modelling to forecast key macroeconomic variables including inflation.

4. Data and Time Series Properties

Quarterly data available from the Central Bank of Sri Lanka and the Department of Census and Statistics (DCS) are used for the following VECM analysis. The time period under consideration is Q1:2002 to Q2:2015. Within the sample period, the conclusion of the civil war in the second quarter of 2009, can be termed as a structural break in the economy. Similarly, there could be another structural break particularly with regard to the domestic credit market when the Central Bank imposed restrictions on the aggregate lending of commercial banks to stem the rapid rise in private sector credit, commencing from Q1:2012 to Q4:2012. Structural breaks, which cause a change in the behavior of nominal and real variables, must be incorporated into the empirical model in order to get robust results. Descriptive statistics of the data set is reported in Table 1.

Table 1
Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Quarterly GDP (Rs. Mn)	618,630	154,924	394,341	912,534
Inflation (Y-o-y)	8.8	5.8	(0.2)	28.2
Credit to Private Sector* (Rs. Mn)	1,373,329	772,993	405,260	2,963,159
Average Weighted Lending rate (%)	16.1	2.1	11.3	20.1
Repurchase Rate (%)	8.3	1.6	6.5	11.5
Bank Capital* (Rs.mn)	3,271,210	1,858,446	1,131,649	7,304,381

* Stock value as at end period.

Credit to the private sector accounts for around 58%, on average, of the total domestic credit extended by the banking sector. Credit granted to the private sector excludes loans provided to the public sector and is limited to credit extended by the licensed commercial banks.

Bank capital is used to describe the supply side factors affecting bank loans. The volume of bank capital is taken from the monetary survey on a monthly basis and was averaged over a three month period to create a quarterly series. Bank capital reflects the size of the bank and could yield substantial economic interpretations such as regulatory constraints faced by individual banks.

Since loans to the private sector mainly consists of longer maturities such as medium- to long-term, the most relevant interest rate would be the medium-term capital market rent approximated by the yield on outstanding bonds. However, previous research has relied on a variety of interest rates to approximate the lending rate. These interest rates have ranged from the rate on current account loans to mortgage loans. De Mello and Pisu (2009) following previous literature define the lending rate as a weighted average of a host of bank lending rates on working capital, overdraft facilities and discounts of promissory notes.

Likewise, we employ **the Average Weighted Lending Rate (AWLR)** to approximate the lending rate of banks for Sri Lanka. The AWLR is calculated based on all outstanding loans and advances extended by commercial banks to the private sector and includes interest rates charged for categories such as personal guarantees and promissory notes, pawning advances, immovable property, plant and machinery and leasing and hire purchases. The composition of loans in formulating the AWLR indicates that the majority of loans are in the form of immovable property, plant and machinery, which could be termed as loans provided for businesses with relatively longer maturities. Hence, the AWLR is most suited to capture the lending rates for medium- to long-term loans granted to the private sector.

The Repurchase Rate, which was renamed the SDFR in 2014, is considered the main policy variable of the Central Bank. According to Amarasekara (2005), the Central Bank has increasingly been relying on interest rates as the preferred instrument for conducting monetary policy in Sri Lanka since shifting away from non-market policy instruments. Therefore, a variable for a monetary aggregate is not included in the VECM analysis. Hülsewig et al. (2001) followed a similar method by disregarding M_3, the intermediate target for Deutsche Bundesbank in favor of a short-term money market rate in their analysis of the bank lending channel in Germany.

The year-on-year change in the **Colombo Consumer Price Index (CCPI)** is the proxy for the inflation rate. The CCPI is the most widely used measure

of inflation for monetary policy purposes in Sri Lanka. The real sector is mirrored by **Real GDP**[6] which is also the proxy for loan demand although it can also influence the supply of loans.

Chart 6 summarizes the levels and first difference of all the variables in the VECM model. Private sector credit, GDP and bank capital are expressed in logarithms and inflation is expressed as a growth rate.

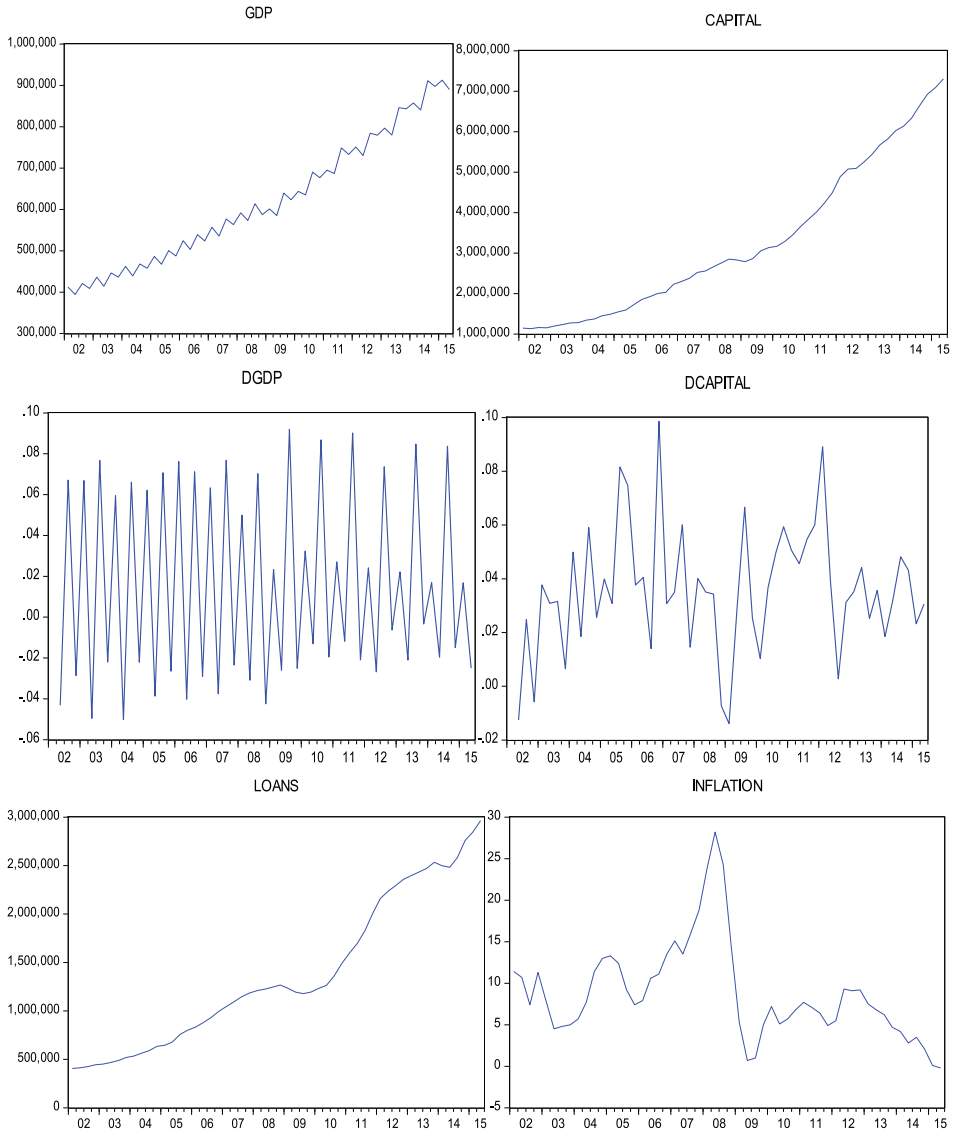
The results of the unit root tests for the variables in levels and first difference are shown in Table 2. Based on the Augmented Dickey Fuller (ADF) test statistic and the respective critical values, the null hypothesis of a unit root is rejected for all variables in levels. Although there is evidence to suggest that inflation is stationary in levels at the 5% significance level, this hypothesis is rejected at the 10% significance level. As such, inflation will be treated as non-stationary in levels. Accordingly, these variables can be termed as integrated of order one. At first difference, the null hypothesis of a unit root is not rejected for all variables, which confirms that these variables can be modeled as I(1). Hence, the results of the unit root allow us to perform a VECM.

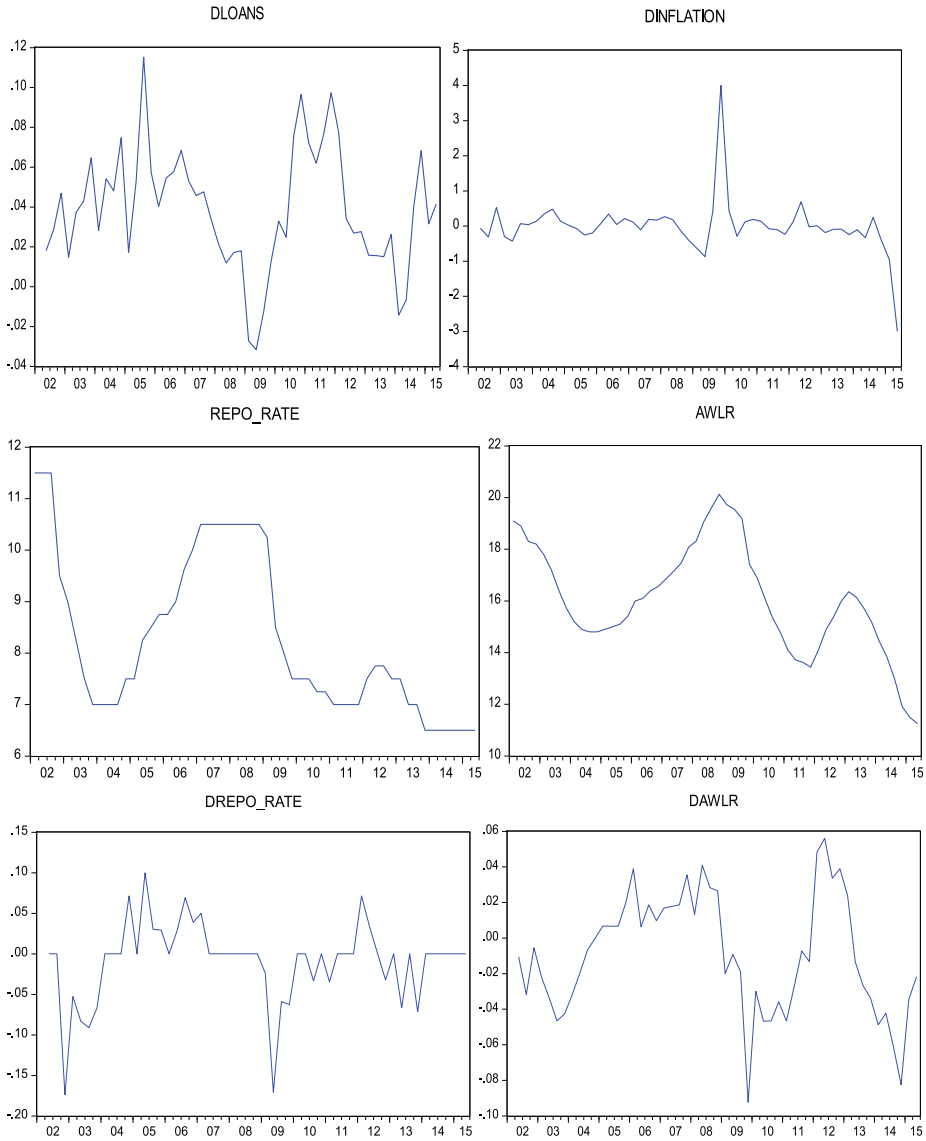
Table 2
Results of the Unit Root Tests

Variable	Levels			First difference		
	ADF Statistic	Trend	Significance (5%, 10%)	ADF Statistic	Trend	Significance (5%, 10%)
GDP	0.47	C	-2.96, -2.62	-2.62	C	-2.96,-2.62
Loans	-0.21	C	-2.95,-2.62	-2.84	C	-2.96,-2.62
Capital	-1.36	T &C	-3.54,-3.20	-4.53	C	-2.96,-2.62
Inflation	-2.92	C	-2.95,-2.61	-2.89	none	-1.95,-1.61
Repo Rate	-0.84	C	-2.95,-2.61	-4.06	none	-1.95,-1.61
AWLR	-1.10	C	-2.96,-2.67	-2.81	none	-1.95,-1.61

6. The Department of Census and Statistics (DCS) replaced the base year for national accounts statistics from 2002 to 2010. However, for the current study, the base year for real GDP is 2002.

Chart 6
Time Series in Levels and First Difference




DLOANS
DINFLATION
REPO_RATE
AWLR
DREPO_RATE
DAWLR

5. Results of the VECM Analysis

Similar to De Mello and Pisu (2009), we consider a simple aggregate model of loan supply (l^s) and loan demand (l^d). The supply of loans depends on the sources of funds available to banks, such as capital (c), the borrowing rate paid by banks for external funds (r_b), and inflation (π), which affects the real rate of return on loans granted to the private sector. Loan demand depends on macroeconomic conditions such as economic activity (y), inflation (π), and the lending rate (r_l) offered by banks. According to De Mello and Pisu (2009), this simple model allows for the identification of the supply and demand for loans, thus circumventing the identification problem that arises in the estimation of reduced-form credit supply equations. The model can be written as:

$$l^s = l^s = (c, \pi, r_{b,} r_l) \quad (1)$$

and

$$l^d = l^d = (y, \pi, r_l) \quad (2)$$

As per the literature on the bank lending channel (Kakes, 2000; Hülsewig et al., 2002; and De Mello and Pisu, 2009), if two cointegrating relationships are established, the identification of the demand and supply functions depends on the estimated sign of the lending rate, which should be negative in the demand equation and positive in the supply equation, and the sign of the Repurchase Rate (borrowing rate for banks), which should be negative in the supply equation. The long-run identification of the above equations also requires **r** restrictions for each vector, with **r** being the number of integrating vectors. Accordingly, a number of homogeneity, exclusion and exogeneity restrictions were imposed on the cointegrating vectors.

The VECM analysis includes six variables with Bank Capital, the Repurchase Rate and the AWLR representing factors that drive the supply of bank loans. The monetary policy instrument is the Repurchase Rate. Loan demand will be represented by real GDP and the AWLR. The remaining two variables in the analysis are loans granted to the private sector and inflation. The model also includes two dummies as exogenous variables to account for potential structural breaks in data for the period under consideration. D902 is an unrestricted jump dummy accounting for a potential structural break in the data following the conclusion of the civil war in Sri Lanka in Q2: 2009. Accordingly, D902 is one for the second quarter of 2009 and zero for the rest of the quarters. D121 is

included as a dummy to capture a potential structural break in private sector credit during the period Q1 2012 to Q4 2012, when the Central Bank imposed a credit ceiling on bank credit growth. The restriction on private sector credit was subsequently removed with the growth of private sector credit falling steeply during the period of the imposition of a credit ceiling.

The optimal lag length is selected on the basis of various statistics, including the Schwartz Criterion (SC), Akaike Information Criterion (AIC), the Hanna-Quinn Criterion (HQ) and various misspecification tests. All three statistics recommended a lag length of three, which was sufficient to overcome autocorrelation of the error term in the underlying vector auto regressive model. In addition, all characteristic roots lie within the unit circle and as a result, the system is stable and converges to its long-term equilibrium.

Table 3 reports the results of the Johansen trace test for cointegration. The results are based on a VECM with three lags, an unrestricted constant and two dummies – D092 and D121, which represents structural breaks associated with the conclusion of the war and the restrictions placed on credit growth for commercial banks during the period Q1:2012 to Q4:2012. The null hypothesis of a cointegration rank of at most **r** is rejected if the trace statistic is greater than the critical value. On the basis of the test, the null is rejected for **r**=0 and **r**≤1. The two estimated unrestricted cointegrating vectors are reported in Table 4.

Table 3
Johansen's Trace Test

Null Hypothesis	Trace Statistic	Critical Value	p-value (5%)
r=0	135.41	95.75	0.000
r≤1	72.76	69.82	0.028
r≤2	42.60	47.86	0.142
r≤3	17.02	29.80	0.638
r≤4	4.638	15.50	0.846

Table 4
Unrestricted Cointegration Vectors

	GDP	Inflation	Loans	AWLR	Repo Rate	Capital
β_1	-525.7590	0.862188	-48.64312	-1.81242	-2.19618	269.3497
β_2	192.1632	-0.501552	-25.38485	1.66395	0.60960	-52.09457
Test of Weak Exogeneity[a]						
	13.27 [0.001]	1.738 [0.419]	0.355 [0.083]	4.937 [0.081]	9.42 [0.008]	0.03 [0.982]

a. The test statistics are distributed as x^2 with 2 degrees of freedom. *P*-values are reported in brackets.

In the case of a significant bank lending channel, it is presumed that the supply of loans is positively related to the lending rate (AWLR) and bank capital, and is negatively related to the policy rates of the Central Bank. The negative relationship between the policy interest rate and the supply of loans is based on the premise that banks cannot fully offset a decline in liquid funds due to a restrictive monetary policy by substituting alternative sources of funds. The demand for loans can be either positively or negatively related to the level of economic activity, proxied by real GDP. According to Hülsewig (2000), higher incomes derived from higher economic activity should increase the demand for loans. Nevertheless, higher economic growth also enables corporates to finance expenditure by internally generated funds, thereby decreasing the demand for bank loans. The latter argument is called the "cash flow effect."[7] However, the cash flow effect is dependent on certain rigidities. Therefore, according to Hülsewig, at least in the long-run, the demand for bank loans should be positively related to real GDP. On the other hand, the lending rate (AWLR), which represents the cost of borrowing is expected to have a negative relationship with the demand for bank loans. The volume of bank capital is expected to have a positive relationship with real GDP and its relationship with inflation is presumed to be negative.

When **r** >1, it is not rational to take the unrestricted estimates of the vectors in Table 4 directly as economically meaningful long-run parameter estimates. Therefore, in order to identify the system, the two unrestricted cointegration vectors are normalized with respect to loans. In addition, the following exclusion restrictions are imposed on the cointgration parameters: $H_o = \beta_{1rb} = \beta_{1c} = \beta_{2y}$. If

7. Cash flow effect is used to describe the positive correlation between the level of interest rates and the growth of loans. Worms (1988) explains the cash flow effect in Germany while Bernanke and Gertler (1995) provide an explanation for US data.

the null hypothesis is rejected, loan demand is unaffected by bank capital and the Repurchase Rate, while the loan supply is unaffected by economic activity. Finally, the test of weak exogeneity indicates that both inflation and bank capital are weakly exogenous. Hence, exogeneity restrictions are imposed on the cointegrating relationships such that $H_o = \alpha_{1\pi} = \alpha_{2\pi} = \alpha_{1c} = \alpha_{2c}$.Weakly exogenous variables imply that such variables in the first difference do not contain information about the long-run parameter β. The results of weak exogeneity are in line with previous empirical research on the bank lending channel. Hülsewig (2001) found bank equity to be weakly exogenous for German data, and Cyrille (2014) found bank capital and real GDP to be weakly exogenous for the CEMAC[8] area. For Brazil, De Mello and Pisu (2009) found inflation and bank capital as weakly exogenous variables. They interpreted the weak exogeneity of inflation as such that any disequilibrium in loan supply and demand not containing information about the future direction of inflation. Hence, they conclude that credit aggregates offer limited information on the future trajectory of inflation in Brazil. Table 5 reports the outcome after imposing these restrictions.

Table 5
Identified Cointegrating Vectors

	GDP	Inflation	Loans	AWLR	Repo Rate	Capital
β_1	-2.610	0.0094	1	-0.0406	-	-
β_2	-	0.0043	1	-0.0258	0.0086	-1.079

According to the above table, the following long-run relationships can be identified. The first long run relationship can be identified as the demand for loans and the second long-run relationship can be termed as the supply of bank loans. The relevant T-statistics are in parenthesis.

$$LOANS^D = 2.610\ GDP - 0.0094\ INFLATION + 0.0406\ AWLR \quad (1)$$
$$[5.684] \qquad [2.870] \qquad [4.547]$$

$$LOANS^S = -0.004\ INFLATION + 0.025\ AWLR - 0.008\ REPO + 1.079\ CAPITAL \quad (2)$$
$$[1.593] \qquad [3.533] \qquad [8.175] \qquad [6.413]$$

8. It is formed by six countries including Cameroon, Central African Republic, Chad, the Republic of Congo, Equatorial Guinea and Gabon.

Four restrictions, which include three exclusion restrictions and one equality restriction, were imposed to identify the long-run relationships in the cointegration space. These restrictions could not be rejected at standard levels based on a LR test ($\chi^2(5) = 2.38$, p-value $= 0.79$).

Equation 1 describes the loan demand function, which is positively related to real GDP and negatively with inflation. However, the demand for loans is positively related to the AWLR, which runs counter to the expected negative sign. The income elasticity of loan demand, which is greater than one, indicates that economic activity is a strong determinant of demand for loans in Sri Lanka. The estimated income elasticity of loan demand, which is greater than one is comparable with many past empirical studies. Kakes (2000) estimated the income elasticity of loan demand to be 1.75 for the Netherlands and for the Euro area Calza et al. (2006) found the income elasticity to be 1.48. For developing economies, De Mello and Pisu (2009) estimated the income elasticity of loans to be 2.16 for Brazil and for CEMAC area, Cyrille (2014) found it to be 1.335. According to De Mello and Pisu (2009), there is no prior on the sign of the relationship between demand for loans and inflation. A positive sign could indicate that as inflation increases, demand for loans becomes cheaper in real terms. A negative sign could indicate that firms would demand fewer loans as inflation rises, because inflation dampens productivity and real spending of consumers.

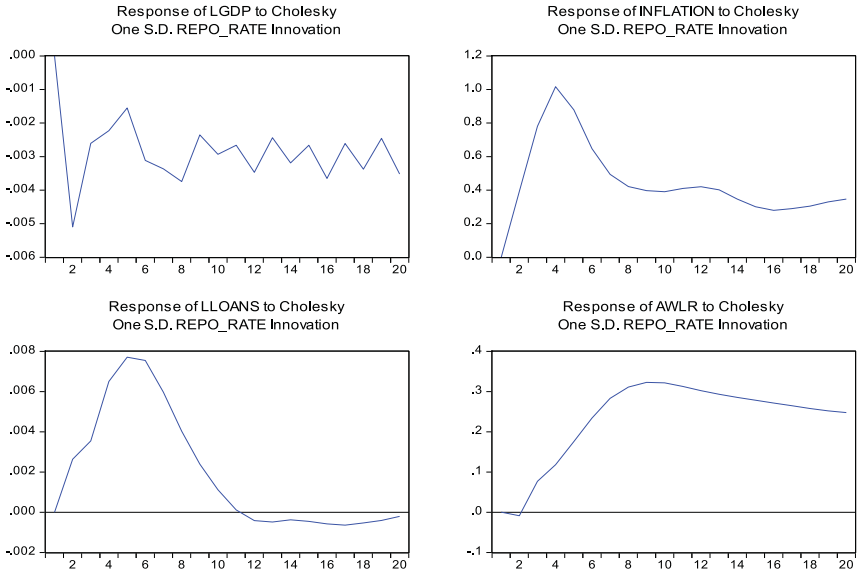
Equation 2 describes the loan supply relationship. Accordingly, banks' supply of loans is positively related to bank capital and the AWLR, while it is negatively related to the monetary policy instrument, the Repurchase Rate. The negative relationship between the supply of loans and the Repurchase Rate indicates the existence of the bank lending channel in Sri Lanka as a tightening of monetary policy induces banks to lower the supply of loans. The policy rate elasticity of credit supply is calculated by multiplying the estimated coefficient on the Repurchase Rate (-0.008) with the sample mean of the Repurchase Rate (8.3). The resulting elasticity (-0.07), indicates that as policy interest rates increase by 1%, the supply of loans by banks falls marginally by around 0.07%. The comparable policy rate elasticity of credit supply for Brazil is -1.86% and -27.71% for the CEMAC area. This indicates that although a tightening of monetary policy reduces the supply of loans by banks which is consistent with the bank lending channel, its significance remains relatively weak. The estimated sign on the AWLR confirms the existence of the bank lending channel as a higher lending rate encourages banks to lend more. This is consistent with both Hülsewig and De Mello and Pisu, who found a positive relationship between the lending rate and the supply of loans in their respective studies on Germany and

Brazil. As expected, bank capital is positively related to the amount of loans provided by banks, indicating that banks' loan supply is sensitive to the shifts in bank capital. However, banks could hold higher amounts of capital for other purposes such as meeting capital adequacy requirements, which requires caution in interpreting the sign of the variable. Nevertheless, the significance of capital in the supply relationship underscores its relevance.

5.1 The Impact of Monetary Policy Shocks

The impulse response functions can be employed on the restricted VECM to analyze the effects of monetary policy shocks on the variables included in the model. Chart 7 shows the impulse response functions for 20 quarters. The results show the effects of a contractionary monetary policy shock on real GDP, inflation, loans and the AWLR.

Chart 7
Impulse Response Functions of Restricted VECM



The results of the impulse responses suggest that the inflation rate increases for about 4 quarters subsequent to a monetary policy tightening before decreasing substantially in the subsequent periods. This increase in inflation, which is at odds with economic theory, is denoted as the price puzzle. However, the price puzzle, which appears frequently in VAR models, gradually dissipates from the

fifth quarter onwards, returning to its long-run trend. Real GDP turns sharply negative to a tightening of monetary policy, but recovers somewhat to remain below original levels in subsequent quarters. The significant fall in output is consistent with the results of Perera and Wicramanayaka (2013), for which GDP declined continuously within the first year of the monetary policy shock. Loans increase significantly and then contract to remain at around 1% below the baseline value. The significant increase in loans immediately consequent to a monetary policy tightening is unexpected. However, this could be explained by the fact that corporates will increase their demand for loans at current interest rates in anticipation of further increases in the policy rate by the Central Bank. Such a reasoning is not entirely without merit as central banks tend to have tightening or loosening cycles for which policy rates would be raised or lowered continually for a period of time instead of a one-off adjustment. Moreover, the initial increase in loans in reaction to an increase in policy rates may reflect the fact that banks are required to service their existing loan contracts and they can only reduce the amount of new loans extended to the private sector. Finally, the AWLR, which represents the response of long-term interest rates to a policy shock, exhibits a continuous increase from the second quarter to the eight quarter, indicating the persistence of the monetary policy shock on long-term interest rates. However, since the impulse responses are conducted on variables that are non-stationary, the impulse responses exhibit a tendency to persist, which requires caution in interpreting the impulse response functions.

6. Conclusion

This paper examined the relevance of the bank lending channel of the monetary policy transmission in Sri Lanka by employing a structural vector error correction model. Since the efficacy of this transmission channel depends on the assumption that monetary policy is able to influence loan supply, identification of the long-run demand for and the supply of loans is a pre-requisite for the empirical estimation technique. Two alternative methods have been employed by previous empirical research to solve for this identification problem. The first is the use of bank-wise data in order to assess how banks of different size, ownership, etc., reacts to changes in monetary policy. The second method is the use of aggregate data with more structure on the estimations in order to identify loan demand and supply. This paper employs the aggregate method mainly due to the extensive use of this method in estimating the bank lending channel as well as its ability to resolve the problem for estimation results of micro level data to be aggregated to a macro level to derive meaningful interpretations.

The Johansen (1988) technique, which is employed to estimate the bank lending channel with appropriate restrictions, established the existence of a bank lending channel in Sri Lanka over the sample period. Bank lending reacts negatively to the policy instrument of the Central Bank and positively with the AWLR. However, the policy rate elasticity of credit supply remains comparatively low, which calls into question the significance of this channel in transmitting monetary policy impulses to real variables. The policy implication of a weak bank lending channel is that the Central Bank may require larger changes in monetary policy to obtain desired results, although the bank lending channel could complement the interest rate channel, thereby magnifying monetary policy impulses. Factors such as the high degree of market concentration, higher levels of liquid assets in banks' balance sheets, risk adverse nature of banks and issues relating to asymmetric information as highlighted in past empirical studies could explain the lack of significance of the bank lending channel in Sri Lanka.

Avenues for further research that could deepen the knowledge of the bank lending channel may include regressing not only macroeconomic variables, but also bank specific differences in their reaction to monetary policy changes. The use of disaggregated data may be useful to identify the sensitivity of bank lending between different banks (larger vs. smaller) to policy changes of the Central Bank and could complement the results of this study. It may also be worthwhile to assess the significance of the bank lending channel in different subsamples, which may highlight the emergence of a bank lending channel in line with financial sector development in the latter part of the current sample period of this study. Moreover, the exclusion of credit granted to the government by commercial banks in the present study may have important considerations for bank lending channel as the crowding-out of the private sector could provide a disincentive for banks to extend credit to the economy.

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Chapter 7

MONETARY TRANSMISSION IN CHINESE TAIPEI[1]

By
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1. Introduction

Monetary transmission mechanism is a complicated and interesting topic because there is just not one, but many channels through which monetary policy operates. The channels of monetary transmission commonly include interest rate, exchange rate, inflation expectations, credit channels, etc. However, there is no clear evidence showing the exact operation and the relative importance of these channels (Mishkin, 1995).

Since the mid-1980s, Chinese Taipei has adopted a framework of monetary targeting. Over the last thirty years, there have been dramatic changes in the way financial markets operate in Chinese Taipei, for example, the emergence of financial globalization, rapidly developing domestic financial conditions, the rise of direct financing, the complexity of financial innovation and derivatives, etc. The link between monetary policy and the economy has also changed over time. As a result, understanding how monetary policy affects the economy is essential for providing policymakers with pertinent insight for better decision-making.

There are many empirical studies of Chinese Taipei's monetary transmission channels. Wu and Chen (2010) verify the existence of narrow and broad credit channels in Chinese Taipei. Ferng (2009) investigates the channels of transmission of interest rate and credit and concludes that monetary policy shock does affect stock markets through these two channels. In another study, Huang and Yu (2015) emphasize the role of bank loans on monetary transmission and confirm the effectiveness of a credit channel in Chinese Taipei's monetary transmission. Chen and Wang (2011) find no strong statistical evidence of the wealth effect. However,

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all these papers focus on specific channels. Neglecting the dynamic interactions among macroeconomic variables may lead to a biased estimate of the overall monetary policy transmission. There is only one earlier research, Wu (2004), which gives a comprehensive analysis of the effects of the different transmission channels. In addition, as we mentioned earlier, since the monetary transmission mechanism evolved over time, it is necessary for us to consider an integrated approach to estimate the effect of monetary policy transmission.

In this paper, we are interested in the effectiveness of monetary policy implementation, the channels of monetary transmission mechanism, how large the effects are, and how quickly they work. Our analysis is structured around two approaches. The first is to examine the effectiveness of monetary policy implementation. Instead of relying on the recursive Choleski approach to identify model parameters, we propose a structural vector autoregressive (SVAR) model that imposes restrictions on the variables' contemporaneous relationships to estimate the linkage between the monetary target (M2 as the intermediate target, reserve money as the operating target) and the policy instrument (open market operation). We provide evidence that a policy instrument could better affect the intermediate target though the operating target and thus, the more effective implementation of monetary policy in Chinese Taipei.

Subsequent to this analysis, we then present a structural analysis of monetary transmission channels by using the SVAR model. Specifically, we exhaustively investigate the effects of the different transmission channels, which are very different from existing relevant literature in Chinese Taipei. Estimation results find that the bank lending channel, interest rate channel, exchange rate channel, and balance sheet channel are able to shed light on the role of monetary policy transmission in Chinese Taipei.

The rest of the paper is organized as follows. Section 2 provides an overview of the monetary policy framework and main monetary transmission channels in Chinese Taipei. We also briefly highlight the stability of money demand and the relationship between money demand and macroeconomic variables. Section 3 provides a literature review on empirical studies of monetary transmission in Chinese Taipei. Data and the methodology are described in Section 4. Based on a simple open economy model, Section 5 and Section 6 report the empirical results of the effectiveness of monetary policy implementation and monetary transmission channels, respectively. Finally, Section 7 concludes.

2. Monetary Policy Framework and Transmission Channels

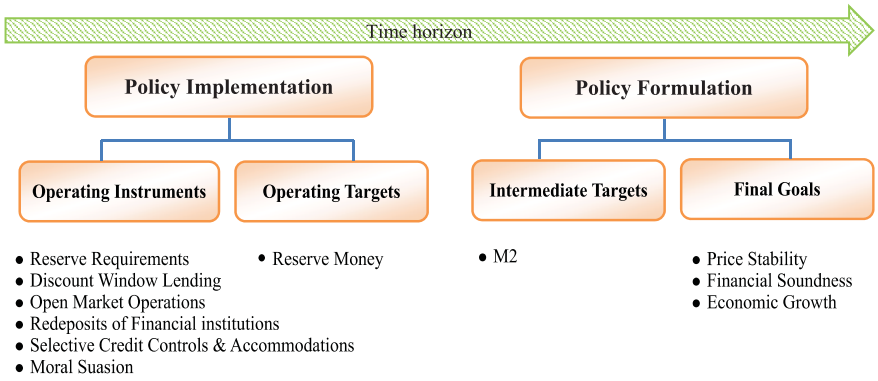
2.1 An Overview of Monetary Policy Framework in Chinese Taipei

Chinese Taipei has adopted a framework of M2 targeting and has been publishing intermediate targets on a yearly basis since 1992. In the framework of monetary targeting, the final goals of monetary policy are price stability, financial soundness and economic growth. However, the transmission mechanism of monetary policy has considerable time lags. If the central bank waits until the policy effects become evident to adjust its policy, it will lose the accurate assessment of the timing and effect to achieve its objectives. Therefore, the *Central Bank, Chinese Taipei* (hereafter, the CBC) adopts operating instruments to achieve operating targets in the short-run and in turn, measures intermediate targets to assess its final policy goals.

For policy formulation, the CBC selects the M2 monetary aggregate as the intermediate target and estimates the money demand function to derive the M2 target zone. Every year, the staff of the CBC uses econometric methods to estimate the money demand in order to determine the target zone of M2 growth for the coming year. Explanatory variables used to estimate money demand include real GDP, expected inflation rate, the opportunity cost of holding money, etc. The CBC then meets with academicians and experts to discuss the estimation results. The Board of Directors reviews the recommendations and decides the on appropriate annual target zone. The final target zone settings and related explanations are announced in the Central Bank's Quarterly Bulletin.

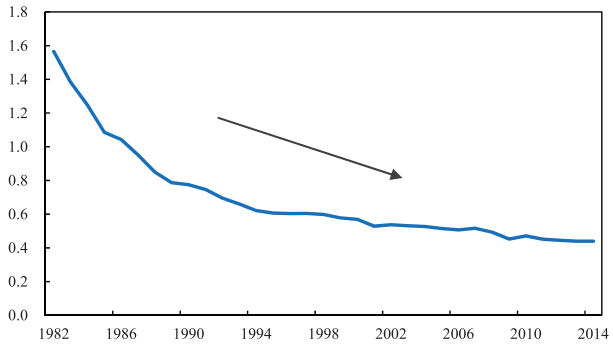
The target zone serves as a guide for monetary policy operation, with changes in real money supply affecting the target zone. For policy implementation, the CBC chooses reserve money as the operating target for its daily operations. This variable is directly managed through tools of monetary policy and is closely related to the intermediate target. At the beginning of each month, the CBC determines the monthly target for reserve money. Policy instruments are used to keep reserve money within the target range. In recent years, open market operations have been the most important and active tool of monetary policy. Other operating instruments include reserve requirements, discount windows, financial institution redeposit, selective credit controls and accommodations and moral suasion. Around the middle of the year, the CBC examines whether the growth of monetary aggregate M2 has stayed within the target zone. If not, it will identify the cause and adopt corrective measures. Table 1 describes the monetary policy framework in Chinese Taipei.

Table1
Monetary Policy Framework in Chinese Taipei



A stable money demand function linking real balances, real income and interest rates is essential to many macroeconomic models and to monetary policy. Therefore, whether the money demand function is stable affects significantly, the accuracy and reasonability of M2 target zone settings. From the perspective of equation of exchange (MV = PY, in which M is money, V is the income velocity of money and P x Y is aggregate nominal GDP) based on quantity theory of money demand, if the income velocity of money is constant (i.e.,$\overline{V}$), the demand for money is solely a function of nominal GDP, not directly affected by interest rates. Chart 1 shows the income velocity of money. From 1980s, the velocity of M2 declined sharply, reflecting financial deepening and the growing exposure to capital inflows (Wu, 2006; Wu, 2009) in Chinese Taipei. In recent years, decreases in the velocity of M2 have been moderate, and thus may become more stable.

Chart 1
The Velocity of M2



Furthermore, the relationship between the money demand function and macroeconomic variables is another critical issue. Again from the equation of exchange, we take natural log and derivative of both sides and find that $\hat{M} + \hat{V} = \hat{P} + \hat{Y}$. Chart 2 describes the M2 growth rate and economic activities (economic growth and inflation rate). From Chart 2, we find that since 1991, M2 growth rates have fluctuated with inflation rate (the blue line and orange bar) and the income velocity of money in Chinese Taipei appears quite stable as discussed earlier. Therefore, when the income velocity of money is stable (V is constant, so $\hat{V} \approx 0$), then the growth rate of money may equal inflation rate plus economic growth rate ($\hat{M} \approx \hat{P} + \hat{Y}$). Since M2 was selected as the intermediate target for monetary policy, M2 growth rate has displayed a similar pattern as economic growth rate plus inflation rate, except the periods during the Asian financial crisis of 1997-1998, the Dotcom bubble of 1999-2001, and the global financial crisis of 2007-2009 (Chart 2). Overall, there is sufficient liquidity to sustain economic growth.

Chart 2
M2 Growth and Economic Activities

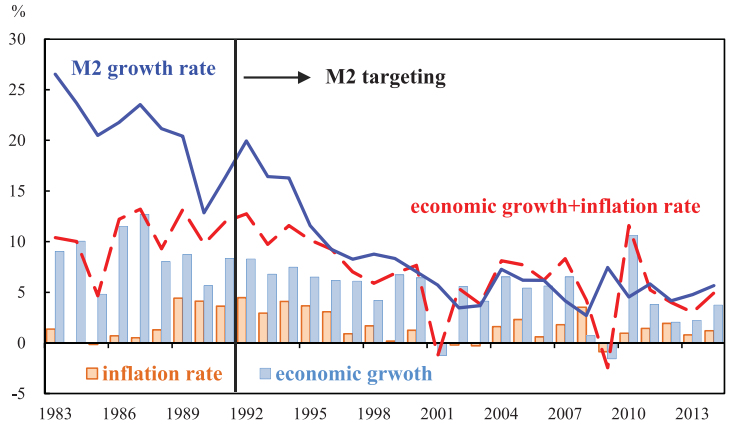
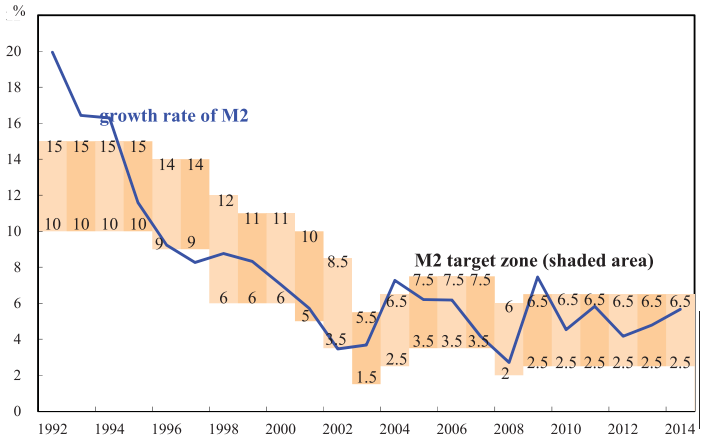


Chart 3 displays M2 growth rate and its target zones. The target zones for M2 growth were between 10%-15% from 1992 to 1995 and 9%-14% in 1996 and 1997, and the range of the target zone was widened from 5 to 6 percentage points in 1998 in response to the uncertainties caused by the Asian financial crisis. Thus the zone was set at 6%-12% in 1998 and at 6%-11% in 1999 and

2000. In 2001, the demand for money decreased as the economy slowed down and the zone was lowered to 5%-10%. Subsequently, it was lowered again to 3.5%-8.5% in 2002 and 1.5%-5.5% in 2003. In 2004, when the economy picked up, the zones increased to 2.5%-6.5% and to 3.5%-7.5% from 2005 to 2007. In 2008, the financial crisis triggered by the US subprime mortgage debacle led to an international economic slowdown. As a result, the zone was adjusted downwards to 2%-6%. The target zones for M2 growth were between 2.5%-6.5% from 2009 to 2014.

Chart 3
M2 Growth Rate and its Target Zones



The framework of monetary policy described above supports the consistency of CBC's policy to its goals. However, factors such as financial globalization, the establishment of new banks and financial innovation increase the complexity of conducting monetary policy and can detract the CBC from fulfilling its objectives. Monetary policy challenges related to the above mentioned factors include the following:

2.1.1 Establishment of New Banks

Before 1991, more restrictions were imposed on the banking sector and there were only 24 domestic banks in Chinese Taipei. In 1991, the Chinese Taipei government started to liberalize and deregulate the financial markets and allowed 16 private commercial banks to be established in 1992. Therefore, the growth

of bank loans and investments increased sharply, which caused uncertainties in M2 and led its growth rate going beyond the target zone in the early 1990s.

2.1.2 Financial Innovation

Since 2003, bond funds, which are similar to money market funds in nature, have grown rapidly at the expense of bank deposits. The amount of bond funds in 2003 reached NT$ 2,400 billion, accounting for 10% of the amount of M2 that year. As a result, the CBC adopted a new target variable - M2 plus bond funds - in 2003 and 2004. In 2003, the zones for the dual target system were 3%-7% for the growth of M2 plus bond funds and 1.5%-5.5% for the growth of M2. In 2004, the zones increased to 4%-8% and 2.5%-6.5% respectively.

2.1.3 Financial Globalization and Abnormal Capital Flows

One of the main characteristics of financial globalization is the increase in capital flows. When cross-border capital flows are large and acute, the exchange rate may become unstable, leading to possible large swings in asset prices, financial markets and monetary growth. During the periods of the Asian financial crisis and the global financial crisis, abnormal capital flows induced the M2 growth rate to go beyond the target ranges.

2.2 Main Monetary Policy Transmission Channels

The monetary policy transmission channel is defined as the way changes in the monetary policy variables affect inflation and output. Effective monetary policy influences economic activity mainly by affecting the cost of money and credit, depending on the economic structures. As mentioned earlier, within the framework of monetary policy, the interbank overnight rate is determined by the interaction between the CBC's control of the supply of bank reserves and the banking system's demand for reserves. Thus, there are some channels of monetary transmission in Chinese Taipei and the effect of monetary policy is transmitted to total output and prices. There are many channels of monetary transmission mechanism,[4] but we will look at four channels that provide the theoretical background for our empirical analysis. The channels are the exchange rate, interest rate, wealth and credit channels. The following paragraphs describe how an expansionary monetary policy affects economic activity through the various transmission channels.

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4. For a more comprehensive discussion of monetary transmission channels, see Mishkin (1995) or more recently, Mishkin (2007, Chap. 23) and Boivin, Kiley and Mishkin (2010).

2.2.1 Interest Rate Channel

The interest rate channel is the primary mechanism at work in conventional macroeconomic models. From the "money view," an increase in the money supply leading to a decrease in the interest rate triggers investment/consumption and ultimately GDP. Accordingly, when the central bank conducts an expansionary monetary policy, nominal interest rates such as interbank overnight rate drop, which may reduce the cost of investment, making more projects profitable, thus stimulating both consumption and spending.

2.2.2 Credit Channel

The credit channel comprises the bank lending channel and the balance sheet channel. An expansionary monetary policy influences bank credit in two ways: (i) increasing bank funds available for making loans (the bank lending channel), and (ii) improving borrowers' financial positions (an increase in firms' net worth), making banks more willing to lend (the balance sheet channel). We will explain each in turn. The bank lending channel operates through quantity of loans available. An expansionary monetary policy increasing supply of loans, leading to an increase in borrowing, generates economic activities through enhanced consumption and investment and thus GDP. The balance sheet channel is performed as follows. Expansionary monetary policy, which causes a rise in stock prices, raises the net worth of firms and so leads to an improvement in the cash flow of borrowers, and banks become willing to lend because of the decrease in adverse selection and moral hazard risks. This subsequently boosts higher investment spending and aggregate demand.

2.2.3 Wealth Channel

An expansionary monetary policy may raise asset prices, such as stock and housing prices and consequently, increase the wealth of the general public and consumer spending.

2.2.4 Exchange Rate Channel

In a smaller and more open economy and especially after financial globalization, the exchange rate channel assumes more importance. In this channel, monetary policy affects economic activities mainly through net exports. Thus, lower interest rates reduce the attractiveness of domestic assets, depressing the value of the currency and increasing net exports.

An expansionary monetary policy brings domestic interest rates down as it adds to the appeal of foreign fixed income assets relative to domestic ones, which weakens the domestic currencies, improving export competitiveness, thereby promoting exports. Osorio et al. (2011) stated that the exchange rate channel is relatively important in Chinese Taipei.

3. Literature Review

In this section, we are going to review related literature of monetary transmission in Chinese Taipei. First of all, the central bank's ability to affect market retail rates is the first step in typical transmission channels, and therefore an important linkage between monetary policy variable and the economy. Kao and Wan (2014) analyze the interest rate pass-through in Chinese Taipei, and they find that the change in interbank overnight interest rate, which represents the change in monetary policy, would pass-through to commercial banks' deposit rates and lending rates. It means that the central bank is able to affect the market retail rates in Chinese Taipei.

There are many empirical researches on the existence of various monetary transmission channels in Chinese Taipei. The following are reviews of some recent empirical studies. Wu (2004) uses quarterly data during 1982-2003 to comprehensively analyze the effects of different transmission channels with vector autoregressive (VAR) model. She finds that most transmission channels, including interest rate channel, bank lending channel, balance sheet channel and exchange rate channel, are significant in Chinese Taipei. However, the wealth effect channel is insignificant in her empirical findings.

To examine the existence of the interest rate channel and the credit channel, Ferng (2009) utilizes daily data during 1989-2008 to investigate the effect of a monetary policy shock on daily stock returns. The proxy of a monetary policy shock is the interbank overnight rate's orthogonal innovations extracted from a SVAR model. According to his regression results, an interest rate channel does exist, and it is more effective for the industrial sectors which are capital intensive or cyclical. Furthermore, a credit channel also exists, and it has a stronger effect on firms that are financially constrained.

To analyze the role of the credit channel in Chinese Taipei's economy, Wu and Chen (2010) use quarterly data to build a large-scale macroeconometric model. Their empirical results show that an increase in reserve money would affect bank loans and private investment; a decrease in the interbank overnight rate would affect bank loans, the stock and housing markets, and thus domestic

demand. The former indicates that a narrow credit channel exists, and the latter illustrates that a broad credit channel also exists. Moreover, they also find that a deterioration in international economic conditions would impact Chinese Taipei's economy negatively.

Chang et al. (2010), who collate monthly data of Chinese Taipei's commercial banks from January 1993 to June 2008, employ a panel GMM model to examine the asymmetric effect of monetary policy on loan supply. They use the interbank overnight rate as a proxy of monetary policy. The empirical results show that the bank lending channel is operative in Chinese Taipei, and the degree of the asymmetric policy effect depends on bank balance sheet characteristics, such as asset size and liquidity strength. Moreover, a contractionary monetary policy has a stronger effect on bank credits.

To investigate the wealth effect in Chinese Taipei, Chen and Wang (2011) apply aggregate data covering 1992Q1-2009Q3 and household survey data covering 1996-2006 to estimate the effect of changes in asset wealth on private consumption expenditure. According to their estimation results, the stocks wealth effect is significant but less effective in aggregate. Moreover, it is significant for middle and older households at the household level. The housing wealth effect is insignificant at both the aggregate and household levels, and an increase in housing prices has a negative impact on consumption expenditure of younger households and renters.

In addition, Osorio et al. (2011), who employ the weighted-sum and principal-component approaches, construct a Financial Conditions Index (FCI) for 13 Asian economies to capture the linkages between financial conditions and economic activity during 2001Q1-2010Q2. They find that the exchange rate channel is relatively important in Chinese Taipei like other export-dependent economies, such as Hong Kong and Singapore.

Recently, Huang and Yu (2015) apply VAR models to study the existence of the bank lending channel in Chinese Taipei with data covering 1997M1-2011M5. They find that after a monetary tightening, business and secured loans increase while consumer and unsecured loans decline, resulting from bankers' decision on loan supply rather than customers' decision on loan demand. Accordingly, the role of the credit channel in Chinese Taipei's monetary transmission is confirmed.

Table 2 provides a summary of the research on monetary transmission. We can see that first, a change in policy rate is able pass-through to the market rates (Kao and Wan, 2014), so the central bank would be able to affect the market

retail rates in Chinese Taipei. Second, most transmission channels are significant in Chinese Taipei, including the interest rate channel (Wu, 2004; Ferng, 2009), the bank lending channel (Wu, 2004; Wu and Chen, 2010; Chang et al., 2010; Huang and Yu, 2015), the balance sheet channel (Wu, 2004; Ferng, 2009; Wu and Chen, 2010) and the exchange rate channel (Wu, 2004; Osorio et al., 2011). On the other hand, the wealth effect channel is insignificant or less effective (Wu, 2004; Chen and Wang, 2011).

Table 2
A Summary of Recent Monetary Transmission Literature

Literature	Estimation Methods	Sample Periods	Main Conclusions
Wu (2004)	VAR	1982Q1-2003Q4	Interest rate, exchange rate, and credit channels are significant in Chinese Taipei.
Ferng (2009)	OLS	1989/1/1 -2008/12/31	Monetary policy shock would affect stock markets through interest rate and credit channels.
Wu and Chen (2010)	Macroeconometric model	-2008Q2	Narrow and broad credit channels exist in Chinese Taipei.
Chang et al. (2010)	Panel GMM	1993M1-2004M6	Bank lending channel is operative, and the degree of the asymmetric policy effect depends on bank balance sheet characteristics.
Osorio et al. (2011)	The construction of FCI (weighted-sum/principal-component approach)	2001Q1-2010Q2	Exchange rate channel is relatively important in Chinese Taipei.
Chen and Wang (2011)	OLS/2SLS/VECM/ random-effect model	1992Q1-2009Q3/ 1996-2006	Wealth effect is insignificant or less effective.
Kao and Wan (2014)	ARDL (threshold/ cointegration model)	1980s-2011	The change in the interbank overnight interest rate would pass through to commercial banks' deposit and lending rates.
Huang and Yu (2015)	VAR	1997M1-2011M5	Monetary policy shock would affect bankers' decision on loan supply.

Compared with the other channels, the wealth effect is not so important since it is insignificant or less effective. Therefore, our empirical study will focus on the other channels, which are more effective and more important in Chinese Taipei's monetary transmission.

4. Model, Data and Estimation Methods

4.1 SVAR Model

The VAR model has been extensively used in the literature to measure the response of output and price to the shocks in the monetary policy transmission. The use of VAR for the pioneer study on monetary policy started with the seminal work of Sims (1980). Nonetheless, Cushman and Zha (1997) point out that the recursive Choleski approach of VAR, which is widely cited in the literature, while appropriate for large and relatively closed economies, is likely to be problematic for small open economies. The authors suggest that instead of relying on reduced form equations and the recursive Choleski techniques, a SVAR approach is better to describe the variables' contemporaneous relationships, since it allows for more flexible imposition of restrictions in identifying model parameters. Therefore, in order to analyze the impact of monetary policy actions on macroeconomic variables (i.e. output and price), we construct a structural form model to identify the effects of monetary policy on output and price, and the model is imposed with the minimal structural restrictions. In addition, we also compute the impulse response function and forecast error variance decomposition.

We begin with a general specification. A SVAR model with k endogenous variables and p lags can be specified as:

$$\boldsymbol{A}\boldsymbol{y}_t = \sum_{i=1}^{p} \boldsymbol{A}_i L^i \boldsymbol{y}_t + \boldsymbol{e}_t,$$

where $\mathbf{y}_t$ is a $k \times 1$ vector, $\mathbf{A}$ and $\mathbf{A}_1, \cdots, \mathbf{A}_p$ are $k \times k$ matrices, L^i is the lag operator, and $\boldsymbol{e}_t$ is a vector of white noise residuals with

$$\mathrm{E}[\boldsymbol{e}_t \boldsymbol{e}_t'] = \mathbf{D},$$

whilst $\mathbf{D}$ is a positive definite matrix with $\mathrm{E}[e_{it} e_{jt}] = 0$ and $i \neq j$.

Since matrix $\mathbf{A}$ specifies the contemporaneous relationships between the variables, the econometric identification of the model is obtained through restrictions on $\mathbf{A}$, i.e., imposing restrictions on variables' short-run relationships. A common means of orthogonalizing the shocks in an SVAR system is to assume a recursive (Cholesky) ordering of variables. In a recursive model, $\mathbf{A}$ is specified as a lower triangular matrix, which implies that y_{it} would influence y_{it} contemporaneously for $i < j$, but the converse is not true. Consequently, the ordering of variables in the recursive model gives rise to certain economic

interpretations of the variables used in the model. Although the recursive SVAR is just-identified and relatively easy to estimate, any orderings of variables are not always plausible. To avoid this criticism, Blanchard and Watson (1986), Bernanke (1986), Sims (1986), and Sims and Zha (2006) suggest a generalized method, SVAR, using non-recursive structure while imposing restrictions only on contemporaneous structural parameters.

The first issue that needs to be decided is whether the model should be used at level or differenced. The literature holds divergent views. There are three different ways to specify the VAR model: (i) make the variables stationary by taking the difference; (ii) follow the Sims (1980) and Christiano et al. (1996) by displaying a SVAR in levels; and (iii) use the Vector Error Correction Model (VECM) by applying the cointegration technique. The choice of any of them remains debatable.[5] All three choices mentioned above have their own pros and cons. There is no clear-cut guideline whether stationarity should be forced on the data or VAR at level is preferable. The literature use various approaches. For example, Bernanke and Blinder (1992), Sims (1992), Levy and Halikias (1997), Peersman and Smet (2001) estimate VAR at level; Kim and Roubini (2000) use SVAR at level, while Monticelli and Tristani (1999) use stationary variables in the SVAR model.

On top of that, Toda and Yamamoto (1995) point out that tests for unit roots have arbitrarily low power in finite samples and as the cointegration test depends on the order of the VAR, the cointegration test is not always reliable. As a result, the VAR model based on taking the difference or cointegration relationship may suffer pretest biases. In brief, this study will estimate SVAR at level. Needless to say that differencing will result in some loss of information.

Another issue of interest is on the lag selection. Selection of lag lengths (p) for the SVAR model is usually ad hoc in the literature. For example, Cushman and Zha (1997) choose 12 lag lengths, whilst Gordon and Leeper (1994); Kim and Roubivi (2000) and Kim (2003) estimate models with 6 lags. However, none provide the reasons for their lag selection procedures. For this study, we employ the lag-augmented VAR approach suggested by Toda and Yamamoto (1995). They adopt a ($p + d_{max}$)th-order for non-stationary series, where p is the order chosen by general lag selection criterions and d_{max} is the maximal order of integration.

5. Hamilton (1994) provided a comprehensive and technical discussion of the various multiple time series methods (among VAR and SVAR).

4.2 Data Description

The data span from January 2000 to December 2014, and the descriptions and the sources are summarized in Table 3. For real economic activities, as monthly GDP is not available, we use the index of industrial production as a proxy of output (Y) and price (P) are represented by the consumer price index. Both of these series use 2011 as base year.

Table 3
Data Source and Description

Variable	Description	Source
Y	Index of Industrial Production	Industrial Production Statistics Monthly
P	Consumer Price Index	Price Statistics Monthly
L	Loans and Investments of Monetary Financial Institutions–Claims on Private Sector	Financial Statistics Monthly
NCD	Negotiable Certificates of Deposit	Financial Statistics Monthly
RM	Reserve Money	Financial Statistics Monthly
M2	Monetary Aggregate M2	Financial Statistics Monthly
R	Interbank Overnight Interest Rate	Financial Statistics Monthly
ER	Spot Exchange Rate of NT$ against US$	Financial Statistics Monthly
SP	Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX)	Financial Statistics Monthly
OIL	Crude Oil (Petroleum), Simple Average of Three Spot Prices	IMF

Bank lending (L) is represented by the variable "loans and investments of monetary financial institutions - claims on private sector."[6] Note that this variable consists of not only loans, but also investment.[7] Owing to these two reasons: (i) investments of monetary financial institutions include corporate bonds, as they are another form that businesses finance their investment or operations; and (ii)

6. In addition to banks, "monetary financial institutions" include other credit-creating institutions, such as credit cooperative associations, and the credit departments of farmers' or fishermen's associations.

7. During the sample period, "loans" account for 88%-96% of bank lending.

the change in investments of monetary financial institutions could affect M2,[8] investments of monetary financial institutions could be related to real economy and monetary aggregate M2. Thus, it's more reasonable to utilize "loans and investments" rather than "loans".

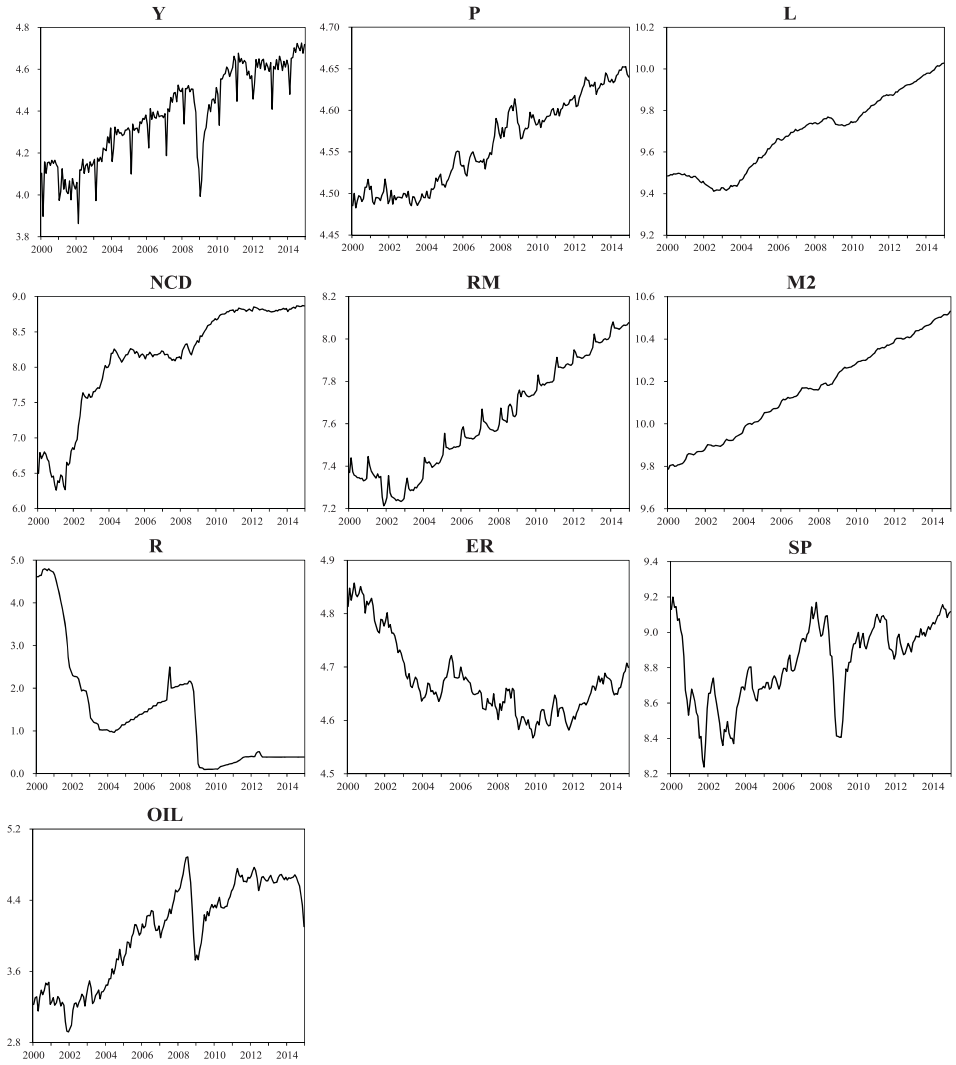
About the other variables, the Interbank Overnight Interest Rate (R) is the proxy of monetary policy. It is considered that each interest rate has a corresponding money supply while money demand equates to money supply to clear the money market. The foreign exchange rate (ER) is the exchange rates of NT$ against US$. The stock price index, Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX), is the proxy of the performance of stock market (SP). For a small open economy, foreign influences cannot be ignored. We take world crude oil price (OIL) as an exogenous controlled variable to capture this effect.

To verify the effectiveness of monetary policy implementation, we would like to estimate the connection between the monetary target and the policy tool. The monetary target includes M2, the intermediate target, and reserve money (RM), which is the operating target for daily operations. Since open market operations are the most important and active tool of monetary policy and Negotiable Certificates of Deposit (NCD), the most frequently used open market instrument, the amount of NCD is taken as the policy tool variable.

All variables are taken at natural log except for interest rate. The data patterns are plotted in Chart 4. We can see that Y dropped sharply during the financial crisis of 2008, while the pattern of P is correlated with OIL, especially for mid-2007 to 2008. There are two sharp decreases in R during mid-2001 to 2003 and the 2008 financial crisis, which were in reaction to the economic recession and the slowdown in domestic demand. The amount of NCD increased sharply during mid-2001 to 2003 and mid-2008 to 2010, and its outstanding balance was NT$ 7,106.3 billion at end-2014. RM has an evident seasonal pattern, resulting from a temporary seasonal surge in money demand during the Chinese Lunar New Year holidays.

8. For robustness check, we also use "loans of all banks - claims on private sector" to substitute"loans and investments of monetary financial institutions–claims on private sector," and the result does not change. See the discussion in section 6.3.

Chart 4
Time Series Plots Data



5. Effectiveness of Monetary Policy Implementation

5.1 Identification

To verify the effectiveness of monetary policy implementation, we construct a SVAR model to estimate the link between the monetary target and policy instruments. The data vector contains four endogenous variables: {NCD, R, RM, M2} in our first model. NCD is the policy instrument, and R and RM represent price and quantity in the market for reserves respectively. M2 is the intermediate target.

The following is the identification scheme of the SVAR model for monetary policy implementation:

$$\mathbb{A}\mathrm{y}_t = \begin{bmatrix} 1 & 0 & 0 & 0 \\ \mathbb{a}_{21} & 1 & 0 & 0 \\ \mathbb{a}_{31} & 0 & 1 & 0 \\ 0 & \mathbb{a}_{42} & \mathbb{a}_{43} & 1 \end{bmatrix} \begin{bmatrix} \mathrm{NCD}_t \\ \mathrm{R}_t \\ \mathrm{RM}_t \\ \mathrm{M2}_t \end{bmatrix} = \sum_{i=1}^{p} \mathbb{A}_i L^i \mathrm{y}_t + \begin{bmatrix} \mathrm{e}_t^{\mathrm{NCD}} \\ \mathrm{e}_t^{\mathrm{R}} \\ \mathrm{e}_t^{\mathrm{RM}} \\ \mathrm{e}_t^{\mathrm{M2}} \end{bmatrix}.$$

For the verification of the effectiveness of monetary policy implementation, we would like to know whether NCD affects M2 and the market for reserves as well as M2. The first equation assumes that NCD, the policy instrument, is not related to other variables contemporaneously. The second and third equations show that the issuance of NCD would affect price and quantity in the market for reserves, R and RM are therefore assumed to react to NCD contemporaneously. RM is also the operating target. The fourth equation assumes that the intermediate target, M2, is related to R and RM contemporaneously, so M2 is affected by NCD indirectly.

In addition, several exogenous variables are considered in the SVAR model: monthly dummy variables, lunar calendar holiday regressor,[9] and the 2008 financial crisis dummy.[10]

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9. The lunar calendar holiday regressor is generated from the Genhol program. For more details, see the manual of U.S. Census X-12.

10. The period is from September 2008 to August 2009.

If the estimated result shows that NCD can affect R and RM, and RM can affect M2, this means that the policy instrument can affect policy variables, so that the implementation of monetary policy is effective in Chinese Taipei.

5.2 Empirical Results

To estimate the SVAR model, we choose the lag length based on AIC (Akaike information criterion). AIC statistics yields p=7. We assume d_{max}=1 because the possible maximal order of integration of macroeconomic variables are usually regarded as 1. Thus, we obtain lags=8.

Table 4 reports the estimated coefficients that indicate contemporaneous effects between the variables, while the impulse response of R, RM and M2 are shown in Chart 5. We can see that the overnight interest rate and reserve money can affect monetary aggregate M2 immediately. M2 increases as interest rate decreases ($a_{42} > 0$) and reserve money increases ($a_{43} < 0$). Although the contemporaneous coefficients of NCD on R and RM are insignificant, R increases and RM decreases in response to NCD shocks. Besides, the RM shock has a positive and persistent effect on M2, and M2 decreases in response to R shocks at a 10% significance level.

Table 4
The Contemporaneous Coefficients (Model 1)

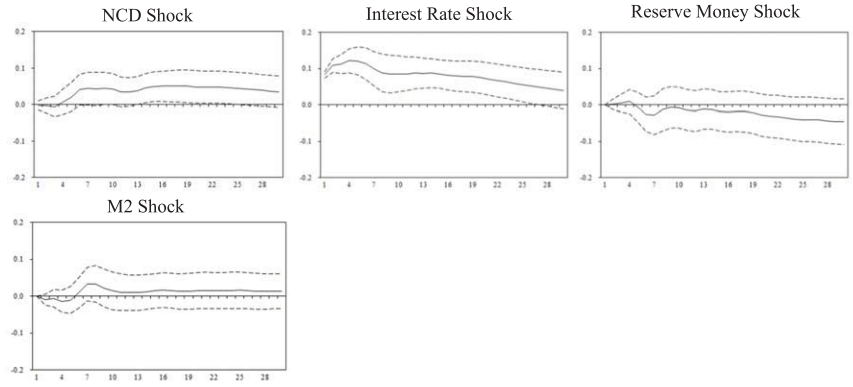
	coefficient	standard error	*t*-statistics	*p*-value
a_{21}	0.056	0.151	0.374	0.708
a_{31}	0.053	0.034	1.564	0.118
a_{42}	0.005*	0.003	1.798	0.072
a_{43}	-0.073***	0.012	-6.262	0.000

Note: ***, **, and * indicate the significance level of 1%, 5%, and 10%, respectively.

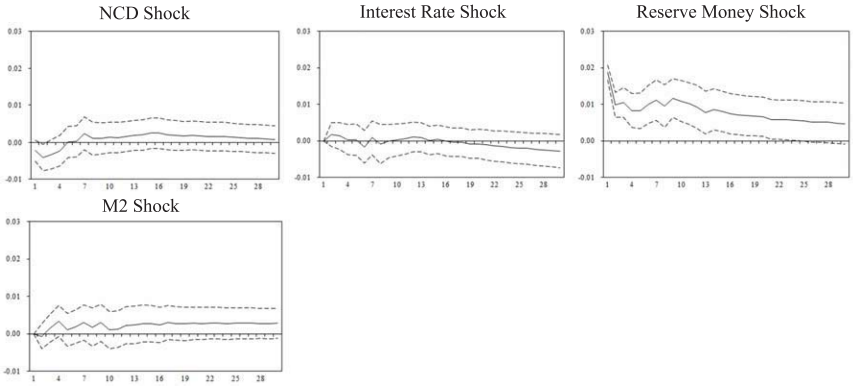
Accordingly, the issuance of NCD could affect interest rate and reserve money through absorbing excess liquidity, and M2 would be affected by a change in reserve money. Thus, the estimated result shows that the policy instrument could affect the intermediate target through the operating target, showing that the implementation of monetary policy is effective in Chinese Taipei.

Chart 5
Impulse Response to Different Shocks (Model 1)

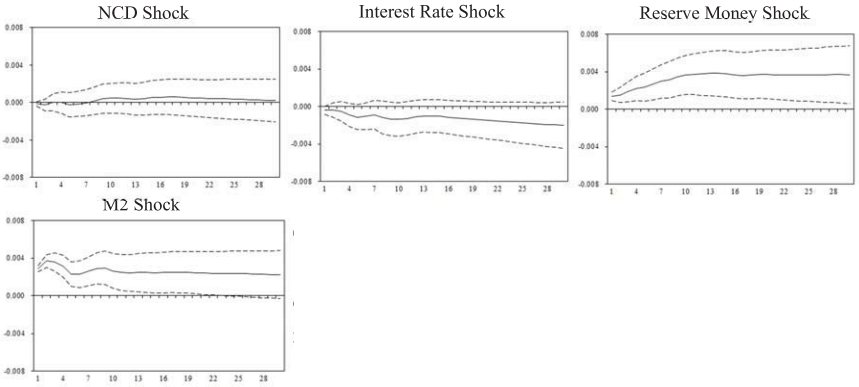
(a) Impulse Response of Interest Rate (R)



(b) Impulse Response of Reserve Money (RM)



(c) Impulse Response of M2



Notes: 1. Response to One Standard Deviation.
2. The dotted line indicates 95% confidence interval.

6. Channels of Monetary Transmission

6.1 Identification

As the main objective of the study is to investigate the importance of transmission channels in Chinese Taipei, in our second model, the data vector is {Y, P, L, M2, R, ER, SP}. The first two variables - industrial production index (Y) and consumer price index (P) are target variables but to verify the relative strength of transmission channels, we need intermediate variables. Each intermediate variable represents a certain transmission channel. Our intermediate variables are bank lending (L), overnight interest rate (R), exchange rate (ER) and stock price (SP). These variables represent the bank lending channel, the traditional interest rate channel, the exchange rate channel and the balance sheet channel, respectively.[11] Since R could be affected by the central bank through open market operations, it could be used to represent the monetary policy stance. As Chinese Taipei adopts a framework of M2 targeting, we also include the monetary aggregate M2 (M2), as is the case in similar studies.

Referring to empirical literature discussed earlier, we stipulate the identification scheme of the SVAR model for Chinese Taipei's monetary transmission as follows:

$$\boldsymbol{A}\boldsymbol{y}_t = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & a_{35} & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & a_{45} & 0 & 0 \\ a_{51} & a_{52} & 0 & 0 & 1 & 0 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 & a_{67} \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & 0 & 1 \end{bmatrix} \begin{bmatrix} \mathrm{Y}_t \\ \mathrm{P}_t \\ \mathrm{L}_t \\ \mathrm{M2}_t \\ \mathrm{R}_t \\ \mathrm{ER}_t \\ \mathrm{SP}_t \end{bmatrix} = \sum_{i=1}^{p} \boldsymbol{A}_i L^i \boldsymbol{y}_t + \begin{bmatrix} \mathrm{e}_t^{\mathrm{Y}} \\ \mathrm{e}_t^{\mathrm{P}} \\ \mathrm{e}_t^{\mathrm{L}} \\ \mathrm{e}_t^{\mathrm{M2}} \\ \mathrm{e}_t^{\mathrm{R}} \\ \mathrm{e}_t^{\mathrm{ER}} \\ \mathrm{e}_t^{\mathrm{SM}} \end{bmatrix}.$$

The first two equations describe real economic activity, including output and price. Because of contract restrictions or adjustment costs, the adjustments of output and price are sluggish, so both of them are assumed not to contemporaneously react to the other economic and financial variables.

11. We do not consider the wealth effect channel in our empirical analysis based on our earlier discussions of the papers of Wu (2004) and Chen and Wang (2011).

There is a time lag in signing a contract, so loans are quasi-rigid. The third equation illustrates that when the banking sector makes a lending decision to the private sector, it takes macroeconomic conditions and the central bank's monetary policy stance into consideration. Hence, the variables Y, P and R have contemporaneous effects on bank lending. The fourth equation states the determinants of the monetary aggregate M2. Based on the quantity theory of money, money demand is dependent on output, price and interest rate. On the other hand, an increase in bank lending and investment will also expand the monetary aggregate, so that M2 is assumed to react to Y, P, R, and L contemporaneously. The fifth equation depicts that the central bank takes output and price as its policy targets, to the extent that R reacts to Y and P immediately.

The last two equations assume that all the economic and financial variables have contemporaneous effect on the exchange rate and stock price. Because foreign exchange rate and stock price are forward-looking asset prices, they react to real and nominal shocks immediately. However, stock price has a contemporaneous effect on the exchange rate, but not vice-versa, the reason being that the performance of the stock market may induce capital flows, affecting the exchange rate.

In addition, we also consider several exogenous variables in our SVAR model: monthly dummy variables, lunar calendar holiday regressor, the 2008 financial crisis dummy, and the world crude oil price.

6.2 Empirical Results

In this section, we discuss the empirical results of monetary policy transmission in Chinese Taipei. For estimating the SVAR model, we choose the lag length based on AIC again, and it yields p=2. Then, we assume d_{max}=1 because macroeconomic variables are usually regarded as I(1), and obtain lags=3 as a result.

Table 5 shows the estimated coefficients of the SVAR model. The coefficients indicate contemporaneous effects between the variables. The statistics and its significance level of the likelihood ratio (LR) test for the null hypothesis of over-identifying restrictions are X^2 (1) = 1.918 and 0.166, respectively, making the identification of the SVAR model reasonable.

Table 5
The Contemporaneous Coefficients (Model 2)

	coefficient	standard error	*t*-statistics	*p*-value
a_{31}	-0.018**	0.009	-2.021	0.043
a_{41}	0.014**	0.006	2.375	0.018
a_{51}	-0.559***	0.152	-3.676	0.000
a_{61}	0.015	0.019	0.781	0.435
a_{71}	-0.322***	0.095	-3.387	0.001
a_{32}	0.102*	0.060	1.695	0.090
a_{42}	-0.098**	0.039	-2.540	0.011
a_{52}	0.547	1.051	0.521	0.603
a_{62}	0.253**	0.126	2.009	0.045
a_{72}	0.377	0.632	0.595	0.552
a_{43}	-0.074	0.048	-1.547	0.122
a_{63}	-0.122	0.155	-0.788	0.431
a_{73}	0.181	0.778	0.232	0.816
a_{64}	0.447*	0.255	1.756	0.079
a_{74}	-5.563***	1.211	-4.593	0.000
a_{35}	0.003	0.004	0.714	0.475
a_{45}	0.001	0.003	0.455	0.649
a_{65}	-0.011	0.009	-1.217	0.224
a_{75}	-0.004	0.044	-0.079	0.937
a_{67}	0.079***	0.015	5.303	0.000

Note: ***, **, and * indicate the significance level of 1%, 5%, and 10%, respectively.

For the statistically significant coefficients, most of their signs are as expected. From the estimation results, we can see that an increase in output will raise the demand of bank lending ($a_{31} < 0$). Although output has a negative contemporaneous effect on M2 ($a_{41} > 0$), the impulse response of M2 to output is still positive (see Appendix). Therefore, an increase in output raises M2 after a time lag. In addition, M2 rises as price rises ($a_{42} < 0$). Interest rate will be raised as output increases ($a_{51} < 0$). However, the effect of price on interest rate (a_{52}) is insignificant. There are two possible reasons for this: (i) price inflation has been at a low and stable level during sample periods;[12]

12. From January 2000 to December 2014, the average of CPI annual change rate is 1.07% and its sample variance is 2.10.

(ii) the central bank reacts to price inflation in a forward looking way (Chen and Wu, 2010).

6.2.1 Impulse Response Function

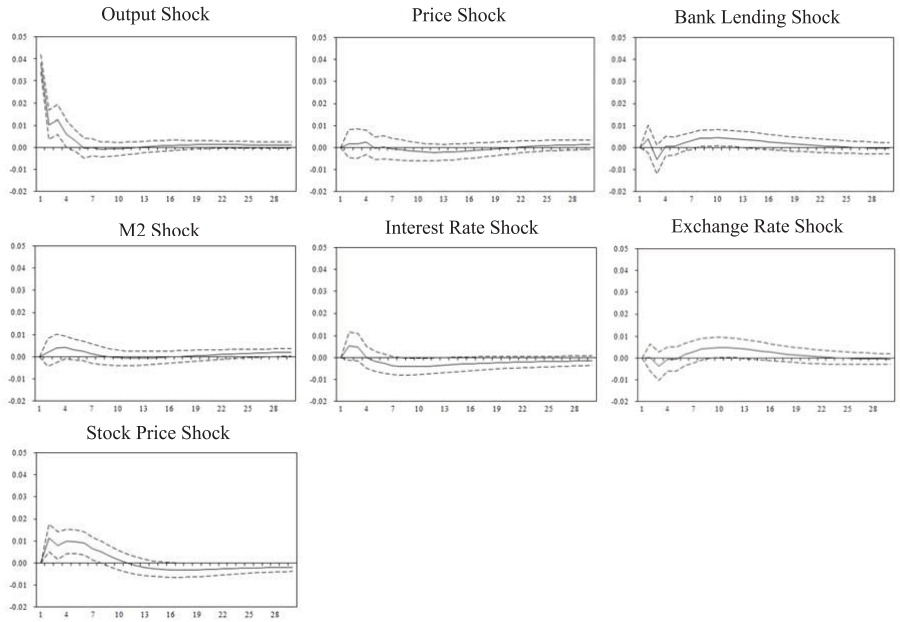
Impulse response functions provide the visual representation of the behavior of observed series in response to structural shocks and are used to measure the effectiveness of policy changes. In this paper, we are particularly interested in the response of output and price to innovations in monetary policy transmission. (For impulse responses of bank lending, M2, and stock price, see Appendix.)

The upper part of Chart 6 displays the response of output to various one-standard-deviation positive shocks. The confidence interval band is 95% (over 30 months). As shown and as expected, an increase in interest rate reduces output, though with lag effects. This decline in output is significant starting from the 7th month and the effects last for almost 13 months. Moreover, we also expect that depreciation in exchange rate raises output, which indicates that the exchange rate channel plays an important role in the monetary policy transmission process given the small open economy that Chinese Taipei is. Moreover, an increase in bank lending boosts economic growth, confirming the role of a bank lending channel in Chinese Taipei. The response of output to stock price is also pronounced and statistically significant, which means that the balance sheet channel does exist. After a positive shock in the stock price, output increases and reverts back to the initial level after the 9th month. Furthermore, it is worth noting that in addition to the effect of the balance sheet channel, stock price shocks may also reflect changes in international economic and financial conditions, or developments in the industrial sector.

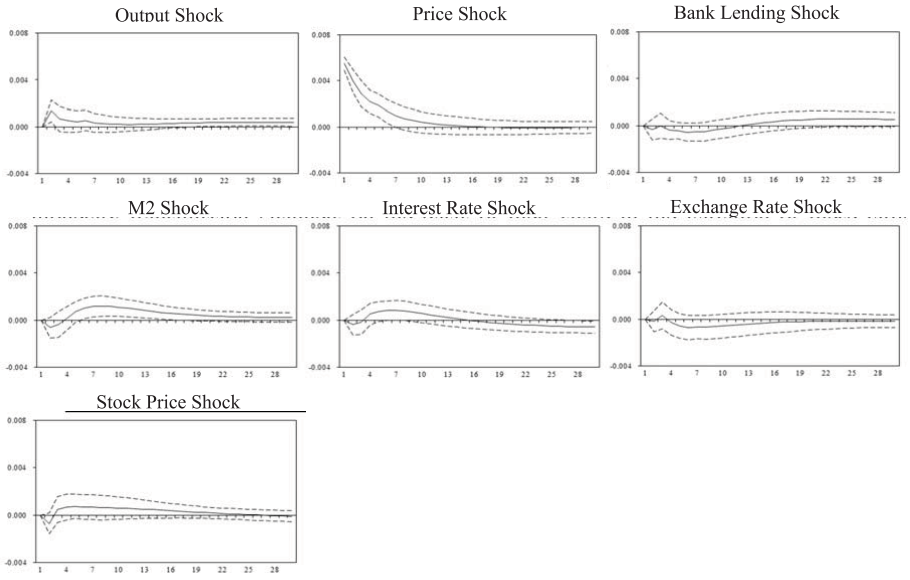
The lower part of Chart 6 shows the response of CPI to various one-standard-deviation positive shocks. An increase in bank lending pushes up CPI with lag effects. This increase in output is significant starting from the 22nd month after the shock and the effects last for 8 months. In response to an interest rate shock, CPI goes up at first, and then decreases after the 24th month. In the case of the price to exchange rate shock, depreciation can have controversial impacts on the economy, leading to either an increase or a decrease in inflation. It is complex and depends on the composition of the CPI basket, the behavior of tradables and non-tradables and even the prices of tradable goods and services affected by changes in international prices. In our study, the results are not significant. Moreover, after a positive shock in M2, CPI significantly rises from the 5th month on and lasts for 16 months.

Chart 6
Impulse Response of Output and Price to Different Shocks (Model 2)

(a) Impulse Response of Output (Y)



(b) Impulse Response of Price (P)



Notes: 1. Response to One Standard Deviation.
2. The dotted line indicates 95% confidence interval.

6.2.2 Ranking of Monetary Policy Transmission Channels—Variance Decomposition

As our target variables are output and price, we show their relative importance for the monetary transmission channels on the basis of their share in the variation of these target variables. Table 5 reports the results of variance decomposition of output and price respectively.

Table 5
Variance Decomposition for Output and Price (Model 2)

(a) Output (Y)

Step (Month)	Y (%)	P (%)	L (%)	M2 (%)	R (%)	ER (%)	SP (%)
1	100.00	0.00	0.00	0.00	0.00	0.00	0.00
6	72.84	0.51	2.11	2.21	2.53	0.70	19.10
12	62.39	1.02	5.31	2.03	5.46	4.62	19.18
18	57.84	1.48	6.53	1.91	6.73	6.13	19.39
24	56.30	1.46	6.53	2.02	7.37	6.06	20.26
30	55.20	1.67	6.38	2.55	7.66	5.94	20.60

(b) Price (P)

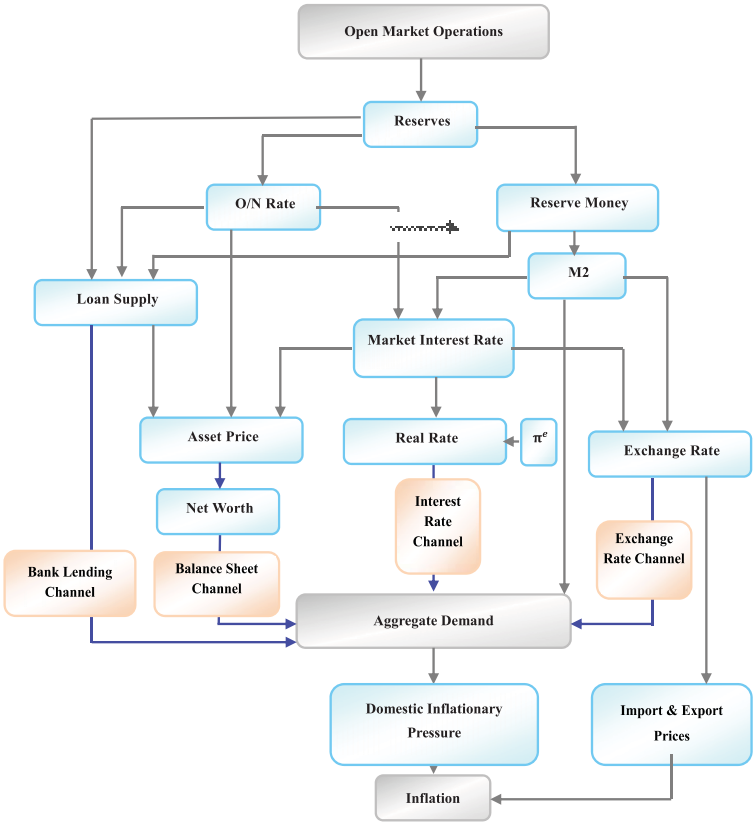
Step (Month)	Y (%)	P (%)	L (%)	M2 (%)	R (%)	ER (%)	SP (%)
1	0.00	100.00	0.00	0.00	0.00	0.00	0.00
6	4.11	85.68	0.92	2.82	2.20	1.33	2.93
12	3.77	71.91	1.57	10.17	4.47	3.29	4.82
18	4.09	68.00	2.16	12.19	4.34	3.63	5.58
24	4.76	64.87	3.95	12.36	4.94	3.62	5.51
30	5.47	61.72	5.58	12.11	6.30	3.56	5.26

For output, stock price shocks represent a major factor driving the fluctuations, accounting for about 19% of the output variation. As discussed earlier, in addition to the balance sheet channel, stock price shocks could also reflect changes in international economic and financial conditions, or developments in the industrial sector. Chinese Taipei is a small open economy, so output can be easily affected by changes in international economy and finance. Moreover, shocks of bank lending, interest rate and exchange rate jointly explain the 19.39%-19.98% of the

variations in output since the 18th month. For price, M2 explains a large fraction of the variance in price. Shocks of bank lending, interest rate, exchange rate and stock prices account for 15.71%-20.7% of the variations in price after the 18th month.

To sum up, the impulse response function and variance decomposition suggest that fluctuations in output in Chinese Taipei are largely driven by the key shocks, such as bank lending, interest rate, exchange rate, and stock prices. We find that the bank lending channel, interest rate channel, exchange rate channel, and balance sheet channel play important roles in monetary policy transmission in Chinese Taipei. This result is consistent with previous empirical studies. Chart 7 shows the details about of cardinal monetary policy transmissions in Chinese Taipei.

Chart 7
Monetary Policy Transmission Channels in Chinese Taipei



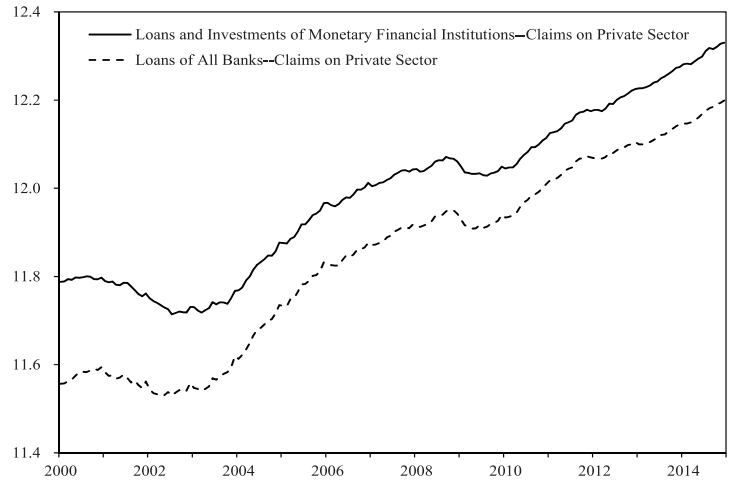
Note: → indicates the channel is significant in our empirical analysis.

6.3 Robustness Check

In our empirical work, bank lending is represented by the variable "loans and investments of monetary financial institutions - claims on private sector." However, some works of literature utilize bank loans to investigate the credit channel (Wu and Chen, 2010; Chang et al., 2010; Huang and Yu, 2015). Thus, we replace "loans and investments of monetary financial institutions - claims on private sector" with "loans of all banks - claims on private sector" for robustness check.[13]

The time series plots of these two variables (in natural log) are shown in Chart 8. "Loans of all banks - claims on private sector" accounts for 80%-90% of "loans and investments of monetary financial institutions - claims on private sector" during the sample period, and we can see that their patterns are very similar.

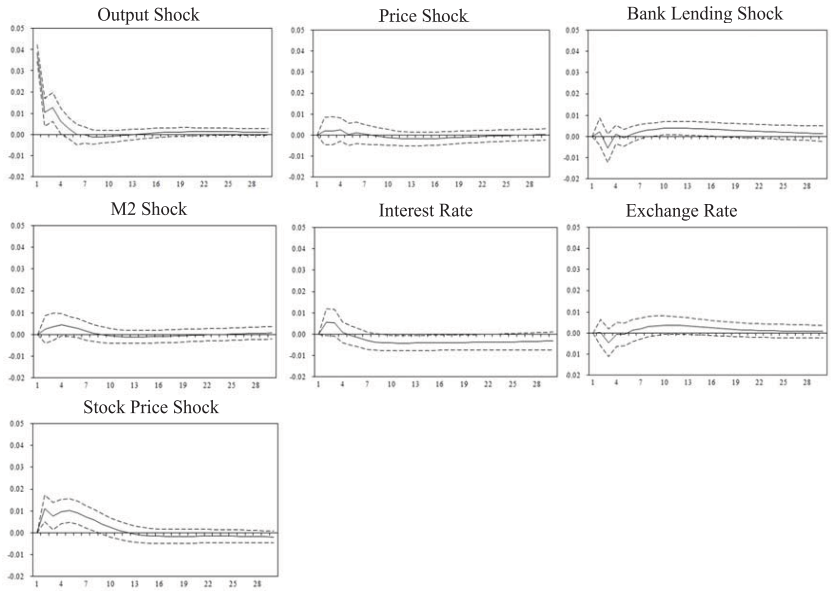
Chart 8
Two Different Variables for Bank Lending



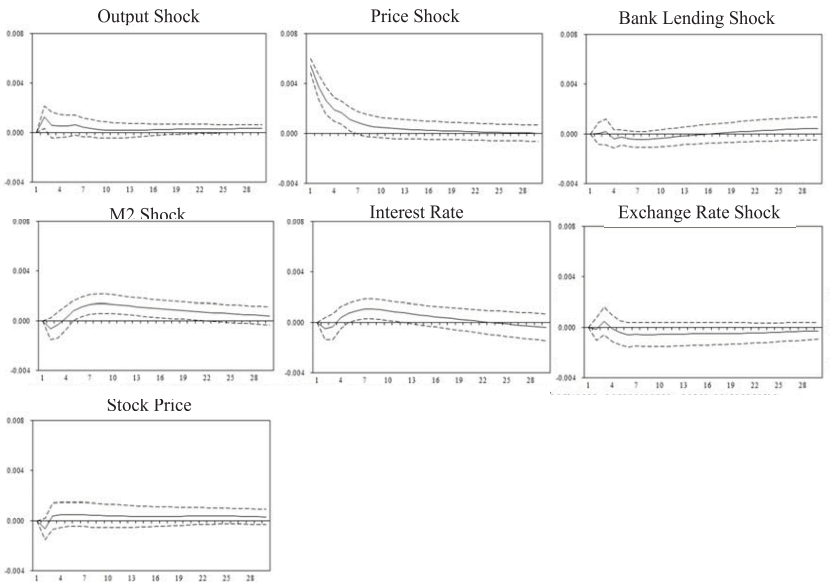
13. The variable "loans of all banks - claims on private sector" is calculated as "claims on private enterprises" plus "claims on individuals," and the data source is Financial Statistics Monthly.

Chart 9
Impulse Response of Output and Price to Different Shocks (Model 2, Changing the Bank Lending Variable)

(a) Impulse Response of Output (Y)



(b) Impulse Response of Price (P)



Notes: 1. Response to One Standard Deviation.
2. The dotted line indicates 95% confidence interval.

With the different bank lending variable, the responses of output and price are displayed in the upper and lower part of Chart 9 respectively, while the variance decomposition of output and price are reported in Table 6. We can see that the patterns of impulse responses are similar with Chart 6, while the shares of each variable in the target variables' variation are also similar with Table 5. Thus, the result remains unchanged.

Table 6
Variance Decomposition for Output and Price (Model 2, Changing the Bank Lending Variable)

(a) Output (Y)

Step (Month)	Y (%)	P (%)	L (%)	M2 (%)	R (%)	ER (%)	SP (%)
1	100.00	0.00	0.00	0.00	0.00	0.00	0.00
6	72.80	0.66	1.56	2.50	2.60	0.94	18.94
12	63.77	0.83	3.89	2.38	5.44	3.19	20.51
18	58.67	1.31	5.97	2.36	8.15	4.32	19.22
24	55.99	1.35	6.86	2.25	10.43	4.42	18.71
30	54.24	1.31	7.15	2.22	12.16	4.37	18.56

(b) Price (P)

Step (Month)	Y (%)	P (%)	L (%)	M2 (%)	R (%)	ER (%)	SP (%)
1	0.00	100.00	0.00	0.00	0.00	0.00	0.00
6	4.32	85.57	0.59	3.64	2.85	1.12	1.91
12	3.81	66.85	1.25	14.30	8.33	2.81	2.65
18	3.72	60.24	1.16	18.77	9.04	3.96	3.12
24	4.02	56.82	1.43	20.58	8.62	4.78	3.75
30	4.41	54.34	2.27	21.00	8.61	5.12	4.26

According to the empirical results, we can find that M2 is an important variable in the model, e.g., its direct effect on price. However, M2 is not considered as a "transmission channel" in most literature, because it is usually deemed pivotal within the channel. Therefore, we remove M2 from the SVAR model to check the robustness of other channels.

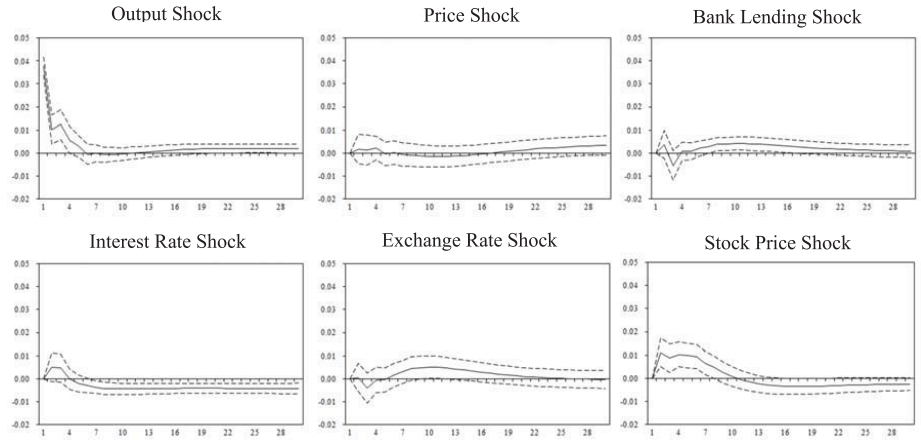
The SVAR model without M2 is then estimated. The impulse responses of output and price are shown in the upper and lower parts of Chart 10 respectively, and we can see that the patterns are still similar to Chart 6. Table 7 reports the variance decomposition. For output, the relative importance of each variable

remains unchanged; for price, only output becomes more important, but price itself is still the dominant factor.

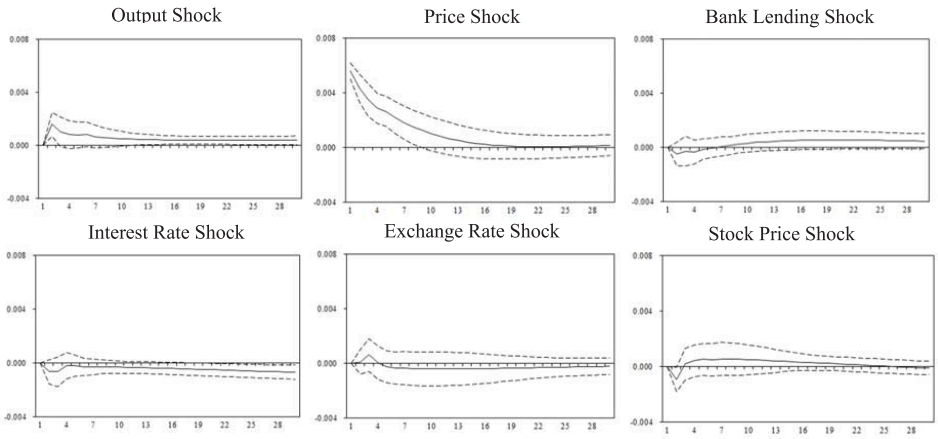
Therefore, using a different variable to represent bank lending or removing M2 from the model will not change the result, proving that our estimation results are robust.

Chart 10
Impulse Response of Output to Different Shocks (Model 2, without M2)

(a) Impulse Response of Output (Y)



(b) Impulse Response of Price (P)



Notes: 1. Response to One Standard Deviation.
2. The dotted line indicates 95% confidence interval.

Table 7
Variance Decomposition for Output and Price (Model 2, without M2)

(a) Output (Y)

Step (Month)	Y (%)	P (%)	L (%)	R (%)	ER (%)	SP (%)
1	100.00	0.00	0.00	0.00	0.00	0.00
6	73.51	0.42	2.06	2.51	0.82	20.69
12	62.59	0.67	5.05	6.01	5.30	20.37
18	56.69	0.73	6.56	8.86	6.82	20.35
24	53.42	1.21	6.73	11.39	6.52	20.72
30	50.56	2.72	6.47	13.64	6.10	20.52

(b) Price (P)

Step (Month)	Y (%)	P (%)	L (%)	R (%)	ER (%)	SP (%)
1	0.00	100.00	0.00	0.00	0.00	0.00
6	6.16	89.93	0.47	1.07	0.63	1.74
12	6.96	86.37	0.88	1.43	1.38	2.98
18	7.54	82.53	2.23	2.17	2.08	3.45
24	7.98	79.03	3.64	3.42	2.49	3.44
30	8.35	75.78	4.67	5.23	2.66	3.31

7. Conclusions

This paper investigates the effectiveness of monetary policy transmission channels in Chinese Taipei. We first characterize the framework of monetary targeting and identify the relationship between money demand function and macroeconomic variables in Chinese Taipei. We find that consistent and rigorous monetary policy operations augment the effectiveness of monetary policy transmission.

We then examine the effectiveness of monetary policy implementation and the effects of key financial and economic variables on output and inflation. Instead of relying on the recursive Choleski approach to identify model parameters, we propose the SVAR model. The estimation of the SVAR model which takes into account the interactions between monetary policy and key variables, imposing the minimal structural restrictions, is better suited to depict the variables' contemporaneous relationships.

In the first estimation, we provide evidence that policy instruments (open market operations) can better affect the intermediate target (M2) through the operating target (reserve money), therefore showing that monetary policy is implemented effectively in Chinese Taipei.

In the second part, we reconsider an integrated approach to capture the effectiveness of monetary policy transmission. Although many empirical studies depict Chinese Taipei's monetary transmission channels, most papers focus on specific channels, neglecting the dynamic interactions among macroeconomic variables, which may bias the estimation of monetary policy transmission. Therefore, we apply a structural analysis of monetary transmission channels using a SVAR model. Specifically, we investigate exhaustively, the effects of various transmission channels, which is relatively different from the literature in Chinese Taipei. Estimation results show that the bank lending channel, interest rate channel, exchange rate channel, and balance sheet channel highlight the role that monetary policy transmission plays in Chinese Taipei. In addition, the results also show that as a small open economy, Chinese Taipei can easily be affected by international financial and economic changes. This is in line with the literature on Chinese Taipei in our earlier analysis.

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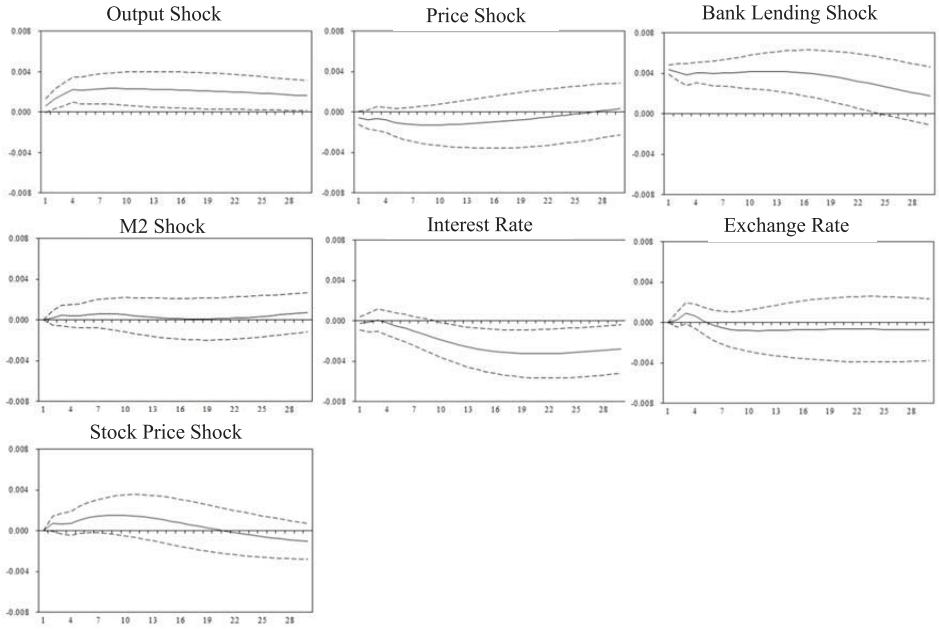
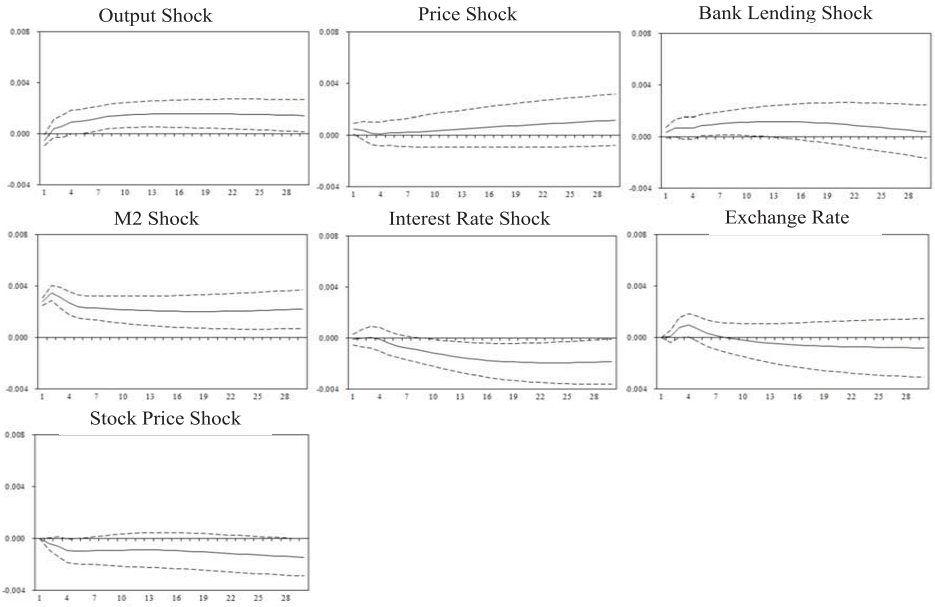
Appendix: Impulse Response of Bank Lending, M2, and Stock Price to Different Shocks (Model 2)

(a) Impulse Response of Bank Lending (L)



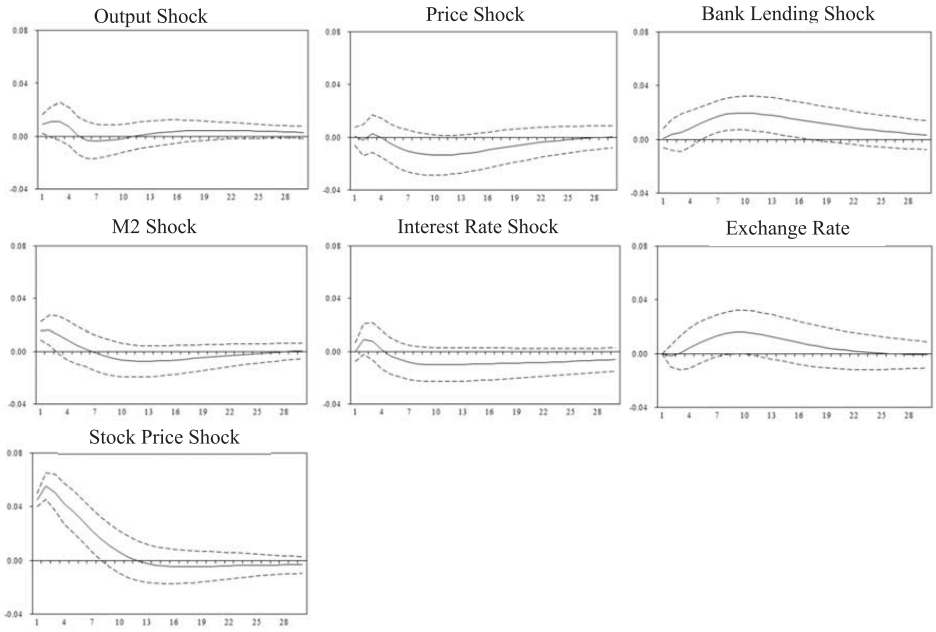
Notes: 1. Response to One Standard Deviation.
2. The dotted line indicates 95% confidence interval.

(b) Impulse Response of M2



Notes: 1. Response to One Standard Deviation.
2. The dotted line indicates 95% confidence interval.

(c) Impulse Response of Stock Price (SP)



Notes: 1. Response to One Standard Deviation.
2. The dotted line indicates 95% confidence interval.

Chapter 8

DETERMINANTS OF MONETARY POLICY TRANSMISSION VIA BANK LENDING CHANNEL IN THAILAND: A THRESHOLD VECTOR AUTOREGRESSION APPROACH[1]

By
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1. Introduction

"Most economists would agree that, at least in the short-run, monetary policy can significantly influence the course of the real economy...There is far less agreement, however, about exactly how monetary policy exerts its influence."

Excerpt from "Inside the Black Box: The Credit Channel of Monetary Policy Transmission," Bernanke and Gertler (1995)

We have come a long way toward unraveling the black box on monetary transmission mechanism. Since the theoretical underpinnings of various channels have been found, an extensive sum of empirical researches have shed some light on what happen in the interim from changes in monetary policy to changes in output and inflation. *In light of Thailand experience, the empirical results point to a transmission mechanism in which banks play an important role, through the adjustment of both price and quality of loans, relative to exchange rate and asset price channel.* Disyatat and Vongsinsirikul (2002) argue that the traditional interest rate channel accounts for around half of output

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1. The views expressed in this paper are of the authors and do not reflect those of the Bank of Thailand, its executives or The SEACEN Centre. All errors and opinions expressed in this paper are sole responsibility of the authors.

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response after 2 years while Charoenseang and Manakit (2007) show that shocks to policy rate increase private credits significantly for about 4 month, which in turn help stimulate output mainly through private investment. Consequently, given the economy's heavy reliance on the banking sector, monetary policy effectiveness is believed to depend largely on commercial banks' rate adjustment as well as sensitivity of credits and deposits following changes in policy rate in Thailand.

In a changing economy, the channels of monetary transmission are unlikely to be constant over time. According to the preliminary studies done for recent policy easing cycle, the sensitivity of retail rates to money market rates' reduction appears to decline, thereby suggesting a weakening interest rate pass-through after 2010. Meanwhile, monetary easing in Thailand seems to have less influence in boosting bank loan in the current credit decelerating trend. Therefore, in order to continuously ensure appropriate design and successful conduct of monetary policy, it is of great importance to be alerted of the impact of changes that alter the economic effects of given monetary policy measures. The main objective of this paper is thus to revisit the transmission via banking sector and identify the determinants behind those changes for Thai economy.

While there are studies that look into the influences of bank friction on monetary policy effectiveness both theoretical and empirical[6], this paper's aim is to test the effect of the boarder economic landscape on monetary policy effectiveness. Motivated by the current state of economy, we ask whether monetary policy is effective in an economic downturn period. Intuitively, the initial economic condition determines where we are on the aggregate supply curve and how large is the aggregate demand shift as a result of a monetary policy shock, hence the change in equilibrium output. A shift in aggregate demand could be larger when the economy is below par and firms are underleveraged but this trend could be offset by the effect of worsening business confidence. On the other hand, in an economic downturn phase, when there are large amounts of spare capacity available, the aggregate supply curve is expected to be very elastic. Hence, the effect of monetary easing on output is expected to be higher.

With the above hypothesis in mind, we ask whether/how the impact of monetary policy on macroeconomic dynamics changes with the phase of business cycle for Thailand. To conduct an empirical exercise, the threshold vector autoregression (TVAR) methodology is employed as it is appropriate for modeling regime shifts, i.e., shift between subpar and above par GDP regime. Our results

6. Including Disyatat (2010), Gambarcorta and Marques-Ibanez (2011) and Ananchotikul and Seneviratne (2015).

indicate that the dynamics of the interactions among credit market condition, economic activities, and monetary policy seems to change as the economy moves from a subpar growth regime to an above-par regime. Although credit growth tends to show smaller response to monetary policy easing, possibly due to subdued private sector confidence, output response seems to be higher during a downturn when the economy is more likely to be have low capacity utilization.

To set stage for our discussion on monetary policy transmission, we begin by reviewing the conceptual framework of how transmission channels via banks could change with the phase of the business cycle in Section 2. Section 3 contains a brief overview/stylized facts on the transmission mechanism in Thailand. The methodology and database are presented in Section 4, followed by the empirical results from the TVAR analysis in Section 5. Section 6 concludes and the technical details are presented in the appendices.

2. Literature Review and Conceptual Framework

2.1 Conceptual Framework and Theoretical Considerations

Over the past decade, there are a growing number of literatures which seek to provide evidence that the effectiveness of monetary policy depends, among other factors, on the state of economic activities. This section provides a simple framework for investigating the various theories underpinning this concept. The merit of such a framework is that it allows us to bridge the arguments which rest on different assumptions and lines of reasoning suggested by each model with their following empirical results.

According to the traditional macroeconomic concept, the equilibrium of real output and the price level is determined by the intersection of the aggregate supply and the aggregate demand curves. Monetary policy affects such equilibrium, via its influence on aggregate demand. Monetary easing, for instance, lowers interbank financing costs, and commercial banks typically pass on the lower cost to their customers in terms of lower lending rates. At the same time, as funding costs become lower, banks also tend to expand their loan supply. As a result, private spending and aggregate output rise. Nevertheless, there is empirical evidence which suggests that loan demand and supply might also depend on factors other than costs of funds. The following section outlines the key determinants of loan demand and loan supply respectively. Finally, after considering the equilibrium in the credit market – which determines the aggregate demand curve – and the curvature of the aggregate supply curve, we then move on to explain how monetary policy effectiveness varies with the state of economic activities.

Transmission of monetary policy relies crucially on its role in influencing credit demand in three ways, as summarized in the following functional form.

Loan demand = f(lending rate, expectation on economic outlook, borrower's balance sheet)

Firstly, firms will increase their borrowing if the cost of funds falls below the internal rate of return. In this sense, the traditional strand of monetary transmission contends that monetary easing reduces the firm's cost of fund, which then induces aggregate demand. However, such a conclusion rests importantly on the assumption that banks will pass on the lower cost to firms.

Secondly, firms' demand for borrowing is positively correlated with their expectation on the outlook of the economy. A bright economic prospect will prompt firms to acquire more credits to fund their investments. This notion is supported by Kashyap, Stein, and Wilcox (1993) who provide evidence of a positive relationship between economic conditions and the demand for bank credit. Nevertheless, it is important to stress that such a conclusion requires monetary policy to be sufficiently credible, so that the monetary easing action is perceived to contribute to a brighter growth prospect going forward. In the absence of such credibility, the demand for loans may not be as responsive to the monetary stimulus.

Thirdly, firms' demand for borrowing is also subject to the prevailing conditions of their balance sheets. Highly-leveraged firms or firms with deteriorating balance sheet conditions tend to face limitations in their external financing. In this respect, monetary easing can alleviate such tensions in their balance sheets, as a corresponding fall in the discount rate helps increase the net present value of firms' assets. The channel in which monetary policy exerts its influence on firm's balance sheet is generally referred to as the 'balance sheet channel,' which is one of the two strands of the credit channel of transmission.

On the supply side, the key factors which determine bank loan supply are the following:

Loan supply = f(external finance premium, expectation on borrower's balance sheet, level of risk aversion)

First of all, the financing condition of a financial intermediary has an influence on the supply of credit. Monetary policy exerts influence on a bank's external

funding cost by directly setting the policy rate, which in turn acts as short-term benchmark rates in the financial markets. At the same time, monetary policy influences market expectation of future path of interest rate, which then affects the costs of longer-term financing. In addition, monetary easing indirectly affects the default risk premium which banks face in tapping market financing due to its influence on banks' balance sheets. Monetary easing which pump up asset prices also improve banks' net worth in the same way as the effects of the aforementioned effects on firms' balance sheet.

Firms' balance sheets also play a role in determining the provision of credit. Bernanke and Gertler (1989) designed a model of business cycle with the inclusion of the role of firms' balance sheets for highlighting this concept. Assuming that a bank maximizes profit and has to deal with imperfect information of the borrowers, the expected net worth of a firm serves as a leading indicator of a borrower's probability to default. As a firm's wealth deteriorates, adding to the possibility of a default, a bank may guard its wealth against such default risks by tightening the credit condition and vice-versa. The key implication is that this mechanism becomes a source of pro-cyclicality, exacerbating the downturn and fueling the expansion. Bayoumi and Melander (2008) developed the macrofinancial linkages and found significant evidence that credit conditions have influence on real spending.

Finally, loan supply may also vary with risk aversion of financial intermediaries which changes in response to business/economic outlook. Kahneman and Tversky (1979) proposed the so-called prospect theory which argues that when economic agents become risk averse in an environment, consumption will fall below a habit-based reference level – a concept which could also help explain the behavior of banks. The implication is that an economic recession usually concurs with some sort of confidence crisis, which further acts as a propagator of negative shocks to economic growth, delaying the recovery.

Putting together the factors affecting loan demand and supply would result in the equilibrium in the loan market. This, in turn, determines the magnitude of the shift in the aggregate demand curve following a monetary easing action. In the low-growth regime, for instance, if the sentiment factor dominates a fall in financing costs, then a shift in aggregate demand (AD) will be marginal. However, in the absence of negative sentiment or uncertainty, a shift in AD will be relatively larger.

The shape of the aggregate supply curve also plays a role in determining the effectiveness of monetary policy. Keynes is among the earlier supporters of

this argument which suggests that the aggregate supply (AS) curve is positively-sloped up to the expected price level and vertical afterwards as the economy reaches its long-run potential. The Keynesian concept implies that monetary policy shocks in the state of high economic activity are neutral but those in a low-activity environment are effective, implying that monetary policy is more powerful in a state of low economic growth than in the period of expansion.

Related theories include the 'costly price adjustment' strand, cited in Tsiddon (1993), and Ball and Mankiw (1994). Ball and Mankiw (1994) proposed the so-called "Menu Cost" model which is derived on microeconomic foundations. The model assumes that a single firm bears "the Menu Cost" of adjusting prices to maintain the relative price of its goods to the overall price, in a backdrop of continuing positive inflation. The authors argue that a positive inflation rate helps offset a negative shock in overall prices, bringing the relative price back to its preferable level without needing any downward adjustment. On the contrary, inflation acts as propagator of positive shock to the overall price and the firm has to raise its price even higher to shore up its relative price towards the desired level. Thus, a firm is more likely to adjust their price upwards rather than downwards, with implications of a convex aggregate supply curve.

Based on this simple AD-AS framework, the resulting equilibrium output depends on two forces – the magnitude of shift in the AD curve, and the slope of the AS curve. For instance, in a state of high economic activity, a monetary easing shock may shift AD significantly, but given the relatively steep AS curve, the effect on output would become smaller.

2.2 Empirical Evidence

2.2.1 Reviews of Literatures on Monetary Policy Transmission in Thailand

Literatures on transmission via the banking sector in Thailand are divided into two main strands. The first strand of research concerns the quantitative assessment of the consequences of a change in the policy rate on macroeconomic variables and how they change over time. The second strand focuses on the determinants of the transmission mechanism. Finally, we also outline the key factors underlying the evolution of monetary transmission in the past decade.

Regarding traditional interest rate channel, the prominent view is that there was a significant decline in the pass-through from the policy rate to bank retail rates in Thailand following the East Asian financial crisis in 1997. Using the

Error Correction Model (ECM) analysis, Disyatat and Vongsinsirikul (2002) argued that the retail rates in Thailand is generally sticky to policy rate movement compared to those in developed countries and they became stickier in the aftermath of the crisis. These results are consistent with Atchana and Singhachai (2008), whose work documents a decline in the responsiveness of retail rates to policy rate changes following the financial crisis, with stickiness of policy pass-through being most evident around 2004-2005. Also, Charoenseang and Manakit (2007) found that despite the observable long-run relationship between the policy rate and money market rates, the pass-through effect of the policy rate on banks' retail rates is quite low, at about 20% during 2000-2006. The authors also estimated the vector autoregression (VAR) system on Thailand data during 2000-2006 and found that the policy rate does not strongly influence the lending rate, suggesting a weaker transmission through interest rate channel after the adoption of inflation targeting in 2000.

According to the abovementioned literatures, level of competition and the liquidity in the banking sector are noted as the two main catalysts. Disyatat and Vongsinsirikul (2002) contend that a cost of rate adjustment is higher in the less competitive banking sector than in a more competitive system. In addition Atchana and Singhachai (2008) argue that the degree of risk aversion in the banking system has changed since the outbreak of the 1997 financial crisis, as bank reserves greater portion of cash and liquid assets in excess of the legal requirement. Against this backdrop, marginal tightening in monetary policy would not be able to tempt banks to raise its lending rates. Charoenseang and Manakit (2007) draw a similar conclusion on excess liquidity. It was not until mid-2015 that the excess liquidity started to reduce, after which the interest rate pass-through began to pick up more evidently.

Most of the literatures on monetary transmission generally agree that the bank lending channel could help amplify the effect of interest rate shock beyond what would be predicted if the monetary policy were to transmit its effect through the interest rate channel alone. According to Disyatat and Vongsinsirikul (2002), monetary tightening leads to a fall in bank credits with about 3 quarters lag and bank loans also have significant implication on the impulse response of GDP from interest rate shocks. Similarly, Charoenseang and Manakit (2007) found that shocks to monetary policy induced major changes in commercial banks credits to private sector for about 4 months while commercial bank credits have strong impact on private investment.

However, there is a growing recognition that the significance of the credit channel and the importance of bank loans have declined since the crisis period.

As argued by Disyatat and Vongsinsirikul (2002), the sensitivity of loan supply to monetary shocks has gone down since 1999, along with effectiveness of monetary policy associated with the bank lending channel. By comparing the VAR of the whole sample and truncated data of up to 1999, the paper finds that the response of output and bank credits to monetary policy of a similar size is more pronounced in the pre-crisis period. The authors argued that this is attributed to a rise in prominence of non-deposit funding for banks, which serve as a cushion against a tightening of monetary policy, in turn reducing the sensitivity of loan supply and output to monetary shocks. Also, a firm can substitute nonbank financing for bank loans when monetary policy tightens.

In addition, Disyatat and Vongsinsirikul (2002) also focused on the financial health of the banking and corporate sector which affects how monetary shock is translated into bank credit, the chief motivation of our study. By effectively constraining new bank lending, a continued weakness in the banking sector following the crisis, tended to offset the impact of monetary easing. At the same time, excess capacity and balance sheet weakness in the corporate sector also act as a constraint on investment demand, thereby blunting the credit channel of monetary policy. We will elaborate more on this argument.

Nonetheless, there are also a few literatures, providing evidences in favor of an improved bank lending channel. Amarase and Rungcharoenkitkul (2014) offers a model to support the fact that greater bank competition and lower risk-free rate raise the screening costs, eventually leading to a pooling equilibrium involving larger credits at cheaper prices. In context of the Thai experience, a shift in Specialized Financial Institutions' (SFIs) lending strategy may have triggered a transition of equilibrium from credit rationing to credit boom. As competition and risk-taking intensified during the 2011-2013 easing episode, banks strategically increased credit supply, as reflected by a compressed spread. Therefore, bank competition can play an important part in strengthening the impact of monetary policy on bank lending and economy during the current easing cycle.

In sum, based on literature of the Thai experience, banks are still central elements in monetary policy transmission mechanism. Nevertheless, its relevance has declined mainly through the price perspective. On top of the monetary policy framework which should influence the degree of transmission, the literature also point to (i) excess liquidity and competition in banking sector; (ii) financial deepening; and, (iii) financial health of banks.

2.2.2 Evidence of Non-linear Monetary Policy Influence on Real Output

Many literatures confirm the non-linear interaction between monetary policy and real output with regard to a state of economy. In the case of developed countries, the earlier study of Garcia and Schaller (2002) examined the goodness of fit of the Markov-switching model which treats the state of economy as a latent variable versus the linear model in simulating the response of output to policy rate. Their results confirm the existence of the asymmetry regarding the economic environment. Lo and Piger (2003) also deploy VAR analysis on the US data during 1954Q3 to 2002Q4 and find strong evidence of time variation in the relationship between monetary policy and output. Regressing the probabilities of change in this relationship on several state variables, the authors find strong evidence that regime shifts can be well explained by the phase of the business cycle. The study, however, finds no strong evidence in favor of asymmetry with regard to the direction of policy action and does not test whether policy direction matters within each growth regime. Some of the literatures adopt the threshold vector autoregression (TVAR) model, including Balke (2000) who tested the two-regime switching model and Avdjiev and Zeng (2014) who developed a three-regime switching model in similar spirit to Balke (2000). Both studies corroborate the existence of the asymmetry. Other papers include Weise (1999), and Thoma (1994).

Using U.S. data, empirical literatures show mixed results. The first group favors the argument for more potent monetary policy in a state of low-economic growth than those in high growth periods, namely Weise (1999), Balke (2000), Garcia and Schaller (2002), and Lo and Piger (2003) and Avdjiev and Zeng (2014). Estimations deployed in Garcia and Schaller (2002) affirms that the effect of monetary tightening on output is more powerful during recessions than during expansions.

According to the credit-rationing proposition, Balke (2000) finds that monetary tightening shocks are more potent in the tight-credit environment which is concurrent with the state of subdued economic activity and confidence. So do Avdjiev and Zeng (2014), who argue that monetary easing is more effective when economic agents are under credit constraint than when the agents are already fully financed. Note that the nature of asymmetry with regard to a state of economy depends on whether monetary policy action is expansionary or contractionary.

On the other hand, there is also evidence supporting the claim that monetary tightening is more effective in the low-growth regime. Thoma (1994) finds that monetary tightening has a stronger adverse effect on output which is significant during the three to five quarters after the policy action is taken. On the contrary, contractionary policy has no significant effect during recessions. Monetary policy is also found more potent in a state of high growth rates by Tenreyro and Thwaites (2015), consistent with the "pushing on the string" concept.

In the case of the Asian economies, there are mixed evidences on both the existence of non-linearity and in which regime monetary policy is more powerful. Hooi et al. (2008) employed a Generalized Hamilton Markov switching model in the same spirit as the prior work of Garcia and Schaller (2002). Utilizing quarterly data of Indonesia, Malaysia, Philippines and Thailand during 1974Q1 to 2003Q1, the results confirm the existence of asymmetry with respect to a state of economy and shows that monetary policy has larger effects on output during expansions. Shen (2000) applied a time-varying asymmetric model on Chinese Taipei data and failed to reject the linearity of a relationship between monetary policy and output. However, the point estimates imply that monetary tightening is more effective during the contraction and confirms the hypothesis of credit-rationing.

3. Overview of Thailand's Monetary Policy and its Transmission

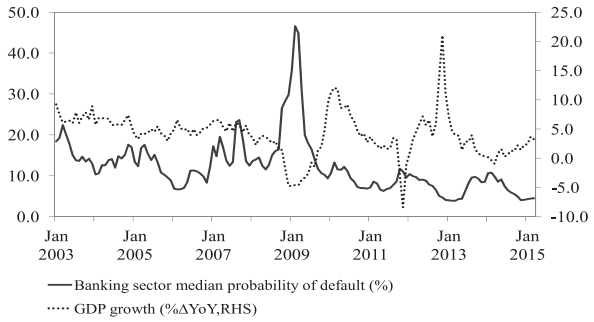
This section aims to provide stylized facts on how the dynamics between credit, economic activities, and monetary policy should interact during the period of economic downturn in Thailand. By analyzing a set of selected variables according to the conceptual framework laid out in second section, we will attempt to provide an analysis regarding the size of the aggregate demand shift and slope of the aggregate supply curve which should serve as a initial evidence on how credit conditions and eventually economic activities should change in response to monetary easing in a period of economic slump in Thailand. Simply put, this section serves as a qualitative review of the effectiveness of monetary easing in Thailand, before proceeding to the quantitative results from the TVAR approach in the following sections.

3.1 Aggregate Demand Curve and Credit Market Condition

As described in last section, the equilibrium credit and the size of shift in the AD curve is determined by both interest rates, i.e., external finance premium (EFP), and the sentiment of economic agents regarding economic outlook.

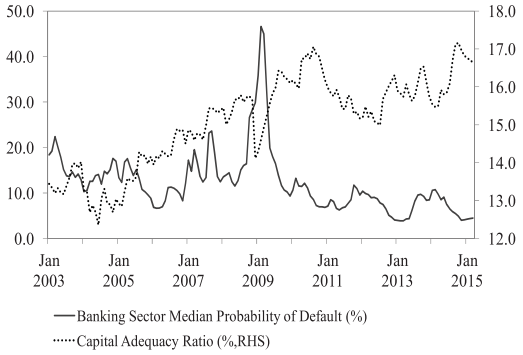
In the case of Thailand, in the period where GDP growth is subpar, the amount of credit could be highly responsive to monetary easing considering the possibility of reduction in EFP (proxied by probability of default for the Thai banking sector). As can be seen in Figure 1, the high level of EFP during the subpar growth implies a large space for reduction after monetary easing. Furthermore, the potential response of bank net worth (proxied by bank capital) to positive a policy shock and the association negative relationship between bank net worth and EFP (Figure 2) could provide amplification for the effect of monetary easing on the amount of credit supply. In other words, after monetary easing, banks' net worth could increase, causing a decline in the EFP. With lower cost of funds, banks are more willing to increase their lending, thus contributing to a greater effect on output.

Figure 1
External Finance Premium and Economic Growth



Source: National Economic and Social Development Board, Bloomberg, Authors' calculations.

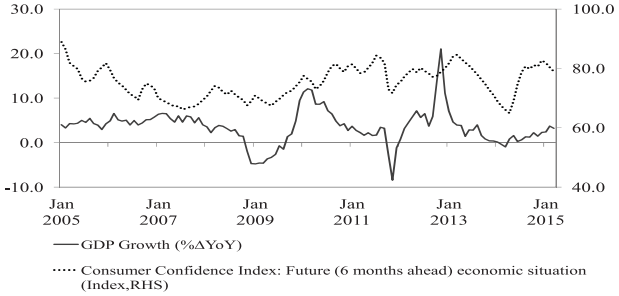
Figure 2
External Finance Premium and Bank Capital



Source: Bank of Thailand, Bloomberg, Authors' calculations.

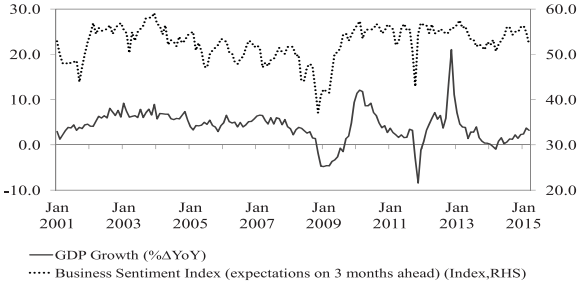
Having said that, the fact that confidence is relatively low during subpar economic growth than in high-growth regime (Figure 3 and 4), this could mean that the pass-through of monetary easing to credit could be limited during the low-growth phase. In a period of economic downturn, banks tend to increase their credit standards, while firms have the tendency to lower their demand for loans given the worse sentiments. Hence, credit is likely to respond less to monetary easing during the subpar growth regime.

Figure 3
GDP Growth and Consumer Confidence



Source: University of the Thai Chamber of Commerce, National Economic and Social Development Board, Authors' calculations.

Figure 4
GDP Growth and Business Sentiments



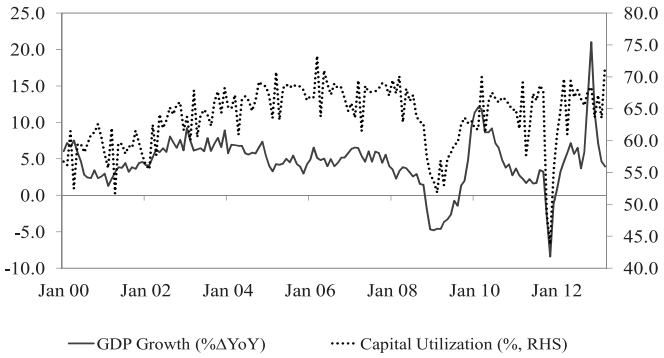
Source: National Economic and Social Development Board, Bank of Thailand, Authors' calculations.

In determining the overall effect of a monetary shock on equilibrium credit and thus the size of shift in the AD curve during economic downturn, the EFP and the sentiment factor should both be taken into account. This is the essence of Section 5 where quantitative exercises are carried out to examine the overall effect of a monetary policy shock.

3.2 Aggregate Supply Curve and the Equilibrium Output

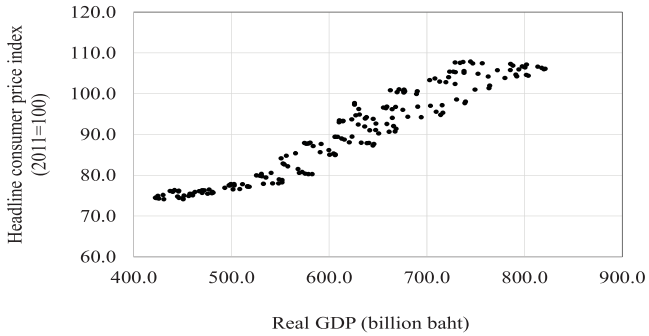
In addition to the size of shift in the AD curve, the slope of the AS curve is also vital in determining the output effect of monetary easing. As shown in Figure 5, in the declining phase of the business cycle, there are large quantities of spare capacity available (low capital utilization), suggesting that the AS curve is very elastic at low levels of output (Figure 6). Hence, monetary easing, which shift the demand curve to the right, could lead to greater impact on output.

Figure 5
GDP Growth and Capital Utilization



Source: National Economic and Social Development Board, Bank of Thailand, Authors' calculations.

Figure 6
GDP Growth and Headline Inflation



Source: Bank of Thailand, Authors' calculations.

4. Empirical Methodology

4.1 Model Specification

In this paper, the Threshold Vector Autoregression (TVAR) is used to explore the monetary policy transmission via the bank lending channel. As opposed to a linear VAR model, the TVAR enables us to test whether the effectiveness of monetary policy varies with the prevailing macroeconomic conditions. Moreover, another advantage of the TVAR is that it allows for non-linearity stemming from regime switching and asymmetric reaction to shocks. This is because the threshold variable is also included in the system of endogenous variables.

Several literatures which look at the monetary transmission mechanism via the bank lending channel use credit market conditions (Balke, 2000) as threshold variables. For instance, Avdjiev and Zeng (2014) employs real GDP growth as a threshold variable for separating two distinct phases of the business cycle.

The TVAR model specification used in this paper is as follows:

$$Y_t = AY_{t-1}\big(I(c_{t-d} > \gamma)\big) + BY_{t-1}\big(1 - I(c_{t-d} > \gamma)\big) + \varepsilon_t$$

where Y_t is a vector containing endogenous variables. A and B are lag polynomial matrices while ε_t is structural disturbance term. c_{t-d} is the value of the threshold variable at time $t - d$, where d is the lagged period of such variable. γ is the threshold value, which is determined using a selection criterion described in the following section. $I(c_{t-d} > \gamma)$ is a function that takes the value 1 if the value of the threshold variable at time exceeds , and 0 otherwise**.**

We estimate the preceding TVAR model using monthly Thailand data that runs from January 2000 to March 2015. In our model, Y_t consists of 4 variables: (i) real GDP growth[7] which is translated from quarterly to monthly using the coincidence economic indicator as a proxy. This variable is also a threshold variable; (ii) inflation is calculated as the growth rate of headline CPI; (iii) policy rate; and, (iv) real private credit growth. Definition of variables and data sources can be found in Appendix A.

7. All of the variables in growth rate form are calculated in terms of the current month's data compare with the same period last year (year-over-year, yoy).

With regard to the selection of a regime variable, we emulate Avdjiev and Zeng (2014) whose study used real GDP growth to capture the dynamics of the relationship among the endogenous variables as output growth changes. Furthermore, the U.S. Industrial Production Index and Thai flooding dummy variables are used as exogenous variables, as they are factors which would likely affect domestic output, but are beyond the control of domestic monetary policy. Finally, we use a similar ordering of variables in the VAR system akin to those of most standard VAR literatures that adopt a recursive structure.

With regard to the lag order selection, our objective is to strike a balance between minimizing the conventional information criterion and maintaining a sizable number of observations in each regime to ensure reliability of results. In our case, although higher lags lower the information criterion[8], it results in too few observations in one regime or the other. With this in mind, we consider that VAR of order 1 to be the optimal choice, as this yields a meaningful number of observations in each regime, while not significantly compromising on the information criterion.

4.2 Threshold Value Selection

While estimating model (1), it is important to formally test for the presence of non-linearity, with a linear VAR under the null hypothesis and a threshold VAR under the alternative. A complication arises as the threshold value is unknown because the parameter γ is identified only under the alternative, leading to a so-called nuisance parameter problem. A common testing approach consists of first conducting a grid search over c_t and the possible threshold values, estimating each time the selected specification of the TVAR model and computing the test statistics on the restriction of equality between the linear and the non-linear models (see, for instance, Hansen (1996), and Balke (2000)).

The estimated threshold values are those that maximize the log determinant of the "structural" residuals. To avoid the overfitting problem, we trim some of the highest and lowest values, as is the case in Hansen (1996) and Balke (2000).

4.3 Impulse Response Function

We emulate Koop et al. (1996*)* in the construction of a Generalized Impulse Response Function for non-linearity models. The definition of the Generalized

8. Schwarz information criterion (SIC).

Impulse Response Function (GIRF) is the response of a specific variable after a one-time shock hits the forecast of the variables in the model.

Firstly, we estimate the GIRF as follows:

$$E[Y_{t+k}|\Omega_{t-1}, u_t] - E[Y_{t+k}|\Omega_{t-1}] \quad (2)$$

where Ω_{t-1} is the past information set at time t – 1 and u_t is a particular realization of the exogenous shock. Typically, the effect of a single exogenous shock is examined at a time, so that value of the ith element in u_t, u_t^i is set to a specific value. The difficulty arises because, in the TVAR, the moving-average representation is not linear in the shocks (either across shocks or across time). As a result, unlike linear models, the impulse-response function for the nonlinear model is conditional on the entire past history of the variables and the size and direction of the shock.

The conditional expectations of Y_{t+k} are calculated by simulating the model using randomly drawn shocks. To compute $E[Y_{t+k}|\Omega_{t-1}]$, we use the random sample u_{t+k} by taking the bootstrap sample from the estimated model residual, u_t. We repeat the simulation for $-u_{t+j}$ in order to eliminate any asymmetry that might arise from sampling variation in the draws of u_{t+j}. This is repeated 5,000 times, and the resulting average is the estimated conditional expectation.

5. Empirical Results

Based on the methodology outlined in the previous section, the estimated threshold of real GDP growth is 3.27% (year-on-year). Such a threshold essentially separates the observations into two regimes, henceforth called the high-growth regime and the low-growth regime. In this paper, our focus is on analyzing the impacts of monetary easing on three key macro variables: real GDP growth, headline inflation, and real credit growth.

The following section reports the responses of each variable under the two growth regimes, following a one-time monetary shock. As the responses are symmetric, we will only report the impacts of a monetary easing action, which seems more relevant given the current situation in Thailand. Finally, consistent with the literature of other economies, we expect monetary easing to have a larger impact on the real variables in the low-growth regime than in the high-growth regime. Details of the estimated equations are provided in Appendix B.

5.1 Responses of Real GDP Growth

In both regimes, real GDP growth responds positively to monetary easing, which in this case, is a one standard deviation (one-SD) shock in the policy interest rate. However, as seen in Figure 7, the magnitude of the response is higher in the low-growth regime than in the high-growth regime. In the low-growth regime, the response of real GDP growth peaks at around 0.28 SD (equivalent to 0.98% yoy), one quarter after the policy rate cut, while the peak is only 0.08 SD (0.28% yoy) in the high-growth regime. In both regimes, the effects of the shock die down at around the eighth quarter, after which the responses turn slightly negative.

In short, monetary easing seems to be more effective in raising output when the economy is in a low-growth regime than in a high-growth one – in line with our expectation. Nevertheless, the swift reaction of output to monetary shocks remains puzzling, particularly in contrast with the conventional notion that monetary policy typically has a lag of around 6-8 quarters.

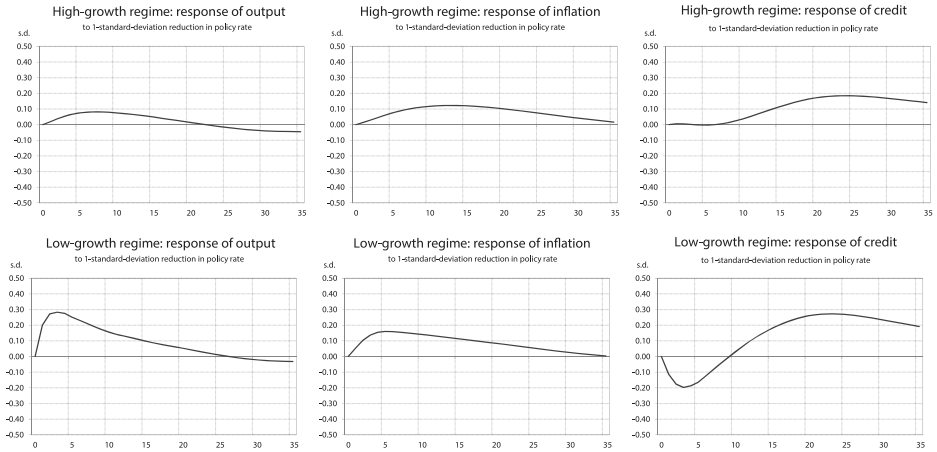
5.2 Responses of Headline Inflation

In both regimes, headline inflation responds positively to monetary easing. No price puzzle is detected in the 35-month horizon investigated. Similar to the responses of output, monetary easing raises inflation more when in the low-growth regime than in the high-growth one. In the low-growth regime, the response of inflation peaks at around 0.16 SD (equivalent to 0.31% yoy), while the magnitude is halved in the high-growth regime. In both regimes, the peaked responses of inflation occur approximately two quarters after the shock. Regarding the persistence of the responses, the effects of the shock on inflation are virtually zero after twelve quarters.

5.3 Responses of Bank Credit

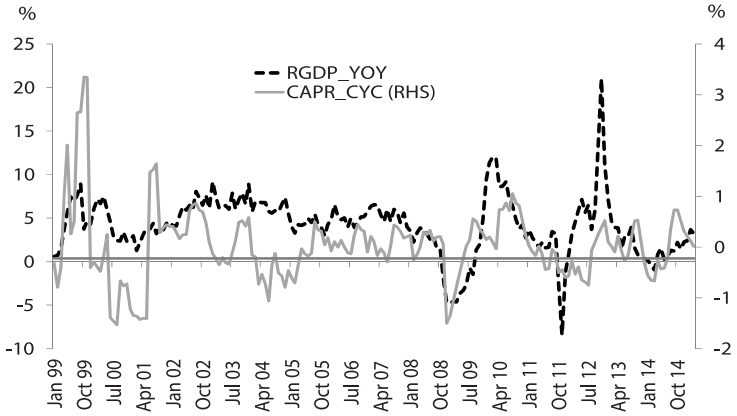
Overall, bank credit responds positively to monetary easing. In the low-growth regime, however, there is credit puzzle during the first three quarters, when bank credit falls and bottoms out after the first quarter. From Figure 7, it can be seen that bank credit responds more to monetary easing when in the low-growth regime than in the high-growth one, with the peak responses of around 0.27 SD (equivalent to 2.24% yoy) and 0.18 SD (1.51% yoy) respectively. In both regimes, the effects of monetary easing on bank credit gradually die down but remain fairly sizable even at the end of the 35-month horizon.

Figure 7
Responses of Real Variables to a One-SD Negative Monetary Shock



Source: Authors' calculations.

Figure 8
Economic Growth and Detrended Bank Capital



Source: Bank of Thailand, authors' calculations.

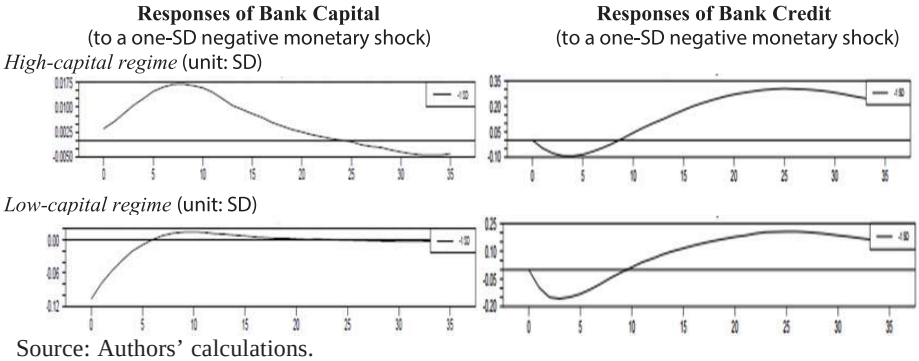
In an attempt to explain the different responses of bank credit in the two regimes, we investigated the role of bank capital in influencing the credit supply, by using capital as a threshold variable instead of real GDP growth. At the same time, bank capital is included as an endogenous variable in the VAR system in order to investigate its role as a shock propagator. In essence, this exercise allows us to track the evolution of bank credit after its capital is affected by monetary easing. In undertaking such an exercise, we opt for the de-trended capital ratio rather than the level of bank capital itself[9], as the latter is non-stationary and trends with economic growth over time. Therefore, removing its trend allows us to observe, in a more meaningful way, how bank capital evolves with the business cycle, on top of banks' own discretion on capital holding. At the same time, this manipulation allows us to observe the interaction between bank capital and the state of economic activities**.** Indeed, a basic plot of real GDP growth and de-trended bank capital in Figure 8 shows that the two series are fairly correlated, particularly in the aftermath of the Global Financial Crisis in 2008.

Comparing the two charts on the left-hand-side of Figure 9, it is obvious that bank capital responds differently to monetary easing, depending on the initial condition of capital. In a low-capital regime[10], bank capital initially falls following a negative monetary shock, whereas in a high-capital regime bank capital responds positively. A fall in bank capital during the first two quarters helps explain the credit puzzle in the bottom right chart in Figure 9.

9. Henceforth, this de-trended bank capital will be referred to as 'bank capital' for simplicity's sake.

10. Following the same methodology as the GDP exercise, the estimated threshold for de-trended capital is -0.22% (yoy).

Figure 9
Responses of Bank Capital and Credit to Monetary Policy Shock



Source: Authors' calculations.

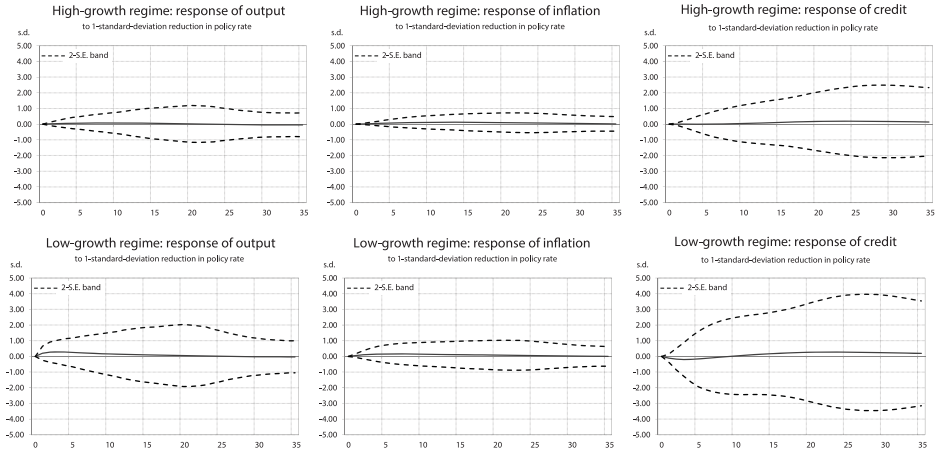
5.4 Significance of Results

As explained in the methodology section, several attempts have been made to improve the significance of the regression. Exogenous variables such as the Industrial Production (IP) Index of the U.S. and the dummy variable for the flooding incident are included in the final model specification as they are factors which likely affect domestic output but are beyond control of domestic monetary policy. A number of other variables are also included, but seem to contribute only marginally to the overall significance of the regression.

Despite the aforementioned attempts, the explanatory power of the TVAR model remains fairly low for both regimes[11]. As seen in Figure 10, the standard-error bands are therefore wide compared to the mean of responses for all three real variables, particularly for bank credit. This implies that the reported responses of real variables to monetary shocks are not statistically significant.

11. See Appendix B for the estimated equations.

Figure 10
Responses of Real Variables to a One-SD Negative Monetary Shock



Source: Authors' calculations.

6. Conclusion

We have come a long way in unveiling the black box on monetary transmission mechanism. In the case of Thailand, the empirical results point to a transmission mechanism in which banks play an important role, through the adjustment of both price and quality of loans, relative to the exchange rate and asset price channel. However, according to the preliminary studies done for the recent policy easing cycle, the quantity of bank lending and hence output, may not be as responsive to monetary policy actions as the central bank desires. Motivated by such a trend, the main objective of this paper is to identify the determinants behind those changes for the Thai economy**.** In particular, this paper asks whether and how the impact of monetary policy on macroeconomic dynamic changes with the phase of the business cycle, that is whether monetary policy is still effective during the economic downturns.

Intuitively, the initial economic conditions determine where we are on the aggregate supply curve and how large aggregate demand shifts in response to a monetary policy shock, with the resulting change in the equilibrium output. A shift in aggregate demand could be larger when economic growth is below par and firms are underleveraged but this could be offset by the effect of worsening business confidence. On the other hand, in the downturn phase, when there is ample spare capacity, the aggregate supply curve is relatively elastic. Hence,

the effect of monetary easing on output is expected to be higher than is the case during the boom times.

In conducting the empirical study to test the above hypothesis, the TVAR model with four endogenous variables, namely GDP growth, inflation, credit, and policy rate is adopted. Our results, which are consistent with the stylized fact found for Thailand's data, provide evidence that the dynamics of the interactions among credit market conditions, economic activities, and monetary policy is likely to change as the economy moves from subpar growth regime to above-par regime. Although credit growth shows a smaller response to monetary policy easing during the initial period, possibly due to subdued private sector confidence, the output response seems to be higher during the downturn when the economy is more likely to have low capacity utilization.

At first glance, it might seem that our finding of greater effectiveness of monetary policy in the low-growth regime contradicts the anecdotal evidence of the recent sluggish recovery in Thailand. However, it should, by no means, convey the message that monetary easing is effective in the current economic backdrop, as there could be other factors that may hinder the accommodative power of monetary policy on output, but are not captured in our model. In order to fully comprehend the interplay of these factors, the model can be further improved to study their dynamics using different regime variables. The candidates for regime variables that have received attention by monetary policy transmission studies include the bank business model, financial market development and global liquidity.

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Appendix A: Definition of Variables and Data Sources

Capital Adequacy Ratio (CAPR)
Measuring adequacy of capital funds serving as absorption of losses potentially generated by risky assets, capital adequacy ratio is equal to aggregate capital funds divided by risk-weighted assets in percent. The data covers those of commercial banks registered in Thailand and also foreign bank branches and publicly reported on a monthly basis. Commercial banks are subject to Basel-based capital regulations. Banks registered in Thailand are required to maintain the ratio not below 8.5% since 1988 while foreign bank branches are subject to a 8.5% minimum requirement since 2013, compared to 7.5% during August 1988 and December 2012. *(Table FI_CB_030 and FI_CB_030_S2 Bank of Thailand Statistics)*

Real Credit Growth (RCREDYOY)
Credit is defined as end-month outstanding amount of commercial banks credit to domestic Other Nonfinancial Corporations (ONFCs), households, and Nonprofit Institutions Serving Household Sector (NPISH), in accordance with the Monetary and Financial Statistical Manual (MFSM2000). Credit growth is in year-over-year basis and expressed in percentage. *(Table EC_MB_012 Bank of Thailand Statistics (Jan-2000 to Dec-2002) and commercial bank private credit data used internally by Monetary Policy Group of Bank of Thailand (Jan-2003 to Mar-2015)*

Real GDP Growth (RGDPYOY)
Started with the quarterly dataset compiled by the National Economic and Social Development Board (NESDB), we constructed the monthly data of Gross Domestic Products by using interpolation to convert quarterly GDP to monthly data. While, we proxy movement of monthly GDP each month with movements of Coincidence Economic Indicator. The indicator is constructed from 5 components including real imports, manufacturing production index, real gross value added tax, volume sales of automobiles and real debit to demand deposit. GDP growth is on year-over-year basis and express in percentage. *(URL: http://www.nesdb.go.th/Default.aspx?tabid=95)*

Policy Rate (POL)
The policy rate is the rate that The Monetary Policy Committee announced to conduct monetary policy in Thailand under the inflation-targeting framework. The 14-day repurchase rate (RP rate) was used as the policy interest rate up

until 16 January 2007, after which the policy interest rate was switched to the 1- day RP rate. Since 12 February 2008, with the closure of the BOT- run RP market, this was switched to the 1-day bilateral RP rate. Policy rate is on percent per annum basis and expressed in the end of the month. *(Table FM_RT_001 and FM_RT_001_S2 Bank of Thailand Statistics)*

Headline Inflation Rate (HLCPIYOY)

The headline consumption price index dataset collected by Ministry of Commerce used as inflation because the Monetary Policy committee has agreed to propose new monetary policy target for 2015. The new target is set for the annual average of headline inflation in 2015 to be at 2.5 percent with a tolerance band of ± 1.5 percent. Inflation rate is in year-over-year basis and expressed in percentage. *(URL: http://www.price.moc.go.th/content1.aspx?cid=1)*

US Industrial production index (USIPIYOY)

The US industrial production index measures the real output of all manufacturing, mining, and electric and gas utility establishments. Because of Thailand is a small open economy, it is important for controlling external factors. To distinguish the impact of policy rate to real GDP growth and headline inflation from global effects, US Industrial production is included as exogenous variable.

Thai Flooding Dummy Variable (DUMFLD)

Thailand has experienced severe flooding in 2011 that impacts to sharp drop in manufacturing sector and slump Real GDP growth. We applied the same way as US industrial production index variable by controlling other factor to influence monetary transmission mechanism. It takes a value of 1 for data since October 2011 to December 2011, and 0 otherwise.

Appendix B: Estimation Results

Table 1: Estimation Results: Whole Sample

Estimation period: 2000:4 - 2015:3								
	(1)		*(2)*		*(3)*			
Dependent variables:	*RGDPYOY*		*HLCPIYOY*		*RCREDYOY*		*(4) POL*	
CONSTANT	1.04	***	0.19		-0.42		0.03	
(S.E.)	(0.40)		(0.14)		(0.49)		(0.04)	
DUMFLD	-2.80	**	0.12		-0.45		-0.10	
	(1.11)		(0.40)		(1.36)		(0.11)	
USIPIYOY	0.05		0.02	*	-0.01		0.00	
	(0.04)		(0.01)		(0.04)		(0.00)	
RGDPYOY(-1)	0.79	***	0.02		0.02		-0.002	
	(0.05)		(0.02)		(0.06)		(0.00)	
HLCPIYOY(-1)	0.00		0.94	***	0.17		0.05	***
	(0.09)		(0.03)		(0.11)		(0.01)	
RCREDYOY(-1)	-0.01		-0.004		0.96	***	-0.001	
	(0.02)		(0.01)		(0.02)		(0.00)	
POL(-1)	-0.08		-0.06		0.04		0.93	***
	(0.16)		(0.06)		(0.20)		(0.02)	
Number of observation	180		180		180		180	
Degree of freedom	173		173		173		173	
Significant level of F-stat (p-val)	0.0000		0.0000		0.0000		0.0000	
Log likelihood	-355.7		-173.2		-393.2		52.8	
D-W statistics	1.7		1.4		1.9		1.4	

Note: *, **, *** significant at 10%, 5% and 1% respectively.
Sources: Authors' calculations.

Table 2: Estimation Results: Subsample in High Growth Regime

Subsample from the whole period of 2000:4 - 2015:3								
	(1)		*(2)*		*(3)*			
Dependent variables:	*RGDPYOY*		*HLCPIYOY*		*RCREDYOY*		*(4) POL*	
Constant	1.79	**	0.28		0.70		0.05	
(S.E.)	(0.70)		(0.19)		(1.03)		(0.06)	
DUMFLD	0.00	***	0.00	***	0.00	***	0.00	***
	(0.00)		(0.00)		(0.00)		(0.00)	
USIPIYOY	-0.03		0.00		-0.07		-0.005	
	(0.07)		(0.02)		(0.10)		(0.01)	
RGDPYOY(-1)	0.74	***	-0.01		-0.02		-0.01	
	(0.07)		(0.02)		(0.11)		(0.01)	
HLCPIYOY(-1)	-0.05		1.01	***	0.02		0.06	***
	(0.12)		(0.03)		(0.18)		(0.01)	
RCREDYOY(-1)	0.02		0.01		0.95	***	0.00	
	(0.03)		(0.01)		(0.04)		(0.00)	
POL(-1)	-0.07		-0.08	*	-0.07		0.94	***
	(0.18)		(0.05)		(0.26)		(0.02)	
Number of observation	115		115		115		115	
Degree of freedom	109		109		109		109	
Significant level of F-stat (p-val)	0.0000		0.0000		0.0000		0.0000	
Log likelihood	-225.8		-73.6		-270.2		52.4	
D-W statistics	1.8		1.7		1.9		1.7	

Note: *, **, *** significant at 10%, 5% and 1% respectively
.Sources: Authors' calculations.

Table 3: Estimation Results: Subsample in Low Growth Regime

Subsample from the whole period of 2000:4 - 2015:3								
	(1)		*(2)*		*(3)*			
Dependent variables:	*RGDPYOY*		*HLCPIYOY*		*RCREDYOY*		*(4) POL*	
Constant	3.03	***	0.72		-2.01	***	0.47	***
(S.E.)	(1.13)		(0.55)		(0.63)		(0.13)	
DUMFLD	-2.76	**	0.91		-1.55	**	0.22	
	(1.23)		(0.60)		(0.69)		(0.14)	
USIPIYOY	0.07		0.01		0.02		-0.004	
	(0.05)		(0.02)		(0.03)		(0.01)	
RGDPYOY(-1)	0.62	***	0.13	**	-0.04		0.04	***
	(0.12)		(0.06)		(0.07)		(0.01)	
HLCPIYOY(-1)	0.38	*	0.89	***	0.17		0.09	***
	(0.20)		(0.10)		(0.11)		(0.02)	
RCREDYOY(-1)	0.00		0.01		0.95	***	0.01	**
	(0.04)		(0.02)		(0.02)		(0.00)	
POL(-1)	-1.33	*	-0.35		0.77	**	0.68	***
	(0.68)		(0.33)		(0.38)		(0.08)	
Number of observation	65		65		65		65	
Degree of freedom	58		58		58		58	
Significant level of F-stat (p-val)	0.0000		0.0000		0.0000		0.0000	
Log likelihood	-123.4		-77.0		-85.5		19.5	
D-W statistics	1.6		1.5		1.6		1.7	

Note: *, **, *** significant at 10%, 5% and 1% respectively.
Sources: Authors' calculations.