MONETARY POLICY TRANSMISSION IN MONGOLIA[1]

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Abstract

This paper attempts to determine the macroeconomic effects of monetary policy shock and its transmission mechanism. Firstly, we define and extract unanticipated or structural monetary policy shocks, using VAR approach. Secondly, by estimating the OLS, we examine effects of unanticipated policy shocks to intermediate target variables (bank loan outstanding to private sector, nominal exchange rate and offered lending rate). And finally, we estimate the VAR model, its impulse response function and its forecast error variance decomposition to determine the impact of intermediate variables on inflation and output. Applying 2002Q1-2015Q2 data for Mongolia, we conclude that bank lending (including offered lending rate channel) is the most effective channel of monetary transmission to price and output.

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1. INTRODUCTION - GOAL OF THE PAPER

As most of the emerging and developing countries face, 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 certainly did not make it an easier task to assess the transmission channels.

Following the adoption democratic regime and shifting to a market based economy in early 90's, Mongolian economy has been evolving continuously over time, in terms of structure of production, development of financial sector and trade openness etc. Number of trade partners and the volume of trade turnover widened tremendously. Moreover, giant mining project, Turquoise hill, of copper and other coal projects made Mongolia a popular spot for foreign investors. Needless to say, mining sector has become one the economic drivers in a very short period. Following the real sector, raising fund at international financial markets via IPO and other form of debt securities became increasingly popular among major banks, corporates and even for the government. In a nutshell, Mongolian economy received significant amount of capital inflow in the last half a decade.

One of the most recent and extremely debated shifts in monetary policy was injection of public money to credit market by both the central bank and the Development Bank of Mongolia, under direct lending program to targeted sectors in–line with the government's development plan during 2012-2014. Consequently, domestically issued public debt increased more than 50 percent in the past 5 years. Since investment expenditure by the Development Bank of Mongolia is in the similar veins 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.

With the increased financing from both domestic and foreign sources, although the financial intermediary is deepening, Mongolian financial sector were no exception to the Global Financial Crisis and both banking and non-banking sector suffered drastically.

Every structural shift or major change in "the way things work" raises the question "How do these developments affect the transmission mechanism of monetary policy? How should Bank of Mongolia (BOM) respond to shocks in different economic environment? What is the appropriate monetary policy?" These developments did not only have lasting impact on the evolution of transmission mechanism, but also on the framework of monetary policy. For instance, monetary targeting framework based on strong lending channel was effective at curbing hyper-inflation until the mid of 2000s. However, financial deepening, fiscal dominance and significant monetization process resulted in unstable relationship between broad money and reserve money, hence

hindered the central bank's ability to steer domestic demand in its desired direction. Since then evolution of monetary policy framework at Bank of Mongolia shifted from monetary targeting to eclectic strategic framework with inflation as primary target and then to a more forward looking framework after the Global Financial Crisis. The intended framework is close to inflation targeting and proposes a complete system of forecast based monetary policy decision making and policy formulation. Needless to say, while making macroeconomic forecasts and formulating and implementing monetary policy under the new framework, it is of greatest importance to have sufficient idea over the monetary policy transmission mechanism. In other words, it is hard to use your tool, if you do not know how it works.

This study will focus on determining relative strength of each monetary policy transmission channel in accordance to recent shifts in economic and financial environment. The result 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. Chapter II discusses the monetary policy framework and transmission channels in Mongolian economy by assessing economic and financial factors that may play active role in determining relative strength and weakness of each channel. Chapter III briefly reviews the literature on transmission mechanism of Mongolia. Chapter IV and V discuss data and methodology and the empirical results. The final chapter 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 Bank of Mongolia (BOM) are regulated under the Central Banking Act declared by the Parliament of Mongolia. The Act states that BOM is responsible for formulating and implementing monetary policy; issuing 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, primary objective of monetary policy is to promote stability of the national currency. Within the boundaries of its primary objective BOM may take fostering actions towards 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.

a. Monetary targeting (1995-2006)

Bank of Mongolia has had 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 relationship between reserve money and broad money, the money multiplier, had become unstable and impact of M2 on inflation became 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

b. Eclectic (2007-2009-2011)

Considering the difficulties of targeting monetary aggregates, with the collaboration of IMF TA, BOM initiated an eclectic anchoring strategy that set inflation as a goal and monitored 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 BOM introduced Policy rate as the main policy instrument to shock the market and its ultimate intention was to shift to inflation targeting framework in the future. Unfortunately, before BOM could complete the transition, Mongolian economy was hit by the wave of world financial crisis in 2009, sharply. In order to safeguard the foreign exchange reserves and relieve immediate pressure on exchange rate, BOM adopted the IMF Stand-by program in 2009. The program's terms required BOM to target monetary aggregate by putting ceiling on net domestic assets and setting a floor for net foreign assets. In 2011 BOM successfully completed 18 month Stand-by program and finalized it.

c. Transition to forward looking framework (2011-on going)

Since 2011 BOM has been laying out the ground works to a more forward looking monetary policy framework. Namely, Forecasting and Policy Analysis System (FPAS), which is a complete system 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, FPAS is expected to strengthen monetary policy transmission in the economy. In other words, desired outcome of FPAS is to reinforce link between policy rate, short term market rate, long term rate and ultimately inflation expectations. Yet, currently BOM lacks well-defined operational target and anchor for inflation expectations, which are considered foundational bricks of the FPAS system. Hence it is an uneasy task for BOM to maneuver longer term rate in desired direction, and it often misses inflation target and consequently credibility issues arise. In this regard, for the last couple of years 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, BOM formulates its monetary policy and implements it using several direct tools, such as reserve requirement, policy rate, standing facilities and foreign exchange deals.

Reserve requirement: On banks, BOM currently imposes a minimum reserve requirement of 12 percent of liabilities 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 percent of the reserve requirement daily. Banks' demand deposit at the Central bank is considered eligible and accounted towards the compliance measure of reserve requirement. The liability base includes practically all deposits in both domestic and foreign currencies by nonbanks.

Policy rate: In 2007 BOM introduced policy rate (7 days central bank bill rate) to maneuver short term rate on interbank market. But the transmission from policy rate to banks' deposit/ lending rates remains problematic because of shallow bond and interbank market and strong exchange rate channel.

Standing facilities: BOM employs two standing facilities: overnight repo and overnight deposit. Overnight repo facility is fully collateralized, priced at two percentage points above the policy rate. While the overnight deposit facility is priced at two percentage points below the policy rate. Overnight repo and overnight deposit facilities are the last transaction approved on a business day and matures the first on the

following business day. The ration behind these tools is to provide a corridor around the policy rate, so that interbank interest rate floats within 2 percentage point of the policy rate.

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

Foreign exchange deals: In order to reduce excess volatility in exchange rate and align exchange rate movement in-line 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 and non-banks, as well.

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 originated substantial direct lending to banks at below-market rates, under Price Stabilization Program, Mortgage program and direct lending to banks. The total planned allocation under these programs is equivalent to 19 percent of GDP in 2013. In the same year, central bank's claims on banks increased more than 10 times and reserve money grew by 54 percent compared to end of 2012.

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

In August 2013, Bank of Mongolia injected liquidity of MNT 900 billion to the banking system, in the form of one-year time deposit at 7 percent 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 to provide low-cost mortgage loans to qualified debtors. Funding under this program was provided to banks at 4 percent interest rate and on-lent by banks through 20-year mortgages at 8 percent interest.

2.2. Main Monetary Policy Transmission Channels of Mongolia

In this section we discuss factors that affect transmission mechanism of monetary policy in Mongolian economy. 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 industrial sector, conventional transmission channel of interest rate is unlikely to work efficiently in developing economies.

One of the reason behind the weak interest rate channel of monetary policy transmission in Mongolia is poor development of interbank and securities market. Change in short-term rate should transmit to longer-term bond rate, since expected short-term rate determines long-term bond rate. However, this channel is not observable because currently yield curve of government security and corporate debt is not available and is uncertain information for investors and banks. Although the Mongolian government is attempting to develop government security market, secondary market for domestic government bond is still shallow and illiquid. Moreover, most non-major domestic firms have limited opportunity to raise additional fund by issuing corporate debt. Not to mention, raising capital in domestic equity market via IPO and SPO is constrained by shallow investor base and illiquid market. This poor development of 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; the World Bank http://wdi.worldbank.org/table/5.4

As a market for short term liquidity, money market plays an important role for transmission of short-term rate to long-term rates. Money market serves as a base platform where financial institutions can easily fulfill their short term liquidity needs at competitive cost. As the size of money market widens, pass through of short-term rate to longer term rate becomes stronger. However, in Mongolian economy, the size of

interbank market and banks' funding from interbank market are marginal. For instance, banks' fund raised at interbank market is below 4 percent of banks' total equity and liability. Moreover, most of the transactions at interbank market are settled among only 5-6 large banks and total monthly turnover in interbank market is usually less than 5 percent of total asset in banking sector.

Though the effect of interbank market rate to bank lending rate is generally referred to as a bank lending channel, one part of a broader bank credit channel, we describe this channel in detail, as follows[5]. Central bank maintains interbank market rate around its desired level by employing policy rate and interest rate corridor of 2 percentage points around the policy rate. Since interbank market is a potential source of funding for banks, banks' short term rate should not deviate far from the interbank market rate. This short term rate is expected to affect the banks' deposit and lending rate. Banks sets its lending rate and it is determined by sum of 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 Mongolian case, since 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] Yet, Mongolia is not fortunate enough to escape the pitfalls of emerging economy that lead to weak interest rate channel.

In case of Mongolian economy, although link between lending and long term deposit rate and household consumption and capital formation may still be intact, transmission of short term rate to long term deposit and lending rate may be the point of breakdown.

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

Another factor is competition in the banking sector. Competition between three major banks over its large depositors is fierce and this fierce competition in depositors and lenders disables the three major banks to decrease their deposit rates or increase their corporate lending rate, following a change in policy rate. For the case of relatively

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

[6] For instance, at the end of 2010 and 2014, deposits comprised 75 percent and 44 percent of total bank liabilities, respectively. The reduction of deposits share 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 banking sector.

smaller banks, there is an institutional factor that creates a buffer for their deposit rates against policy rate. In 2011, the government introduced guarantee on deposits up to 20 million MNT and since then banks' risk profile became less important relative to interest rate differential. Hence, in case of a reduction in policy rate, a single small bank cannot reduce its deposit rate accordingly, in the fear of losing its depositors to a different bank offering higher deposit rate, regardless of its risk profile.

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

2.2.2. Exchange rate channel

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

The effectiveness of this channel depends on the central bank's willingness to allow the fluctuation of exchange rate and it is referred to term of "fear of floating". The degree of "Fear of Floating" and central bank interventions in the foreign exchange market can be assessed in relation with the balance sheet effect. For instance, exchange rate fluctuations negatively affects 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 government, financial institutions, firms and households. In Mongolian banking system, around 30 percent of total loan and deposit is held in foreign currency. Due to the absence of relevant restrictions on conversion of deposits from domestic currency to foreign currency or vice versa, following a change in the depositors' expectation regarding the stability of domestic currency, deposit conversion that has potential hazardous effect on banking

[7] Calculated as interest income over loan outstanding
[8] http://www.dbm.mn

system may emerge and risk of currency mismatch arises. Following a nominal depreciation, this adverse effect of 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 global financial crisis and recent economic downturn, a significant amount of conversion from domestic currency to foreign currency deposits was observed in the banking system.

Furthermore, in recent decade Mongolian banks, corporations and the Government have been actively participating in international financial market, to raise funds to meet its financing needs. A bank that raises fund as a debt in international market tends to be forced to issue foreign currency dominated loan to domestic borrowers, so as to hedge their currency risk and to fulfill prudential regulation on foreign exchange open position[9]. Since interest rate 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 Bank of Mongolia cannot adopt full-fledged flexible exchange rate regime because of high dollarization and balance sheet effect. Also, the stability of domestic currency is considered an important indicator for the credibility of Bank of Mongolia and the confidence of economic agents in domestic economy. General public and the politicians still tend to see exchange rate as a main indicator while assessing the effectiveness of monetary policy and economic condition, though complete exchange rate stability is not the primary objective of monetary policy. Not to mention the significance of exchange rate fluctuation 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 exchange rate transmission channel. In an economy where capital mobility is relatively high resulting from change in short term domestic rate, great amount of capital transfer tends create large fluctuations on exchange rate. In other words, control and restrictions on capital movement can discourage capital mobility and hence reduces the significance of exchange rate channel. Although, Mongolia does not impose any type of restrictions or control on capital mobility, such as taxes or tariffs, similar to the case of emerging countries in the 1980s, it still faces difficulties to attract capital flow and it is becoming certain that differential between domestic and foreign interest rates is not sufficient. It seems obvious that while making decision on their investment, in addition to the interest rate differential, investors put significant weight on other factors such as uncertainty over exchange rate fluctuations, capital productivity, legal framework, regulatory and institutional risk, capital and labor productivity and its cost and development of financial intermediation and etc.

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

Last but not least, higher pass-through of exchange rate to inflation plays significant role on the relative strength of nominal exchange rate transmission to aggregate demand. Greater the pass-through, 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 50percent at the third quarter of initial shock. It is consistent with the fact that a third of goods in consumer basket and around half of intermediate goods in production sector are imported from abroad.

2.2.3. Bank lending channel

In literature, traditional bank lending channel of monetary policy is described as follows. Expansionary monetary policy increases banks' reserves and deposits, in other words available fund to issue credit, and with improved liquidity condition interest rates should decline. Since households and non-corporate firms are highly dependent on bank lending compared to large corporates, following the rise in credit at relatively lower pricing, private consumption and private investment are expected to increase as well. 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 central bank may either decrease short term interest rate and increase banks' profit margin, or reduce reserve requirements and charge on banks' capital or increase remuneration for required reserves that would increase available fund for lending activity. Macro prudential measures such as capital adequacy requirement may also put limit on the available fund. Moreover, one of the most popular tools of the last decade, priority sector lending targets or stylized quantitative easing programs also serve as an instrument which transmits the effect of monetary policy through lending channel.

In case of Mongolia, Bank of Mongolia has several policy instruments and has taken both orthodox and unorthodox measures throughout its history. For instance, in order to anchor the short term rate through the interbank market rate, Bank of Mongolia introduced *policy rate* in 2007 and interest rate corridor with overnight deposit and lending rates in 2012. As mapped above, expansionary monetary policy by decreasing the policy rate should reduce cost of funding for banks and increase their margin, which lead to higher credit supply.

In addition to the interest rate instruments, Bank of Mongolia imposes a minimum *reserve requirement* of 12 percent on banks' liabilities. This instrument was first introduced in 1993 and serves the double purpose of managing the supply of money and providing liquidity to the banking system. For instance, by reducing liquidity in the system, the central bank implements contractionary monetary policy and discourages credit supply and domestic demand, consequently. Over the years, the 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, 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 and starting 2015, BOM started to pay remuneration equivalent to a half of overnight deposit rate. In 2014, in order to encourage foreign exchange inflow, Bank of Mongolia removed the minimum requirement on banks' liabilities of foreign origin with maturities 3 years or more.

Parallel to traditional monetary policy instruments, in order to maintain the stability of financial system, Bank of Mongolia employs several macro prudential measures, as well. For example, high capital adequacy ratio may restrict banks' fund and liquidity available for lending activity and hence put cap on credit supply. Addressed properly, timing and magnitude of these measures may play significant role in explaining irregularities in the effectiveness of lending channel.

In recent years, Bank of Mongolia has been actively engaging in unorthodox monetary policy measures or stylized quantitative easing programs. Starting late 2012, in cooperation with the Government of Mongolia, the central bank introduced direct lending program to prioritized sectors in-line with the government's development goals. Under the program, over the course of 3 years a total of 5 trillion MNT was provided to agriculture, construction, mining, real estate and banking sectors and year over year growth of credit, base money and M2 money supply reached as high as 58, 36 and 54 percent, respectively. Currently most of the programs have come to an end and significant portion of the initial funding is retracted from the system. Hence while assessing the lending channel this direct increase in credit supply must be taken into account.

According to Barran et al (1996), bank lending channel depends on the central bank's control over the banking system and the availability of lending source alternate to 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, banking sector comprises over 95percent of the financial sector and there is little substitutability over financing source for households and non-bank corporates. Superficial judgment based on this statistics would suggest strong lending channel in Mongolian 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, though the size of banks is not a significant determinant. Similarly, Mishra et al (2010) have found that the banking sectors of many LICs tend to maintain high levels of liquidity, compared with those of banks in higher-income countries. In 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 credit channel.

Either strong or weak, literature asserts that effect of monetary policy through lending channel may have asymmetric impact on the end-users. In case of contractionary monetary policy, banks become reluctant to issue credit and likely to withdraw its exposure to credit market. However, the way banks reduce their credit may not be symmetric across all type of debtors. It may be that banks have more negotiating power over SMEs and households rather than 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, effect of monetary policy may feed into 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 lower discount factor, net worth of business projects and companies, increases and thus its stock price rises at the market and investors receive higher dividend, leading to higher domestic demand. Second, expansionary monetary policy raises investor's expectation of prosperous future economic growth. With elevated expectation of future cash flow asset price tends to increase.

Mishkin (1996) explains the asset price channel through stock price, also known as the Tobin's Q channel, in by two main links. First, higher stock price increases 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 project at cheaper cost, having less need to issue additional stocks at the market. However in case of Mongolian economy, immaturity of the domestic capital market reflecting firm's very limited opportunity to raise additional fund through IPO and SPO might discourages the significance of Tobin's Q channel.

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

One of the factors behind strong housing price channel may be explained by 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 percent[10] per annum. Consequently, in the past 2 years more than 50 thousand new housing and apartments were supplied to the market; more than 80 thousand housing and residential real estate were sold; and housing price increased by more than 30 percent[11]. This increase in housing price not only elevated wealth of home owners, but also caused surge in construction and real estate investment. However, it is important to bear in mind that this program increased household indebtedness which negatively affected the household's disposable income and current consumption expenditure. Over the past 2 years, mortgage loan increased by 3.4 times to finance around 44percent of houses sold in the market. As mentioned above it may put negative impact on current consumption of households who are first-time homeowners. Yet the same cannot be argued for ones that already owned housing before the program.

Though Tobin's Q channel may seem insignificant in Mongolian economy, it is important to emphasize the combined effect of asset price channel and credit channel. Since banks usually ask for land, residential or non-residential real estate and factory buildings as collateral for issuing either new loan or refinance existing loan; increase in its price of real estate or the valuation of the company project would be translated as higher opportunity for the firm to borrow from a bank.

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 in the field of measuring effectiveness of monetary policy transmission, empirically, only a few of them focus on the transmission channel in a typical emerging market, low income country, and it is safe to assume the literature is in its infancy in this field. Yet, before looking at previous studies on Mongolian case, it is constructive to look at the technical overview of these studies on monetary policy transmission in emerging economies.

Overall technique employed in most of the monetary policy transmission studies, is recursive Vector Autoregressive approach with Choleski decomposition, where monetary policy is assumed as exogenous and ordered at the beginning of Choleski exogeneity list. Hence it is assumed that the shocks of monetary policy have

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

[11] www.nso.mn

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 follows. 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 shock, where the impact of the policy action is observed with a lag, Bernanke and Blinder (1992) proposed 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 their scheme by adding commodity price to the system and bringing federal funds rate as monetary policy variable instead of 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 all of 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, monetary policy variable was not always ordered last in the Choleski ordering. Peersman and Smets (2001) estimated the monetary transmission mechanism in 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 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 that nominal exchange rate depreciation in current period would cause increasing pressure on price level, then the central bank 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)

$$M = a_1R + a_2P + a_3Y + e^d \text{ (Demand for reserves)}$$

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

Bernanke and Mihov (1998) adopted a different model of the reserves market with similar approach. And 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 exchange rate respond to all other variables in a contemporaneous manner. Kim and Roubini (2000) extended Sims-Zha framework with world commodity price and world short term interest rate, and it is often used to identify structural shifts in low income countries.

Several other studies were conducted on transition countries in Central Asia, where characteristics such as low income, weak institution, low degree of integration to 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 Armenian economy, Samkharadze (2008) on Georgian economy, Bordon and Weber (2010) on Armenian economy, Bakradze and Billmeier (2007) on 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.

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

3.2 Literature Review on Monetary Policy Transmission in Mongolian Economy

In literature there are few papers that directly touch on the monetary policy transmission mechanism in Mongolia. However, several studies published in the series of Bank of Mongolia research books are in the extent of providing indirect intuition to the subject. For instance, number of researchers studied lagged effect of monetary policy on inflation and 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 topic of monetary policy transmission mechanism in Mongolia, this section briefly reviews the common methodologies and outcome of the studies and tries to paint overall picture of monetary policy effectiveness. In addition, drawing intuition on the historical nature of monetary policy and its impact on financial market as well as real economy will provide significant explanatory power for the outcome of this research paper.

One of the earliest studies on monetary policy and inflation in the 2000s, (Luvsannyam, 2004) studies lagged effect of money supply, central bank bill's rate and exchange rate on inflation during 1996 and 2004, using recursive VAR method. According to (Luvsannyam, 2004), the effect of exchange rate on inflation starts in the third month of nominal shock and peaks in the fifth to sixth month. Whereas, 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 exchange rate channel is the most significant channel of monetary policy in Mongolian economy.

A later study on the same topic, where (Doojav & G, 2004) used Granger causality and VAR analysis over data on different monetary aggregates, reinforces the result of the previous study. Doojav & Borkhuu (2004) have found that exchange rate and central bank bill's rate both have 4 month lagged effect on inflation. Yet exchange rate channel was still the strongest. For the case of monetary aggregates, M1 and M2 monetary aggregates both had similar effects on inflation with 4 and 8 month lags. In 2009[b], Doojav, G. further narrowed his study by eliminating central bank bill's rate and M2 monetary aggregates and distinguished monetary policy and exchange rate impact in the longer term and shorter term. The paper concludes that 1 percent increase in M1 supply increased CPI by 1 percent in the long term and 0.05-0.06 percent in the short term (6-7 months after the initial shock). In the short term exchange rate had faster and larger effect on CPI. 10 percent depreciation increased CPI by 0.37-0.41

percent 3 months after the shock. However in the longer term the same shock had 0.31 percent effect on CPI. The study also checks the relation with core inflation. The only difference observed is for the exchange rate shock. 1 percent depreciation increases core CPI by 0.4 percent in the longer term.

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

In 2010 he further widened his research by studying symmetry of exchange rate fluctuations on inflation. According to (Doojav, 2010) nominal depreciation has stronger effect on inflation compared to nominal appreciation. Hence, the study suggests that in case of 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 effect of policy rate change.

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

In 2011, Demid E. studied lending channel of monetary policy with 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's rate and lending rates have opposing impact on credit supply but of same magnitude, and central bank bill's rate, banks' reserves and equity have no impact on credit demand. For the sample period between 2004 and 2011, estimation results suggest that for 1 percent increase in banks' reserves, credit supply increases by 0.2 percent after 1 quarter, for 1 percent increase on equity, credit increases by 0.1 percent. However, for 1 percent increase in lending rate, lending activity declines by 0.02 percent only. Hence it concludes that banks decide on credit supply mostly by observing its reserve and equity, rather than the increased opportunity to exploit over central bank bill's rate and so credit channel in Mongolia is strong. For the credit demand side, its elasticity from lending rate is 0.1

and elasticity from GDP is 1.3. Since income effect is stronger than cost effect, the study concludes that 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 percent significance level. The paper proposes that interest rate differential between lending and deposit has narrowed until first half of 2008, due to lower reserve requirement and higher growth of M2. Moreover, based on his finding that interbank market rate has significant effect on bank's excess reserve and consequently interest rate differential, Doojav (2009[a]) asserts that if Bank of Mongolia succeeds at maneuvering interbank market rate, 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 opportunity cost of banks' lending activity and lending rate based on banks' cost calculations. Based on its assumptions the paper comes to the following results:

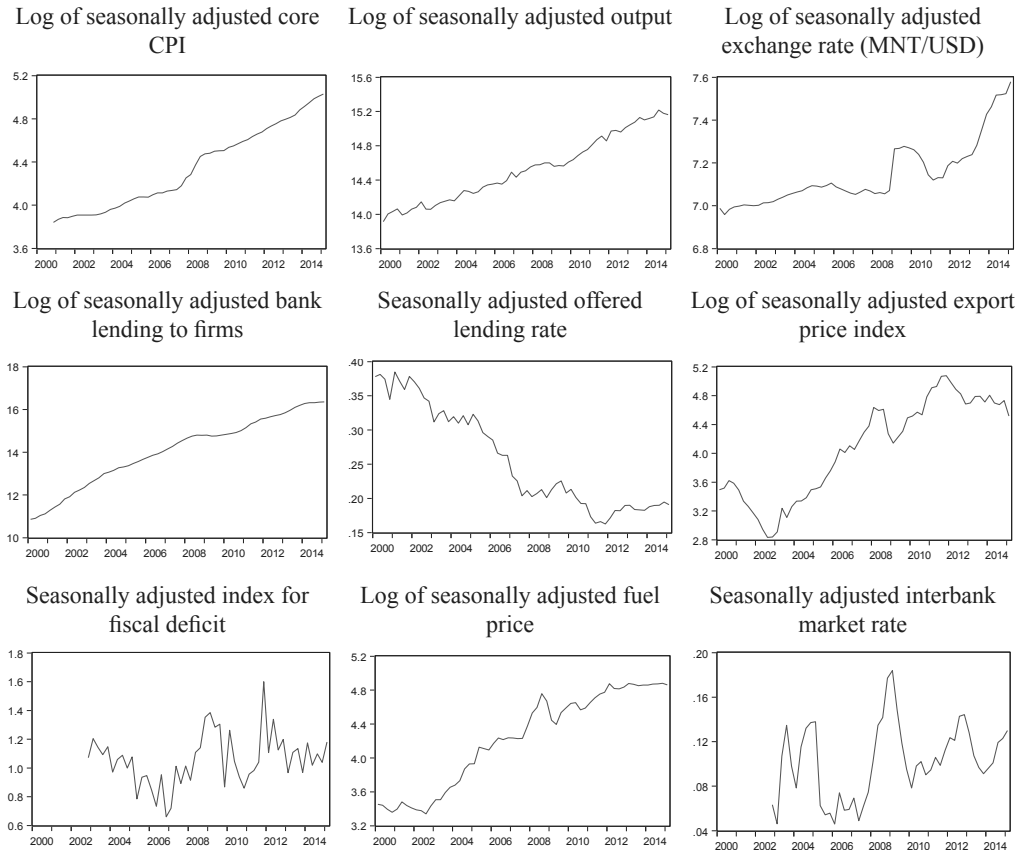
- Banks pay dividend to its owners by the share of their equity. However owners have the choice to invest their equity in central bank bill and earn interest income of at least the policy rate. So, by not investing in central bank bill, the owners are incurring opportunity costs and it is compensated by the banks' equity cost, which is incorporated in the lending rate. According to Demid et al (2012)'s estimation, out of lending rate of 17.43 percent in September of 2012, 0.27 percentage was contributed by the cost of equity. That is 1.5 percent of lending rate is channeled through the opportunity cost of equity.
- Banks are obligated to hold a certain amount of liquid asset at the central bank as required reserve. 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 profit at the policy rate. Here, banks incur cost on required reserve as a lost opportunity to earn interest income and it must incorporate it in its lending rate. The paper has estimated that this opportunity cost is 1.33 percentage of total lending rate of 17.43 percent. In other words, 7.6 percent of cost estimated lending rate is channeled through the reserve requirement.

The result is also confirmed by the "Lending rate survey" outcome, where banks suggested policy makers to reduce inflation, match policy rate with inflation, reduce RRR, keep foreign exchange market stable and create a stable macroeconomic environment that would reduce financial sector risk.

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 World Bank and Bank of Mongolia (BOM) database.



Source; The National statistical office of Mongolia and The Bank of Mongolia

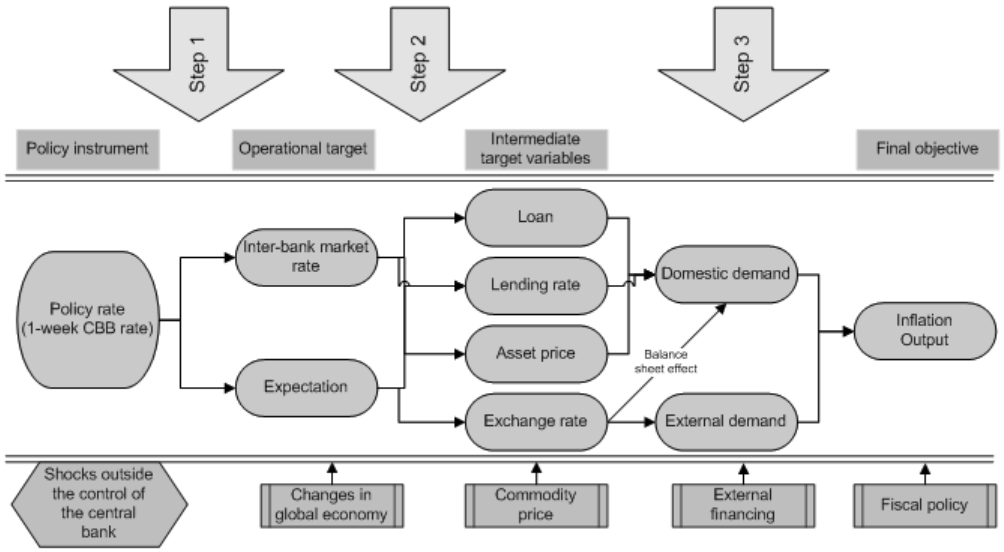
The price series is core Consumer Price Index (CPI, pc_sa), output series is quarterly real Gross Domestic Product (GDP, y_sa), exchange rate is measured by the price of US dollar per national currency MNT (e_sa), and we used a total outstanding loan (l_sa) from banks to private sectors. Analysis of monetary policy transmission requires careful choice of interest rate that sufficiently captures the true nature of monetary policy stance. For this reason, we checked couple of short term interest rate variables: interbank market interest rate (weighted average rate, ibr_sa) and central bank bill rate and have decided to use interbank market rate as a proxy for policy stance. As for the long term rate, due to limited length of available choices, we used offered lending rate

(lr_avg_sa). All 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 called the policy rate and expressed by 1-week central bank bill (CBB). Central bank bills are a main instrument for absorbing excess liquidity from interbank market and steering interbank rate. Also, policy rate signals to market participants on monetary policy stance and future development of inflation. Interbank rate and expectations further affect intermediate-targets such as lending rate, banks credit to private sector, 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 bank 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 VAR approach. Second, by estimating the OLS we examine the effect of unanticipated policy shocks to intermediate macroeconomic and financial variables[12]. Third, 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 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 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, Philippine etc. tend to consider the movements of exchange rate; thus they reacted to sharp depreciation by increasing policy rate in short term during GFC-08/09. In case of Mongolia currency stability is set as primary objective of monetary policy, while output and inflation are included in policy rule of main forecasting model. However, BoM explains currency stability as a price stability.

L.J. Christiano et al (1999) identifies monetary policy shock as 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 exogenous shock to the preference of monetary authority for unemployment and inflation. Second, it reflects Fed's desire to avoid the social costs of disappointing private agents' expectations (Ball (1995) and Chari, Christiano and Eichenbaum (1998)). Third; it reflects technical factors that is the measurement error in the preliminary data available to the FOMC at the time it makes its decision (Hamilton (1997) and Bernanke and Mihov (1995)).

[12] Loan outstanding to private sector from banks, nominal exchange rate and lending rate

Therefore, in order to determine unanticipated monetary policy shocks we estimate VAR model that controls output and inflation as a main information that agent can consider to predict policy changes. Also, the VAR includes interbank market rate as a policy variable. It means that unexpected policy shock is determined by movements in interbank market rate that is not explained by output and inflation and is measured by residual of equation for interbank market rate in 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 step 1 and 3. The general form of the VAR(p) model with deterministic terms and exogenous variables is given by following equation;

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

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

In step 1, the VAR model includes log of output, log of CPI and interbank market rate[13] as endogenous variables and 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, VAR model is estimated to determine effects of intermediate variables which are bank loans to private sector, lending rate and exchange rate. It includes 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 by Akaike information criterion (AIC), Schwarz information criterion (SIC), Hannan-Quinn information criterion (HQ), Final prediction error (FPE), Sequential modified LR test statistic (LR). Furthermore, the stability of the estimated model was checked via roots of the AR characteristic 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

[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.

variables in the VAR system. In order to determine impulse response functions, the VAR model is transformed into a VMA representation.

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

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 and it has several advantages: it can be estimated by simple least squares; it is robust to misspecification of the DGP; it is easily applicable for non-linear specification and etc. This approach has also been used in Vargas, H., Gonzőlez, A., & Lozano, I. (2012). They estimate the impulse responses of GDP to fiscal shock, and those of public bond rate and market rates to an unexpected monetary policy shock. Following the same idea, 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 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 exchange rate, lending rate or bank loan to private sector. Hence, we use the following equation;

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

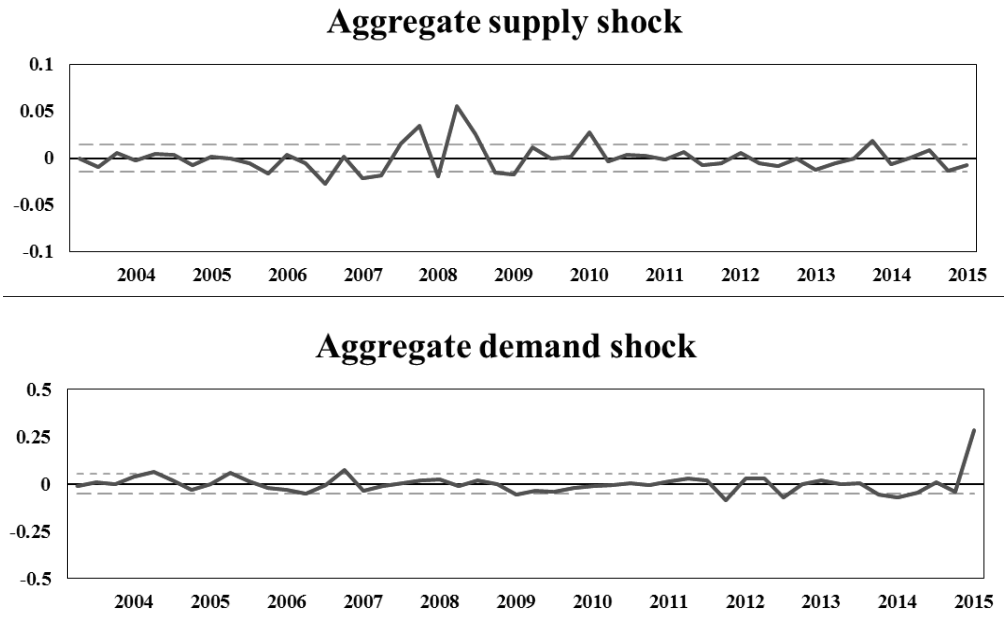
Where X_t represents an intermediate target variable, u_t is potentially serially correlated error term, ε_t is unanticipated monetary policy shock which is extracted from VAR model in step 1. In this model ψ_h represents the impulse response coefficients at horizon h. Therefore, the number of lags is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

5. EMPIRICAL RESULTS

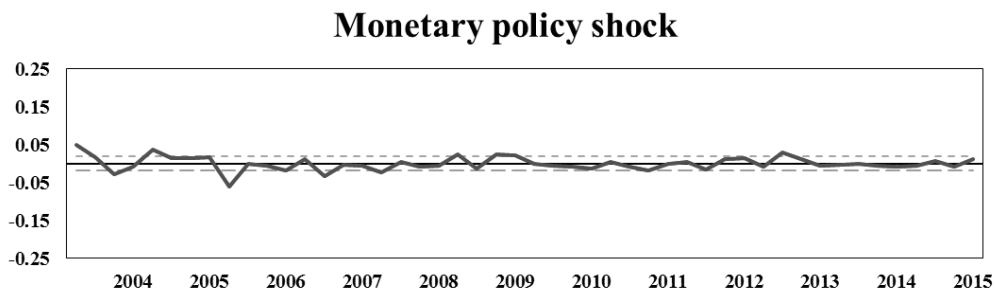
Macroeconomic indicators that are used to put diagnosis on general "well-being" of the economy, are prone to numerous external and internal shocks such as economic policy shocks, not to mention the fact that policy indicators are intertwined in the system so deep that it is difficult to identify exactly through which channel the policy shock transmits to macroeconomic indicators. Hence, for the sake simplicity in both 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, reduced form VAR model is initially estimated on CPI, nominal GDP and interbank market rate (*pc_sa, y_sa, ibr_sa*) in order to isolate 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 OLS technique, we estimated the significance of policy shock on intermediate targets such as exchange rate, lending rate, and credit issued by banks to private sector. ***Third,*** we estimate a reduced form VAR model with inflation, output, exchange rate, lending rate, and credit issued in order to see the significance of each transmission channel.

Step 1- Identifying policy shock

Figure 1. Historical evolution of structural shocks (2003Q2-2015Q1)



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



In this model, interbank market rate is considered as a proxy for monetary policy instrument and the reduced form VAR suggest that unanticipated change in monetary policy has negative impact on both output and inflation. However, 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 is consistent with the literature, we proceed to check its 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 policy shock on intermediate targets, which are the "starting point" of exchange rate, interest rate and lending channel of monetary policy by estimating 3 independent equations in the following; [15]

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

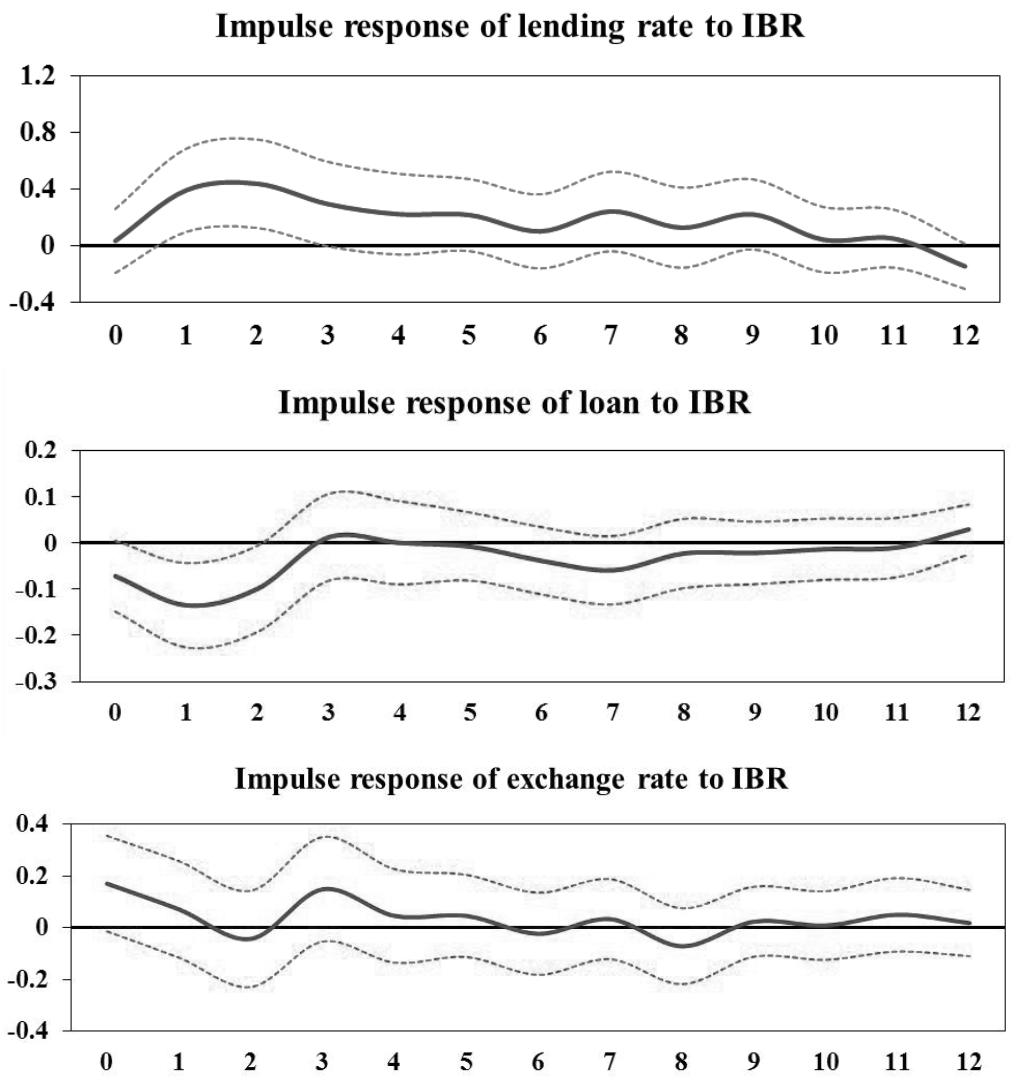
$$Eq\ 2: l\_sa_t = b_0 + \sum_{i=0}^{12} b_{i+1}\varepsilon_{t-i} + AR(1) + e_t^{l}$$

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

where ε_t is unanticipated monetary policy shock obtained from VAR estimation in step 1, c, a and b represent for impulse response of intermediate variables, respectively. OLS estimation result of *Eq 1* suggests that impact of 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, an increase in interbank market rate leads to higher lending rate. In case of the second equation, though the goodness of fit is not as good as the first equation, impact of unanticipated policy shock on lending is stronger within 2 quarters of the initial shock with theoretically correct signs. In the last equation where exchange rate is regressed on unanticipated policy shock, effect of change in interbank market rate is not statistically significant.

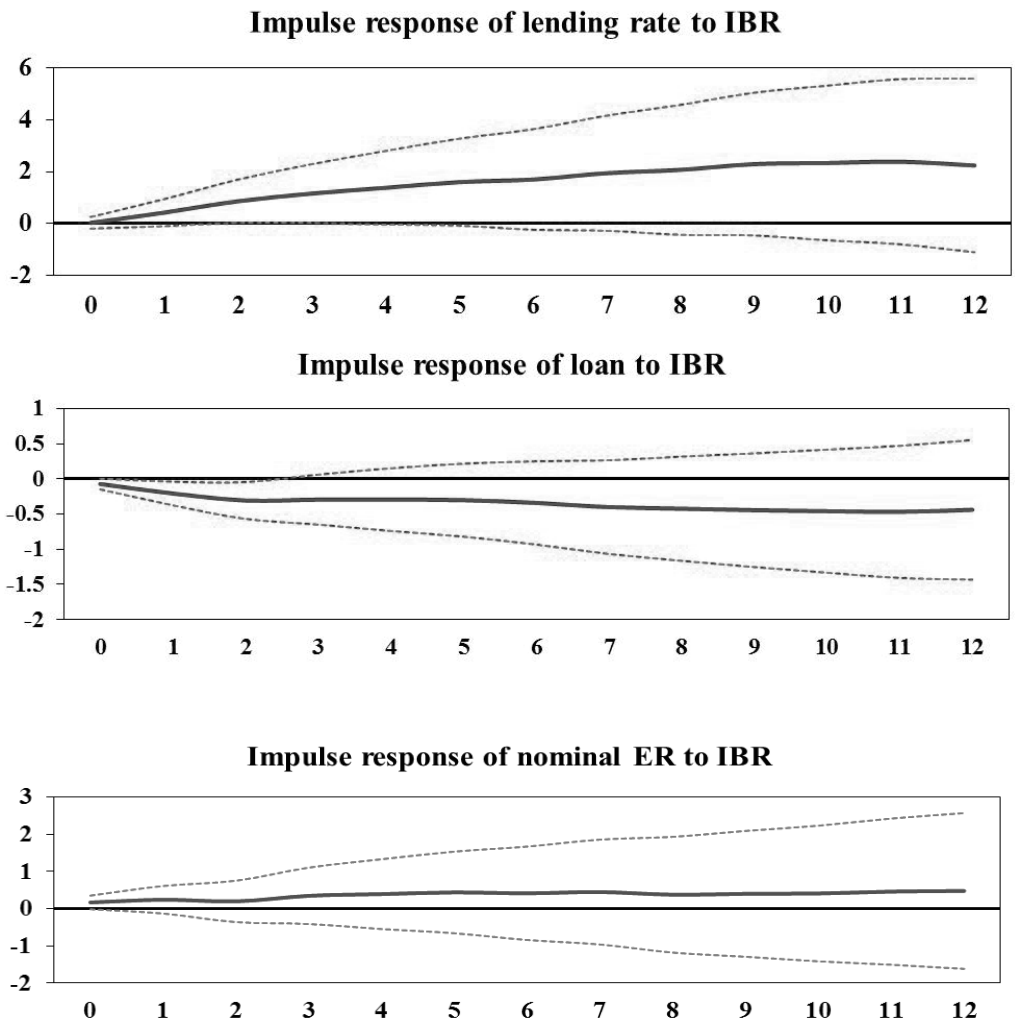
[15] Estimation results are shown in Appendix B1-B3

Figure 2: Impulse responses to 1 percent unanticipated shock of interbank market rate.



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

Figure 3: Accumulated impulse responses to 1 percent unanticipated shock of interbank market rate

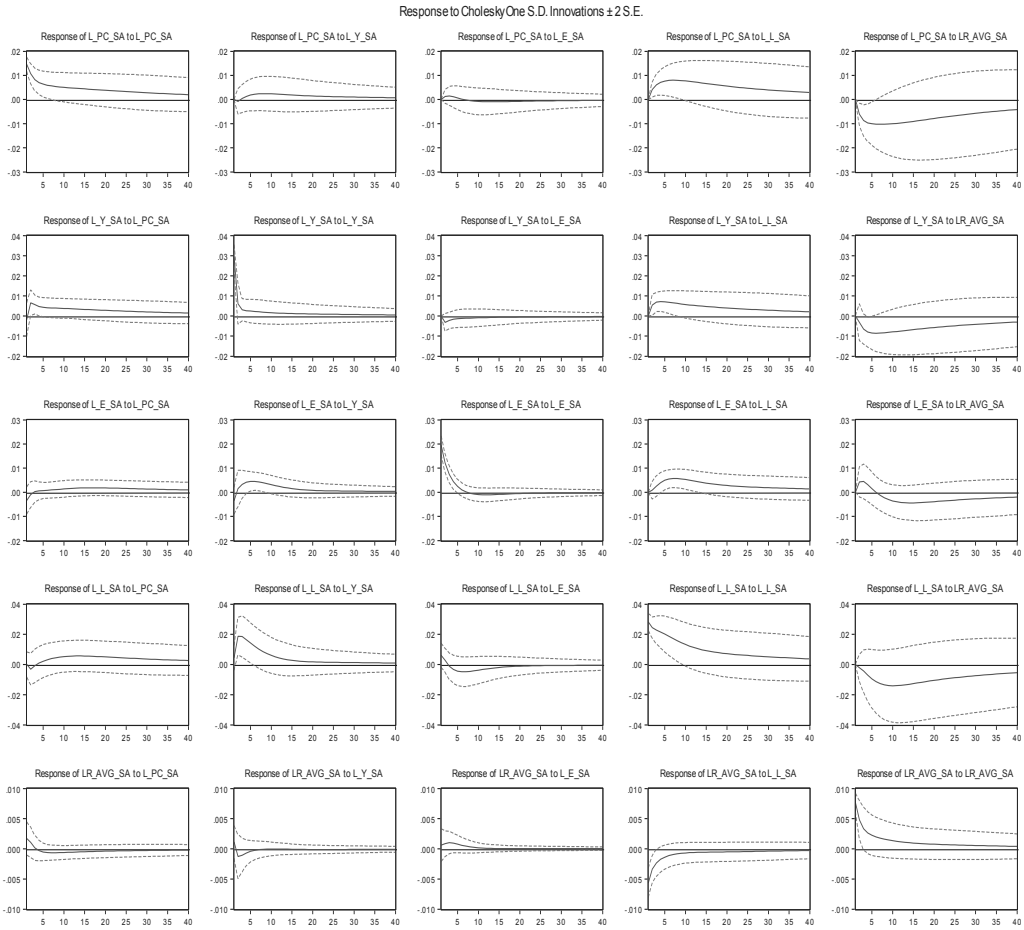


At initial glimpse, out of the three equations estimated, equation for exchange rate seems inferior and that exchange rate is dull in response to policy shock. However, if we consider the extent of foreign exchange intervention conducted by the central bank, effect of interest rate change on exchange 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, 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*). Moreover, 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 lending rate to inflation is strongest within 4-6 quarters of the shock and in first 6 quarters statistically significant. For the response of output, it is theoretically consistent and its magnitude is significant between 4th and 5th quarter of the shock.

One unit of loan. The lending to private sector from banks has a positive impact on inflation and output with the delay of number of quarters. The response of inflation is statistically significant 10 quarters after the shock and the strongest impact is observed

[16] See estimation output in Appendix C

in 6-8th quarters. The transmission to output is statistically significant in 9 quarters after shock.

The loan and lending rate channel have statistically significant impact on both of inflation and output while exchange rate channel does not have statistically significant impact on the final targeted variables. Comparing the 2 effective channels, the impact of lending channel on inflation is marginally stronger than of lending rate channel while lending rate channel has a slightly stronger impact on output.

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

Surprisingly enough, in contrast with several studies, we find exchange rate not significant on price and output in Mongolia. One plausible explanation suggest that the effect of exchange rate is captured by private loan. This is because the level of outstanding loan and exchange rate are highly correlated. And secondly, the causality test shows that loan and lending rate causes exchange rate without 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 deficit and depreciation in the medium term. Impulse response function shows exchange rate depreciation from 5th quarter after lending shock lasting for long horizon while response of exchange rate to lending shock is not significant.

Overall, 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 transmit 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 of the bank lending[17]. According to impulse analysis, supply of bank lending immediately leads to decline in offered lending rate; also, it leads to depreciation of domestic currency, starting from 5th quarter till 13th quarter. Then, offered lending rate affects price and output which is consistent with theoretical concepts, whereas the effect of exchange rate shock on other variables within the VAR system is not statistically significant. Following softer credit condition, higher output leads to increase in loan demand at the later stage and it is seen from statistically significant impulse response of bank loan to shock of output. Also, greater output affects depreciation of the domestic currency in the medium term. It seems that supply of bank lending driven usually by fiscal deficit, capital inflow and/or favorable condition of terms of trade (with resulting higher liquidity in banking

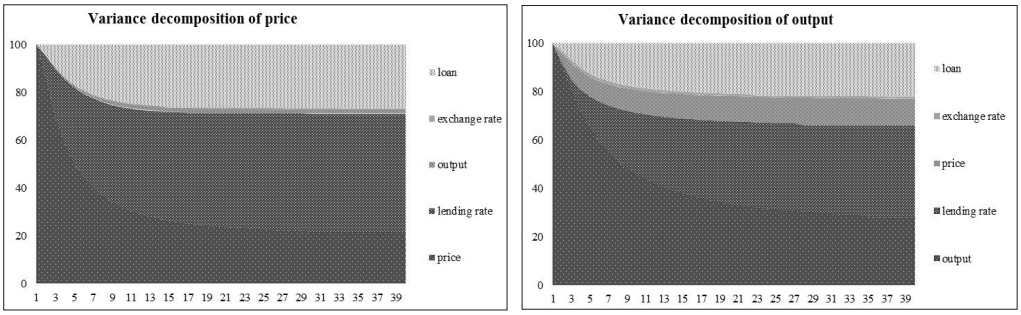
[17] This consumption loan is determined as a loan that is issued to household, not including mortgage and SME loan.

system) boosts the economy and exerts pressure on inflation during the boom period. Then, it drives the economy to overheating and higher current account deficit which make exchange rate to depreciate.

It may be necessary to note that all variables except for lending rate in VAR system are unit root in level and they are I(1). This implies that 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 proved by roots of the AR characteristic. Polynomial and the null hypothesis of multivariate normality of VAR residual are not rejected by normality test. Also, LM test did not reject the null hypothesis of no serial correlation of VAR residual.

Figure 5 reveals the contribution of 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, 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, respectively only 21 percent of the price variation and 28 percent of the output variations in 40th quarter though they start from 85 percent and 90 percent, respectively. On the contrary, lending rate shock starting from 9.8 percent of the price variation in second quarter converges to 49.8 percent in 40th quarter. In addition, the proportion of lending rate shock in output variation increases from 1 percent in 2nd quarter to 38.2 percent in 40th quarter.

Figure 5: Forecast error variance decomposition.



6. CONCLUSION AND POLICY IMPLICATIONS

This paper aims to draw a general picture of channels of monetary policy shock to inflation and output. However, our conclusion is limited by our belief that there is no misspecification problem in our statistical model. Macroeconomic variables are closely related and affect each other through 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 is still a misspecification problem; though there are several statistical methods i.e., VAR which are proposed and extensively applied in empirical research to identify true DGP.

Instead of a structural model that could have incorporated the behavioral relationships of agents, VAR and OLS techniques are applied with 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 the most of estimation period. In the second step, estimation to identify the impact of unexpected monetary policy shock to intermediate target variables shows that the shock are transmitted to bank loan, lending rate and exchange rate, significantly. Lending rate responds to shock in 1st and 2nd quarter after the shock while amount of loan reacts to shock in 1st and 2nd quarter, too. In contrast, the response of exchange rate is within the quarter of the shock but it is only significant at 10%. In the following stage, due to the estimation result of VAR model, lending rate and bank credit to private sector can affect both inflation and output with 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 exchange rate on inflation and output are statistically insignificant. Unfortunately, we cannot find solid argument to defend our result; however, one plausible explanation might be that the effect of exchange rate is captured by private loan. This is supported by uni-directional 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 with further research.

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

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Appendices

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

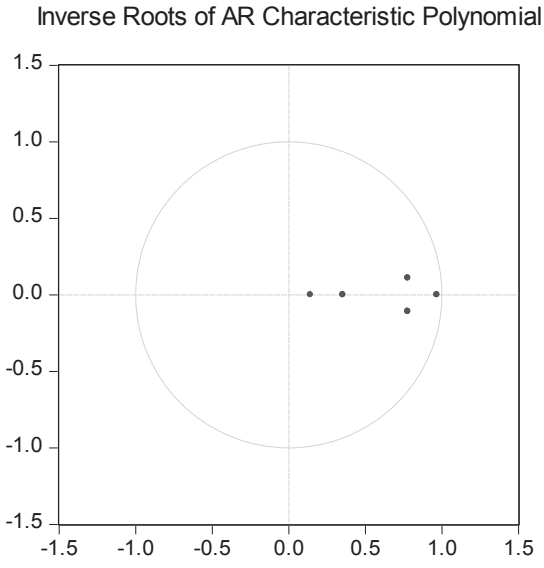
Lag	LogL	LR	FPE	AIC	SC	HQ
0	475.8255	NA	1.87e-14	-17.43302	-15.90340	-16.85053
1	688.8130	315.2214*	1.07e-17	-24.95252	-22.46689*	-24.00598*
2	717.4125	36.60738	1.03e-17*	-25.09650	-21.65486	-23.78590
3	743.5867	28.26818	1.20e-17	-25.14347	-20.74582	-23.46882
4	779.0982	31.25006	1.13e-17	-25.56393*	-20.21026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



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