МОНГОЛБАНК

OUTPUT COMPOSITION OF MONETARY POLICY TRANSMISSION IN MONGOLIA

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The views expressed in this paper are the only authors and do not necessarily reflect the Bank of Mongolia.

ABSTRACT

The transmission of monetary policy has been found to differ between countries in the empirical literature. Understanding the degree to which each gross domestic product (GDP) component - investment, consumption and net export - is affected by policy changes is essential to conducting monetary policy. This paper examines the output composition of monetary policy transmission in Mongolia based on data from 2005Q1 to 2019Q2 and three kinds of benchmark VAR models. It is also comparing the results with other countries, finding Mongolian monetary policy transmission is dominated by the investment channel and its response is quicker than comparator countries.

Keywords: Monetary policy transmission, output composition, Vector Auto Regression

JEL Codes: E52, C32

I. INTRODUCTION

Transmission of monetary policy is heterogenous across countries, depending on their specific economic characteristics. Theoretically, the monetary policy transmission is classified into neoclassical (interest rate, asset price and exchange rate) and non-classical transmission (credit). These mechanisms combine to impact the economy through three main channels: investment, consumption and international trade (Boivin, Kiley & Mishkin 2010). According to the neoclassical theory, the investment channel is from changes to the cost of capital (marginal return on investment) and value of firms (Tobin's q). Consumption channel is defined by consumers wealth and intertemporal substitution effect while international trade channel is due to changes in the exchange rate. While the non-neoclassical transmission or the credit-based mechanism affects all three channels.

There has been a lot of research on monetary policy transmission, however, most of this has focused on specific instruments such as interest rate, exchange rate pass-through and credit mechanism. This is also true for Mongolia. Understanding the output composition effects is equally important to developing effective policy approaches but has been less studied. Being aware of which output channel has stronger for the economy may be the first stage to understand monetary policy mechanism to define the monetary policy stance, policy instruments and the monetary policy rule (Meier & J. Muller 2006).

Although investment is believed to be more sensitive to monetary policy than consumption, all empirical studies do not support this argument. For example, the consumption effect is dominant in the US while investment contributes highest relative to the output components in the Euro area (Angeloni et al. 2003), Japan (Ippei 2004) and Australia (Jamaldeen 2013[2]; Phan 2014) according to VAR and DSGE modelled estimates. VAR estimations also vary for developing countries, with the strongest channel being consumption in

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[2] He found that for the first year the net export effect is highest, but in next years, the investment effect is strongest.

Pakistan (Kamal 2016) and Indonesia (Afandi 2009) whereas investment in Thailand (Disyatat & Vongsinsirikul 2003) and Bangladesh (Suranjit 2016). Mukherjee and Bhattacharya (2011) conclude that the elasticity of private consumption and private investment to interest rate changes varies considerably among developing countries, which may be related to financial market development. Angeloni (2003) defined several reasons why the dominant channel is different among countries. Firstly, if investment adjustment is slow in the economy, consumption effects will be high and thus interest rate smoothing might be required (highly persistent interest rate). Secondly, the consumption response is low as the high persistence habit of consumption. Conversely, if the consumers have a high willingness to shift consumption over time (the intertemporal elasticity of substitution is high), consumption channel is stronger. Lastly, higher capital to output ratio leads to higher investment adjustment.

In respect of Mongolian monetary policy, few studies have been done and the results reach differing conclusions. Some literature concludes that exchange rate pass-through plays the most important role in the transmission mechanism (Luvsannyam 2004) and that monetary policy may give more importance to the exchange rate than the inflation, even though the main target is inflation (Sanduijav 2016; Taguchi & Khishigjargal 2018) based on VAR and IV-GMM modelled estimates. From result of DSGE model, Buyandelger (2015) found that the exchange rate pass-through is weak and need to improve. Other studies focused on interest rate pass-through in Mongolia. For instance, Doojav and Kalirajan (2016) used an ARDL model to show that the interest rate pass-through is weak but has improved. Also, Khishigjargal (2018) concluded that the significance of interest rate transmission has improved after introducing interest rate corridor system (2013) based on the VAR model. According to Bayarsaikhan, Batmunkh & Chuluun's VAR model (2016), the bank lending channel is most effective, while Demid (2011) found the credit channel to be the strongest. Having reviewed the literature, which monetary policy channel is significant cannot be concluded clearly and no single literature touches on output composition of monetary policy transmission in Mongolia. This paper thus contributes to the research field by examining the significance of output composition channels for monetary policy in Mongolia using VAR models. Consistent with the theoretical hypotheses, this paper finds the investment is adjusted more quickly and more important channel in Mongolia.

This paper is organised as follows. Section II introduces the VAR models; Section III explains the estimation results and the final section provides a conclusion.

II. VAR MODELS

The most popular methodology for analysing monetary policy transmission are VAR models (Boivin, Kiley & Mishkin 2010). The models are a useful tool and base econometric technique, dealing with reverse causality for recognizing how monetary policy shock affects other macro-economic variables. In most prior research, VAR models are used to estimate the significance of output composition of monetary policy transmission and defined differently depending on country-specific terms. This paper analyses the output composition of monetary policy transmission in Mongolia through three versions of benchmark VAR models explained individually below. All of the models are based on short-run restrictions or contemporaneous relations. Identification of the first two models is recursive and the other one is included non-recursive VAR model.

1. Model 1 follows the approach of Bernanke & Gertler (1995). They structured the VAR system including variables, log of GDP decomposition (durable, nondurable private consumption and residential, business investment), GDP deflator, log of commodity price, Fed rate, ordered by exogeneity. For Mongolian case, commodity price is not excluded since the VAR estimation do not show the price puzzle. Also, CPI is used instead of GDP deflator considering the central bank target is CPI inflation. Policy variable is policy interest rate in Mongolia.

   The identification assumption:
   Order of the VAR is private consumption, private investment, other components of GDP, CPI and policy interest rate. It is assumed that

the policy rate is affected by other variables, GDP components and CPI contemporaneously.

2. Model 2 is based on Peersman & Smets (2001). The model is extended by money aggregates (money supply, private credit) and real exchange rate. In this paper, model 2 is added variables, M2 or loan outstanding and real exchange rate into the Model 1. In the benchmark model, real exchange rate gap is affected by all other variables in the system contemporaneously. But, for Mongolian case, it is assumed that the policy rate is affected by the exchange rate because the real exchange rate gap is included in the monetary policy rule (Gungaa et.al 2013).

   The identification assumption:

   Order: private consumption, private investment, other component of GDP, CPI, M2, loan, real exchange rate and policy interest rate. It is assumed that the policy rate is affected other variables contemporaneously.

3. According to Kim & Roubini (2000), Model 3 includes foreign variables and nominal exchange rate by non-recursive identification. Mongolia is small open economy and so the foreign variables are exogenous variables in the system. The exogenous shock is important to explain price changes (Tsendsuren 2013). Since the Mongolian economy is influenced considerably by Chinese demand and its mining sector, the Chinese GDP and trade weighted world commodity price index are included as exogenous variables. Two identifications are used in estimating Model 3: one is recursive while the other follows the non-recursive benchmark model.

   The identification assumption:
   Model 3a: Recursive identification.

Order: private consumption, private investment, other component of GDP, CPI, M2, nominal exchange rate and policy interest rate. Exogenous variables: Chinese GDP and commodity price index. It is also assumed that the policy rate is impacted by other variables contemporaneously.

Model 3b: Non-recursive identification.
The structural matrix, A_0 is identified as follows:

$$A_0 = \begin{pmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & a_{56} & 0 \\ 0 & 0 & 0 & 0 & a_{65} & a_{66} & a_{67} \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} \end{pmatrix} \begin{matrix} u_{pcons\_l} \\ u_{pinv\_l} \\ u_{oth\_l} \\ u_{CPI\_l} \\ u_{M2\_l} \\ u_i \\ u_{ex\_l} \end{matrix}$$

In the non-recursive identification, the difference from previous assumptions is specifications of money aggregates and interest rate. Money supply depends on the interest rate besides CPI and GDP components, which is consistent with conventional money demand function. The policy reaction or the policy interest rate is determined by the money supply and nominal exchange rate. This assumption is related to an information timing restriction, meaning available information when the policy decision was made (that is the current exchange rate, money aggregates and for other variables, only lagged values are known). It is assumed that this is also true for Mongolia.

Data: The study employs quarterly data between 2005Q1 and 2019Q2 which is the longest available data for quarterly GDP demand components. All variables are in log form[3] except policy interest rate and all of them are

[3] Temporary monetary policy shock may have a temporary impact on growth rates of variables, but a permanent impact on level variables in the economy.

seasonally adjusted by X-13ARIMA-SEATS approach[4]. The description of the variables and sources are illustrated in Table 1.

Lag length and stationarity: The lags are 2 quarters due to the small sample and the VAR stationary condition (Appendix 1) satisfies for all model.

Table 1: Variables' description and source

Name	Description	Source
pcons_l	Log of real private consumption	National Statistical Office of Mongolia (NSO)
pinv_l	Log of real private investment; Real private investment=real total capital formulation – (government investment/GDP deflator) *100	NSO; Monthly budget balance, Ministry of Finance of Mongolia (MoF)
oth_l	Log of other GDP components; Other=Real GDP-real private consumption-real investment. Since other component in Mongolia is not always positive, the number is added to all series to be positive for log transformation.	NSO
cpi_l	Log of CPI index for Ulaanbaatar	NSO
i_p	Policy interest rate, a week CBB rate	Monthly bulletin, Bank of Mongolia (BoM)
rer_l	Log of real effective exchange rate	BoM
M2_l	Log of M2 money supply	BoM

[4] Mongolia has four season and economic activity is highly dependent on seasons. The approach is one of the common approaches to adjust seasonality.

loan_l	Log of loan outstanding	BoM
ex_l	Nominal average exchange rate (MNT/USD)	BoM
gdp_cn_l	Log of real GDP of China	Bloomberg
pcom_l	Log of commodity price index; Commodity price index is trade weighted price of copper, coal, gold, oil and iron ore.	BoM, Bloomberg

III. ESTIMATION RESULTS

Impulse response (Figure 1; Table 2)**:** The general pattern of the impulse response is consistent for all models (Figure 1). Because of the high volatility in Mongolian economy, mainly due to mineral exports (Barnett, Bersch & Ojima 2012), variables have high standard deviation as well as the small sample, which leads to statistically insignificance of the estimation. However, the consistency of the estimations provides robustness.

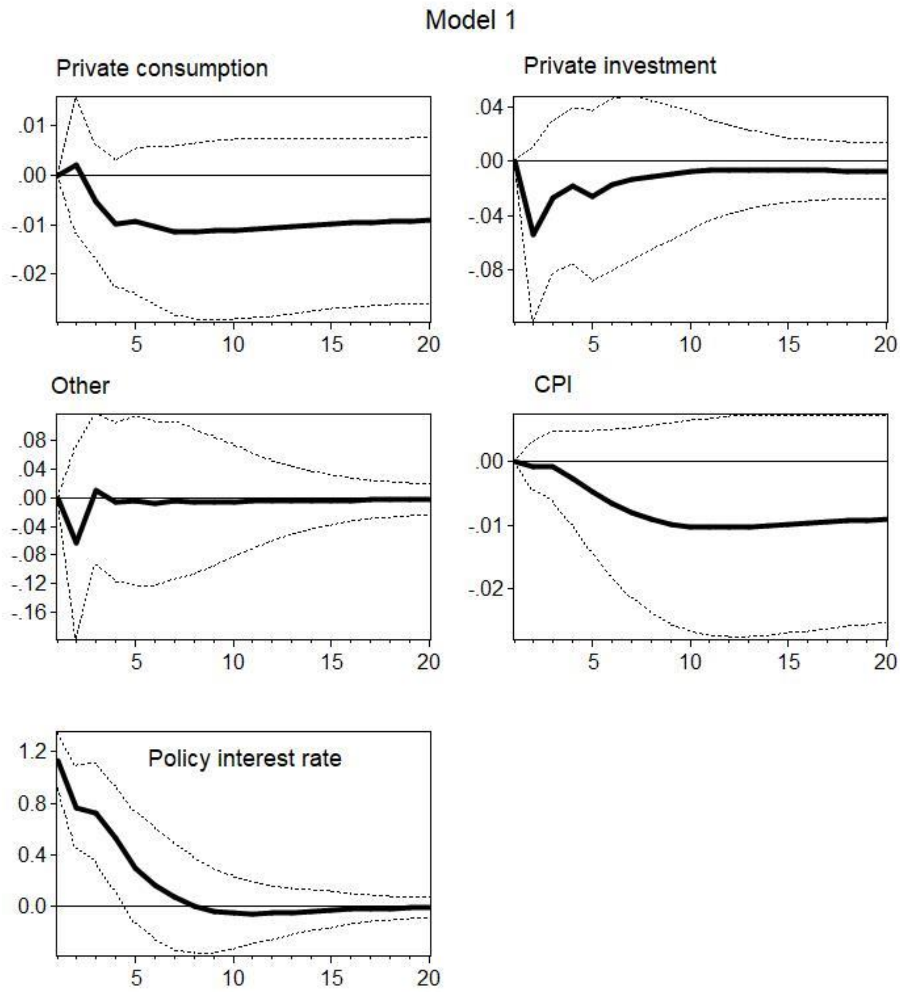
From the estimation result, increasing the policy interest rate or implementing tighter monetary policy reduces total demand through all components of GDP - investment, consumption and other. The decline in demand leads to lower prices in Mongolia, while in some models decreasing monetary aggregates and an appreciating exchange rate are evident.

In terms of speed of response, private investment is the most sensitive to the monetary policy in all models (Figure 1; Table 2). Private investment responds much quicker to the monetary policy with peaking only after 2 to 4 quarters. While private consumption change reaches the peak point with 5 to 7 quarter lags. The response of the other component is slowest in Model 3 whereas quickest in Model 1.

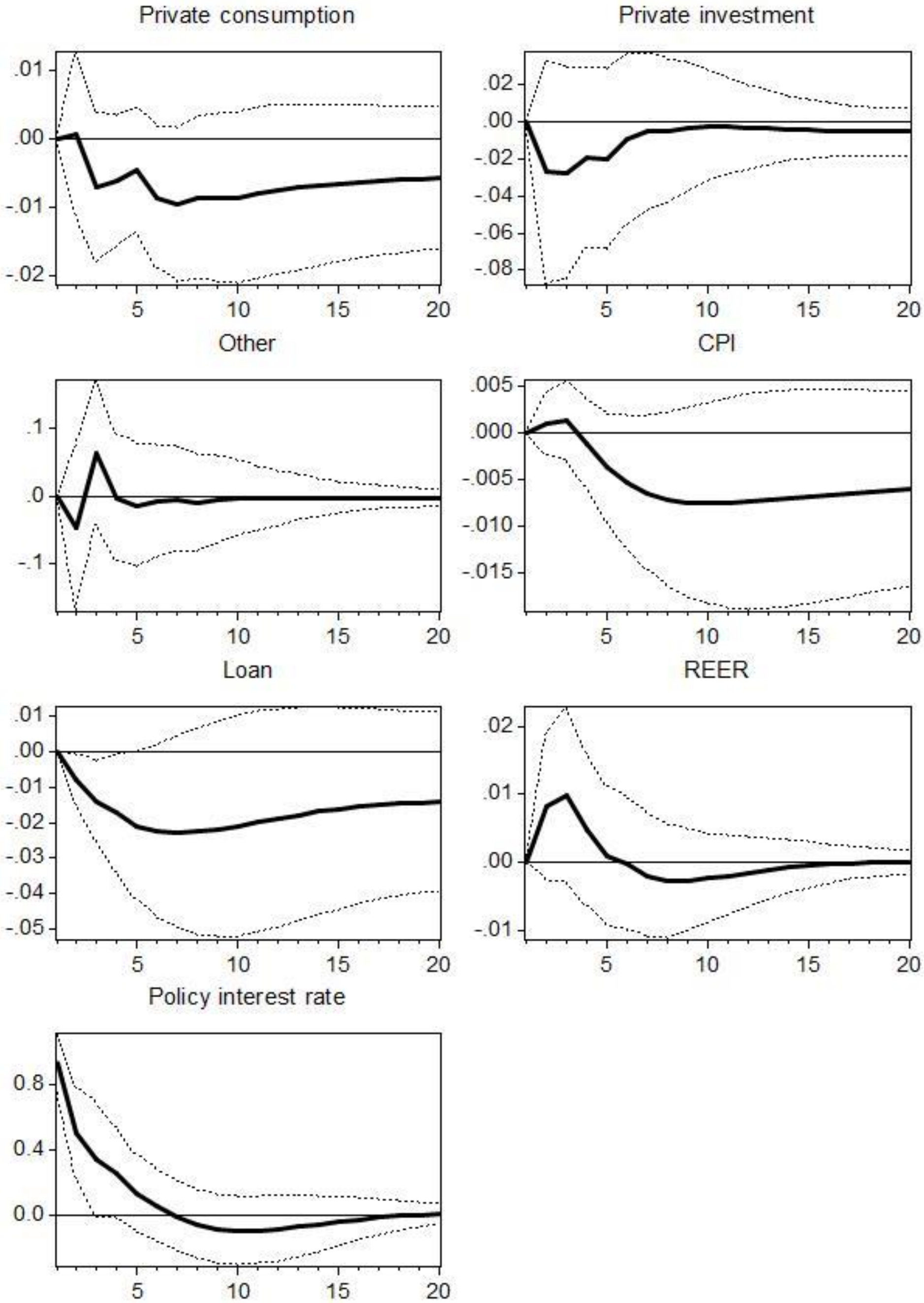
As for the monetary policy target variable, price level, the effect of shock reaches peak value in 9 to 11 quarters.

Proportional effect (Table 2): According to the estimation, private consumption is the least impacted proportionally to the monetary policy shock. While investment changes highest proportionally in model 3, the other component has the highest proportional change in model 1 and 2. However, to define the importance of channels, the size or contribution effect needs to be considered.

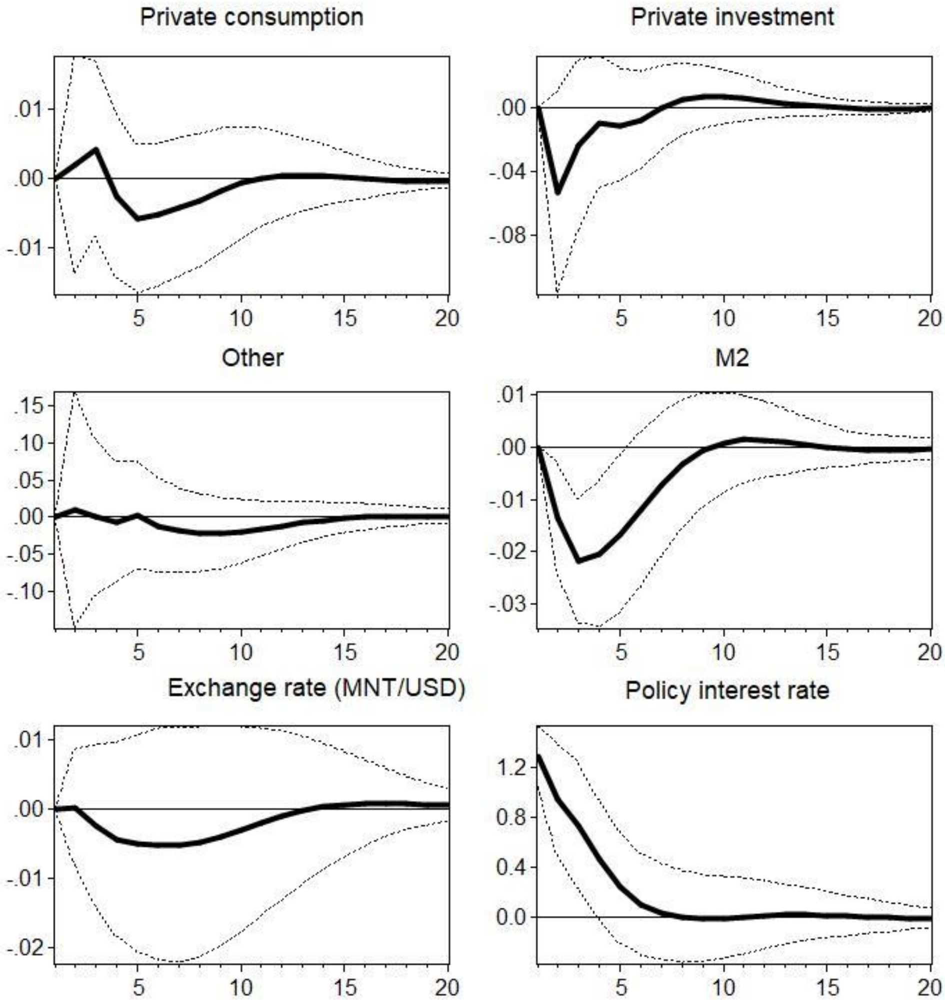
Figure 1: Impulse responses of tightening monetary policy shock (one standard deviation of the policy interest rate). Solid line is the impulse responses and dashed lines illustrate confidence intervals which are drawn using 10th and 90th percentile values of 1000 bootstrap simulations; All variables except policy interest rate are in log form (or %).



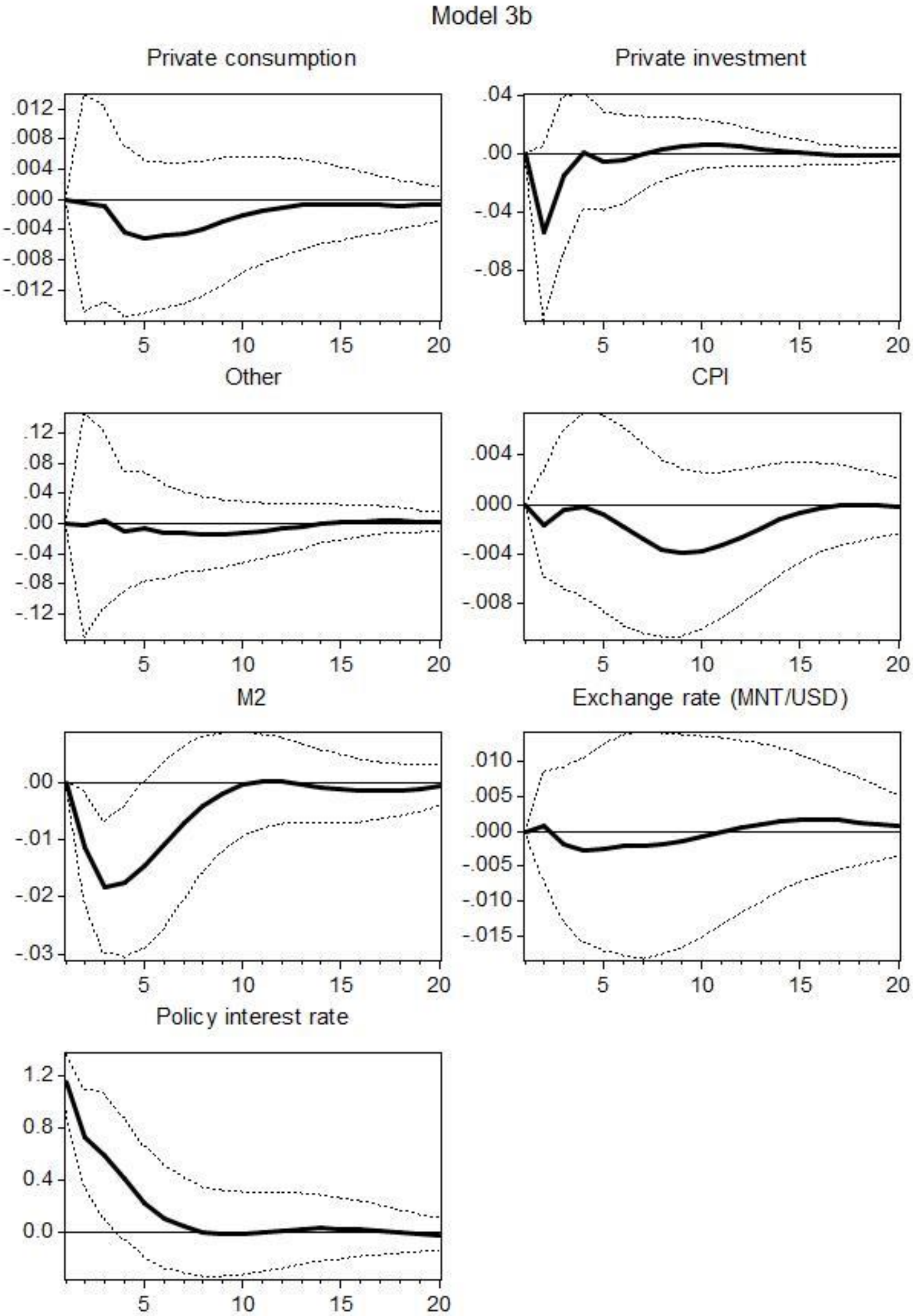
Model 2


Private consumption
Private investment
Other
CPI
Loan
REER
Policy interest rate

Model 3a



Private consumption
.01
.00
-.01
5
10
15
20
Private investment
.00
-.04
-.08
Other
.15
.10
.05
.00
-.05
-.10
M2
.01
.00
-.01
-.02
-.03
Exchange rate (MNT/USD)
.01
.00
-.01
-.02
Policy interest rate
1.2
0.8
0.4
0.0



Model 3b
Private consumption
Private investment
Other
CPI
M2
Exchange rate (MNT/USD)
Policy interest rate

Table 2: Proportional effect in Mongolia

Variables	The peak point of the response				Lag for the peak point			
	Model				**Model**			
	1	**2**	**3a**	**3b**	**1**	**2**	**3a**	**3b**
Private consumption	-1.14%	-0.97%	-0.48%	-0.51%	7	7	6	5
Private investment	-5.37%	-2.76%	-5.38%	-5.38%	2	3	2	2
Other GDP component	-6.22%	-4.64%	-1.41%	-1.41%	2	2	8,9	8,9
CPI	-1.03%	-0.76%	-0.39%	-0.39%	11	10	9	9
Loan		-2.27%				7		
Reer		1.00%				5		
m2			-1.84%	-1.84%			3	3
Exchange rate (MNT/USD)			-0.28%	-0.28%			4	4

Comparison with other countries (Table 3): Compared to the findings of empirical studies elsewhere, the proportional effect of investment is higher than that of the consumption except for Pakistan's case. Additionally, the investment response tends to quicker than consumption. For lag of reaching the peak, 5 quarter in investment and 6 quarter in consumption meanwhile for the peak proportional effect, investment has -3.7% and consumption has -1.5% on average.

Advanced countries response may more similar with each other for both of the lags and values while developing countries have more variances between each other.

Another point is that the lag of CPI to reach the peak tend to shorter and the peak proportional effect tend to higher in developing countries. The advanced countries have 12 to 20 lags and -0.1% to -0.4% proportional peak value whereas the developing countries have 2 to 12 lags and -0.1% to -2.5% proportional peak value. The average of lag is 13 and the peak value is -0.7% for the all countries.

Comparing Mongolia with other countries, the investment peak is reached around twice as fast. While consumption and CPI change patterns are similar to the average. Also, the all of the proportional changes in Mongolia are consistent to the average of the other countries.

Table 3: The peak proportional effect of contractionary monetary policy shock by country

(the initial effects in the studies are converted into 100 bases point policy rate decline; lags are in quarter; effect in proportional change)

	Consumption		Investment		CPI		Dominant	
Country	Effect	lag	Effect	lag	Effect	lag	channel	Source
US	-1.0%	8-9	-4.7%	6-8	-0.2%	20	Consumption	(Angeloni et al. 2003)
Euro	-1.0%	8	-2.0%	6-8	-0.3%	20	Investment	(Angeloni et al. 2003)
Japan	-1.0%	5	-4.0%	5	-0.4%	12-14	Investment	(Ippei 2004)
Australia	-0.3%	6-8	-1.3%	5	-0.1%	20	Investment	(Phan 2014)
Thailand	-0.6%	5	-1.5%	5	-0.1%	10-12	Investment	(Disyatat & Vongsinsirikul 2003)
Indonesia	-1.2%	5	-2.5%	5	-1.1%	8	Consumption	(Afandi 2009)
Bangladesh	-6.0%	4	-11.0%	5	-1.0%	10	Investment	(Suranjit 2016)
Pakistan	-2.0%	2	-1.0%	4-6	-2.5%	2-4	Consumption	(Kamal 2016)
Mongolia	-0.9%	5-7	-5.0%	2-3	-0.7%	9-11	Investment	This paper

Contribution effect (table 4)**:** On average, the proportional contributions to demand side GDP in Mongolia are: private consumption 55%; investment 34%; all others 12%. This means that the private consumption is 1.7 times higher than private investment meanwhile the private investment is about triple times higher than the other components. When proportional effects are converted into size effects, the monetary policy peak impact on investment is about triple that of consumption and about 4 times the other components on average. In order words, the investment change explains around 65% of the total GDP impact of the monetary policy shock, which means the investment channel is the most important for monetary policy transmission in Mongolia. While consumption explains about 20% and the other component 15% of the peak change of GDP caused by the monetary policy shock.

Table 4: Size and contribution effect in Mongolia, in billion tugrug

GDP components	Mean	Share of GDP	Size effect				Contribution effect			
			Model				Model			
			1	2	3a	3b	1	2	3a	3b
Private consumption	1,707,572	55%	(19,466)	(16,625)	(8,162)	(8,640)	20%	26%	12%	12%
Private investment	1,057,332	34%	(56,779)	(29,182)	(56,884)	(56,884)	57%	46%	81%	80%
Other	365,654	12%	(22,744)	(16,963)	(5,156)	(5,156)	23%	27%	7%	7%

IV. CONCLUSION

The empirical analysis suggests that the investment change is not only the highest, but its response is quickest. Therefore, it can be concluded that the investment channel represents the strongest and fastest monetary policy transmission mechanism consistent with traditional theoretical hypothesis.

The contributions of the paper are that it is the first to estimate the output composition of Mongolian monetary policy transmission and compare it with the existing literature for other countries. The investment effect peaks more quickly in Mongolia than the other studied countries.

From the comparison, there appears to be a pattern related to the country's development level that could usefully be explored further. For the Mongolian case, investigating why investment is the most important channel as well as why the response is quicker than for other countries could also be studied further.

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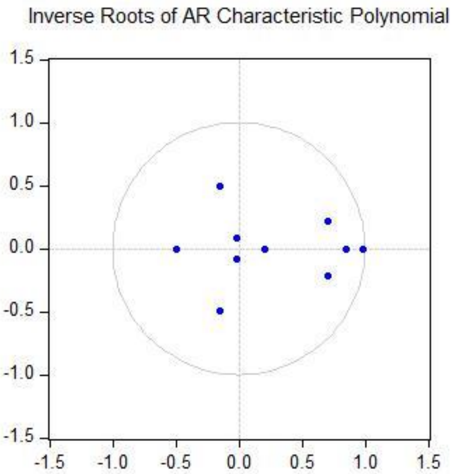
APPENDIX

1. Stability tests:

Model 1:

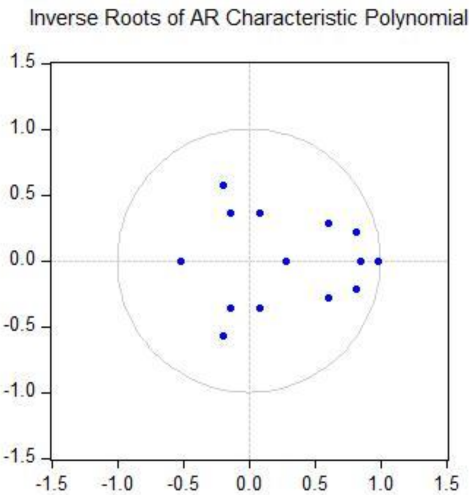


Roots of Characteristic Polynomial
Endogenous variables: PCONS_L_D11 PINV_L_D11 OTHER_L_D11 CPI_L_D11 I_P
Exogenous variables: C
Lag specification: 1 2
Date: 10/21/19 Time: 20:08

Root	Modulus
0.988132	0.988
0.845460	0.845
0.705280 - 0.213845i	0.737
0.705280 + 0.213845i	0.737
-0.146235 - 0.495398i	0.517
-0.146235 + 0.495398i	0.517
-0.496706	0.497
0.204933	0.205
-0.015656 - 0.078617i	0.080
-0.015656 + 0.078617i	0.080

No root lies outside the unit circle.
VAR satisfies the stability condition.

Model 2:

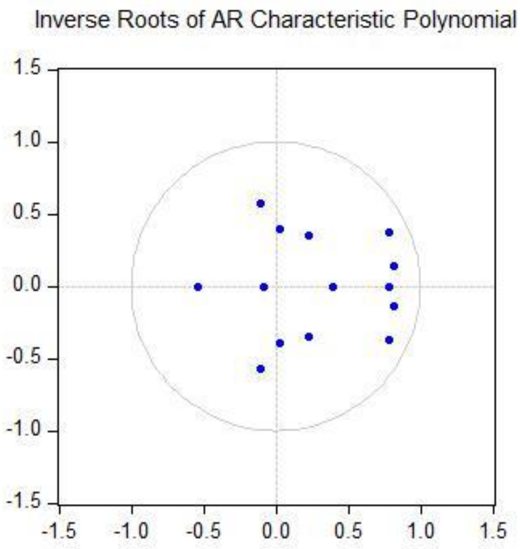


Roots of Characteristic Polynomial
Endogenous variables: PCONS_L_D11 PINV_L_D11 OTHER_L_D11 CPI_L_D11 LOAN_L_D11 REER_L_D11 I_P
Exogenous variables: C
Lag specification: 1 2
Date: 10/21/19 Time: 20:10

Root	Modulus
0.985350	0.985350
0.851601	0.851601
0.815900 - 0.218193i	0.844572
0.815900 + 0.218193i	0.844572
0.601006 - 0.284707i	0.665031
0.601006 + 0.284707i	0.665031
-0.189699 - 0.576648i	0.607049
-0.189699 + 0.576648i	0.607049
-0.513989	0.513989
-0.137085 - 0.362754i	0.387792
-0.137085 + 0.362754i	0.387792
0.085834 - 0.364748i	0.374712
0.085834 + 0.364748i	0.374712
0.280070	0.280070

No root lies outside the unit circle.
VAR satisfies the stability condition.

Model 3a:

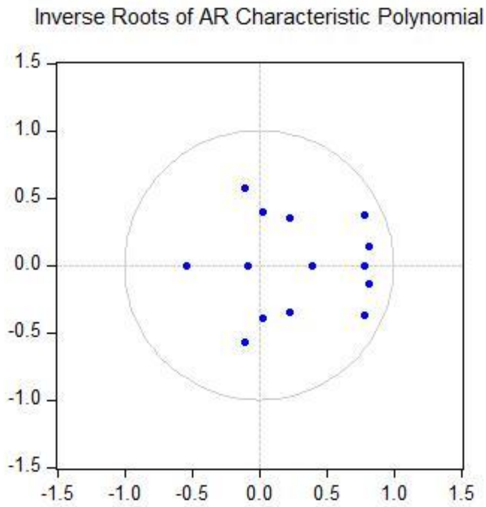


Roots of Characteristic Polynomial
Endogenous variables: PCONS_L_D11
PINV_L_D11 OTHER_L_D11
CPI_L_D11 M2_L_D11 EX_L_D11 I_P
Exogenous variables: C GDP_CN_L
PCOM_L
Lag specification: 1 2
Date: 10/20/19 Time: 20:53

Root	Modulus
0.778553 - 0.375355i	0.864
0.778553 + 0.375355i	0.864
0.813534 - 0.137169i	0.825
0.813534 + 0.137169i	0.825
0.782752	0.783
-0.104824 - 0.576971i	0.586
-0.104824 + 0.576971i	0.586
-0.533550	0.534
0.232368 - 0.348462i	0.419
0.232368 + 0.348462i	0.419
0.030089 - 0.396566i	0.398
0.030089 + 0.396566i	0.398
0.397087	0.397
-0.086128	0.086

No root lies outside the unit circle.
VAR satisfies the stability condition.

Model 3b:



Roots of Characteristic Polynomial
Endogenous variables: PCONS_L_D11 PINV_L_D11 OTHER_L_D11 CPI_L_D11 M2_L_D11 EX_L_D11 I_P
Exogenous variables: C GDP_CN_L PCOM_L
Lag specification: 1 2
Date: 10/20/19 Time: 20:55

Root	Modulus
0.778553 - 0.375355i	0.864
0.778553 + 0.375355i	0.864
0.813534 - 0.137169i	0.825
0.813534 + 0.137169i	0.825
0.782752	0.783
-0.104824 - 0.576971i	0.586
-0.104824 + 0.576971i	0.586
-0.533550	0.534
0.232368 - 0.348462i	0.419
0.232368 + 0.348462i	0.419
0.030089 - 0.396566i	0.398
0.030089 + 0.396566i	0.398
0.397087	0.397
-0.086128	0.086

No root lies outside the unit circle.
VAR satisfies the stability condition.

2. Impulse responses:

Model 1:

Period	PCONS_L_	PINV_L_D11	OTHER_L_	CPI_L_D11	I_P
1	0	0	0	0	1.14
	(0)	(0)	(0)	(0)	(0.107)
2	0.00201	-0.0537	-0.0622	-0.000691	0.769
	(0.00692)	(0.0317)	(0.0666)	(0.00188)	(0.161)
3	-0.00532	-0.0273	0.0112	-0.000849	0.723
	(0.00572)	(0.0279)	(0.0522)	(0.00277)	(0.194)
4	-0.00991	-0.0187	-0.00654	-0.00258	0.532
	(0.00642)	(0.0284)	(0.0552)	(0.00367)	(0.204)
5	-0.0094	-0.0258	-0.00489	-0.00471	0.3
	(0.00739)	(0.0314)	(0.0587)	(0.00476)	(0.216)
6	-0.0103	-0.0177	-0.00866	-0.0065	0.167
	(0.00807)	(0.0317)	(0.0575)	(0.00577)	(0.217)
7	-0.0114	-0.013	-0.00428	-0.00798	0.0696
	(0.00857)	(0.0299)	(0.0547)	(0.00663)	(0.206)
8	-0.0114	-0.0111	-0.00648	-0.00908	-0.000657
	(0.00893)	(0.0274)	(0.0501)	(0.00734)	(0.185)
9	-0.0112	-0.00933	-0.00584	-0.00979	-0.0391
	(0.00911)	(0.0245)	(0.0447)	(0.00789)	(0.162)
10	-0.0111	-0.00765	-0.00554	-0.0102	-0.0546
	(0.00917)	(0.0215)	(0.0387)	(0.00828)	(0.139)
11	-0.0109	-0.00705	-0.00506	-0.0103	-0.0586
	(0.00914)	(0.0186)	(0.0331)	(0.00852)	(0.12)
12	-0.0106	-0.00678	-0.00485	-0.0103	-0.0548
	(0.00905)	(0.0162)	(0.028)	(0.00865)	(0.104)
13	-0.0103	-0.00669	-0.00441	-0.0102	-0.0471
	(0.00893)	(0.0143)	(0.0236)	(0.00868)	(0.0905)
14	-0.0101	-0.00675	-0.00408	-0.01	-0.0385
	(0.00881)	(0.0129)	(0.02)	(0.00865)	(0.0793)
15	-0.00987	-0.00691	-0.00377	-0.00982	-0.0307
	(0.0087)	(0.0118)	(0.0171)	(0.00858)	(0.0694)
16	-0.00969	-0.00705	-0.00351	-0.00962	-0.0242
	(0.0086)	(0.0111)	(0.015)	(0.00848)	(0.0606)
17	-0.00954	-0.00717	-0.00328	-0.00943	-0.0193
	(0.00852)	(0.0107)	(0.0134)	(0.00839)	(0.0529)
18	-0.0094	-0.00726	-0.00309	-0.00926	-0.016
	(0.00847)	(0.0104)	(0.0122)	(0.0083)	(0.0465)
19	-0.00928	-0.00731	-0.00293	-0.00911	-0.014
	(0.00843)	(0.0102)	(0.0113)	(0.00822)	(0.0415)
20	-0.00916	-0.00732	-0.00279	-0.00897	-0.0129
	(0.00841)	(0.0101)	(0.0107)	(0.00816)	(0.0378)

Cholesky Ordering: PCONS_L_D11 PINV_L_D11 OTHER_L_D11 CPI_L_D11 I_P

Standard Errors: Analytic

Model 2:

Period	PCONS_L_	PINV_L_D11	OTHER_L_	CPI_L_D11	LOAN_L_D11	REER_L_D	I_P
1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.931463
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.08802)
2	0.000696	-0.027246	-0.046390	0.000986	-0.007821	0.008239	0.506620
	(0.00592)	(0.02974)	(0.06110)	(0.00163)	(0.00349)	(0.00544)	(0.13836)
3	-0.007137	-0.027600	0.065042	0.001317	-0.013931	0.009960	0.340204
	(0.00550)	(0.02846)	(0.05329)	(0.00213)	(0.00566)	(0.00643)	(0.17206)
4	-0.006218	-0.019585	-0.002179	-0.001144	-0.017318	0.004785	0.262357
	(0.00473)	(0.02432)	(0.04652)	(0.00233)	(0.00817)	(0.00561)	(0.14062)
5	-0.004641	-0.019917	-0.013913	-0.003715	-0.020992	0.000956	0.138311
	(0.00459)	(0.02425)	(0.04571)	(0.00289)	(0.01045)	(0.00511)	(0.11775)
6	-0.008603	-0.009008	-0.007403	-0.005269	-0.022503	-0.000309	0.057208
	(0.00515)	(0.02311)	(0.04168)	(0.00353)	(0.01223)	(0.00490)	(0.10910)
7	-0.009736	-0.005375	-0.004789	-0.006436	-0.022669	-0.001933	-0.003054
	(0.00564)	(0.02118)	(0.03878)	(0.00413)	(0.01361)	(0.00454)	(0.10516)
8	-0.008755	-0.004702	-0.010480	-0.007202	-0.022549	-0.002811	-0.054429
	(0.00589)	(0.01924)	(0.03596)	(0.00466)	(0.01462)	(0.00414)	(0.10386)
9	-0.008651	-0.003137	-0.005902	-0.007496	-0.021985	-0.002678	-0.080069
	(0.00612)	(0.01725)	(0.03214)	(0.00507)	(0.01529)	(0.00373)	(0.10319)
10	-0.008604	-0.002156	-0.003950	-0.007565	-0.020941	-0.002346	-0.087361
	(0.00625)	(0.01503)	(0.02786)	(0.00539)	(0.01561)	(0.00330)	(0.10397)
11	-0.007991	-0.002699	-0.004000	-0.007532	-0.019849	-0.001984	-0.087129
	(0.00625)	(0.01298)	(0.02388)	(0.00561)	(0.01564)	(0.00291)	(0.10387)
12	-0.007524	-0.003080	-0.003401	-0.007404	-0.018802	-0.001486	-0.079323
	(0.00618)	(0.01129)	(0.02022)	(0.00574)	(0.01547)	(0.00258)	(0.10093)
13	-0.007232	-0.003398	-0.002548	-0.007230	-0.017790	-0.001029	-0.065971
	(0.00608)	(0.00987)	(0.01687)	(0.00579)	(0.01514)	(0.00226)	(0.09495)
14	-0.006896	-0.003918	-0.002567	-0.007049	-0.016888	-0.000687	-0.051205
	(0.00593)	(0.00871)	(0.01405)	(0.00578)	(0.01474)	(0.00196)	(0.08622)
15	-0.006600	-0.004400	-0.002517	-0.006862	-0.016136	-0.000419	-0.036560
	(0.00577)	(0.00783)	(0.01174)	(0.00573)	(0.01430)	(0.00168)	(0.07554)
16	-0.006392	-0.004737	-0.002333	-0.006672	-0.015514	-0.000221	-0.022755
	(0.00562)	(0.00718)	(0.00990)	(0.00565)	(0.01388)	(0.00144)	(0.06411)
17	-0.006216	-0.005032	-0.002255	-0.006489	-0.015016	-0.000102	-0.010875
	(0.00549)	(0.00676)	(0.00851)	(0.00555)	(0.01349)	(0.00123)	(0.05319)
18	-0.006063	-0.005264	-0.002208	-0.006316	-0.014633	-3.87E-05	-0.001397
	(0.00537)	(0.00655)	(0.00757)	(0.00544)	(0.01315)	(0.00108)	(0.04387)
19	-0.005946	-0.005405	-0.002104	-0.006153	-0.014342	-1.43E-05	0.005715
	(0.00528)	(0.00649)	(0.00700)	(0.00534)	(0.01287)	(0.00097)	(0.03683)
20	-0.005853	-0.005479	-0.002013	-0.006005	-0.014122	-2.14E-05	0.010552
	(0.00520)	(0.00654)	(0.00674)	(0.00525)	(0.01266)	(0.00090)	(0.03218)

Cholesky Ordering: PCONS_L_D11 PINV_L_D11 OTHER_L_D11 CPI_L_D11 LOAN_L_D11 REER_L_D11 I_P
Standard Errors: Analytic

Model 3a:

Period	PCONS_L_	PINV_L_D11	OTHER_L_	CPI_L_D11	M2_L_D11	EX_L_D11	I_P
1	0	0	0	0	0	0	1.15
	(0)	(0)	(0)	(0)	(0)	(0)	(0.109)
2	-0.000513	-0.0538	-0.00307	-0.00163	-0.0113	0.000834	0.725
	(0.0072)	(0.0295)	(0.0745)	(0.00212)	(0.0048)	(0.00388)	(0.185)
3	-0.000798	-0.0145	0.0048	-0.000481	-0.0184	-0.00192	0.584
	(0.00647)	(0.0266)	(0.0581)	(0.00322)	(0.0058)	(0.00553)	(0.237)
4	-0.00434	0.00122	-0.00937	-0.000159	-0.0174	-0.00281	0.411
	(0.00573)	(0.0195)	(0.0398)	(0.00373)	(0.00671)	(0.00663)	(0.235)
5	-0.00506	-0.005	-0.00566	-0.000839	-0.0145	-0.00242	0.228
	(0.00506)	(0.0168)	(0.0361)	(0.00397)	(0.00735)	(0.00745)	(0.216)
6	-0.00478	-0.00467	-0.0115	-0.00185	-0.0108	-0.00211	0.112
	(0.00485)	(0.0152)	(0.031)	(0.004)	(0.0073)	(0.00797)	(0.196)
7	-0.00447	-6.74E-05	-0.0117	-0.00284	-0.00714	-0.00208	0.0472
	(0.00467)	(0.0128)	(0.0267)	(0.00383)	(0.00674)	(0.00812)	(0.181)
8	-0.00391	0.00323	-0.0141	-0.0036	-0.00403	-0.00188	0.00463
	(0.00447)	(0.0109)	(0.0242)	(0.00359)	(0.00597)	(0.00798)	(0.171)
9	-0.00297	0.00494	-0.0141	-0.00393	-0.0018	-0.00144	-0.0148
	(0.00418)	(0.00956)	(0.0224)	(0.00336)	(0.0052)	(0.00766)	(0.165)
10	-0.00215	0.006	-0.0128	-0.00381	-0.000411	-0.000846	-0.0132
	(0.00387)	(0.00842)	(0.0205)	(0.00316)	(0.00455)	(0.00723)	(0.16)
11	-0.00151	0.0059	-0.00982	-0.00334	0.000192	-0.000158	-0.000525
	(0.00356)	(0.00748)	(0.0187)	(0.00296)	(0.00408)	(0.00673)	(0.153)
12	-0.00102	0.00483	-0.00661	-0.00266	0.000176	0.000537	0.0141
	(0.00326)	(0.00662)	(0.017)	(0.00274)	(0.00374)	(0.00619)	(0.145)
13	-0.000727	0.00336	-0.00329	-0.00191	-0.000206	0.00112	0.0258
	(0.00298)	(0.00577)	(0.0152)	(0.0025)	(0.00345)	(0.00564)	(0.137)
14	-0.000622	0.00184	-0.000412	-0.00122	-0.000712	0.00153	0.0312
	(0.00271)	(0.00496)	(0.0134)	(0.00226)	(0.00319)	(0.00511)	(0.128)
15	-0.000634	0.000469	0.00177	-0.000676	-0.00116	0.00174	0.0294
	(0.00243)	(0.00422)	(0.0117)	(0.00203)	(0.00296)	(0.00459)	(0.118)
16	-0.000693	-0.000541	0.00305	-0.000308	-0.00143	0.00174	0.0219
	(0.00214)	(0.00362)	(0.0102)	(0.00182)	(0.00274)	(0.00409)	(0.107)
17	-0.000752	-0.0011	0.00353	-0.000118	-0.00148	0.00159	0.0109
	(0.00186)	(0.00317)	(0.00901)	(0.00163)	(0.00253)	(0.0036)	(0.0952)
18	-0.000775	-0.00125	0.00336	-7.17E-05	-0.00131	0.00133	-0.000804
	(0.00159)	(0.00284)	(0.00804)	(0.00145)	(0.0023)	(0.00311)	(0.0828)
19	-0.000742	-0.00108	0.00276	-0.000121	-0.001	0.00101	-0.011
	(0.00134)	(0.00255)	(0.0072)	(0.00127)	(0.00205)	(0.00263)	(0.0708)
20	-0.000653	-0.000726	0.00196	-0.000214	-0.000622	0.000703	-0.0182
	(0.00113)	(0.00226)	(0.00641)	(0.0011)	(0.00178)	(0.00219)	(0.0599)

Cholesky Ordering: PCONS_L_D11 PINV_L_D11 OTHER_L_D11 CPI_L_D11 M2_L_D11 EX_L_D11 I_P
Standard Errors: Analytic

Model 3b:

Period	PCONS_L_	PINV_L_D11	OTHER_L_	CPI_L_D11	M2_L_D11	EX_L_D11	I_P
1	0	0	0	0	0	0	1.15
	(0)	(0)	(0)	(0)	(0)	(0)	(0.109)
2	-0.000513	-0.0538	-0.00307	-0.00163	-0.0113	0.000834	0.725
	(0.0072)	(0.0295)	(0.0745)	(0.00212)	(0.0048)	(0.00388)	(0.185)
3	-0.000798	-0.0145	0.0048	-0.000481	-0.0184	-0.00192	0.584
	(0.00647)	(0.0266)	(0.0581)	(0.00322)	(0.0058)	(0.00553)	(0.237)
4	-0.00434	0.00122	-0.00937	-0.000159	-0.0174	-0.00281	0.411
	(0.00573)	(0.0195)	(0.0398)	(0.00373)	(0.00671)	(0.00663)	(0.235)
5	-0.00506	-0.005	-0.00566	-0.000839	-0.0145	-0.00242	0.228
	(0.00506)	(0.0168)	(0.0361)	(0.00397)	(0.00735)	(0.00745)	(0.216)
6	-0.00478	-0.00467	-0.0115	-0.00185	-0.0108	-0.00211	0.112
	(0.00485)	(0.0152)	(0.031)	(0.004)	(0.0073)	(0.00797)	(0.196)
7	-0.00447	-6.74E-05	-0.0117	-0.00284	-0.00714	-0.00208	0.0472
	(0.00467)	(0.0128)	(0.0267)	(0.00383)	(0.00674)	(0.00812)	(0.181)
8	-0.00391	0.00323	-0.0141	-0.0036	-0.00403	-0.00188	0.00463
	(0.00447)	(0.0109)	(0.0242)	(0.00359)	(0.00597)	(0.00798)	(0.171)
9	-0.00297	0.00494	-0.0141	-0.00393	-0.0018	-0.00144	-0.0148
	(0.00418)	(0.00956)	(0.0224)	(0.00336)	(0.0052)	(0.00766)	(0.165)
10	-0.00215	0.006	-0.0128	-0.00381	-0.000411	-0.000846	-0.0132
	(0.00387)	(0.00842)	(0.0205)	(0.00316)	(0.00455)	(0.00723)	(0.16)
11	-0.00151	0.0059	-0.00982	-0.00334	0.000192	-0.000158	-0.000525
	(0.00356)	(0.00748)	(0.0187)	(0.00296)	(0.00408)	(0.00673)	(0.153)
12	-0.00102	0.00483	-0.00661	-0.00266	0.000176	0.000537	0.0141
	(0.00326)	(0.00662)	(0.017)	(0.00274)	(0.00374)	(0.00619)	(0.145)
13	-0.000727	0.00336	-0.00329	-0.00191	-0.000206	0.00112	0.0258
	(0.00298)	(0.00577)	(0.0152)	(0.0025)	(0.00345)	(0.00564)	(0.137)
14	-0.000622	0.00184	-0.000412	-0.00122	-0.000712	0.00153	0.0312
	(0.00271)	(0.00496)	(0.0134)	(0.00226)	(0.00319)	(0.00511)	(0.128)
15	-0.000634	0.000469	0.00177	-0.000676	-0.00116	0.00174	0.0294
	(0.00243)	(0.00422)	(0.0117)	(0.00203)	(0.00296)	(0.00459)	(0.118)
16	-0.000693	-0.000541	0.00305	-0.000308	-0.00143	0.00174	0.0219
	(0.00214)	(0.00362)	(0.0102)	(0.00182)	(0.00274)	(0.00409)	(0.107)
17	-0.000752	-0.0011	0.00353	-0.000118	-0.00148	0.00159	0.0109
	(0.00186)	(0.00317)	(0.00901)	(0.00163)	(0.00253)	(0.0036)	(0.0952)
18	-0.000775	-0.00125	0.00336	-7.17E-05	-0.00131	0.00133	-0.000804
	(0.00159)	(0.00284)	(0.00804)	(0.00145)	(0.0023)	(0.00311)	(0.0828)
19	-0.000742	-0.00108	0.00276	-0.000121	-0.001	0.00101	-0.011
	(0.00134)	(0.00255)	(0.0072)	(0.00127)	(0.00205)	(0.00263)	(0.0708)
20	-0.000653	-0.000726	0.00196	-0.000214	-0.000622	0.000703	-0.0182
	(0.00113)	(0.00226)	(0.00641)	(0.0011)	(0.00178)	(0.00219)	(0.0599)

Cholesky Ordering: PCONS_L_D11 PINV_L_D11 OTHER_L_D11 CPI_L_D11 M2_L_D11 EX_L_D11 I_P
Standard Errors: Analytic

3. Description statistics of the variables

Date: 10/22/19 Time: 20:33
Sample: 2000Q1 2019Q2

	GDP	PCONS	PINV	OTHER
Mean	3130557.26...	1707572.07...	1057331.68...	365653.514...
Median	2905790.6935	1721831.42	1010222.63...	368414.467...
Maximum	5478062.745	2715087.279	2162505.99...	2020536.54...
Minimum	1106225.497	659370.8705	84631.7047...	-601649.47...
Std. Dev.	1080262.99...	635709.920...	533159.283...	523609.515...
Skewness	0.20763496...	0.00717536...	0.28771734...	0.50712118...
Kurtosis	2.00967569...	1.67180033...	2.44245866...	3.74648448...
Jarque-Bera	2.78687908...	4.26377401...	1.55144544...	3.83265613...
Probability	0.24822007...	0.11861325...	0.46037093...	0.14714628...
Sum	181572321....	99039180.3...	61325237.4...	21207903.8...
Sum Sq. Dev.	665171832...	230352448...	162027528...	156275147...
Observations	58	58	58	58