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Macroeconomic policy empirical analysis using an unrestricted standard VAR Model: The case of Mongolia

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Abstract. This paper is mainly about key fiscal policy indicators and their interrelations between each other. The model that is used in the analysis is the Vector Autoregressive Model. There are seven variables selected: GDP, Money Supply, Government Revenue, Government Expenditure, Export, Government Debt, and Global Copper Price. Besides VAR estimation, IRFs are computed to define how variables react to certain shocks. The key finding of the research is that both GDP and government revenue are sensitive to copper price changes and the resulting shock. Copper Price is an effective tool to predict these two variables in the short-run. Government Revenue is an effective tool to impact export in the short-run. Government Debt is not an effective indicator to affect any variables except Government Expenditure. Money Supply is only effective for GDP. Government Expenditure is also not significantly effective in having an impact on other variables, but is weakly affected by Government Revenue, Copper Price, and Export. Most variables considered in the research belong to fiscal policy, thus, effective fiscal policy can be implemented using the results of this paper.

Keywords: VAR model, IRFs, macroeconomic policy, variables, shocks

1. Introduction

Mongolia has a small open economy and its natural resources include copper, gold, coal, and a small amount of raw oil. These are the current mainstays of the whole economy. The key challenge of policy in Mongolia is to strengthen the resource price-susceptible economy and transform natural resources into a substantial asset with long-term sustainable development (Avralt-Od et al. 2012).

The conditions that Mongolia faces so far have been low copper prices, high levels of debt, shortage of government revenue, and depreciation of the national currency. Some of these important macroeconomic indicators are carried out through macroeconomic policies, fiscal, and monetary policies. Thus, it is important to learn the dynamics of those main macroeconomic indicators, their impact on the economy, and their responses to specific shocks.

The main goal of this research paper is to research how key economic indicators relate with each other and to examine if there is any causal relationship between those indicators. Furthermore, the paper wishes to contribute to the policy decision making. Within the scope of the research paper, we hypothesized that external debt has a direct negative effect on GDP, government spending has a positive effect on GDP, and the GDP of Mongolia is sensitive to global copper price shock. The paper also aims to provide an answer to the following research questions:

- How does the economy respond to certain macroeconomic shocks?
- Is there any causal relationship between the key economic indicators considered in this paper?

This paper is organized as follows: Section 2 provides an overview of the economy of Mongolia, Section 3 discusses related studies completed in several different countries, Section 4 presents the data, Section 5 reviews the methodology, Section 6 presents the result, and the final section, Section 7, concludes the paper.

2. Overview of Economy of Mongolia

The Global Financial Crisis of 2008 brought great volatility to the Mongolian economy. The sharp drop in the copper price (US $7850-$3000 per ton) and the Chinese economy slow-down led not only copper production but also total production in Mongolia falling to one third of previous levels. During this period, the government needed to increase its expenditure to stimulate the economy, however, it was difficult for the government to cover this increase given its decreasing revenue. The government of Mongolia had to borrow more money and had no option but to choose pro-cyclical policy during this recession phase (Batpurev–Munkhsoyol 2013, Doojav–Batmunkh 2018, Bayarsaikhan et al. 2016).

Because there were problems of high government expenditure, low copper prices on the global market, delays in mining activity, depreciating exchange rate, and declining currency reserve, the government of Mongolia had to accept 3-year IMF - Extended Fund Facility Program in May 2017. Mongolia is expected to receive about US $5.5 billion in total from IMF and some other financial partners (IMF, 2017).

Li et al. (2017) identified that there were three main difficulties to reaching sustainable growth by using its resource in the long-run for Mongolia, which are the lack of export diversification, weak policy mix, and inefficiency of investment in weak project selection and implementation. When the global market price of commodities went up from 2004, Mongolia benefitted from this rise and total budget revenue increased dramatically. High copper prices brought Mongolia high levels of income and high economic growth. During this time, the Mongolian government conducted an expansionary fiscal policy (Batchuluun et al. 2012). However, all other non-resource export sectors suffered harm from this situation, because human resources, wage rises, the whole economy shifted to the mining industry and the whole country started depending on the development of natural resources. Avralt-Od et al. (2012) also stated that Mongolia was prone to exposure to a negative commodity price shock and external negative shock relevant to natural resources.

Maino et al. (2013) also note that increasing government spending leads to a high risk of macroeconomic instability. According to the budget balance provided by the Ministry of Finance, Mongolia started experiencing significant fiscal deficit from December 2008 and since then, there has been a constant fiscal deficit. (Chuluunbat 2015) Besides external shocks, government expenditure and off-budget expenditure were much higher than the budget income. Based on data from NSO and the Ministry of Finance, government spending as a share of GDP is around 30 percent (Mongolia, Ministry of Finance of Mongolia, 2019).

3. Literature review

Gogas and Pragidis (2013) define that positive government spending shock has no impact on real output or its growth and a negative government spending shock is also not significantly based on low coefficient. Afonso-Sousa (2008) use Bayesian Structural VAR model and indicates that government expenditure shocks have a small effect on GDP and lead to the "crowding-out" effect. It is also noted in the paper that government debt dynamics should be considered. In the paper of Rahman, (2005), it is concluded that monetary policy was more effective on real output growth than fiscal policy based on the unrestricted VAR approach in Bangladesh. Lütkepohl and Krätzig (2004) define VDC as the variability contribution of independent variable X to the h-step forecast error variance of dependent variable Y. This contribution is mostly estimated as a percentage. In the case of Colombia, Vargas-Herrera et al. (2012) find that fiscal expenditure has a greater impact on output and conclude that a reduced ratio of debt-to-GDP decreases the probability of risk of default by the Colombian government and reduces vulnerability to revenue and expense shocks.

In 2017, the Natural Resource Governance Institute published Macro-Fiscal modeling of Mongolia, which concludes that the real growth rate of total GDP will accelerate gradually in the near future and stabilize from 2024. Because of increasing expenditures, the level of debt to GDP ratio is increasing continuously. The economy is fragile to negative shocks, for example, commodity price shocks and delays of mining (Baksa et al. 2017). Li et al. (2017) conclude that a less aggressive investment path would perhaps be better for the country's debt sustainability. Doojav (2018) shows that exchange rate depreciation has a positive effect on macroeconomics, especially on the trade balance of Mongolia in the long-run. The presence of natural resources has a solid impact on the exchange rate, which plays an important role in export and import. Batpurev and Munkhsoyol (2013) find that on goods and service market, budget expenditure has the effect of increasing household consumption dramatically in the short-term and decreasing private investment to a lesser extent.

Based on the research of the impact of monetary and macroprudential policy in a commodity exporting economy in Mongolia, Doojav and Batmunkh (2018) address the key challenges of monetary and fiscal policy of Mongolia and notes external and government spending shocks are vital to business cycle fluctuations. Maino et al. (2013) also address the fact that expansionary fiscal policy, and a rise of credit activity associated commodity boom, leads to increasing price volatility on the asset market and a significant rise in the risk of financial instability. Bayarsaikhan et al. (2016) conclude that a bank lending channel is quite strong in Mongolia compared to other channels, so monetary policy should place more attention on bank lending activities.

As for resource-rich countries, because there was high volatility in prices of natural resource, it leads to significant volatility in output (Ploeg–Poelhekke 2009). Therefore, long-run growth can be negatively affected by unexpected changes. Ploeg (2011) indicated that less openness to foreign trade and foreign direct investment caused resource wealth. Birdsall and Hamoudi (2002) note that most resource-dependent developing countries benefit from export duties, and least benefit from tariffs. Sachs and Warner, (1995) are among the first researchers who discussed the natural resource curse across 97 countries data, mainly referred to as Dutch disease effect. Butkiewicz and Yanikkaya, (2010) mentioned the several explanations of the resource curse, for instance, the Dutch disease, rent seeking and corruption which result in inadequate institutions, debt overhang, and low investment on human capital. Manzano and Rigobon (2001) propose resource rich countries will be disadvantaged with extensive borrowing and a decline in trade. Based on a research paper by BOM, (Avralt-Od.P, et al., 2012), they present that in Mongolia, resource transmission effect is quite high regarding money flow in the mining sector.

4. Data

The main macroeconomic variables which are used in the research are Gross Domestic Product, Money Supply, Total Government Revenue, Government Spending, Export, Government External Debt, and Global Copper Price.

The sources from which the data is collected are the National Statistical Office (NSO), Ministry of Finance (MOF), Bank of Mongolia (BOM), FRED in St. Louis, and General Customs Administration (GCA). The range of data of variables covers the first quarter of 2000 to the fourth quarter of 2018, in total 76 observations for each variable. In the case of data manipulation, the quarterly average exchange rate is used for the calculation (see Table 1).

Table 1 Data Description.

	Variables	**Range of Data**	**Description**	**Sources**
1	GDP	2000Q1-2018Q4	(GDP)	NSO
2	Money supply	2000Q1-2018Q4	(M2)	BOM
3	Government revenue	2000Q1-2018Q4	Total budget income (GREV)	MOF
4	Government expenditure	2000Q1-2018Q4	Budget expenditure on goods and services (GEXP)	MOF
5	Export	2000Q1-2018Q4	Foreign Trade Balance (EXP)	NSO and CGA
6	Government external debt	2000Q1-2018Q4	Total government external debt (GDEB)	BOM
7	Global copper price	2000Q1-2018Q4	Global copper price per metric ton (COPP)	FRED in St. Louis
8	Exchange rate	2000Q1-2018Q4	Quarterly average exchange rate	BOM

Source: Author's interpretation.

For us, it is important to study how GDP moves up and down and how it responds to certain changes of variables in the economy. As Acemoglu et al. (2016) show, total government spending in research covers government purchase of goods and services and does not include bond interest payments, social transfers, or subsidies. In addition, because it is considered a resource-rich economy, export is taken as one of the variables.

The seasonality of the data is cleared by using X-12-ARIMA seasonal adjustment package. Unadjusted data might have a possibility of encountering misspecification, in particular, it can neglect other frequencies because of putting a large focus on fitting the seasonality (Neusser, 2016). Exchange rate is used for the transformation of US Dollars into local currency. In addition, the natural logarithm form of data is considered.

5. Methodology

The model to be used in the paper is the Vector Autoregressive model, especially standard unrestricted VAR model. Vector autoregressive model is helpful to capture the joint dynamics of various time-series (Miranda-Agrippino and Ricco 2018). VARs are mostly used by scholars and policymakers to perform a structural and scenario analysis and to make a forecast. The model was first introduced by Sims (1980), where he estimated a six-variable dynamic system with no theoretical perspectives. Because of its appliances in real cases, more accurate forecasting results, and there is less complexity to apply, so unrestricted VAR model is used in this research. Through the VAR model, specifically, through the Granger causality test, it gives the possibility to see what causes which variable (Koop, 2008).

VAR model that is used in the analysis consists of 5 endogenous variables and 2 exogenous variables. According to residual diagnostics, two variables are better to be concerned as exogenous. The optimal lag of the model is 2-lags. To this end, the system of the VAR model used in the analysis as follows.

Equation 1 VAR(5) model.

$$\begin{bmatrix} GDP \\ GREV \\ GEXP \\ EXP \\ COPP \end{bmatrix} = \begin{bmatrix} C_{1,11} \\ C_{2,11} \\ C_{3,11} \\ C_{4,11} \\ C_{5,11} \end{bmatrix} + \begin{bmatrix} C_{1,1} & C_{1,2} \\ C_{2,1} & C_{2,2} \\ C_{3,1} & C_{3,2} \\ C_{4,1} & C_{4,2} \\ C_{5,1} & C_{5,2} \end{bmatrix} * \begin{bmatrix} GDP_{(-1)} \\ GDP_{(-2)} \end{bmatrix} + \begin{bmatrix} C_{1,3} & C_{1,4} \\ C_{2,3} & C_{2,4} \\ C_{3,3} & C_{3,4} \\ C_{4,3} & C_{4,4} \\ C_{5,3} & C_{5,4} \end{bmatrix} *$$

$$* \begin{bmatrix} GREV_{(-1)} \\ GREV_{(-2)} \end{bmatrix} + \begin{bmatrix} C_{1,5} & C_{1,6} \\ C_{2,5} & C_{2,6} \\ C_{3,5} & C_{3,6} \\ C_{4,5} & C_{4,6} \\ C_{5,5} & C_{5,6} \end{bmatrix} * \begin{bmatrix} GEXP_{(-1)} \\ GEXP_{(-2)} \end{bmatrix} + \begin{bmatrix} C_{1,7} & C_{1,8} \\ C_{2,7} & C_{2,8} \\ C_{3,7} & C_{3,8} \\ C_{4,7} & C_{4,8} \\ C_{5,7} & C_{5,8} \end{bmatrix} * \begin{bmatrix} EXP_{(-1)} \\ EXP_{(-2)} \end{bmatrix}$$

$$+ \begin{bmatrix} C_{1,9} & C_{1,10} \\ C_{2,9} & C_{2,10} \\ C_{3,9} & C_{3,10} \\ C_{4,9} & C_{4,10} \\ C_{5,9} & C_{5,10} \end{bmatrix} * \begin{bmatrix} COPP_{(-1)} \\ COPP_{(-2)} \end{bmatrix} + \begin{bmatrix} C_{1,12} \\ C_{2,12} \\ C_{3,12} \\ C_{4,12} \\ C_{5,12} \end{bmatrix} * [M2] + \begin{bmatrix} C_{1,13} \\ C_{2,13} \\ C_{3,13} \\ C_{4,13} \\ C_{5,13} \end{bmatrix} * [GDEB] \quad (2)$$

6. Results

The research follows two fundamental steps which are VAR estimation, and impulse response functions. In general, VAR model tells if the economic indicators are significantly related to each other, while impulse response function shows how these indicators respond to shocks (Hill et al. 2008). The econometric package that is used in the estimation is Eviews 6.

6.1. VAR Estimation

Within the range of the VAR estimation, the following tests are performed.

- Stationary test and Cointegration test
- Optimal Lag length selection
- Estimation of VAR
- Residual diagnostics
- Granger Causality test

In order to run a VAR model, we first run the stationarity test through the ADF test. In ADF test, Schwarz Information Criteria is used. Because some variables show a trend over time, stationarity is tested through both with and without a trend. T-statistics results of ADF test are compared to the critical values of the Dickey-Fuller unit root t-test statistics table at the significance level of 5 percent. The absolute values of t-statistics are smaller than the absolute value of critical values at a level of 5 percent significance, thus it is failed to reject the null hypothesis, which means an individual variable has a unit root. Based on the result of the ADF test, it is possible to proceed with the analysis without the trend. The variables give an insignificant coefficient for time trend, except export, and government revenue at a 5 percent significance level. For this reason, the time trend is not considered in the further analysis.

Once it is defined that chosen variables are not stationary, cointegrations among variables are tested. According to the first step of the Engle–Granger Two-Step cointegration approach, I run a co-integration test. Cointegration equation follows Ordinary Least Square in the estimation (see Table 2).

Table 2 Cointegration test result.

$$GDP = \beta 0 + \beta 1{*}M2 + \beta 3{*}GREV + \beta 4{*}GEXP + \beta 5{*}EXP + \beta 6{*}GDEB + \beta 7{*}COPP + \varepsilon$$

$$\underset{(0.17)}{GDP=0.38} + \underset{(0.07)}{0.32{*}M2} + \underset{(0.09)}{0.49{*}GREV} - \underset{(0.08)}{0.03{*}GEXP} + \underset{(0.06)}{0.20{*}EXP} - \underset{(0.04)}{0.01{*}GDEB} - \underset{(0.06)}{0.18{*}COPP}$$

$R2 = 0.9876$ N = 76

Source: Author's estimation.

Residual is defined as follows. The result of the ADF test of residual is given in Table 3.

$$RES = GDP - \beta 0 - \beta 1{*}M2 - \beta 3{*}GREV - \beta 4{*}GEXP - \beta 5{*}EXP - \beta 6{*}GDEB - \beta 7{*}COPP$$

$$RES = GDP - 0.38 - 0.32{*}M2 - 0.49{*}GREV + 0.03{*}GEXP - 0.20{*}EXP + 0.01{*}GDEB + 0.18{*}COPP$$

Source: Author's estimation.

Table 3 Residual ADF Test result.

Variables	t-statistics	p-value	1%	5%	10%
RES	−4.270253	0.0010	−5.51233	−4.97684	−4.69648

Source: Author's estimation.

Residual is also tested through the ADF unit root test if it is stationary. The t-statistics result is reliable and it gives certain information whether the zero is accepted or not. In this case, Davidson and MacKinnon (1993) critical value table is used (MacKinnon, 2010). According to the result, t-statistics is smaller than 1 percent, 5 percent, and 10 percent level critical values in absolute form and fails to reject the null hypothesis, which means residual is not stationary. Overall, results show that both chosen variables and the residual are non-stationary. Hence, it is concluded that the variables are not cointegrated with each other. In addition, through cointegration test, we assumed that there was no long-run association among the variables, but there might be a short run association.

Since there is no cointegration among variables, the unrestricted VAR model is employed. In order to make the data stationary, the first difference of the variables are taken and tested again by the ADF test. Based on the t-statistics values given, the values are greater than the critical values in absolute form, which means the null hypothesis is rejected. The result of ADF test of differenced variables is given in Table 4.

Table 4 ADF test result with first difference.

Variables	t-statistics	p-value	1%	5%	10%
D(GDP)	−9.679748	0.0000	−3.521579	−2.901217	−2.587981
D(M2)	−6.935547	0.0000	−3.521579	−2.901217	−2.587981
D(GREV)	−10.64032	0.0001	−3.521579	−2.901217	−2.587981
D(GEXP)	−14.29786	0.0001	−3.521579	−2.901217	−2.587981
D(EXP)	−10.73145	0.0001	−3.521579	−2.901217	−2.587981
D(GDEB)	−7.035967	0.0000	−3.521579	−2.901217	−2.587981
D(COPP)	−6.903266	0.0000	−3.521579	−2.901217	−2.587981

Source: Author's estimation.

Akaike Information Criteria and Likelihood Ratio are mostly used for the lag selection. In the result, selected lag order according to AIC, HQ, LR, and FPE is Lag 1. According to residual autocorrelation LM test, and normality test results, choosing lag order one violates these conditions and lag-one is not enough for the analysis. For this reason, lag order two is selected as an optimal lag length.

Before running the estimation, we considered five out of seven variables as endogenous variables and remained two variables as exogenous variables (see Table 5).

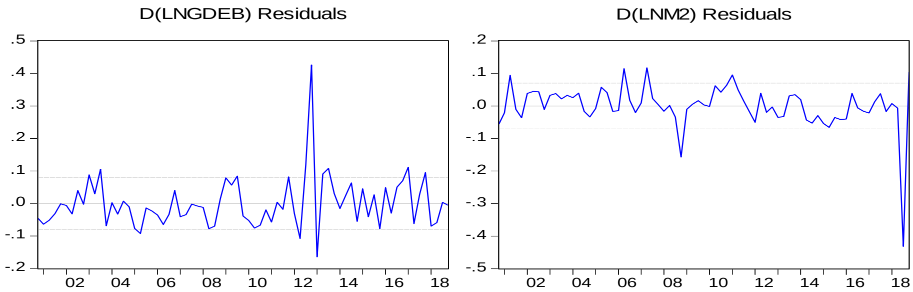
Table 5 Variables of VAR model.

Endogenous variables		Exogenous variables	Lag order
- D(GDP)	- D(EXP)	- D(M2)	2
- D(GREV)	- D(GOPP)	- D(GDEB)	
- D(GEXP)			

Source: Author's estimation.

In terms of BLUE (Best Linear Unbiased Estimation) of coefficients of the VAR model, residuals have to be White Noise process and normally distributed. However, residuals of money supply and government debt resulting from VAR are not normally distributed based on Normality test of residuals. This result affects the joint Normality result, as well. Moreover, because of either unexpected drop or unpredicted rise in the data, these two variables may include outliers in the residuals (see Figure 1). Including outliers causes residuals to violate Normality test and reject the null hypothesis. For these reasons, these two variables are omitted from the model and added as exogenous variables.

Figure 1 Residual plot of GDEB and M2.



Source: Author's estimation.

Furthermore, based on AR root test result, these two variables influence the stability condition of the system. Based on the Granger causality test, these two variables neither have univariate nor bivariate significant causality relationship with all other variables. For this reason, variables are added to the model as exogenous variables in order to observe if it affects the economy, even though it violates prior tests. It is also important for us to learn how government external debt and money supply exhibit an impact on certain macroeconomic variables in the model.

Regarding the result of the estimation of VAR(5) model, we mostly focus on the relation of the variables whether it is positive or not, rather than focusing on interpreting the coefficients (see Equation 2).

Equation 2 VAR Model - Substituted Coefficients.

$$\begin{bmatrix} D(LNGDP) \\ D(LNGREV) \\ D(LNGEXP) \\ D(LNEXP) \\ D(LNCOPP) \end{bmatrix} = \begin{bmatrix} 0.033 \\ 0.047 \\ 0.051 \\ -0.0005 \\ -0.025 \end{bmatrix} + \begin{bmatrix} -0.256 & -0.023 \\ -0.314 & 0.392 \\ -0.099 & 0.430 \\ -0.085 & -0.109 \\ -0.634 & 0.240 \end{bmatrix} * \begin{bmatrix} D(LNGDP(-1)) \\ D(LNGDP(-2)) \end{bmatrix} +$$

$$\begin{bmatrix} -0.064 & -0.047 \\ -0.410 & -0.319 \\ 0.156 & -0.120 \\ 0.501 & 0.113 \\ 0.195 & -0.096 \end{bmatrix} * \begin{bmatrix} D(LNGREV(-1)) \\ D(LNGREV(-2)) \end{bmatrix} + \begin{bmatrix} 0.089 & 0.036 \\ -0.058 & 0.123 \\ -0.494 & -0.016 \\ 0.052 & 0.011 \\ -0.004 & -0.025 \end{bmatrix} * \begin{bmatrix} D(LNGEXP(-1)) \\ D(LNGEXP(-2)) \end{bmatrix} +$$

$$\begin{bmatrix}-0.031 & 0.062\\ -0.036 & -0.016\\ -0.114 & -0.026\\ -0.128 & 0.021\\ 0.214 & 0.058\end{bmatrix} * \begin{bmatrix}D(LNEXP(-1))\\ D(LNEXP(-2))\end{bmatrix} + \begin{bmatrix}0.182 & 0.056\\ 0.441 & 0.099\\ 0.138 & -0.049\\ 0.085 & -0.033\\ 0.194 & -0.201\end{bmatrix} * \begin{bmatrix}D(LNCOPP(-1))\\ D(LNCOPP(-2))\end{bmatrix} +$$

$$+ \begin{bmatrix}0.198\\ 0.279\\ -0.009\\ 0.232\\ 0.713\end{bmatrix} * [D(LNM2)] + \begin{bmatrix}-0.027\\ -0.242\\ -0.342\\ 0.263\\ 0.278\end{bmatrix} * [D(LNGDEB)] \tag{3}$$

In Table 6, only coefficients with significant t-statistics are given. According to the result of VAR estimation, it is said that today's value of GDP significantly and positively depends on the previous period value of copper price and the value of money supply. Future value of government revenue depends negatively on the previous first and second lag order value of itself and positively on the previous first lag value of the copper price. This means that if there is a shock given to copper price, the impact of this shock will influence to government revenue in the next quarter. The impact is positive.

Table 6 Final VAR results

Variables	Coefficient	Standard errors	t-statistics
	Dependent Variable: GDP		
D(LNCOPP(-1))	0.182478	(0.05404)	[3.37675]
C	0.032529	(0.01165)	[2.79170]
D(LNM2)	0.198313	(0.08829)	[2.24623]
	Dependent Variable: GREV		
D(LNGREV_SA(-1))	−0.410497	(0.14560)	[−2.81943]
D(LNGREV_SA(-2))	−0.318773	(0.14755)	[−2.16045]
D(LNCOPP(-1))	0.440601	(0.10571)	[4.16800]
C	0.046928	(0.02279)	[2.05881]
	Dependent Variable: GEXP		
C	0.050897	(0.02502)	[2.03401]
D(LNGDEB)	−0.342356	(0.17835)	[−1.91961]
	Dependent Variable: EXP		
D(LNGREV_SA(-1))	0.500868	(0.22870)	[2.19004]
	Dependent Variable: COPP		
D(LNGDP_SA(-1))	−0.633787	(0.37145)	[−1.70625]
D(LNEXP_SA(-1))	0.213536	(0.10824)	[1.97287]
D(LNM2)	0.713432	(0.20669)	[3.45176]

Source: Calculation of Eviews.

As for government expenditure, government external debt possibly negatively affects government expenditure. Previous first lag value of government revenue has a positive impact on the future value of export of Mongolia. This can be understood as increasing government revenue resulting in increasing government spending through hiring more people on the export sector or giving subsidies to large companies to stimulate the economy and this may lead to increase in export. Lastly, the most influential variable to impact the next period value of the copper price is money supply according to the estimated result. It should also be noted that copper price is determined by many different factors. Therefore, Mongolian macroeconomic variables only play a small part. As for export and GDP, they show low significance t-statistics.

Four key tests are performed in the residual diagnostics which are autocorrelation LM test, Normality test, Heteroscedasticity White test, and VAR system stability test. Based on the significance level of the Autocorrelation LM test result, the null hypothesis fails to reject at lag order 2. Thus, there is no residual autocorrelation, which means that it is not necessary to omit variables and lag order two is enough for the analysis.

The statistics can be biased against the null hypothesis because of non-normal residuals (Sims, 1980). The chosen Normality method is the Cholesky of covariance (Lütkepohl, 2005). From the result of the normality test, the probabilities of all measurements indicate that it fails to reject the null hypothesis. From the Jarque-Bera joint test result, it is possible to say that the system of residuals is normally distributed. Residuals are also tested according to White Heteroscedasticiy with no cross term. According to the test result, we can conclude that residuals are homoskedastic. Based on the result of the AR root table, it is certain that no root lies outside the unit circle and that VAR satisfies the Stability Condition. This result also shows that the system is stationary. By having passed these tests, we are able to get better models for the analysis.

One main goal of this research is to define if there is any relationship between the given variables. We used Granger causality test to define the causal relationship of variables. Interpretation of this test as follows: If it is said that A is Granger cause of B, this implies that past and present values of A contain some information which is helpful to predict future values of B (Pesaran, 2015). Table 7 given below only shows significant results from Granger causality test. Other non-significant values are not provided.

Table 7 Granger causality test results

Dependent variable: D(LNGDP_SA)			
Excluded	Chi-sq	Df	Prob.
D(LNCOPP)	12.99300	2	0.0015
All(GREV,GEXP,EXP,COPP)	20.61104	8	0.0083
Dependent variable: D(LNGREV_SA)			
Excluded	Chi-sq	Df	Prob.
D(LNCOPP)	18.87552	2	0.0001
All (GDP,GEXP,EXP,COPP)	26.16184	8	0.0010
Dependent variable: D(LNEXP_SA)			
Excluded	Chi-sq	Df	Prob.
D(LNGREV_SA)	4.796452	2	0.0909

Source: Author's estimation.

Based on the p-value of the test, it can be concluded that the null hypothesis is rejected, which means that there are some causal relationships among dependent and independent variables. More precisely, an independent variable causes the dependent variable, thus, the independent variable can possibly predict the dependent variable. The detailed interpretations of these results are given in the following table (Table 8).

Table 8 Interpretation of Granger causality test results

Dependent variable: GDP
Copper price does Granger cause GDP. All variables (Government revenue, Government expenditure, Export, Copper price) jointly do Granger cause GDP
Dependent variable: Government revenue
Copper price does Granger cause Government revenue. All variables (GDP, Government expenditure, Export, Copper price) jointly do Granger cause Government revenue.
Dependent variable: Export
Government revenue does Granger cause Export. (at 10 percent significance level)

Source: Author's interpretation.

As for government expenditure, no independent variable gives significant value. None of the independent variables Granger cause government expenditure. As for copper price, copper price is handled globally in the market. Hence, Mongolian economy indicators are not necessarily a cause of global copper price dynamics.

According to the interpretation given in Table 8, both GDP of Mongolia and Government revenue are sensitive to global copper price. It is possible to predict both GDP and government revenue future values by using copper price and joint of all other variables. In other words, the economic growth of Mongolia can be affected by the change of global copper price. So does the change in government revenue. This implies that the third hypothesis of our research is true, which is that GDP is sensitive to copper price shock. As for exports, the only variable that changes its dynamics is government revenue. However, the causal relationship is significant at 10 percent significance level.

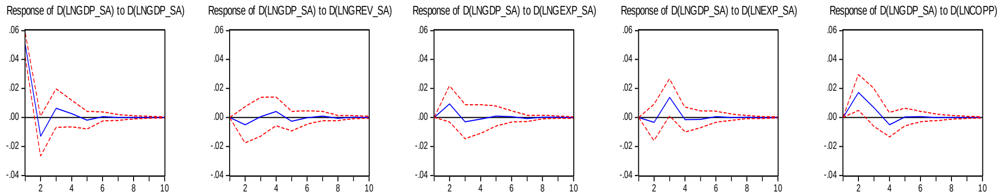
6.2. Impulse Response Function

One main goal of this paper is to study how the chosen variables respond to certain types of shocks. If there is a response of one variable to the impulse of another, it follows that the latter variable causes the former (Lütkepohl, 2005). In the IRFs, Cholesky decomposition method is used to evaluate the response of shocks. Cholesky ordering of IRFs is D(LNGDP_SA), D(LNCOPP), D(LNGREV_SA), D(LNEXP_SA), and D(LNGEXP_SA).

In IRF, the line between two asymptotic lines is IRF calculated by the model. Two asymptotic lines are 95 percent confidence intervals. In the graph, the horizontal axis starts from 1. IRF is usually considered as giving one standard deviation shock rather than one-unit shock to overcome measurement issues (Hill et al. 2008).

In Figure 2, it is most probable that shocks, which are given to the value of GDP of previous lags, affect the future value of GDP itself. From the second sub-figure, one standard deviation shock to government revenue (GREV) initially brings slightly negative impact on GDP. The volume of the response of GDP to government revenue shock is quite small and it fluctuates around its steady state. From the third sub-figure, one standard deviation shock to government expenditure (GEXP) brings the positive reaction to GDP in the first period and GDP goes back to its steady state in the second period and the response to shock disappears from the fifth period. From the fourth sub-figure, it can be seen that shock to export (EXP) presents a slightly negative reaction of GDP in the first period. However, GDP responds positively in the second period, and goes back to its steady state in the third period. Finally, in the last sub-figure, the response of GDP to shock to copper price is initially noticeably positive in the first period in relatively big volume compared to the other three. GDP declines in the next two periods.

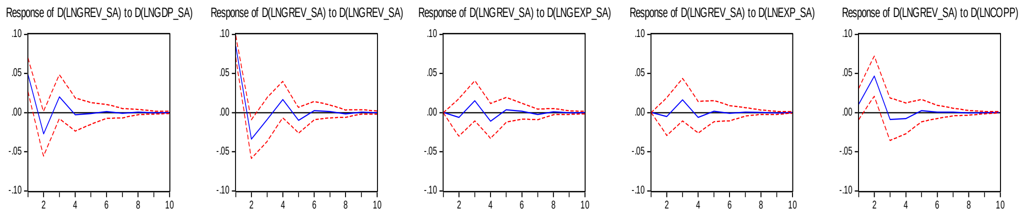
Figure 2 Response of GDP to other variable shocks.



Source: IRF estimation

The first sub-figure in Figure 3, government revenue initially responds negatively and decreases sharply in the first period. In the second period, government revenue goes up. The second sub-figure shows the response of government revenue to government revenue itself. The third sub-figure implies that government revenue reacts slightly negatively to government expenditure in the first period, then it positively reacts from the second period until the third period. The fourth sub-figure shows that government revenue responds positively to export shocks in the second period and is back to its steady state from the period five. In the final sub-figure, it is shown that government revenue responds positively to shocks to the copper price in the beginning. Copper price shock is effective in the first one or two periods and the response to shock disappears from the fourth period.

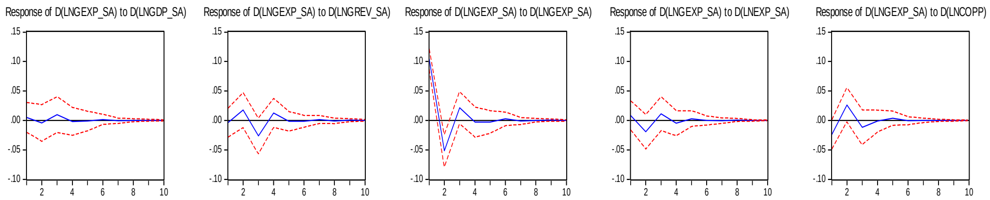
Figure 3 Response of Government Revenue to other variable shocks.



Source: IRF estimation

Government expenditure shows almost no response to the shock of GDP. GDP is not an effective tool to predict the government expenditure indicated in the first sub-figure (Figure 4). However, it reacts positively to shock to government revenue in the first period. In the second period, government expenditures fall lower than their steady state. The response of government expenditure is negative to shock to export in an initial period. However, it reacts positively in the next period, then gradually returns to its steady state. The response to shock to copper price is in the opposite direction as to export shock. In other words, the reaction is positive in the beginning and slightly wanes from the fourth period.

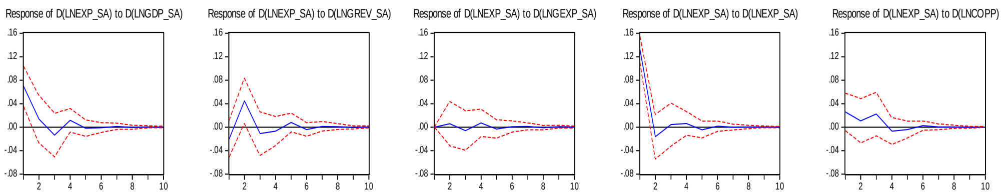
Figure 4 Response of Government Expenditure to other variable shocks.



Source: IRF estimation

Mongolian exports respond negatively to shock to GDP in the beginning. Export initially declines sharply in the first two periods and increases over its steady state in the third period (Figure 5).

Figure 5 Response of Export to other variable shocks.



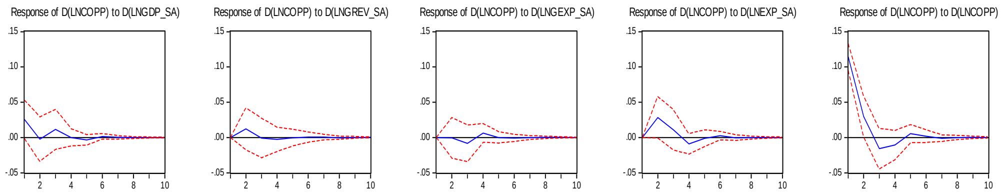
Source: IRF estimation

As for shock to government revenue, the export responds significantly positively in the first period. Then, it declines and fluctuates around its steady state. Government expenditure is not an effective tool to predict export. In case of giving one standard deviation of a shock to copper price, export responds rather stably above its steady state and gradually goes back to its steady state from the sixth period. A shock to GDP has a negative impact on export in the short run. In contrast, government revenue shock has a positive effect on export in the short run. Government expenditure has almost no effect on export either in the short run or in the long run. Shock to copper price has a gradual negative effect on export in the short run.

As we assume, the copper price usually does not respond significantly to shocks to Mongolian economic indicators. This can be observed from the following figure (Figure 6). However, shocks to export and GDP bring slight changes to the copper price.

Copper price responds negatively and fluctuates around its steady state to shocks to GDP. Copper price responds positively to shock to export in the first period and gradually declines in the second and third period. The impact of a shock to export disappears from the fifth period.

Figure 6 Response of Copper price to other variable shocks.



Source: IRF estimation

7. Conclusion

In the beginning, we had two research questions as follows:

- How does the economy respond to certain macroeconomic shocks?
- Is there any causal relationship between the key economic indicators considered in this paper?

We have obtained answers to both research questions through the analysis. We also had three hypotheses, only one of which is accepted. The accepted hypothesis is that the GDP of Mongolia is sensitive to global copper price shock.

Based on the result of the analysis, both previous value of copper price and the value of the money supply positively affect the next period value of GDP. Granger causality test provides that GDP is sensitive to copper price. IRFs provide evidence that in the short run, shocks to government expenditure, export, and the copper price have a simple positive impact on GDP.

Money supply is considered as an exogenous variable in the analysis. Its effect is positive on GDP. The next period government revenue is affected positively by the previous period value of the copper price. The Granger causality test also proves that government revenue of Mongolia is sensitive to global copper price. IRFs give information that in the short-run, shocks to copper price and export have noticeable and small positive impact on government revenue, respectively. In contrast, a shock to GDP has a negative impact on government revenue in the short-run.

Government external debt has a negative effect on government expenditure. Shocks to government revenue and the copper price have a positive impact on government expenditure in the short run and shock to export has minimal negative effect.

Previous first lag value of government revenue has a positive impact on the future value of export. This is given in the analysis that the only variable that results in export dynamics is government revenue. However, the causal relationship is significant at 10 percent significance level. IRFs indicate that shock to GDP has negative impact on export in the short run. In contrast, government revenue shock has positive effect on export in the short run and shock to copper price has a gradual negative effect on export in short run. GDP. Government external debt also violates residual normality test, thus, we consider this variable as an exogenous variable.

Because the copper price is managed globally, the indicators impacting on this variable are few. GDP and export have weak significance in affecting the copper price and money supply is the only influential indicator according to VAR estimation. Global copper price can predict the dynamics of GDP and government revenue in the short-run according to the result of the Granger causality test. Shocks to GDP and export have negative impact on copper price in the short run.

Finally, there are four fundamental issues that should be discussed in further research. In order to obtain better model and better estimation results, the addition of data and variable is recommended. Also, the research could be extended by using different models in different countries and comparing the results. Most variables used in this paper are part of fiscal policy, therefore, our results could be useful in implementing effective fiscal policy.

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