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Impact of monetary policy on the macroeconomy under dollarization: evidence from the Lao PDR

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Abstract

Purpose – This study empirically aims to analyze the transmission of monetary policy in consideration of asymmetry based on the Bank of the Lao PDR (BOL)'s monetary policy tools and real and financial variables in the domestic market.

Design/methodology/approach – This study adopts two approaches, conventional vector autoregression (VAR) and asymmetric VAR, to investigate the impact of monetary policy on macroeconomic variables including inflation and real GDP growth in the Lao PDR.

Findings – Under a highly dollarized monetary regime, the policy rate change plays a weaker role compared with M0, which exerts significantly positive effects on real GDP growth and inflation. The results of the asymmetric VAR model further substantiate that the real economy responds to a positive M0 shock (easing monetary policy) rather than a negative shock (tightening monetary policy).

Practical implications – Overall estimation results suggest that the effectiveness of monetary policy is limited in Laos, which would take priority over efforts to strengthen the development of the short-term financial market and de-dollarization.

Originality/value – This study can fill the gap in the literature in which the discussions on the transmission mechanism of monetary policy in the BOL's monetary policy are still little known.

Keywords Monetary policy, Dollarization, Macroeconomy, Asymmetric VAR model

Paper type Research paper

1. Introduction

The Lao economy has continued to grow at an average annual rate of 7% since it transitioned from a centrally planned economy to a market-oriented economy in 1986. The Lao economy, however, has a weak industrial infrastructure and thus has a very volatile structure influenced by fluctuations in overseas demand. Also, it is difficult for the Bank of the Lao

JEL Classification — F43, J11, O47

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PDR to exercise monetary policy sovereignty due to continued dollarization. US dollar and Thai Baht are commonly used in addition to the domestic currency, Kip, as Lao people lack trust in government policies and banks.

To achieve price stability, meanwhile, the Bank of the Lao PDR (BOL) implemented monetary policies focusing on the stability of the KIP's exchange rate through the hard peg exchange rate mechanism. As continuous upward adjustment of the exchange rate became inevitable, however, the BOL converted to the managed floating exchange rate system since September 1995. In addition, monetary targeting was introduced to ensure the effectiveness of the monetary policy after the outbreak of the Asian Financial Crisis (AFC) in 1997. In other words, both systems are operated as the nominal anchor or intermediate target of monetary policy.

In theory, the exchange rate target system is more likely to be effective on price stability in a country with high import dependency and expected to have favorable effects on foreign capital inflow thanks to the reduction of uncertainty in foreign transactions at the enterprise level and the decrease of foreign exchange risk. Despite being confronted with the trilemma (impossible trinity) that makes it difficult to exercise monetary sovereignty, the BOL sticks to exchange rate targeting as well as monetary targeting.

In reality, the implementation of two systems is based on the experience that the exchange rate path, a monetary policy transmission channel, works only in the short run since the exchange rates in a small open economy more easily succumb to foreign factors, such as foreign capital flow and currency value fluctuation of major trading partners, rather than domestic factors. Furthermore, the BOL believes that for countries with financial markets that are not mature enough like Laos, anchoring in the money supply exerts a relatively stable influence on the real economy in the long term through a credit channel. There is also an inherent perspective that the monetary aggregate targeting is conducive to lowering the expectation for inflation that prevail among the public.

Against this backdrop, it is crucial to empirically analyze the transmission of monetary policy by constructing empirical models based on the BOL's monetary policy tools and real and financial variables under dollarization.

The remainder of this study is organized as follows: Section 2 discusses the existing literature. Section 3 provides a detailed description pertaining to data and model specification, followed by empirical results as well as interpretation. Section 4 describes concluding remarks.

2. Literature review

In this section, we conduct an overall review of related previous literature on financial markets, monetary policy and economic growth under dollarization. According to Yoon (2002), since the late 1970s, countries in Latin America have suffered from inflation and high currency risk due to severe inflation. Dollarization started out in Ecuador in April 2000 and spread throughout Latin American countries. As of 2002, over 60% of Latin American deposits were in US dollars. In the case of small open economies with weak economic bases, especially developing countries, it is possible to counter currency risks and financial instability through dollarization. However, Céspedes *et al.* (2002) analyze that emerging countries have shown that fixed exchange rates are less efficient than discretionary exchange rates. The adoption of a fixed exchange rate leads to inefficiencies due to the gap between real and nominal exchange rates. This paper suggests that alternative monetary policies, such as flexible inflation targeting, strict inflation targeting and flexible inflation targeting, all have lower welfare losses compared to fixed exchange rates.

Meanwhile, Chang and Velasco (2001) examine whether debt dollarization and the resulting balance of payments hinder the traditional role of monetary policy. Modeling a small open economy with poor capital market development, the possibility of domestic investment or output declined due to the weakness of the financial market. Also, Cook (2004) examines that in developing countries, foreign debt is repaid in the powerful currency of a developed country such as the dollar. Such debt dollarization can cause exchange rate fluctuations, which can de-stabilize the business cycle of developing countries. Also, Felices and Tuesta (2013) address the general equilibrium of a small open economy under partial dollarization. The framework of the paper concludes that the higher the degree of dollarization, the greater the trade-off between inflation and output gaps and the lower the central bank's stabilization function. As the dollar changes, the domestic economy fluctuates, and the central bank's monetary power decreases. Central banks need to intervene in order to stabilize the economy, which leads to the conclusion that the Taylor Rule needs to be expanded.

Studies on developing countries under dollarization have been growing in number. Morón and Winkelried (2005) show that developing countries that do not have strong financial resources have little room for external shocks such as capital outflows caused by foreign exchange rates. It shows how efficient it would be to use inflation-targeting policies under high debt dollarization, suggesting that in small open economies, it may be best to follow a non-linear policy to defend against exchange rates. On a related note, Piontkovsky (2003) studies how the degree of dollarization depends on the relative returns of financial assets, inflation volatility and financial market development in the transitional economy. Finally, Fabris and Vujanović (2017) observe that Serbia has been in the inflation targeting policy since 2006, facing the dollarization of the financial sector. This paper analyzes inflation in Serbia according to the exchange rate path. Unpredictability under financial dollarization has a significant effect on the nominal exchange rate, but the impact on inflation continues at a low level. In particular, the impact on inflation was attributed to financial dollarization itself, and the impact on the exchange rate was less. This is probably because Serbia's central bank controlled the shock by intervening in the exchange rate market.

According to Brodsky (1997), dollarization is a common phenomenon in transitional economies, often driven by economic reforms or inflation. The degree of dollarization depends on each country's economic situation and policies. In Russia, the rate went up from 40% to 50% due to policy mistakes. The difference between the exchange rate and the inflation rate may determine the degree of dollarization. High levels of dollarization not only adversely affect domestic investment and aggregate demand but also increase the instability of the monetary credit policy. Meanwhile, Calvo (2006) illustrates that developing countries' monetary policy has decisive vulnerabilities facing the volatility of the exchange rate. He argues that the interest rate rules would be less effective under a sudden stop of capital inflow. Bannister *et al.* (2018) show that dollarization had a negative impact on the financial sector. This turns out to cause high inflation and lower financial efficiency. Due to dollarization, domestic capital tended to go abroad. The declining effects of monetary policy were also an important factor. Therefore, to ensure the safe development of local finance, there need to be policy efforts to reduce dollarization. If the domestic financial market is developed after dollarization, domestic savings and investment will increase to replace foreign investment.

Overall, little is known about the interactions between monetary policy and financial and foreign exchange markets under dollarization as only several papers exist on the topic. For example, Pennings *et al.* (2015) empirically explore the effects of monetary policy on stock prices and exchange rates in small open economies and non-dollarized economies, such as Korea, Canada, Australia, New Zealand, the UK, Indonesia, Malaysia and Thailand.

3. Model specifications and empirical results

3.1 Model and data

In this section, we employ a vector autoregression (VAR) model, namely, a popular method used to establish the connection among several variables without any prior constraints but paying more attention to information from the data itself, to explore the impact of monetary policy on the macroeconomy of the Lao PDR. By incorporating lagged variables and utilizing post-estimation, such as impulse response functions (IRFs) and forecast error variance decomposition, the VAR model is suitable to be extended to any field connected to the dynamic economic system.

The mathematical expression of the structural vector autoregression model (SVAR(p)) is as follows:

$$\lambda Y_t = \sum_{i=1}^{p} \lambda_i Y_{t-p} + \varepsilon_t \tag{1}$$

where Y_t denotes the vector of endogenous variables, p is the lag length and ε_t is vectors of the error term. λ represents the coefficient matrix which captures contemporaneous correlations among all endogenous variables, while λ_i depicts the intertemporal relationship. If λ is invertible, both sides of the equation can be multiplied by its inverse matrix, and we get a (reduced-form) VAR as follows:

$$Y_t = \sum_{i=1}^{p} \phi_i Y_{t-p} + \upsilon_t \tag{2}$$

where $\phi_i = inv(\lambda)\lambda_i$.

In a nutshell, assuming that all endogenous variables are part of the autoregression (AR) process, the VAR model attempts to estimate all-time series jointly. The SVAR underlines contemporaneous correlations between the variables at time t, while the VAR puts emphasis on the relationships between time t and t–p. In the VAR model, we carry out estimation with five macroeconomic variables which are all regarded as endogenous variables. The lag length is set to 4 based on AIC and SBC criteria and using quarterly data. Since the VAR model requires stationarity of the data series, the results of unit root tests are shown in Table 1.

To ensure the robustness of test results, we conducted both the Augmented Dickey–Fuller (ADF) test and the Phillips–Perron (PP) test. The ADF test is the most commonly used unit root test, but it is sensitive to lag orders that results vary by setting. Furthermore, financial time series including the interest rate and policy rate are frequently accompanied by heteroskedasticity and autocorrelation. The PP test is essentially equivalent to the ADF test with robust heteroskedasticity, which is widely applicable to financial time series.

As shown in Table 1, most variables reject the null hypothesis at 1%, and the ADF test results are in accordance with the PP test. Test results vary on the inflation rate, but they are at least stationary at 10%. A conceivable explanation is that the inflation rate in the Lao PDR

Variable	Augmented Dickey–Fuller test *t*-statistics	*p*-value	Phillips–Perron test *t*-statistics	*p*-value
policy_d	−9.485	0.0000	−9.486	0.0000
m0_sa_c	−5.300	0.0000	−5.397	0.0000
m0_sa_c_pos	−4.997	0.0000	−5.045	0.0000
m0_sa_c_neg	−8.672	0.0000	−8.957	0.0000
cpi_sa_c	−2.200	0.0152	−3.243	0.0761
real_gdp_sa_sa	−8.572	0.0000	−8.537	0.0000
exr_c	−5.025	0.0000	−4.948	0.0000
rate_d	−8.457	0.0000	−8.402	0.0000

Source(s): Authors' work

Table 1.
Unit root tests

has been skyrocketing in the two to three years after it came under influence of the Global Financial Crisis. The average level is fairly higher compared to other sample periods, particularly, the inflation rate reached its peak at 28.7% in the second quarter of 2008.

The summary statistics for all variables in this study are presented in Table 2. All data we use are quarterly data ranging from 1996q2 to 2018q4 (1996q1 is missing value due to the calculation of quarter-over-quarter growth rate). The policy rate is a short-term average indicator (less than 7 days), but we adopt mid-term (less than 3 months) as a proxy indicator from 1996 to 2001 due to data availability. Since M0 and real GDP consist of annual and quarterly data, to keep data frequency consistent, M0 is converted to quarterly data by using the cubic spline interpolation and real GDP to quarterly data by the proprietary local quadratic interpolation. The quarterly inflation rate (CPI growth rate) is calculated on the basis of monthly data by means of an arithmetic average. The quarterly exchange rate of LAK against USD is obtained from the IMF IFS. Regarding market interest rate, we first compute the quarterly average value of the one-year deposit and loan rate of commercial banks based on monthly data and then average the two rates for the same period. What is more, the variables of M0, real GDP and CPI are seasonally adjusted.

Meanwhile, in the case of the VAR, the IRFs and forecast error variance decompositions are performed under the assumption that reactions to an identical magnitude of positive or negative shock are equivalent in terms of absolute value. However, in some economic fields, the responses to shocks tend to reveal asymmetric effects, in other words, the fluctuation caused by a positive shock is either higher or lower than that from a negative shock. In order to capture the asymmetric effects in the macroeconomy of the Lao PDR, we need to consider an asymmetric VAR model.

In this regard, we investigated the impact of monetary policy on the macroeconomy in the Lao PDR using the asymmetric VAR Model [1]. The asymmetric VAR is employed to test asymmetry in the effects of tightening and easing the monetary policy. Specifically, the series reflecting monetary policy will be divided into tightening series and easing series and each set will be estimated separately by VAR. Following this system, the asymmetric VAR model can be written in Equation (3) as follows:

$$Y_t = A_0 + A_1(L)Y_t + b_{tight}MP_{t,tight} + b_{ease}MP_{t,ease} + \varepsilon_t \tag{3}$$

where Y_t is the vector of endogenous variables, $MP_{t,tight}$ denotes the tightening monetary policy, while $MP_{t,ease}$ represents the easing monetary policy and L is the lag operator. The monetary policy is measured by M0 growth since the negative values in policy rate change

Variable	Definition	Obs.	Mean	Standard deviation	Min	Max
policy_d	policy rate change (%)	91	−0.34	1.79	−15.00	0.67
m0_sa_c	M0 growth rate (%)	91	6.50	5.64	−4.60	21.13
m0_sa_c_pos	positive series of M0 growth rate (%)	91	6.72	5.31	0.00	21.13
m0_sa_c_neg	negative series of M0 growth rate (%)	91	−0.22	0.81	−4.60	0.00
m2_sa_c	M2 growth rate (%)	91	6.91	5.10	−6.98	21.83
cpi_sa_c	inflation rate (%)	91	3.39	6.24	−1.31	28.74
real_gdp_sa	real GDP growth rate (%)	91	1.50	3.22	−10.78	15.79
exr_c	exchange rate change (%)	91	2.90	10.20	−13.11	62.40
rate_d	market interest rate change (%*p*)	91	−0.11	0.81	−2.00	2.92

Source(s): Bank of the Lao PDR and IMF IFS

Table 2.
Descriptive statistics

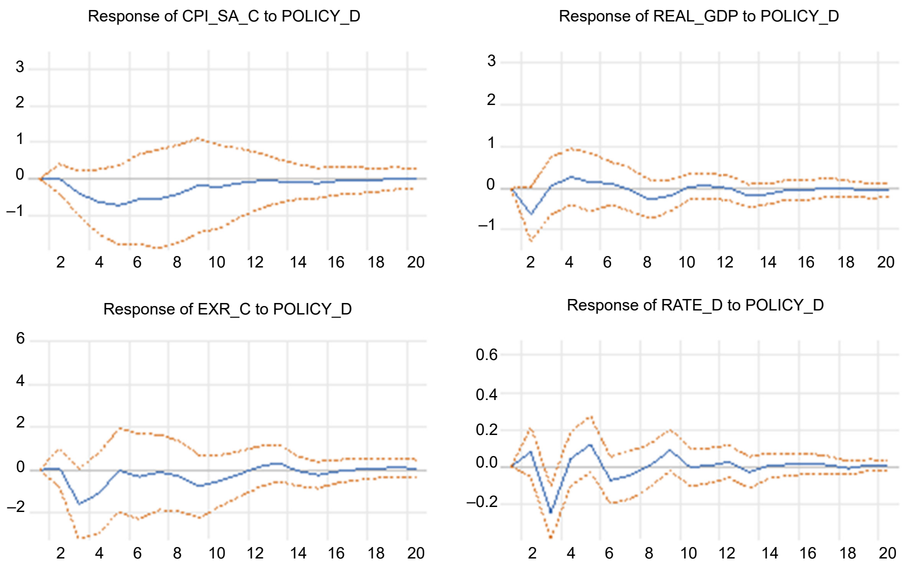
are substantially disproportional to their positive values. We generate m0_sa_c_pos by substituting zero for all negative series in M0 growth and m0_sa_c_neg by substituting zero for all negative ones.

In sum, we analyze the impact of monetary policy on macroeconomic variables through orthogonalized IRFs and forecast error variance decompositions in both the VAR and the asymmetric VAR models. The ordering of endogenous variables has a critical influence on the results, Cholesky ordering thus hinges on the results of the Granger causality test and theoretical foundation. In the VAR model with the policy rate change, the Cholesky ordering is cpi_sa_c, real_gdp_sa, exr_c, rate_d and policy_d. If the money supply growth rate is included in the VAR model, M0 growth rate is always first, followed by real_gdp_sa, cpi_sa_c, exr_c and rate_d. For the asymmetric VAR model, m0_sa_c_pos or m0_sa_c_neg is first, followed by real_gdp_sa, cpi_sa_c, exr_c and rate_d.

For evaluating the relative importance of other variables, we conduct forecast error variance decompositions to examine the contribution (measured by variance) of other variables to each endogenous variable. This variance decomposition is to determine how much of the forecast error variance is explained by itself and the variance of other variables for each endogenous variable. To this end, the covariance matrix of the error term is transformed into an orthogonal matrix and the variance of the forecast error for each variable is decomposed using this matrix.

3.2 Estimation results

3.2.1 VAR model. Figure 1 illustrates the orthogonalized impulse responses of four other endogenous variables to policy rate change shocks under the Cholesky decomposition. A policy rate change shock results in a decrease in real GDP growth followed by an upswing at the beginning, as opposed to the response to market interest rate change, which undergoes an ascending trend and then moves toward 0. Both the inflation rate and exchange rate are barely affected at the early stage, but from the third quarter, opposite reactions appear in



Source(s): Authors' work

Figure 1.
Impulse responses to policy rate change shocks <VAR> (data sample: 1996Q2–2018Q4)

different magnitudes. It is noteworthy that although all variables fluctuate over the horizon, responses are statistically insignificant. It seems that the policy rate change plays a weaker role in the monetary policy in the Lao PDR.

Many countries tend to use the interest rate as a primary and indirect channel to implement monetary policy as it was formed by a sequence of financing activities between the central bank and diversified financial institutions. Theoretically, a sound interest rate formation mechanism begins with effective monetary policy tools, which can influence a variety of interest rates in the market. Why is the policy rate change ineffective in the Lao PDR? A plausible interpretation is that several reasons are creating obstacles amid the transmission mechanism of the policy rate.

(1) Permission for financial institutions, credit ceiling and foreign exchange transactions are all subject to the rigorous supervision and restriction of the BOL. Lower liquidity of capital gives rise to lower degree of marketization in the formation of interest rates. Besides, the intervention of the central bank cannot be achieved in the form of marketization. In other words, in spite of adjusting the policy rate, a reasonable market expectation cannot be formed, therefore, the macroeconomic indicators will not change significantly.

(2) In principle, financial infrastructure such as legal environment, accounting standards, regulatory system, payment system and other supporting facilities needs to keep up with the rapid development of the financial market. Nonetheless, the domestic financial market in the Lao PDR succumbs to insufficient market transparency and obvious information asymmetry and limited capital cannot be allocated to market participants who are capable of maximizing the utility. In addition, the vulnerable financial infrastructure implies a lack of capacity to withstand an external shock.

Table 3 shows that the inflation rate is entirely self-influenced in the first quarter and that this figure still remains at 50% after three years. The contribution of real GDP growth to the variance decomposition of the inflation rate reaches a peak of 35.4%, then gradually declines. While the exchange rate change shows an upward trend, it is approximately half the contribution of real GDP growth at the end. The contribution of the policy rate change to the variance decomposition of the inflation rate remains low, from 1% in the 3rd quarter to 3% in the 12th quarter. This means that the impact of the policy rate change on the inflation rate is significantly less compared to other variables.

Table 3. Variance decomposition of inflation rate (VAR: policy rate)

Period (quarter)	cpi_sa_c	real_gdp_sa	exr_c	rate_d	policy_d
1	100.00	0.00	0.00	0.00	0.00
2	85.92	12.78	1.06	0.24	0.00
3	56.20	35.35	7.23	0.22	1.00
4	55.39	33.12	8.53	0.61	2.35
5	51.21	33.41	11.10	1.06	3.21
6	50.29	32.04	12.83	1.65	3.19
7	49.23	30.91	13.85	2.76	3.25
8	49.02	29.94	14.70	3.13	3.21
9	49.50	28.81	15.24	3.39	3.07
10	49.81	28.05	15.52	3.57	3.04
11	50.17	27.58	15.60	3.64	3.01
12	50.31	27.34	15.74	3.62	2.99

Source(s): Authors' work

Also, real GDP growth is the most important self-impacting factor throughout the horizon. The contribution accounts for about 70% after a year as shown in Table 4, and it is found that other variables have little effect on real GDP growth, no more than 13%. Especially, the contribution of the policy rate change in the variance decomposition of the real GDP growth rate is 4% after two quarters and remained similar after three years, indicating the lowest contribution compared to other variables.

Not surprisingly, the exchange rate change, particularly at the outset, is a dominant factor that exercises tremendous self-influence. With the passage of time, the contribution of inflation rate change through variance decomposition culminates in one and a half years and remains steady at 50% (see Table 5).

According to Figure 2, the impulse response of real GDP growth to M0 growth shock is at its highest level in the first quarter and significantly increases, followed by a transitory fluctuation and eventually remains at 0.5%. In theory, the short-term impact of the money supply predominantly influences the output rather than prices. In the long run, the prices are closely related to the money supply, which is not relevant to real GDP growth. Related to this, the response of the inflation rate to M0 growth shock exerts a continuous positive impact which remains significant in the 9th quarter.

Period (quarter)	cpi_sa_c	real_gdp_sa	exr_c	rate_d	policy_d
1	1.64	98.36	0.00	0.00	0.00
2	3.61	84.27	7.98	0.11	4.03
3	4.70	79.73	8.43	3.31	3.83
4	6.54	74.00	11.31	3.99	4.15
5	6.86	71.35	11.58	6.15	4.07
6	7.52	71.30	11.69	5.65	3.84
7	7.88	71.09	11.62	5.60	3.81
8	7.90	69.87	12.25	5.71	4.27
9	7.82	69.11	12.39	6.22	4.46
10	8.45	68.12	12.55	6.48	4.40
11	8.34	68.49	12.40	6.42	4.35
12	8.17	68.84	12.46	6.28	4.25

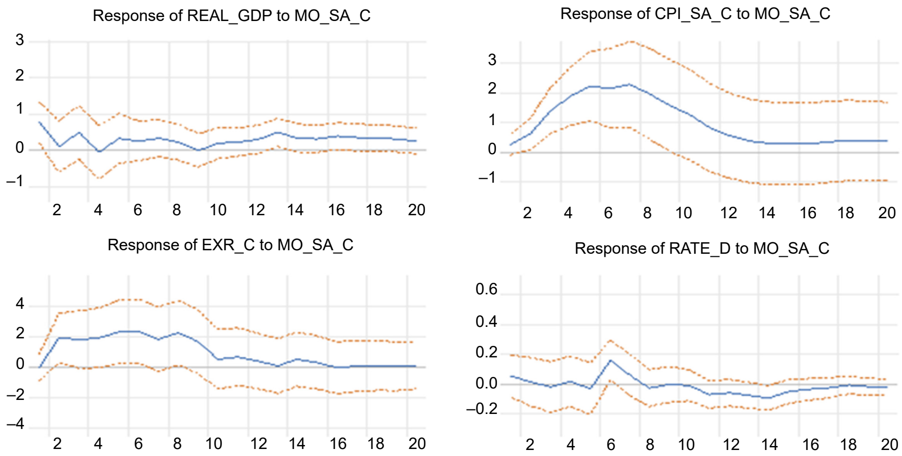
Source(s): Authors' work

Table 4. Variance decomposition of real GDP growth (VAR: policy rate)

Period (quarter)	cpi_sa_c	real_gdp_sa	exr_c	rate_d	policy_d
1	8.98	1.06	89.96	0.00	0.00
2	38.50	19.69	41.75	0.04	0.02
3	39.56	25.78	31.11	0.11	3.44
4	37.40	25.52	32.17	0.44	4.47
5	47.38	21.64	26.70	0.68	3.61
6	49.99	20.40	25.06	1.09	3.46
7	45.33	22.57	27.98	1.01	3.11
8	45.64	21.52	29.00	0.93	2.92
9	45.90	21.39	28.55	0.90	3.26
10	45.62	21.21	28.78	0.98	3.42
11	45.87	21.35	28.15	1.28	3.36
12	46.10	21.34	27.95	1.27	3.35

Source(s): Authors' work

Table 5. Variance decomposition of exchange rate change (VAR: policy rate)



Source(s): Authors' work

Figure 2. Impulse responses to M2 growth shocks <VAR> (data sample: 1996Q2–2018Q4)

Also, the exchange rate change responds to the M0 growth shock as expected. Depreciation of domestic currency is bound to occur if its purchasing power falls at a more rapid pace compared to foreign currency. The exchange rate change immediately spikes, peaking at 2.4% in the 6th quarter. The market interest rate change moves almost parallel to the horizontal axis, which indicates that an increase in the money supply has no significant impact on the market interest rate.

Table 6 shows that the self-contribution of the inflation rate initially accounts for a substantial proportion of the variance decomposition. In just 3 years, however, it plummets from 86.4% to 29.2%, which is in stark contrast to M0 growth whose contribution to the inflation rate is less than 10% in the first half of the year, gradually rising to become the key driver to influence the inflation rate, ending at 47.8% after three years. Stabilizing the money supply implies a sound of macroeconomy. In view of the curbing inflation rate, the money supply should be the fundamental measure to keep the price level and other macroeconomic indices stable.

Period (quarter)	cpi_sa_c	real_gdp_sa	exr_c	rate_d	policy_d
1	86.41	11.07	0.00	0.00	2.52
2	82.80	6.81	1.22	0.47	8.69
3	55.64	14.44	9.06	1.02	19.84
4	48.33	9.65	10.62	0.67	30.72
5	40.78	7.12	13.77	0.50	37.83
6	37.24	5.53	16.19	0.52	40.53
7	33.66	4.51	16.74	1.01	44.08
8	31.62	4.01	17.40	0.99	45.99
9	30.44	4.16	17.45	0.95	47.00
10	29.65	4.38	17.32	0.92	47.73
11	29.33	4.79	17.14	0.90	47.84
12	29.17	5.03	17.05	0.92	47.83

Source(s): Authors' work

Table 6. Variance decomposition of inflation rate (VAR: M0)

The contribution of the inflation rate to real GDP growth has been stable at around 10% in the long term (see Table 7). The contribution of an exchange rate change on real GDP growth increases over time and finally hovers around 12% while the contribution of the interest rate change on that is negligible. The proportion of M0 growth in the variance decomposition of the real GDP growth is 8–10% regardless of the horizon, which is more than double the policy rate contribution (4%).

Table 8 unveils that exchange rate change is primarily steered by the inflation rate change except for during the initial period. Inflations' contribution begins to taper off after peaking in the third quarter. In the meantime, the self-contribution of the exchange rate change takes a precipitous plunge until it reaches a trough, reaching less than 25% (6th quarter). The contributions of real GDP growth and M0 growth to exchange rate change, by and large, assume an ascending trend during the horizons.

3.2.2 Asymmetric VAR model. As shown in Figure 3 echoing Figure 2, with the stimulation of easing monetary policy, both the inflation rate and exchange rate change soar up accordingly. This affects the real GDP growth in a statistically significant manner in the initial period. Positive M0 growth accounts for over 40% of the variation in the forecast error in the inflation rate after six quarters, while the comparable value of the inflation rate itself is less than 40% (see Table 9). Table 10 shows that the inflation rate, exchange rate change as well as positive M0 growth explain 10.7%, 11.7% and 10.5% of the variation in the forecast

Table 7. Variance decomposition of real GDP growth (VAR: M0)

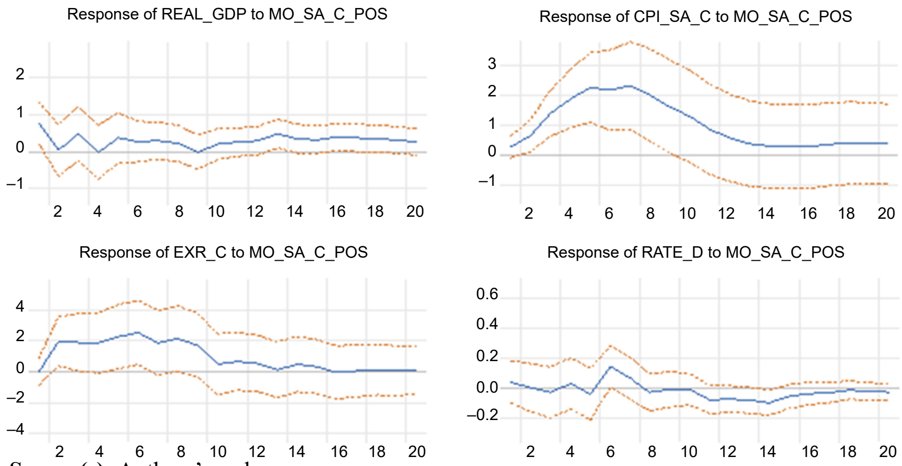
Period (quarter)	cpi_sa_c	real_gdp_sa	exr_c	rate_d	policy_d
1	0.00	92.09	0.00	0.00	7.91
2	6.97	77.97	8.17	0.13	6.76
3	9.31	72.36	7.88	1.74	8.71
4	9.30	70.85	9.31	2.36	8.17
5	10.10	67.13	9.72	4.44	8.60
6	10.13	66.61	10.65	4.26	8.35
7	10.11	65.78	10.72	4.27	9.12
8	10.61	64.43	11.51	4.17	9.27
9	10.57	64.15	11.76	4.30	9.23
10	10.47	63.34	12.11	4.79	9.29
11	10.35	63.27	12.04	4.79	9.55
12	10.20	62.89	12.18	4.74	9.98

Source(s): Authors' work

Table 8. Variance decomposition of exchange rate change (VAR: M0)

Period (quarter)	cpi_sa_c	real_gdp_sa	exr_c	rate_d	policy_d
1	13.71	2.11	84.17	0.00	0.00
2	46.07	7.62	38.89	0.39	7.02
3	46.13	9.63	32.76	0.34	11.14
4	41.56	8.54	34.52	0.33	15.04
5	41.18	14.16	27.35	0.36	16.94
6	39.65	14.21	24.91	0.57	20.65
7	35.67	13.76	28.65	0.66	21.26
8	34.80	12.56	28.70	0.60	23.33
9	34.30	12.19	28.10	0.64	24.77
10	34.13	12.15	28.28	0.66	24.77
11	33.81	13.20	27.59	0.89	24.50
12	33.82	13.49	27.37	0.89	24.43

Source(s): Authors' work



Source(s): Authors' work

Figure 3. Impulse responses to positive M0 growth shocks <Asymmetric VAR> (data sample: 1996Q2–2018Q4)

Period (quarter)	cpi_sa_c	real_gdp_sa	exr_c	rate_d	policy_d
1	85.58	11.68	0.00	0.00	2.74
2	82.13	6.95	1.16	0.49	9.27
3	55.64	13.96	9.15	1.13	20.13
4	48.30	9.24	10.95	0.72	30.79
5	40.49	8.65	14.22	0.50	38.13
6	36.89	5.09	16.73	0.48	40.81
7	33.28	4.14	17.22	0.92	44.44
8	31.19	3.68	17.77	0.90	46.45
9	30.01	3.85	17.76	0.87	47.50
10	29.23	4.07	17.57	0.84	48.29
11	28.92	4.45	17.35	0.83	48.46
12	28.78	4.65	17.24	0.83	48.50

Source(s): Authors' work

Table 9. Variance decomposition of inflation rate (asymmetric VAR: positive shock)

Period (quarter)	cpi_sa_c	real_gdp_sa	exr_c	rate_d	policy_d
1	0.00	91.61	0.00	0.00	8.39
2	7.50	77.46	7.72	0.25	7.07
3	10.02	72.06	7.37	1.62	8.93
4	9.96	70.94	8.58	2.18	8.35
5	10.77	66.88	9.05	4.20	9.10
6	10.72	66.43	10.00	3.99	8.85
7	10.67	65.70	10.13	4.03	9.47
8	11.18	64.33	10.94	3.93	9.63
9	11.14	64.06	11.20	4.02	9.58
10	10.99	63.20	11.60	4.52	9.69
11	10.85	63.06	11.51	4.52	10.05
12	10.67	62.70	11.68	4.49	10.46

Source(s): Authors' work

Table 10. Variance decomposition of real GDP growth (asymmetric VAR: positive shock)

error in the real GDP growth after three years, respectively. The corresponding value for real GDP growth by itself surpasses 60%. In the analysis of the forecast error variance decomposition of the exchange rate change, the contribution of inflation, exchange rate change and positive M0 growth is 33.6%, 27.2% and 24.9%, respectively, after three years (see Table 11).

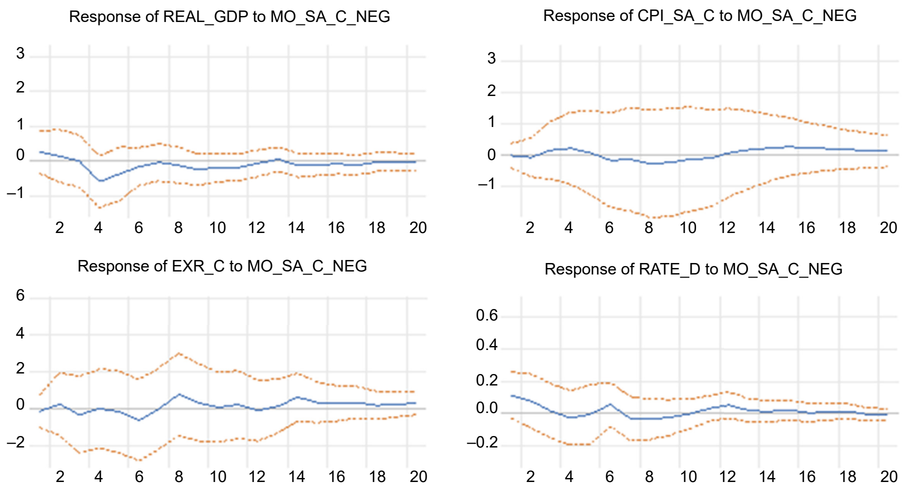
Theoretically, the implementation of tightening monetary policy is enough to slow down the pace of economic expansion. Lowering money supply growth will lead to a rise in interest rates, followed by a reduction in investment and consumption. Consequently, the inflation rate is expected to fall since the aggregate demand and supply tend to move towards an equilibrium. The gap between the domestic interest rate and foreign interest rate accelerates net capital inflows, thus triggering appreciation for domestic currency over foreign currency.

Empirically, from Figure 4, we conclude that all responses are relatively flat and smooth, and not significant over the horizons. A plausible explanation is insufficient data, driven by the fact that the BOL continued to implement an easing monetary policy over a considerable period of time.

Table 11. Variance decomposition of exchange rate change (asymmetric VAR: positive shock)

Period (quarter)	cpi_sa_c	real_gdp_sa	exr_c	rate_d	policy_d
1	13.68	2.10	84.22	0.00	0.00
2	46.18	7.32	38.83	0.40	7.26
3	46.11	8.96	32.72	0.35	11.86
4	41.47	7.94	34.70	0.38	15.51
5	41.00	13.95	27.60	0.36	17.10
6	39.17	14.00	24.90	0.55	21.38
7	35.29	13.62	28.46	0.62	22.01
8	34.64	12.50	28.52	0.57	23.77
9	34.15	12.12	27.88	0.59	25.25
10	34.00	12.08	28.06	0.63	25.23
11	33.68	13.12	27.38	0.86	24.95
12	33.66	13.38	27.15	0.86	24.94

Source(s): Authors' work



Source(s): Authors' work

Figure 4. Impulse responses to negative M0 growth shocks <Asymmetric VAR> (data sample: 1996Q2–2018Q4)

Table 12 proposes that the contribution of negative M0 growth on the inflation rate can be ignored. Table 13 illustrates that the variation in the forecast error in the real GDP growth is largely self-explanatory and that the value is about 13 times greater than that of negative M0 growth. As shown in Table 14, the contribution of negative M0 growth to exchange rate change is negligible.

Period (quarter)	cpi_sa_c	real_gdp_sa	exr_c	rate_d	policy_d
1	98.88	1.12	0.00	0.00	0.00
2	87.49	11.29	1.01	0.15	0.05
3	61.58	31.64	6.39	0.19	0.20
4	61.94	30.19	6.85	0.67	0.36
5	58.90	31.01	8.72	1.10	0.28
6	57.76	30.07	10.14	1.75	0.27
7	56.68	29.21	10.87	2.98	0.26
8	56.54	28.20	11.61	3.30	0.35
9	56.87	27.07	12.09	3.56	0.41
10	57.06	26.42	12.40	3.70	0.42
11	57.33	25.98	12.54	3.73	0.42
12	57.37	25.75	12.74	3.70	0.43

Source(s): Authors' work

Table 12. Variance decomposition of inflation rate (asymmetric VAR: negative shock)

Period (quarter)	cpi_sa_c	real_gdp_sa	exr_c	rate_d	policy_d
1	0.00	99.18	0.00	0.00	0.82
2	1.59	86.82	10.58	0.09	0.92
3	3.20	82.67	10.92	2.34	0.88
4	3.88	75.45	13.67	3.11	3.89
5	3.97	72.41	13.53	5.31	4.78
6	4.03	72.02	14.22	5.08	4.65
7	4.79	71.49	14.13	5.00	4.59
8	4.83	70.60	14.94	5.03	4.59
9	4.82	69.83	14.97	5.39	5.00
10	5.21	68.63	15.18	5.85	5.13
11	5.20	68.87	14.92	5.74	5.27
12	5.25	69.07	14.84	5.64	5.20

Source(s): Authors' work

Table 13. Variance decomposition of real GDP growth (asymmetric VAR: negative shock)

Period (quarter)	cpi_sa_c	real_gdp_sa	exr_c	rate_d	policy_d
1	9.35	1.79	88.75	0.00	0.12
2	42.49	16.95	40.26	0.17	0.13
3	44.92	24.19	30.41	0.24	0.25
4	43.63	24.08	31.72	0.34	0.22
5	50.42	21.61	26.97	0.77	0.22
6	52.31	20.48	25.23	1.40	0.58
7	47.71	22.18	28.34	1.25	0.52
8	48.13	21.08	28.69	1.17	0.93
9	48.54	21.16	28.18	1.15	0.98
10	48.36	21.01	28.49	1.17	0.97
11	48.35	21.17	27.99	1.50	0.98
12	48.47	21.20	27.58	1.50	0.99

Source(s): Authors' work

Table 14. Variance decomposition of exchange rate change (asymmetric VAR: negative shock)

4. Conclusion

In this study, we empirically analyzed the impact of monetary policy on macroeconomic variables including inflation and real GDP growth in the Lao PDR using a VAR model. In addition, we constructed an asymmetric VAR model to compare the asymmetric effects of regime changes including monetary easing and tightening.

According to the results of the VAR model, responses by other variables to policy rate change shocks are statistically insignificant although those fluctuate over the horizons. The results suggest that the policy rate change plays a weaker role in the monetary policy of the Lao PDR. By contrast, the impulse responses of real GDP growth to M0 growth shock are significantly at its highest level in the initial period, and the responses of the inflation rate to M0 growth shock exert a continuous positive impact which remains significant in longer horizons. The exchange rate change immediately rises, whereas money supply shocks have no impact on the market interest rate. Additionally, we investigated the impact of M0 growth on the macroeconomy in the Lao PDR using an asymmetric VAR model. Both inflation rate and exchange rate change soar up accordingly to positive M0 growth shocks. The effects on real GDP growth are also statistically significant in the initial period. Responses of other variables to negative M0 growth shocks, however, are all statistically insignificant.

The following implications can be drawn from the empirical results that the effectiveness of the policy is limited in Laos, a dollarization economy. The authorities of the Lao PDR need to actively promote financial market development to strengthen the effectiveness of monetary policies and secure the stability of the financial system. Especially, promoting the development of the short-term financial market, which is the primary propagation path for monetary policies, is a critical challenge for the Bank of the Lao PDR. Also, the Lao government should improve consistently the confidence in the Kip currency to reduce the degree of dollarization.

Note

1. Bassett *et al.* (2014) also examine asymmetric effects in their VAR model. Also, Tillmann *et al.* (2019) quantify asymmetries in the transmission of tightening and easing the shocks of US monetary policy using the asymmetric VARX model.

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