

ผลกระทบของราคาเชื้อเพลิงและอัตราแลกเปลี่ยนต่ออัตราเงินเฟ้อของ สปป. ลาว The Effects of Fuel Price and Exchange Rate on Inflation Rate of Lao PDR

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การศึกษานี้มีวัตถุประสงค์เพื่อ วิเคราะห์ผลกระทบของราคาเชื้อเพลิง และอัตราแลกเปลี่ยนต่ออัตราเงินเฟ้อของ สปป. ลาว ผู้วิจัยใช้ข้อมูลอนุกรมเวลารายไตรมาสตั้งแต่ไตรมาสที่ 1 ปี 2011 ถึงไตรมาสที่ 4 ปี 2022 มาใช้เพื่อบ่งบอกถึงแบบจำลองการปรับตัวระยะสั้น (VECM) จากการวิเคราะห์เชิงประจักษ์ พบว่าอัตราแลกเปลี่ยนและอัตราเงินเฟ้อมีทั้งความสัมพันธ์ระยะสั้นและระยะยาว และความสัมพันธ์แบบสองทิศทางซึ่งอัตราแลกเปลี่ยนมีผลกระทบเชิงบวกต่ออัตราเงินเฟ้อ ในทางตรงกันข้าม อัตราเงินเฟ้อส่งผลเสียต่ออัตราแลกเปลี่ยน งานวิจัยพบว่าไม่มีความสัมพันธ์ที่มีนัยสำคัญระหว่างราคาเชื้อเพลิงกับอัตราเงินเฟ้อทั้งในระยะสั้นหรือระยะยาว ความเร็วของการปรับตัวสู่จุดสมดุลระยะยาวของแบบจำลองอยู่ที่ 3.47% และผลคาดการณ์ของแบบจำลอง VECM ว่าแนวโน้มของตัวแปรทั้ง 3 ตัวจะใกล้เคียงกัน โดยอัตราเงินเฟ้อมีแนวโน้มเพิ่มขึ้นต่อเนื่องในไตรมาส 1/2566-1 /2567แต่เพิ่มขึ้นไม่ถึง 6% ต่อไตรมาส ราคาน้ำมันมีแนวโน้มเพิ่มขึ้นเล็กน้อยและในบางไตรมาสอาจมีการลดลงก็น้อยกว่า 6% เช่นกัน ในขณะที่เดียวกันอัตราแลกเปลี่ยนก็มีแนวโน้มเพิ่มขึ้นอย่างต่อเนื่องและเพิ่มขึ้นมากกว่า 10% ต่อไตรมาส

คำสำคัญ: ราคาน้ำมัน อัตราแลกเปลี่ยน อัตราเงินเฟ้อ

ABSTRACT

This study aims to analyze the impact of fuel prices and exchange rates on the inflation rate of Lao PDR. The quarterly time series data from 1st quarter of 2011 to 4th quarter of 2022 were used to imply with VECM model. The empirical analysis revealed that the exchange rate and inflation rate have both a short-run and long-run relationship as well as a bidirectional relationship where the exchange rate has a positive impact on the inflation rate while the inflation rate has a negative impact on the exchange rate. There is no significant relationship between fuel prices and inflation, in either both the short or long term. The speed of adjustment to the long-term equilibrium point of the model is 3.47% and the forecast results of the VECM model that the trend of the three variables is similar, with the inflation rate tending to increase continuously in quarter 1/2023-1/2024, but the increase is less than 6% per quarter. The price of fuel tends to increase slightly, and in some quarters, there may be a decrease, is also less than 6%. Meanwhile, the exchange rate tends to rise continuously and increases by more than 10% per quarter.

Keywords: fuel price, exchange rate, inflation rate

1.Introduction

Fuel oil is an important source of energy derived from crude oil. Crude oil was first discovered and developed during the industrial revolution and was used for industrial development in the 19th century (Liberto, 2023). Overall, the oil industry is a multi-billion-dollar industry worldwide. Oil is very important for companies that rely heavily on fuel, such as airlines, plastics manufacturers, and agricultural businesses, etc. Fluctuations in fuel prices lead to changes in production costs, changes in the price level of goods and services and have an impact on macroeconomic variables such as inflation and unemployment. Various theories and studies indicate that the fluctuation in oil prices affects the rate of inflation depending on whether the country is a consumer (importer) or producer (exporter) of oil (Bhattacharya & Bhattacharyya (2001). In generally, price volatility affects Asian countries with a statistically significant (Kiptui, 2009; Misati et al., 2013; Kargi, 2014 & Abounoori et al., 2014). In addition, the fluctuation of the exchange rate also affects the inflation rate, because an increase or decrease in the exchange rate causes the value of the imported goods and services to rise or fall, which in turn leads to a change in the inflation rate. In most cases, the exchange rate has a positive impact on the inflation rate (Musa, 2021).

For decades, exchange rates have been at the center of macroeconomic debates in emerging countries. This is because the exchange rate reflects the value of the country's currency. There are many effects on the country's economy. Changes in exchange rates can have a significant impact on various economic variables. This affects the achievement of economic policy objectives and the overall macroeconomic stability of the country. Considering the wide range of impacts caused by exchange rate fluctuations, Economic policymakers therefore continuously monitor and analyze exchange rates. Moreover, the importance of the macroeconomic effects of exchange rate movements has generated great interest among researchers in the field of international economic theory. It attempts to explain the multiple influences of exchange rates by developing various models. that was later empirically tested (Aleksandra D. Zoric, 2019).

The inflation rate of Lao PDR is continuously increasing, especially since the outbreak of Covid-19 disease. In the first quarter of 2022, it stood at 7.37%, an increase of 5.01% compared to the previous quarter. This is due to the increase in the price of goods in the food and non-alcoholic beverages category, which increased by 5.25% from 2.74% in the previous quarter, such as the price of rice, pork and fresh vegetables, as well as the transportation and communication category, which increased by 16.05% from 11.78% in the previous quarter, the umbrella clothing category at the level of 6.6% from 4.67%, the accommodation, water and cooking fuel category. At the same time, the kip/dollar exchange rate increased from 14,833.52 kip/dollar in July 2022 to 16,862.32 kip/dollar in May 2023. However, in January-March 2023, the kip/dollar exchange rate has a slight downward trend (Bank of Lao PDR, 2022).

The inflation rate and the exchange rate are one of the two issues on the national agenda of the Lao government and the National Assembly. Therefore, studying the causes of inflation rate is very important for policy makers and scholars, all of whom must actively contribute to finding the root cause. Core inflation is the change in the cost of goods and services excluding the cost of fresh food and energy or fuel. The fact that the core inflation rate does not include these products is because these products are very volatile. The core inflation rate is derived from both the CPI index and the PCE index (Johnson, 2001; Gagik G. Aghajanyan, 2005).

Some studies from abroad indicate that oil price changes have a direct influence on inflation in countries with low oil dependency. In countries that are heavily dependent on oil, however, they have an indirect effect on inflation through changes in exporters' production costs

The link between oil prices, inflation and exchange rate has been widely discussed for decades. But the true identity of oil prices remains very obscure. What makes the problem particularly difficult is that oil, inflation and exchange rate are closely linked. Such correlations are difficult to identify using conventional statistical methods. Based on the current economic situation of Lao PDR, where the exchange rate is increasing day by day, and through relevant studies in the past, it was found that there is no study on the impact of fuel price (oil price) and exchange rate on the core inflation rate of Lao PDR, especially in the case of Lao PDR.

Objective of study

The main objective of this paper is to analyze the impact of fuel price and exchange rate on the core inflation rate of Lao PDR.

2. Literature reviews

Inflation can be caused by rising fuel (oil) prices. Fuel prices appear to be inextricably linked to inflation. Musa (2021) used time series data from 1986-2019 and analyzed them with GARCH and VECM models. The results show that the model has a long-run relationship between the money supply and the nominal exchange rate, which affects the inflation rate in the same direction and is statistically significant, implying that the inflation rate in Nigeria is caused by the fluctuation of the exchange rate including the increase in the money supply. Therefore, in order to reduce the rate of inflation, the increase in money supply should be controlled by the central bank. Malhotra and Krishna (2015) found that the price of crude oil in the world market affects the inflation rate but not the interest rate. However, during the financial crisis in 1997, it had a negative effect, which means that the crude oil price in the world market has a negative relationship with the inflation rate during the crisis, which shows that the increase in the crude oil price decreases the inflation rate and vice versa, when the crude oil price decreases, it leads to an increase in the inflation rate. Furthermore, Kpogli

(2015) found that the price of crude oil has a positive effect on the inflation rate in both the short and long term, especially in developing countries, which means that the increase in the price of crude oil leads to an increase in the inflation rate via the exchange rate. To reduce inflationary pressure in the country, the government is therefore trying to control inflation caused by oil costs. Saxena & Ndule (2020) found that when using the ARDL model, inflation and oil prices have a positive effect and a long-term relationship with statistical significance. When using the VAR model, the exchange rate and the oil price have a statistically significant positive impact on the inflation rate and a negative impact on the gross domestic product. To solve this problem, the government should find renewable energy sources to reduce oil imports and achieve a lower inflation rate. Bermingham (2009) found that the change in fuel price affects the inflation rate in two ways: the change in fuel price has a positive effect on the inflation rate, especially on the inflation rate in the agricultural sector, and when controlling for the variable of fuel price or excluding the category of fuel price, it is found that the price of energy still has a positive effect on the overall inflation rate, which is the same.

The relationship between exchange rates and oil prices is well documented in the literature. Fluctuations in oil prices stimulate exchange rate movements in oil exporting and importing countries. This is because the economies of these countries depend on the crude oil trade (Dąbrowski et al., 2022). Reborado (2012) revealed a positive relationship between the exchange rate and oil prices. Mukhtarov, Ahmadov & Mammadov (2019) found that the oil price and the exchange rate have a positive relationship in the long run, and also pointed out that the oil price, regardless of whether it fluctuates at a low or high level, affects the exchange rate through the fluctuations of the oil price. In addition, Nusair and Dennis (2019) show a mixed relationship with both positive and negative effects of oil prices on the exchange rate returns of developing Asian currency markets.

The relationship between exchange rates and inflation. Uribe (1997) has created a dynamic general equilibrium model of a small open economy to demonstrate the interaction between inflation and exchange rates. The exchange rates of developing countries to the currencies of industrialized countries can lower the inflation expectations of these developing countries (Bleaney and Fielding, 2002).

The influence of exchange rate on oil price. Exchange rates can also influence the price of oil directly through the financial markets or indirectly through other financial assets. and through portfolio rebalancing and specific hedging practices because oil prices are expressed in US dollars. Oil futures can be a good hedge against an expected depreciation of the US dollar. Altarturi et al. (2018) found that the exchange rate has a negative impact on the oil price in the short term, while the oil price has a negative impact on the exchange rate in the long term. Hadi et al. (2019), however, point out that there is only a unidirectional causality between oil prices and the exchange rate, which runs from the oil price to the exchange rate.

The influence of inflation rate on oil price. Higher inflation will likely lead to higher oil prices in the long run as the Fed raises interest rates and slows economic growth to control inflation. Oil prices could also fall. So, there are many studies that were carried out at different times. It is believed that there is a strong relationship between oil prices and inflation (Bobai, 2012). Feldkircher & Siklos (2019) found that the impact of prices on macroeconomic variables varies. It depends on whether the country is an oil exporter or importer. He found that oil-exporting countries that have increased oil processing have the opportunity to increase their income. This leads to investment and spending to increase purchasing power and effectively reduce the unemployment rate. In contrast, oil prices tend to rise in oil-importing countries. This leads to higher production costs and the higher producer prices are transferred to consumer prices. This can also lead to a fall in consumer spending and demand.

3. Methodology

The data used in this study are quarterly data from Q1 2011 to Q4 2022. These data come from 2 sources: the core inflation rate and the exchange rate from the annual report of the Bank of the Lao PDR (www.bol.gov.la). The crude oil prices come from the West Texas Intermediate website (www.cmegroup.com). A Vector Error Correction Model (VECM) is then used, which is written as follows:

$$\begin{bmatrix} LnCInf_t \\ LnCOil_t \\ LnEx_t \end{bmatrix} = \begin{bmatrix} \alpha_0 \\ \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \begin{bmatrix} LnCInf_{t-i} \\ LnCOil_{t-i} \\ LnEx_{t-i} \end{bmatrix} + [\lambda_1 \ \lambda_2 \ \lambda_3] \begin{bmatrix} ECT_1 \\ ECT_2 \\ ECT_3 \end{bmatrix} + \begin{bmatrix} u_t \\ v_t \\ z_t \end{bmatrix} \quad (1)$$

$LnCInf_t$: The logarithm of the core inflation rate of Lao PDR in period t.

$LnCOil_t$: The logarithm of the global crude oil price in period t.

$LnEx_t$: The logarithm of the exchange rate (Kip/dollar) in period t.

$\alpha_0, \alpha_1, \alpha_2$: Constants.

b_{1i}, b_{2i}, b_{3i} : The coefficients of independent variables such as core inflation, crude oil and exchange rate.

$\lambda_1, \lambda_2, \lambda_3$: The speed adjustment or the coefficients of the error correction term of core inflation, crude oil and exchange rate respectively, which $-1 < \lambda_1, \lambda_2, \lambda_3 < 0$

ECT_1, ECT_2, ECT_3 : the error correction term

u_t, v_t, z_t : error terms metric.

1.1 Unit root test

The extended Dickey-Fuller test (Dickey, D. A., & Fuller, W. A. (1981) is used to test the stationarity of time series data because the condition of VECM analysis is first-order stationarity and is written as follows:

$$\Delta y_t = \theta y_{t-1} + \sum_{i=1}^p \phi_i \Delta y_{t-i} + u_i \quad (2)$$

- For the intercept: $\Delta y_t = \alpha + \theta y_{t-1} + \sum_{i=1}^p \phi_i \Delta y_{t-i} + u_i$ (3)

- For intercept and Trend: $\Delta y_t = \alpha + \beta t + \theta y_{t-1} + \sum_{i=1}^p \phi_i \Delta y_{t-i} + u_i$ (4)

Where, y_t : the series at t period, $t-i$: the lag length reduced by 1,
 $\alpha, \beta, \theta, \phi$: the coefficients, t : trend, u_i : error term

1.2 Cointegration test

The Johansen cointegration test (Johansen,1988) to determine the short-run and long-run relationships between the variables.

$$Y_t = \alpha_1 Y_{t-1} + \dots + \alpha_p Y_{t-p} + \beta X_t + \varepsilon_t \quad (5)$$

Where Y_t : vector of endogenous variables.

α_p are the autoregressive matrices

X_t is the deterministic vector

β are the parameter matrices

p is the lag order

ε_t : vector of innovation

Hypothesis: H_0 : There is no cointegration means that only short-run causality is constructed.

H_1 : There is cointegration, construct both short-run and long-run causality.

If the result rejects the null hypothesis, the model should include residuals from the vectors, which means there is long-run causality, and we should run a Vector Error Correcting Model (VECM).

1.3 Lagrange multiplier test

The Lagrange multiplier test (LM test) is performed to check for autocorrelation (Johansen, S. 1995) and has the following formula:

$$\Delta y_t = \alpha \widehat{E}_t + \sum_{i=1}^{p-1} \tau_i \Delta y_{t-i} + \epsilon_t \quad (6)$$

Where τ_i : the coefficients

$p - 1$: a VAR lag in which the endogenous variables were first differentiated

\widehat{E}_t : supplemented by the exogenous variables

Hypothesis: H_0 : there is no autocorrelation in the sequence of lags

H_1 : there is an autocorrelation at the level of lags

1.4 Jarque-Bera test

The Jarque-Bera test (Jarque,C.M & Bera, A.K. 1987) is used to test the autocorrelation of the model and can be defined as follows:

$$JB = \frac{n}{6} (S^2 + \frac{1}{4}(K - 3)^2) \quad (7)$$

Where n is the number of observations, S is the sample of Skewness and K is the sample of Kurtosis.

$$K = \frac{1}{N} \sum_{i=1}^N \left(\frac{y_i - \bar{y}}{\hat{\sigma}} \right)^4 \quad (8)$$

$\hat{\sigma}$: the biased estimator for the variance

Hypothesis: H_0 : The residuals are normally distributed or the P-value is > 0.05

H_1 : The residuals are not normally distributed or the P-value < 0.05

4. Empirical Results

1.4. Results

Unit root test

The Augment-Dickey-Fuller test shows that the MacKinnon value after the first difference of all variables is less than the critical value of 0.05 and 0.01, indicating that each variable is stationary at I(1), as shown in the following table:

Table 1. Unit root test

H_0 : has unit root		H_1 : Stationary or do not have unit root			
Before the difference					
Interpolated Dickey-Fuller					
	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	MacKinnon (Sig. Level)
<i>LnCInf_t</i>	5.113	-3.600	-2.938	-2.604	1.0000
<i>LnCOil_t</i>	-1.766	-3.600	-2.938	-2.604	0.3974
<i>LnEx_t</i>	5.606	-3.600	-2.938	-2.604	1.0000
After 1 st differences					
<i>D. LnCh_t</i>	-2.023	-2.414	-1.680	-1.301	0.0246**
<i>D. LnCO</i>	-6.513	-3.607	-2.941	-2.605	0.0000*
<i>D. LnEx</i>	-2.989	-3.607	-2.941	-2.605	0.0359**

Note: *,**,*** Statistically significance at the level of 0.01, 0.05 and 0.1

1.5 Cointegration test

The results of the long-term correlation test using the Johansen method show that the value of the trace statistic at the rank(0) level is above the critical value of 5%, which means that we reject the null hypothesis that the models have no long-term relationship. Therefore, the VECM model was used in the study to test the relationship between the variables.

Table 2. Cointegration test

rank	LL	Eigenvalue	Trace statistic	Critical Value 5%
0	282.98949	-	39.9963	29.68
1	295.75451	0.42593	14.4662*	15.41
2	300.16735	0.17458	5.6405	3.76
3	302.98762	0.11540		

Note: * selected rank

1.6 Lag selection test

The test results of the FPE, AIC, HQIC and SBIC indicators show that the most appropriate lag in this test is at level 2 or lag (2). Therefore, lag (2) is used in the test to test the relationship between core inflation rate, crude oil and exchange rate of Lao PDR.

Table 3. optimal lag

lag	Lag-order selection criteria			
	FPE	AIC	HQIC	SBIC
0	2.8e-06	-4.27125	-4.22658	-4.152
1	1.9e-09	-11.5899	-11.4112	-11.1128
2	9.6e-10*	-12.2603*	-11.9476*	-11.4255*

Note: * optimal lag

1.7 Empirical analysis

Table 4. Empirical analysis using VECM

	Independent variables	Model 1	Model 2	Model 3
		$\Delta LnCInf_t$	$\Delta LnCOil_t$	$\Delta LnEx_t$
Short-run	Cons	0.0018	-0.0016	0.0024
		(0.0017)	(0.0317)	(0.0037)
		[0.323]	[0.960]	[0.509]
	$\Delta LnCInf_{t-1}$	-0.2522	-6.2549	-2.3643
		(0.1775)	(3.1511)	(0.3688)
		[0.155]	[0.047]**	[0.000]*
	$\Delta LnCOil_{t-1}$	0.0034	-0.0344	0.0139
		(0.0087)	(0.1537)	(0.0180)
		[0.694]	[0.823]	[0.438]
	$\Delta LnEx_{t-1}$	0.2392	0.3849	0.450 (0.1781)
		(0.0857)	(1.5223)	[0.012]**
		[0.005]*	[0.800]	

Table 4. cont.

	Independent variables	Model 1 ΔLnCInf_t	Model 2 ΔLnCOil_t	Model 3 ΔLnEx_t
Long-run	ECT_{t-1}	-0.0347 (0.0107) [0.001]*	-0.2251 (0.1901) [0.236]	-0.1208 (0.0222) [0.000]*
Observations		46		
R-Squared		0.8578	0.0912	0.7797
AIC		-12.11976		
HQIC		-11.8666		
SBIC		-11.44396		
Log-likelihood		295.7545		
Det(Sigma_ml)		5.22e-10		

Note: *, **, *** Statistically significance at level of 0.01, 0.05 and 0.1 respectively.

The values in “()” is standard error & the values in “[]” is P-Value

Model 1 shows that the model has a long-term relationship in which the coefficient of the ETC has a negative value (-0.0347) and is statistically significant at a significance level of 0.01. This means that the core inflation rate can only adjust by 3.47 to the long-term equilibrium point during crises. In addition, the exchange rate has a positive statistically significant impact on inflation at the 0.01 level, which means that if other factors are constant, a 1 increase in the exchange rate in the last quarter leads to a 0.23% increase in the core inflation rate and conversely, if the exchange rate falls by 1 in the last quarter, this also leads to a 0.23 decrease in the core inflation rate and the independent variables can explain about 86 of the change.

For model 2, it can be seen that the model has no long-term relationship. The coefficient of ETC has a negative value (-0.2251), but it is not statistically significant and the confidence level is very low, only 9%. This model also shows that the core inflation rate leads to lower fuel prices, which contradicts the theory. Otherwise, the economy of Lao PDR is a small economy, which may not affect the level of fuel prices in the world market.

For model 3, it shows that the model has a long-term relationship where the coefficient of ETC has a negative value (-0.1208) and has a statistically significant level of 0.01, which means that the exchange rate can only adjust 12.08 to the long-term equilibrium point in times of crisis. In addition, it is noted that the core inflation rate is statistically significant and has an effect on the exchange rate in the opposite direction with a significance level of 0.01, which means that when other factors are constant, a 1 increase in the core inflation rate

in the last quarter leads to a 2.36% decrease in the exchange rate. This is due to the government's measures to control the price of imported goods and the introduction of production or conversion to a self-sufficient family economy, which leads to a reduction in imports, causing a decline in demand for foreign currency and leading to a decline in the exchange rate. Furthermore, the exchange rate in the previous quarter affects the exchange rate in the current quarter in the same direction with a statistical significance level of 0.05. This means that, holding other factors constant, if the exchange rate in the previous quarter increases or decreases by 1%, this will cause the exchange rate in the current quarter to increase or decrease by 0.44% in the same direction. However, the independent variables of the model can explain the dependent variable with a confidence level of 78%.

From the above analysis, only the core inflation rate and the exchange rate have bidirectional relationships & the adjustment to the equilibrium point in the long run or the error correction time (ECT) model could be written as follows:

$$ECT_{t-1} = 1.00LnCInf_{t-1} - 0.228LnCOil_{t-1} - 3.249LnEx_{t-1} + 25.537$$

(0.000) (0.089)** (0.473)* (0.000)

Because the main model is the influence of crude oil prices and exchange rates on core inflation. Therefore, we get the main model as follow:

$$\Delta LnCInf_t = 0.0017 - 0.2522\Delta LnCInf_{t-1} + 0.0034\Delta LnCOil_{t-1} + 0.2392\Delta LnEx_{t-1} - 0.0347ECT_{t-1}$$

(0.0017) (0.1775) (0.0087) (0.0857)* (0.0107)*

The results of the main model show that the exchange rate affects the core inflation rate in the same direction and that the speed of adjustment to the long-term equilibrium point is 3.47%, which means that the core inflation rate can only be adjusted to the long-term equilibrium point by 3.47% with a short-term fluctuation in the past quarter. The ability of the adjustment speed to reach the equilibrium point is very low. This can have serious negative effects on the economic system, as the parties involved cannot resolve the situation in a timely manner.

In the Lagrange multiplier test, the use of lag 2 shows that different lag levels lead to different results. At lag 1, we cannot reject the null hypothesis that the model has no autocorrelation problem, which means that the expected values of the random variables are not related or the expected values are independent (expectations in one period do not affect the expectations in other periods) with statistically significant. However, lag 2 level found that there has autocorrelation, showing that we cannot concluded that the VECM model was used is appropriate or not. Therefore, Jarque Bera Test was conducted.

Table 5. Lagrange-multiplier (LM) Test

Lagrange-multiplier test			
lag	chi2	df	Prob > chi2
1	12.7828	9	0.17269
2	18.7159	9	0.02772

For the Jarque Bera Test, indicated that we can reject the null hypothesis, meaning that the values are not normally distributed and the model used in the study is not appropriate.

Table 6. Jarque Bera Test for Residuals

Jarque Bera Test			
Equation	chi2	df	Prob > chi2
D_LnClfn	62.516	2	0.0000
D_LnCOil	5.417	2	0.0667
D_LnEx	49.724	2	0.0000
ALL	117.657	6	0.0000

For this reason, the researcher carries out a test for the stability of the data. Based on the eigenvalue test, it can be seen that the final modulus value is close to the critical value, which means that the final data may not be as stable as it should be, which may be due to the problem of the outbreak of Covid-19 disease and the problem of the fluctuation of fuel prices in the world market. Based on the test criteria of Lutkepohl (2005) and Hamilton (1994), it is found that the modulus of each eigenvalue has a value greater than 1, the estimation of the value may not follow the stability criteria. of specific characteristic values means that the model or the data set used in this study may have some serious deviations.

Table 7. Eigenvalue stability condition test

Eigenvalue stability condition	
Eigenvalue	Modulus
1	1
1	1
.3030962 + .8946493i	.944598
.3030962 - .8946493i	.944598
.9167237 + .1030574i	.922498
.9167237 - .1030574i	.922498
-.603203	.603203
-.1265932	.126593
.00557732	.005577

To confirm that the data set can be analyzed and that the model is really fit or not, the researcher conducted a test for the roots of the companion matrix of the model and the results are as shown below:

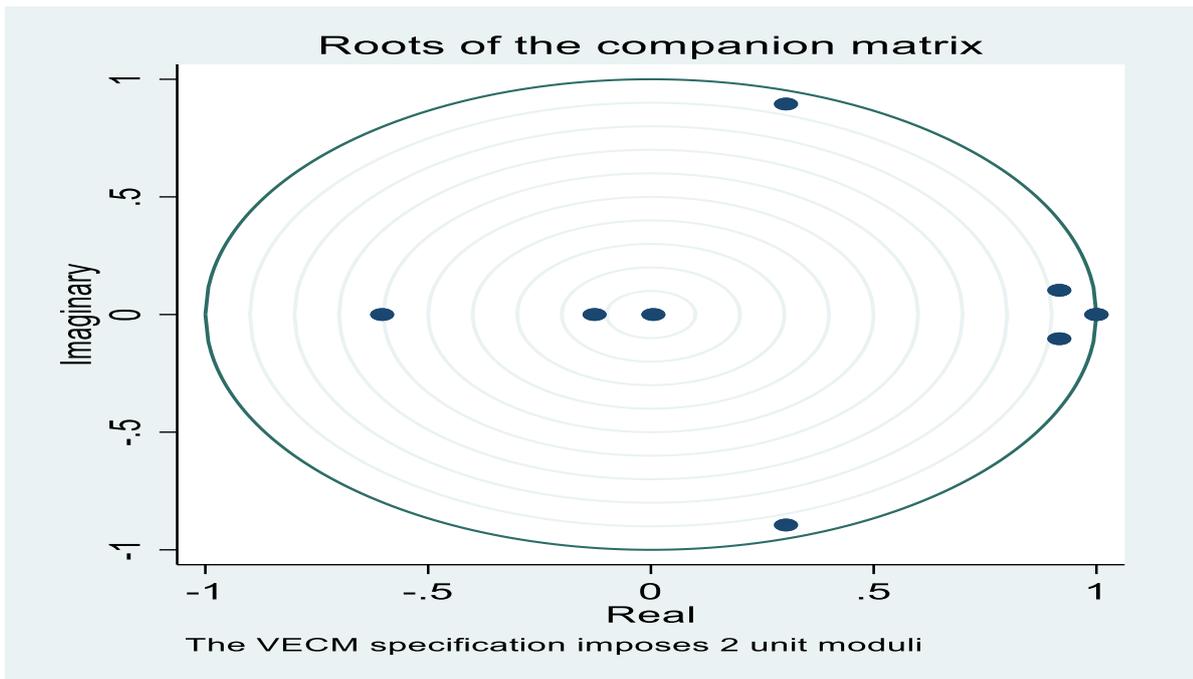


Figure 1. Roots of the companion matrix

The results of the roots of the companion matrix showed that the data values are mostly circular and only one value matches the graph, which means that the covariance of the model is stable. Therefore, it can be said that the VECM model has relatively few problems with data stability and can be used for the analysis.

5. Conclusion and discussion

The empirical analysis of the impact of fuel prices and the exchange rate on the core inflation rate of Lao PDR has shown that the exchange rate and the core inflation rate have both a short-run and a long-run relationship as well as a bidirectional relationship, where the exchange rate has a positive impact on the inflation rate which align with the research of Musa (2021) that exchange rate affects the inflation rate in the same direction, while the inflation rate has a negative impact on the exchange rate, which is contrary to the research of Urbanovský (2016) that only the inflation rate in the past period influences the current inflation rate. In addition, the exchange rate of the previous quarter influences the exchange rate of the current quarter in the same direction. Furthermore, Joof and Jallow (2020) that inflation rate affects the exchange rate in the same direction. There is no correlation between fuel prices and core inflation in either the short or long run, which contradicts the research by Mukhtarov, et al. (2019), according to which fuel prices and inflation rates have a positive relationship in both the long and short run. The speed of adjustment to the model's long-term equilibrium point is 3.47%. This means that with a short-term fluctuation in the last quarter, the core inflation rate has the ability to adjust to the long-term equilibrium point by

only 3.47%. Therefore, the finding on the causality link between exchange rate and inflation are still controversial.

5.1 Suggestions for use in this research

The results of the analysis indicate that the exchange rate has a positive effect on the core inflation rate which means that the fluctuation of the exchange rate causes a change in the core inflation rate in the same direction. This means that the core inflation rate changes in the same direction. In other words, if the exchange rate of the kip increases against the foreign currency (depreciation of the kip), the core inflation rate increases and conversely, if the exchange rate of the kip decreases against the foreign currency (appreciation of the kip), the core inflation rate decreases. Therefore, to reduce the core inflation rate of Lao PDR, the government must introduce exchange rate standards by encouraging the use of kip as a means of payment, reducing imports to reduce the demand for foreign currency, encouraging production for export to achieve a balance of trade and create more sources of income in foreign currency, and ensuring that money is not exchanged outside the system (illegal money exchange) and that money is used for investment or registration in kip to increase the demand for kip.

5.2 Further researchers

1) Separate the fuel price converters into each type and include the kip to baht, kip to yuan and kip to euro exchange rates in the analysis to know which fuel type is statistically significant and has the most influence, which exchange rate is effective and which exchange rate is not effective, and to solve the problem of few variables.

2) The next study should increase the sample size and use panel data for the analysis to better explain the results.

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