Doctoral Dissertation

Empirical Analysis of Exchange Rate and Inflation in Lao People's Democratic Republic

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Abstract

This dissertation consists of three essays examining different aspects of exchange rate and inflation in the Lao People's Democratic Republic (Lao PDR). Chapter 1 focuses on dollarization in Lao PDR and aims to examine whether Lao PDR presents any trend of shifting from using US dollar to using Thai baht or from using US dollar to renminbi. Chapter 2 focuses on investigating the exchange rate pass-through to consumer price in Lao PDR and aims to estimate how much the Thai baht has affected international trade in Lao PDR. Chapter 3 focuses on monetary policy in Lao PDR and aims to examine whether the Bank of Lao PDR reacts to inflation and the change of exchange rate, indicating three types of monetary policy rules—Taylor, McCallum, and Ball rules.

Chapter 1 provides background history information on dollarization in Lao PDR and the role of the Bank of Laos in ensuring adherence to economic development fundamentals. Moreover, the chapter provides empirical evidence by estimating implicit basket weight of a currency block in the target countries using the Frankel and Wei (1994) method as a fundamental to estimate and to extend using modified Frankel and Wei regression proposed by Kawai and Pontines (2016). Finally, this chapter uses daily data from 2012 to 2021, wherein the main country, Lao PDR, is compared with three of its neighboring countries: Vietnam, Myanmar, and Cambodia. Results show the dominant currency remains to be the US dollar; however, for the Thai baht, Lao PDR and Myanmar exhibit stronger signs of shifting to the Thai baht compared to Vietnam and Cambodia. Conversely, for the renminbi, Lao PDR, Myanmar, and Vietnam are more influenced by the Chinese renminbi than

Cambodia. Despite results showing that the dominant currency remains to be the US dollar, which does play a big role in the present, the results did indicate a significant sign of the increasing influence of the Thai baht and renminbi on Lao PDR.

Chapter 2 focuses on exchange rate pass-through to consumer price in Lao PDR using quarterly data from 2005Q1 to 2020Q4. This study uses the autoregressive distributed lag (ARDL) model to determine the possible long-run relationships between exchange rate and domestic price inflation and short-run interactions between the two variables. Results found that the long-run variation in the consumer price index is mainly explained by money supply and US dollar. This result is supported by the error-correction model. Lao is considered a dollarized country, and Lao has made effort to move away from dollarization. However, the US dollar remains the dominant currency in the Lao PDR economy in the long run. In the short run, the results indicate that the Thai baht affects the Lao PDR economy. In the long run, Thai baht does not present any sign of effect to the Lao PDR economy.

Chapter 3 mainly focuses on the reaction and how the government of Lao PDR responds to changes in inflation and exchange rates. This chapter attempts to follow the previous paper by Xaiyavong and Czerkawski (2014) with a different methodology. Hence, we use simple OLS in estimation with more recent data. Moreover, this chapter examines the conduct of monetary policy in Lao PDR using 1986–2017 annual data provided by the Bank of Laos and focuses on the Bank of Lao PDR's response to inflation monetary-based, and exchange rate based on the Taylor, the McCallum, and the Ball rules. Empirical estimation of monetary policy rules, especially in less-developed countries, is key for testing if monetary

policy targeting rules can effectively describe the behavior of monetary authorities and their stated objectives in Lao PDR. Results show that the Taylor rule does not describe the interest rate-setting behavior of the Bank of Laos. Moreover, the impact of inflation on the interest rate is shown when the model includes only the inflation rate. Meanwhile, estimation results for the modified McCullum rules better reflect the behavior of the Bank of Laos as the results show that the coefficient on inflation becomes larger when other variables are removed. The situation of the estimation results with GDP are identical; however, the number is not very large compared to the coefficient of inflation. Finally, the estimation of Ball rules does not present any significant sign as compared to the two other rules (Taylor and McCullum rules). Therefore, the Bank of Laos has been targeting monetary aggregates in its policy decisions, confirming the results of Xaiyavong and Czerkawski (2014).

Chapter 1: Implicit Basket Weight in the Exchange Rate Policy of Lao PDR

1.1 Introduction

Dollarization has received extensive attention over the last few decades in the context of developing and transitional countries, particularly among countries experiencing economic uncertainty and underdeveloped financial systems. Using foreign currency or denominated assets as a medium of exchange, unit of account, and store of value in economies has been a concern in Latin America and some Asian countries. Cowan (2003) and Yeyati (2006) highlight that the monetary transmission instrument may not work properly in pursuing the stability of monetary policy in dollarized economies. In heavily dollarized countries, domestic currency can easily lose value or depreciate. This encourages the switching of financial assets and liabilities into foreign currency. The more the domestic currency devaluates, the greater the downward pressure on the exchange rate. Therefore, based on Marcelin and Mathur (2016), to stabilize exchange rate, central banks must establish domestic currency interest rate at a substantially higher level than that of dollarized assets. However, numerous research have found that dollarization is mainly influenced by macroeconomic policy; hence, concluding that dollarization makes monetary policy less effective is difficult. Berkmen and Cavallo (2010) found that countries with high dollarization are more likely to be actively involved in exchange rate stabilization. Soto (2009) found that dollarization in Ecuador stabilizes domestic price and leads to higher economic growth. Lao PDR has faced the effects of long-

term dollarization and utilizes the Thai baht as a third currency, which uses parallels with the domestic currency (Lao kip).

1.1.1 Background of Lao PDR

In 1975, Lao PDR achieved independence and established a centrally planned economy. In 1986, Lao PDR pursued significant economic reform under new economic mechanisms (NEMS), aiming to improve the economic development system based on the market-oriented economy and transform the country from a closed and centrally planned economy into a market-oriented economy. Transition toward a market economy was accompanied by the expansion of the domestic financial market and the real sector boosted by foreign investment.

Lao PDR has significantly reformed state-owned enterprises and promoted private enterprises and foreign investment while strengthening its banking system and implementing trade liberalization. Major reforms have been performed by removing price controls, abandoning socialist cooperative farming, unifying the exchange rate system removing the government's monopoly on trade, reducing the number of state-owned enterprises (SOEs), promoting private-firm establishments, and improving its business environment to make the country more investor-friendly, together with trade promotion and international cooperation, implementing fiscal reform, and banking financial systems.

Following open-door policies, Lao PDR accepted several offers of support from the government and international organizations worldwide. These factors are assumed to have had positive impact on the country's economic development. Sustained economic growth is instrumental for current and future development, particularly for achieving the development

goal in 2020, which is to emerge from the list of least-developed countries (LDCs). Additionally, Lao PDR expects to achieve at least middle-income country status.

However, structural reforms in the area of state-owned enterprises (SOEs) and fiscal and financial remain lagged. This began in 1990s, with the move from mono-banking to a two-tier banking system consisting of the central bank and state-owned commercial banks (SOCBs). However, owing to the slow pace of reform, SOCBs suffer from high amounts of nonperforming loans (NPLs), a significant portion of which are accounted for by SOEs. Additionally, the Lao PDR economy remains highly dollarized, and, since 1999, foreign currency deposits have accounted for more than half of the board money (M2). Several factors have contributed to dollarization in the country. One of the most important factors was macro-stability in the form of high inflation and rapid exchange rate depreciation (Keovongvichith, 2004).

Similar to other central banks, the Bank of Lao PDR (BOL) holds manages the country's money supply to ensure that it adheres to economic development fundamentals. Adjustment in the money supply is conducted through monetary tools such as required reserves, interest rate, insurance of term deposits, and purchase of bonds.

The Bank of Lao PDR was formally established in June 1990. The bank's rights and duties are to promote and maintain internal and external monetary stability. Since 1990 to 1995, the central bank aimed to achieve the bank credit target by setting an annual credit increase target, setting ceiling interest rate, and providing direct lending to major state-owned

enterprises and commercial banks (BOL annual reports). Monetary policy is managed by BOL under the approval and assignment of the Ministry of Finance.

However, the current institutional arrangement of the BOL does not support financial sector stability owing to lack of autonomy. Moreover, BOL has been ineffective in conducting the monetary policy because of four reasons. First, owing to dollarization in Lao PDR, the amount of foreign currencies deposit is more than 50% of the total deposit (BOL reports). Second, the BOL's lack of autonomy results in a long policy-making process as approval from the Ministry of Finance is a prerequisite. Third, policy lending is used to finance government investments or SOEs. As the BOL uses interest rate to contain credit availability to high return projects, the efficiency of the policy decision decreases as policy lending can affect normal market credit allocation. Fourth, the Bank of Laos has a limited financial resource which interferes with the conduct of appropriate monetary policy. The BOL's banking supervision is weak, particularly in the enforcement area (ADB and world bank, 2002, pp. 14–17).

Because of the 1997 Asian financial Crisis, inflation rate increased to 128% in 1999, and a rapid depreciation of the Lao kip produces loss of confidence in the domestic currency, Lao kip. The country's geographic and cultural proximity to major countries leads to massive cross-border trade with its 3 major trading partners—Thailand, China, and Vietnam—and this is more convenient in large transaction settlements and price denominated for valuable goods. Lao PDR has decided to abandon its fixed exchange rate regime and has since used a manage-floating exchange rate regime. Owing to problems in achieving social and economic development, Lao PDR implemented various policy instruments such as maintaining

macroeconomic stability through exchange rate-based stabilization and disinflation by putting two important targets—annual output growth of 8% and double-digit inflation. Additionally, the government also revising the PM decree into a Presidential Decree in 2008 on FC management and precious metals and further revising it into FC management law in 2014 (Dalaloy, 2015). A PM decree on FC management and promotion of local currency for domestic payment was issued by requiring all units of account to be denominated in Lao kip, conducting regular inspections, and monitoring for stores and shops. A higher reserve requirement on foreign currency (5% for LAK, 10% for USD) was made to improve the domestic payment system (increase the number of ATMs, modernize banking services with online banking, smartphone banking, and salary and utility payments via bank transfers). However, Lao PDR is not only dealing with the US dollar but also Thai baht. Thailand is the largest trade partner for Lao, and transactions between Lao PDR and Thailand used both Thai baht and US dollar. However, recently, Thai baht is more commonly used compared to the US dollar.

For the past 10 years, China has had much foreign direct investment in the Lao PDR. Hence, China plays a more important role in the Lao PDR, especially after the beginning of the high-speed train project. Lao PDR hopes that the train line will help transform the country from a landlocked country to become a land-linked, drawing more foreigners and investors in while sending more of its own out. Despite trade between Lao PDR and China being less valuable compared to that between Lao PDR and Thailand, China remains to be the second-largest Lao PDR trade partner. Therefore, this chapter aims to investigate whether Lao PDR

shows some sign of moving out from dollarization and if it tends to use more Thai baht or Chinese renminbi.

1.2 Literature Review

The basket currency regime was proposed as a desirable system for East Asian countries with diversified trade structures. Stabilizing the real effective exchange rate, as opposed to the nominal bilateral exchange rate vis-a-vis the US dollar, is better conducted by minimizing short-run fluctuation and discouraging speculative capital inflow and its sudden reversal (Ito and Orii, 2006).

Frankel and Wei (1993,1994), who have developed a method of measuring the weight of a basket, negatively concluded on the question of whether the yen has increased its weight in the Asian implicit basket system. Benassy-Quere (1999) applied that to the analysis for developed countries, and Shimizu and Ogawa (2003) found that the implicit basket system seemed to have been restored in several countries. Ito and Orii (2006) estimate the determinants of the yen weight in Asian countries and observed that yen weight increases when the yen depreciates when the domestic interest rate increases. Simultaneously, yen weight decreases when the US interest rate rises.

Kawai and Pontines (2014) examine whether the renminbi has supplanted the US dollar in the currency basket of East Asian Economies. Moreover, they proposed a new technique to fix the multicollinearity from Frankel and Wei's (1994) approach. First, they applied the approach to both the renminbi and the US dollar. Second, they proposed a simple modification of the Frankel and Wei regression model to estimate renminbi weight in the economy currency

basket. However, their results indicated that the renminbi has not yet supplanted the US dollar in East Asia. They concluded that despite the rising importance of the Chinese renminbi, it has not eclipsed the US dollar as the dominant currency in East Asia.

Ito (2016) estimate recent data when the renminbi depegged from the US dollar and presents that some of the emerging Asian currencies co-move with the renminbi more than the US dollar. This means that the Chinese renminbi has improved its weight in the currency basket. This is because they have extended the currency swap agreement with over 30 countries to allow the use of the renminbi for trade, finance, and liquidity assistance.

Shimizu and Sato (2018) estimate the implicit basket weight renminbi after China introduced this new exchange rate index against a basket of 13 trade-weighted currencies, making it a major turning point for the US dollar standard toward a more flexible currency system. However, results show that several Asian economies stabilize their currencies against the US dollar, while Malaysia and Singapore stabilize their currencies against the renminbi. In conclusion, the renminbi has increased its influence on Asian currencies; however, the degree of its influence is smaller than the US dollar's influence.

Various research has been performed on the basket weight of East Asian currencies, which recently focused on the Chinese new exchange rate renminbi. However, most research does not include Lao PDR as one of the target countries to analyze. Hence, this paper aims to analyze the basket weight focusing on Lao PDR compared with three neighboring countries: Myanmar, Cambodia, and Vietnam. Moreover, this paper will also include the Thai baht in another regression since Thailand is the biggest trade partner for Lao PDR.

1.3 Methodology and Data

To estimate the currency basket weight of the Chinese renminbi and Thai baht on Lao kip, Vietnamese dong, Myanmar kyat, and Cambodian riel, this paper will follow the Kawai and Pontines (2014) approach by first using the popular approach by Frankel and Wei (1993, 1994) to estimate the equation of analyzing the influence of important international currencies in the currency basket of individual countries. This is expressed below as follows:

$$\Delta e_t^i = \alpha_0 + \beta_1 \Delta e_t^{USD} + \beta_2 \Delta e_t^{EUR} + \beta_3 \Delta e_t^{JPY} + \beta_4 \Delta e_t^{THB} + \varepsilon_t \quad (1.1)$$

$$\Delta e_t^i = \alpha_0 + \beta_1 \Delta e_t^{USD} + \beta_2 \Delta e_t^{EUR} + \beta_3 \Delta e_t^{JPY} + \beta_4 \Delta e_t^{CNY} + \varepsilon_t \quad (1.2)$$

$$i : LAK,\ KHR, VND, MMK$$

All exchange rate data in this paper use daily data from 2012–2021. As for the numeraire currency, this paper uses the New Zealand Dollar (NZD) owing to data availability.

Variable	Description	Source
e_t^{USD}	US dollar vis-à-vis the numeraire currency	Pacific exchange rate
e_t^{EUR}	Euro vis-à-vis the numeraire currency	Pacific exchange rate
e_t^{JPY}	Japanese yen vis-à-vis the numeraire currency	Pacific exchange rate
e_t^{THB}	Thai baht vis-à-vis the numeraire currency	Pacific exchange rate
e_t^{CNY}	Chinese renminbi vis-à-vis the numeraire currency	Pacific exchange rate
e_t^{LAK}	Lao kip vis-à-vis the numeraire currency	Bank of Laos
e_t^{VND}	Vietnamese dong vis-à-vis the numeraire currency	State Bank of Vietnam

e_t^{KHR}	Cambodian riels vis-à-vis the numeraire currency	National Bank of Cambodia
e_t^{MMK}	„Myanmar kyat vis-à-vis the numeraire currency	Central Bank of Myanmar

As severe multicollinearity between USD and THB and that between USD and RMB is possible, two approaches are necessary for addressing this issue. First, we estimate equations 1.1 and 1.2 when estimated USD is much less than 90%. Second, we use the modified Frankel and Wei regression proposed by Kawai and Pontines (2016). By performing the auxiliary regression to orthogonalize Δe_t^{THB} with Δe_t^{USD} for Equation 1.1 and Δe_t^{RMB} with Δe_t^{USD} for Equation 1.2. After the auxiliary regression, we can then use the Frankel and Wei regression. Following the approach by Kwai and Pontines (2016), we utilize the following two-step process:

1) Auxiliary regression:
$$\Delta e_t^j = \beta^0 + \beta^1 \Delta e_t^{USD} + \beta^2 \Delta e_t^{EUR} + \beta^3 \Delta e_t^{JPY} + \psi_t^j (1)$$

2) Frankel-Wei regression
We use the residual from the first step in the second step regression as follows:

$$\Delta e_t^i = \beta_0 + \beta_1 \Delta e_t^{USD} + \beta_2 \Delta e_t^{EUR} + \beta_3 \Delta e_t^{JPY} + \beta_4 \hat{\psi}_t^j + \varepsilon_t (2)$$

Assumption : $\beta_4 = 1 - \beta_1 - \beta_2 - \beta_3$

$$\Delta e_t^i - \hat{\psi}_t^j = \beta_0 + \beta_1 \Delta e_t^{USD} + \beta_2 \Delta e_t^{EUR} + \beta_3 \Delta e_t^{JPY} + \beta_4 \hat{\psi}_t^j$$

$$-\beta_1 \hat{\psi}_t^j - \beta_2 \hat{\psi}_t^j - \beta_3 \hat{\psi}_t^j - \beta_4 \hat{\psi}_t^j + \varepsilon_t (3)$$

1.4 Results

Figure 1.1 indicates that the coefficient of the Thai baht suggests signs of increasing line, especially for Lao PDR and Myanmar. Hence, both countries exhibit signs of increasingly shifting to the Thai baht. However, the coefficient is considerably small compared to the that of USD, which presents a strong result. This means that although the Thai baht might have some influence, the US dollar remains the dominant currency.

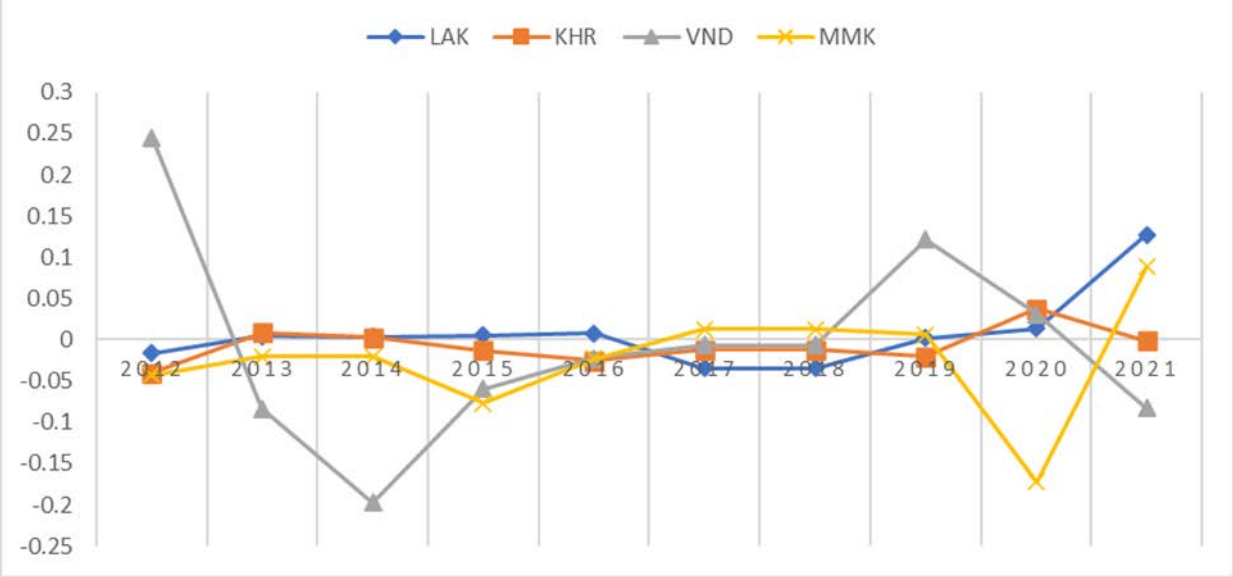


Figure 1.1 Coefficient of THB basket weight 2012–2021 for Equation 1.1

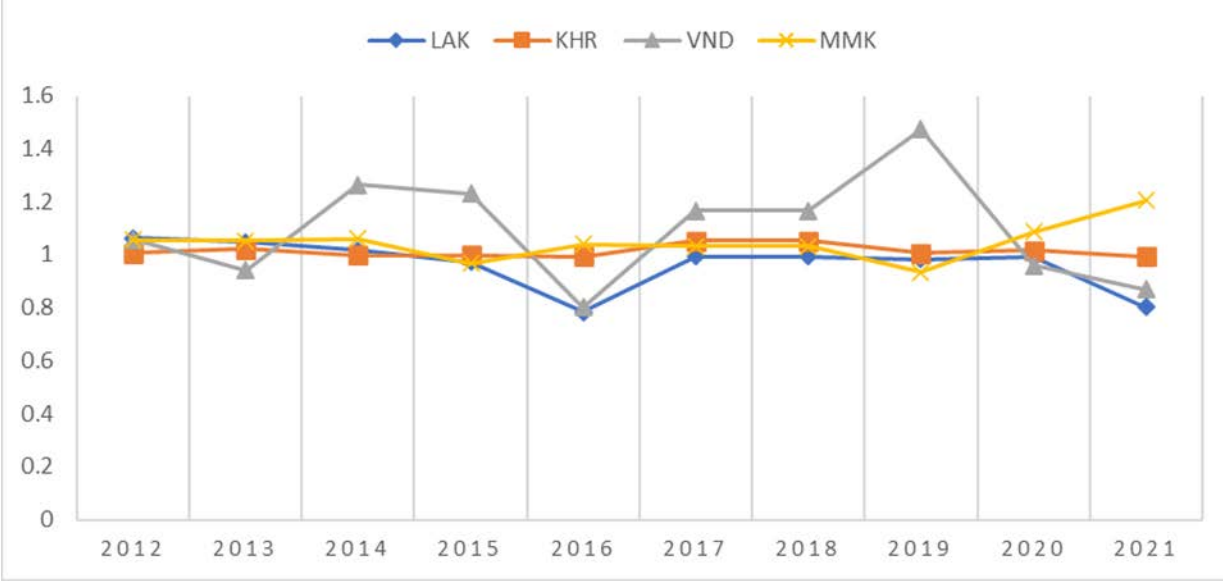


Figure 1.2 Coefficient of 2012–2021 USD basket weight for Equation 1.1

The results are similar to those of Figures 1.3 and 1.4 and indicate that Lao PDR, Myanmar, and Vietnam are influenced by the Chinese renminbi. However, the coefficient of the USD dollar is still considerably large; hence, the US dollar remains to be the dominant currency.

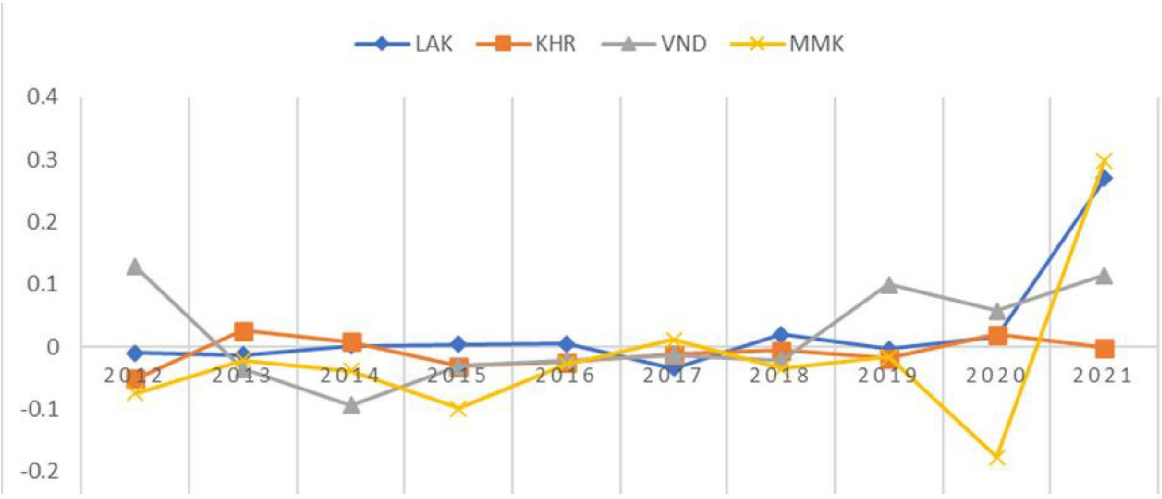


Figure 1.3 Coefficient of CNY basket weight 2012–2021 for Equation 1.2

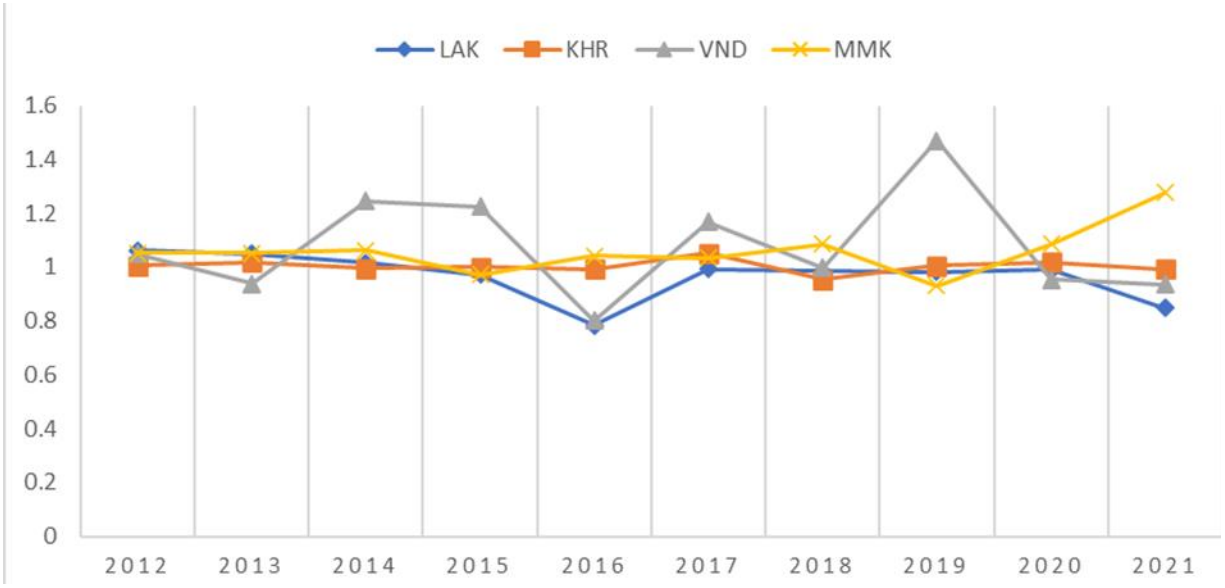


Figure 1.4 Coefficient of THB basket weight 2012–2021 for Equation 1.2

Compare the coefficient of the Thai baht and Chinese renminbi. We see that for Lao PDR and Myanmar, the coefficient has a steep increasing line, especially in 2020–2021, wherein the US dollar exhibits a downtrend. The Myanmar case shows that both renminbi and US dollar have an increasing rate of influence on the Myanmar kyat.

Meanwhile, although the main partner for Lao PDR is Thailand, Lao PDR remains more influenced by the Chinese renminbi compared to the Thai baht. This might be caused by investment from China, which is Lao PDR's second-largest trade partner. Trade between the two countries has been increasing in the recent years; moreover, many agreements have been created between Lao PDR and China, which increases the number of continents for trade. Meanwhile, for Thailand, the COVID-19 situation of the slowdown of trade between two countries and the recent appreciation of the Thai baht have made trade difficult between Lao

PDR and Thailand as the invoices between Lao PDR and Thailand are both in US dollar and Thai baht.

1.5 Conclusion

This study mainly focuses on the implicit basket weight in Lao PDR considering the Chinese renminbi and Thai baht. We first focused on Thai baht because Lao PDR is not only considered as a dollarized country but also Lao PDR is in the baht economic zone, owing to Thailand being the biggest trade partner for Lao PDR. Another reason is that both US dollar and Thai baht are widely used in parallel with the Lao kip (the domestic currency) in the market. Second, we take the Chinese renminbi into account in the estimate because the Chinese renminbi has recently drawn considerable attention in terms of implicit basket weight. Second, accounting for the Chinese renminbi more accurately reflects the recent situation in Lao PDR. China has been increasing investment in Lao PDR, including the construction of a high-speed railway train, which aims to connect China, Lao PDR, and Thailand. By considering implicit basket weight, we can determine whether Lao PDR is shifting away from a US dollar-dominant economy. Estimating the implicit basket weight of the Thai baht and Chinese renminbi on the Lao kip shows that even though the Thai baht and Chinese renminbi show some uptrend weight, the dominant currency remains to be the US dollar despite trade between Laos with Thailand and China being conducted using Thai baht and renminbi, respectively. However, Lao PDR seems to shift more toward to the Chinese renminbi for the last 2 years. This might be a sign that the Chinese renminbi has gained more influence in the economy of Lao PDR. The Lao PDR government needs to consider this. Lao has only used the US dollar and Thai baht. If Lao PDR opts to add the Chinese renminbi, the Bank of Laos

has to work and on computing a monetary policy to control the exchange rate to stabilize the domestic and foreign currencies.

Chapter 2: Exchange Rate Pass-Through to Consumer Price Index in Imports of Lao PDR

This research aims to investigate exchange rate pass-through to consumer price in the Lao People's Democratic Republic (Lao PDR) using 2005Q1–2020Q4 quarterly data. This study uses autoregressive distributed lag (ARDL) model to consider possible long-run relationships between exchange rate and domestic price inflation and short-run interactions between the two variables. Results found that long-run variation in the consumer price index is mainly explained by money supply and the US dollar. This result is supported by the error-correction model. Lao PDR is a known dollarized country, and it has attempted to move away from dollarization. However, in the long run, the US dollar remains the dominant currency in the Lao PDR economy. In the short run, results indicate that the Thai baht affects the Lao PDR economy. Regardless, the Thai baht does not exhibit any effect on the Lao PDR economy in the long run.

2.1 Introduction

A consumers' purchasing power largely depends upon economic growth and price of goods and services. High (low) inflation decreases (increases) an individual's purchasing power (Zhang, 2008). During depreciation, the value of the home currency declines, which may result in an increase in domestic price inflation. This is likely because exchange rate change is passed through to domestic consumption goods. Degree of exchange rate pass-through to consumers depends among others upon product differentiation of imported goods,

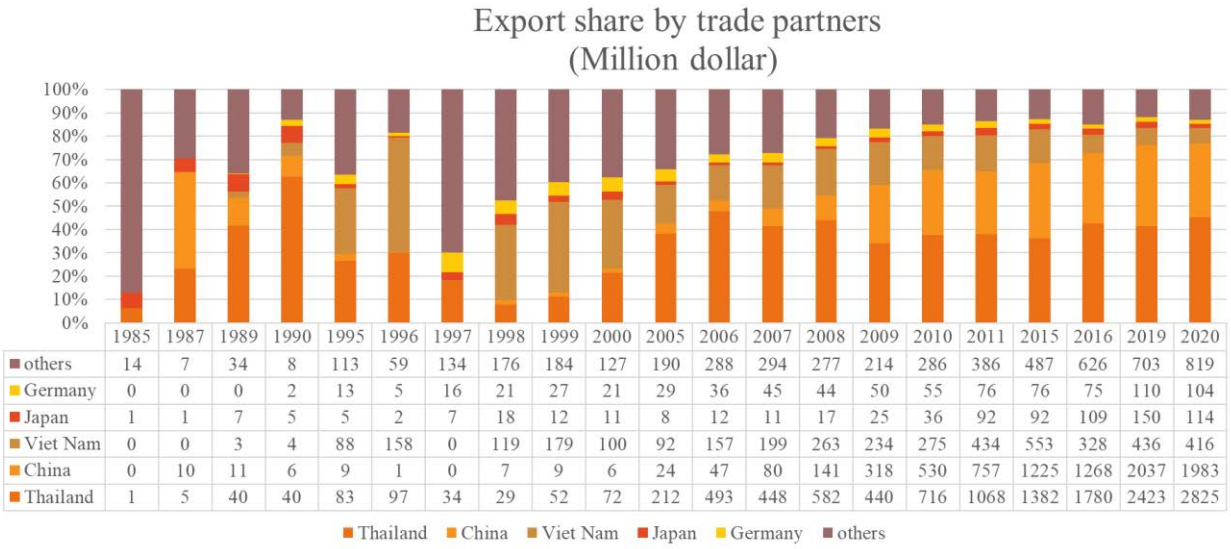
price elasticity of demand, openness, and the monetary policy of the central bank (Adjasi *et al*., 2008).

To understand how domestic price inflation is controlled, exchange rate pass-through is a key research question, especially in the context of developing economies. Exchange rate pass-through is defined as "the percentage change of domestic currency import price arising from one percentage change in the exchange rate between exporting and importing countries" (Goldberg and Knetter, 1997). Since the late-1980s, the link between exchange rate and inflation has been examined by a large number of studies. Empirical investigation of the degree and timing of exchange rate pass-through is crucial for policymakers: degree of exchange rate pass-through may be complete where consumer/import prices respond completely to exchange rate changes. Conversely, a partial price response to the exchange rate is called an incomplete pass-through (Akofio *et al*., 2009).

The dollarization policy has been considered in most developing and transitional economies. Several empirical studies have been conducted on the relationship between exchange rate pass-through and inflation. However, most existing studies focused on advanced and emerging countries and only a few studies have been made on developing countries including dollarization countries. For example, Edward *et al*. (2003) found that economic growth in dollarized economies is lower than in non-dollarized economies. Carranza *et al*. (2009) indicate that a country with a highly dollarized economy presents higher inflation pass-through. Dollarization leads to strong pass-through effects, raising vulnerabilities in the economy and preventing price stabilization. If import goods account for

a considerable share of the total consumption basket, the transmission mechanism from foreign shocks would become crucial (Bhattacharya *et al*.,2011). When it is accepted that a strong and positive correlation is available between the dollarization-pass-through effect and dollarization-inflations. Success in controlling inflation may weaken dollarization and entail possible negative impact on exchange rate pass-through (Taylor, 2000). Only a few studies have considered Southeast Asia. For instance, Kingthong (2017) investigates exchange rate pass-through in five Southeast Asian countries (e.g., Indonesia, Philippines, Vietnam, Cambodia, and Lao PDR).

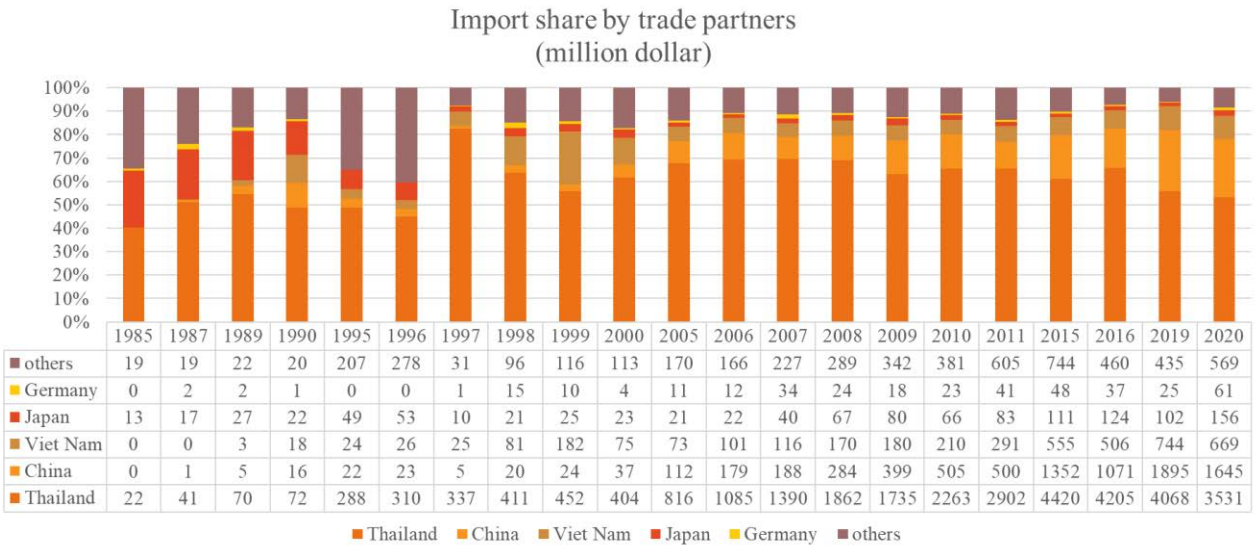
Since 1986, Lao PDR has opened trade with numerous countries and its trade activities have increased yearly ever since (Figures 1 and 2). However, the three major countries that Lao PDR trade with are China, Thailand, and Vietnam. From 1985 to 2017, the share of export from Lao PDR and Thailand, China, and Vietnam increased from 1.16 million dollars to 2115.49 million dollars, 8.80 million to 1421.20 dollars, and from 87.70 million dollars to 516.03 million dollars, respectively. Conversely, Lao PDR also imports intensively from the three countries, especially from Thailand (4150.68 million dollars in 2017), which accounts for almost 60% of the total imports. Likewise, in 2017, imports from China and Vietnam reached 1511.23 million dollars and 687.42 million dollars, respectively.



	1985	1987	1989	1990	1995	1996	1997	1998	1999	2000	2005	2006	2007	2008	2009	2010	2011	2015	2016	2019	2020
others	14	7	34	8	113	59	134	176	184	127	190	288	294	277	214	286	386	487	626	703	819
Germany	0	0	0	2	13	5	16	21	27	21	29	36	45	44	50	55	76	76	75	110	104
Japan	1	1	7	5	5	2	7	18	12	11	8	12	11	17	25	36	92	92	109	150	114
Viet Nam	0	0	3	4	88	158	0	119	179	100	92	157	199	263	234	275	434	553	328	436	416
China	0	10	11	6	9	1	0	7	9	6	24	47	80	141	318	530	757	1225	1268	2037	1983
Thailand	1	5	40	40	83	97	34	29	52	72	212	493	448	582	440	716	1068	1382	1780	2423	2825

Figure 2.1 Amount of Lao PDR export to trade partners

Source: Asian Development Bank



	1985	1987	1989	1990	1995	1996	1997	1998	1999	2000	2005	2006	2007	2008	2009	2010	2011	2015	2016	2019	2020
others	19	19	22	20	207	278	31	96	116	113	170	166	227	289	342	381	605	744	460	435	569
Germany	0	2	2	1	0	0	1	15	10	4	11	12	34	24	18	23	41	48	37	25	61
Japan	13	17	27	22	49	53	10	21	25	23	21	22	40	67	80	66	83	111	124	102	156
Viet Nam	0	0	3	18	24	26	25	81	182	75	73	101	116	170	180	210	291	555	506	744	669
China	0	1	5	16	22	23	5	20	24	37	112	179	188	284	399	505	500	1352	1071	1895	1645
Thailand	22	41	70	72	288	310	337	411	452	404	816	1085	1390	1862	1735	2263	2902	4420	4205	4068	3531

Figure 2.2 Amount of Lao PDR import from trade partner

Source: Asian Development Bank

Among Southeast Asian countries, the Lao PDR is one of the economies with the highest degree of dollarization. The situation in Lao PDR is more unique and complicated than the case of other economies, namely, Cambodia or some Latin American countries. Menon (2008) defined the Lao PDR situation as a "Multiple currency phenomenon" because the country has two foreign currencies—the US dollar and the Thai baht—which are widely used in parallel with the domestic currency, Lao kip. (Inthiphone, 2015). In this study, we discuss which currency, the US dollar or Thai baht, is more vital in Lao's domestic price inflation.

Therefore, monetary policy plays a crucial role in the economy of Lao PDR. This is because, as a small open-economy country, the exchange rate in Lao PDR provides an important part in the transmission of monetary policy. Therefore, this paper examines the foreign exchange rate passing through to domestic price.

2.2 Literature Review

Exchange rate pass-through is defined as "percentage change of domestic price arising from 1% in the exchange rate between exporting and importing countries" (Goldberg and Knetter,1997). The effect of exchange rate changes on price has received the attention of researchers for many years in both theoretical and empirical studies since the 1980s.

Various empirical studies have investigated exchange rate pass-through. However, most studies focused on developed, emerging countries, and, in some Asian countries, only a few studies focus on South East Asian countries as shown below.

Toh and Ho (2001) investigate exchange rate pass-through in four Asian countries—Malaysia, Thailand, Taiwan, and Singapore—following the Engle and Granger (1987) and Johanson and Juselius (1990). This paper utilizes quarterly data that covers the 1975–1994 period. Results indicate that, for primary commodities, degree of pass-through is high, and exchange rate changes influence the export price in foreign currency.

Nhung (2010) investigates exchange rate pass-through into Vietnam's imports from Japan using 1998–2007 monthly data. Results found that Japanese exporters tend to fully pass-through to Vietnam's imports for the case of the machinery industry owing to the transaction being in Japanese yen as Japan is Vietnam's major trade partner. Conversely, the electronic industry-only shows a low pass-through, and this may be because the transaction is in US dollar. This shows that Japanese exporters have strong market power in machinery.

Panit (2013) investigates exchange rate pass-through and inflation in Thailand. Research shows that change in the exchange rate will affect inflation incompletely. One percent of currency depreciation will increase price level by 0.02% and 0.4% in the short and long run, respectively. A low degree of exchange rate pass-through is attributable to the government's reaction to curbing the adverse effect of inflation on living costs.

Haryo (2015) investigates inflation targeting, exchange rate pass-through, and monetary policy rule in Indonesia. Results prove that the complete exchange rate pass-through exists only for import and producer prices. Exchange rate tends to remain unchanged both in pre- and post-inflation targeting. Moreover, the results found that the exchange rate fluctuations fail to explain interest rate policy.

In their study, Nguyen and Tran (2017) investigate exchange rate pass-through. They observed that exporters tend to highly pass-through into the import prices in the categories of "electric machinery" and "machinery and mechanical appliance." Moreover, the prevalence of the US dollar in payment invoices for imports into Vietnam, Japanese yen (JPY), Euro (EUR), and Singapore dollar (SGD) also appeared in the bill of commodities imported from Japan, EU-28, and Singapore.

Kingthong (2017) investigated the impact of exchange rate pass-through in dollarized economies on domestic inflation and economic growth in Southeast Asian countries (e.g., Cambodia, Indonesia, Lao PDR, the Philippines, and Vietnam). This study shows that currency depreciation and dollarization degree has no direct impact on domestic inflation and economic growth. However, the results did exhibit some indirect impact of exchange rate pass-through in dollarized economies across five countries. Dollarization level increases exchange rate pass-through and suggests a positive relationship for domestic inflation.

Although some studies investigate exchange rate pass-through in ASEAN countries, owing to a lack of data, some countries (e.g., Laos, Cambodia, Myanmar) remain left out. However, since this paper aims to investigate and provide insight into domestic and international market power, we decide to use data from the main trade partner, focusing on Lao PDR trading with Thailand.

2.3. Methodology and Data

2.3.1 Data description

Data used in this research comprised secondary data published by the central Bank of Lao PDR (BOL) and the International Monetary Fund (IMF) Statistics. Owing to the lack of data, this study only considers using quarterly data from 2005Q1 to 2020Q4. Nominal effective exchange rate (NEER) includes six import trading partners of Lao PDR (i.e., Japan, South Korea, Singapore, China, Thailand, and Vietnam) using 1% standard criteria based on yearly import data from IMF, the exchange rate of Thai baht vis-à-vis the Lao kip (ETH) data from BOL, total import from Thailand (IM2) of Lao PDR data from the Information Technology and Communication Center Ministry of Commerce of Thailand, consumer price index (CPI) from BOL, and interest rate (INR) from BOL, which is combined money supply (M2) from (BOL).

2.3.2 Methodology

In this study, data analysis was conducted simultaneously to determine the relationship among variables used in the study. To examine foreign exchange rate pass-through to domestic price, which will pass to consumer price using autoregressive regression distributive-lag (ARDL) bounds testing, we used a cointegration procedure developed by Pesaran *et al.* (2001) to examine the long-run cointegration relationship between consumer price as a proxy to measure inflation and its determinants. We selected this test because unlike other cointegration techniques, the ARDL does not impose a restrictive assumption that all variables under study must be integrated sequentially. Essentially, the ARDL approach can

be applied regardless of whether the underlying regressors are integrated of order one [I(1)], order zero [I(0)], or fractionally integrated. The F-test has a nonstandard distribution and depends on whether the variables included in the ARDL model are I (0) or I(1); number of repressors in the system; and whether the ARDL contains an intercept and/or a trend. Secondly, while other cointegration techniques are sensitive to sample size, the ARDL test is suitable even if sample size is small. Thirdly, the ARDL technique generally provides unbiased estimates in the long-run model and valid t-statistics even when some repressors are endogenous (Harris and Sollis, 2003). Given our sample size, this approach is appropriate.

$$CPI=F(NEER, IM, M2) \quad (2.1)$$

$$lnCPI=b_0 + b_1 lnNEER + b_2 lnIM + b_3 LnM_2 \quad (2.2)$$

$$CPI=F(THB, IM, M2) \quad (2.3)$$

$$lnCPI=b_0 + b_1 lnTHB + b_2 lnIM + b_3 LnM_2 \quad (2.4)$$

$$CPI=F(USD, IM, M2) \quad (2.5)$$

$$lnCPI=b_0 + b_1 lnUSD + b_2 lnIM + b_3 LnM_2 \quad (2.6)$$

The correct specification of a long-run relationship that will capture short-run deviations that might have occurred in estimating the long-run cointegrating equation requires an error correction term. Following Pesaran *et al.* (2001), error correction represents the above in the ARDL model as follows:

$$\Delta \ln CPI = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\, \Delta lnCPI_{t-i} + \sum_{i=0}^{n} \beta_{2i}\, \Delta lnNEER_{t-i} + \sum_{i=0}^{n} \beta_{3i}\, lnIM_{t-i} + \sum_{i=0}^{n} \beta_{4i}\, lnM_{2,t-i} + \delta_1 lnCPI_{t-1} + \delta_2 lnNEER_{t-1} + \delta_3 lnIM_{t-1} + \delta_4 lnM_{2,t-1} + \mu_t \quad (2.7)$$

$$\Delta \ln CPI = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\, \Delta lnCPI_{t-i} + \sum_{i=0}^{n} \beta_{2i}\, \Delta lnTHB_{t-i} + \sum_{i=0}^{n} \beta_{3i}\, lnIM_{t-i} + \sum_{i=0}^{n} \beta_{4i}\, lnM_{2,t-i} + \delta_1 lnCPI_{t-1} + \delta_2 lnTHB_{t-1} + \delta_3 lnIM_{t-1} + \delta_4 lnM_{2,t-1} + \mu_t \quad (2.8)$$

$$\Delta \ln CPI = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\, \Delta lnCPI_{t-i} + \sum_{i=0}^{n} \beta_{2i}\, \Delta lnUSD_{t-i} + \sum_{i=0}^{n} \beta_{3i}\, lnIM_{t-i} + \sum_{i=0}^{n} \beta_{4i}\, lnM_{2(t-i)} + \delta_1 lnCPI_{t-1} + \delta_2 lnUSD_{t-1} + \delta_3 lnIM_{t-1} + \delta_4 lnM_{2,t-1} + \mu_t \quad (2.9)$$

2.4 Empirical Results

We utilized three major models for our empirical results. First, we include the nominal effective exchange rate (NEER) as one of the independent variables. Second, we used the Thai baht exchange rate (THB). Third, we used the US dollar exchange rate (USD). In each case, we analyze two time periods: 2005Q1–2020Q4 and 2010Q1–2020Q4.

Table 2.1 ADF unit root test

ADF regression

Variable	Level I(0)	1st difference I(1)	Order of integration
lnCPI	-0.4521	-5.9299	I(1)
lnNEER	-3.4490	-11.0627	I(1)
lnM2	-2.2541	-4.6050	I(1)
lnIM	-1.1145	-4.4954	I(1)
LnTHB	-3.3032	-3.9292	I(1)
LnUSD	-3.8882	-11.3447	I(1)

The stationary test was conducted using the Augmented Dickey-Fuller (ADF) technique. The test was conducted where at the l with intercept and trend, while at 1st difference with intercept and no trend the results found that all variables are integrated at the first difference I(1). Hence, we can use the ARDL methodology for our model.

2.4.1. Results for the nominal effective exchange rate (NEER)

Table 2.2 ARDL bound test for cointegration NEER (2005Q1-2020Q4)

K		5%		10%	
3		I(0)	I(1)	I(0)	I(1)
F- Stat	2.537	3.38	4.23	2.42	3.74
T-Stat	-3.27	-2.86	-3.7	-2.57	-3.46

Table 2.2 indicates that the F-bounds test is in between the upper and lower bounds test at the 10% level. This means that continuing the ARDL test is suitable.

Table 2.3 Estimated long-run coefficients NEER (2005Q1–2020Q4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
NEER	0.064494	0.556426	0.115907	0.9082
REAL_IM_SA	0.02829	0.046735	0.605333	0.5479
LNM2	0.024045	0.257251	0.093471	0.9259
@TREND	0.001612	0.011519	0.139926	0.8893

EC = LNCPI_SA - (0.0645*NEER + 0.0283*REAL_IM_SA + 0.0240*LNM2 + 0.0016*@TREND)

Table 2.4 Error correction model regression NEER (2005Q1–2020Q4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.507626	0.152415	3.330552	0.0017
D(NEER)	0.097068	0.037994	2.554829	0.014
D(NEER(-1))	0.152894	0.045764	3.340944	0.0017
D(NEER(-2))	0.151073	0.044782	3.373505	0.0015
D(NEER(-3))	0.143335	0.038054	3.766654	0.0005
D(REAL_IM_SA)	-0.0175	0.006668	-2.62449	0.0117
D(LNM2)	0.174411	0.084978	2.052427	0.0458
D(LNM2(-1))	-0.25437	0.08936	-2.84663	0.0066
CointEq(-1)*	-0.12971	0.039576	-3.27743	0.002
R-squared	0.439376	Mean dependent var		0.005837
Adjusted R-squared	0.349676	S.D. dependent var		0.023313
S.E. of regression	0.0188	Akaike info criterion		-4.97037
Sum squared resid	0.017672	Schwarz criterion		-4.65345
Log likelihood	155.6258	Hannan-Quinn criter.		-4.84666
F-statistic	4.898289	Durbin-Watson stat		2.435218
Prob(F-statistic)	0.000168			

Table 2.4 demonstrates that the independent variables used in our model jointly accounted for 43% of total variation. The nominal effective exchange rate, real import, and money supply has a significant sign in that these variables affect CPI in the short run but not in the long run. Hence, there is no significant sign in Table 2.3. Deviation of the CPI from equilibrium is 12%.

Table 2.5 ARDL bound test for cointegration (F bounds test) NEER (2010Q1–2020Q4)

K		5%		10%	
3		I(0)	I(1)	I(0)	I(1)
F- stat	3.64	3.38	4.23	2.92	3.74
T-stat	-4.58	-2.86	-3.78	-2.57	-3.46

Table 2.5 indicates that the F-bounds test is in between the upper and lower bounds test at the 5% level. This means that continuing the ARDL test is suitable.

Table 2.6 Estimated long-run coefficients NEER (2010Q1-2020Q4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
NEER	0.673858	0.636102	1.059357	0.2988
REAL_IM_SA	-0.028696	0.020662	-1.38884	0.1762
LNM2	0.246732	0.102614	2.404468	0.0233
@TREND	-0.004446	0.005311	-0.83722	0.4098

EC = LNCPI_SA - (0.6739*NEER -0.0287*REAL_IM_SA + 0.2467*LNM2 - 0.0044*@TREND)

Table 2.6 shows that money supply affects consumer price in Lao PDR. This reflects the situation in Lao PDR as the Bank of Lao PDR (BOL) holds the primary function of managing the country's money supply and ensuring that the supply adheres to economic development fundamentals. When the Bank of Laos increases money supply by 1%, this will cause the CPI to increase by 24%.

Table 2.7 Error correction model regression NEER (2010Q1-2020Q4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.089088	0.021569	-4.13042	0.0003
D(LNCPI_SA(-1))	-0.178937	0.1425	-1.2557	0.22
D(LNCPI_SA(-2))	0.090592	0.149109	0.607555	0.5486
D(LNCPI_SA(-3))	0.554069	0.173093	3.200997	0.0035
D(NEER)	0.137128	0.081713	1.678166	0.1049

D(NEER(-1))	-0.251489	0.095157	-2.64287	0.0135
D(NEER(-2))	-0.045138	0.08546	-0.52817	0.6017
D(NEER(-3))	-0.228805	0.098366	-2.32607	0.0278
D(LNM2)	-0.33796	0.100321	-3.36878	0.0023
D(LNM2(-1))	0.204613	0.084488	2.421804	0.0224
D(LNM2(-2))	-0.379384	0.09483	-4.00068	0.0004
CointEq(-1)*	-0.315578	0.072054	-4.37976	0.0002
R-squared	0.620419	Mean dependent var		0.009184
Adjusted R-squared	0.485729	S.D. dependent var		0.01375
S.E. of regression	0.00986	Akaike info criterion		-6.16968
Sum squared resid	0.003014	Schwarz criterion		-5.67818
Log likelihood	144.648	Hannan-Quinn criter.		-5.98843
F-statistic	4.606277	Durbin-Watson stat		2.174042
Prob(F-statistic)	0.000375			

Table 2.7 indicates that overall goodness of fit, with adjusted R-square of 0.62; hence, the independent variable used in our model jointly accounted for 62% of total variation in the CPI in Lao PDR. Nominal effective exchange rate and money supply are significant. The ECM coefficient (Table 2.7) is negatively significant; hence, the model has a self-adjustment of the sort-run dynamics of the variables with their long-run value. Moreover, speed of adjustment to equilibrium is 0.31, which indicates that a deviation of the CPI from equilibrium is corrected as high as 31%.

2.4.2 Results for exchange rate of Thai baht with home country currency (THB)

Table 2.8 ARDL bound test for cointegration (F bounds test) THB (2005Q1-2020Q4)

K		5%		10%	
3		I(0)	I(1)	I(0)	I(1)
F- stat	3.23	3.38	4.23	2.97	3.74
T-stat	-2.30	-2.86	-3.78	-2.57	-3.46

Table 2.8 indicates that the F-bounds test is in between the upper and lower bounds test at the 10% level. This means that it is suitable for continuing the ARDL test.

Table 2.9 Estimated long-run coefficients THB (2005Q1-2020Q4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNTHB	-0.177766	0.270557	-0.657037	0.5142
REAL_IM_SA	0.021884	0.028951	0.7559	0.4533
LNM2	-0.166346	0.147858	-1.125039	0.2659
@TREND	0.013305	0.006348	2.095982	0.0412

EC = LNCPI_SA - (-0.1778*LNTHB + 0.0219*REAL_IM_SA -0.1663*LNM2 +0.0133*@TREND)

Table 2.10 Error correction model regression THB (2005Q1-2020Q4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.206747	0.364895	3.307109	0.0018
D(LNCPI_SA(-1))	0.150619	0.118182	1.274463	0.2084
D(LNCPI_SA(-2))	0.229758	0.120277	1.910245	0.0618
D(LNCPI_SA(-3))	0.307478	0.120195	2.55815	0.0136
D(REAL_IM_SA)	-0.019198	0.006899	-2.782595	0.0076
CointEq(-1)*	-0.190189	0.057744	-3.293627	0.0018
R-squared	0.302073	Mean dependent var		0.005834
Adjusted R-squared	0.237451	S.D. dependent var		0.023114
S.E. of regression	0.020184	Akaike info criterion		-4.87319
Sum squared resid	0.022	Schwarz criterion		-4.66376
Log likelihood	152.1958	Hannan-Quinn criter.		-4.79127
F-statistic	4.674406	Durbin-Watson stat		2.085605
Prob(F-statistic)	0.001283			

Table 2.10 indicates that overall goodness of fit, with an adjusted R-square of 0.3; hence, the independent variable used in our model jointly accounted for 30% of the total variation in the CPI in Lao PDR. Moreover, the table shows that only real import is significant and explains the short-run variation of a CPI. ECM coefficient is negative and significant, indicating that the model has a self-adjustment of the short-run dynamics of the variables with

their long-run value. Speed of adjustment to equilibrium is -0.19. This indicates that a deviation of the CPI from equilibrium is corrected as 19%.

Table 2.11 ARDL bound test for cointegration (F bounds test) THB (2010Q1-2020Q4)

K		5%		10%	
3		I(0)	I(1)	I(0)	I(1)
F- stat	4.75	3.38	4.23	2.97	3.74
T-stat	-4.57	-2.86	-3.78	-2.57	-3.46

Table 2.11 indicates that the F-bounds test is in above to the upper and lower bounds test at the 5% level. This means that the null hypothesis of no cointegrating relationship can be rejected, implying that CPI is cointegrated with the independent variables.

Table 2.12 Estimated long-run coefficients THB (2010Q1–2020Q4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNTHB	0.107273	0.1433	0.748587	0.4601
REAL_IM_SA	-0.005905	0.010811	-0.546175	0.5891
LNM2	0.129157	0.08947	1.443577	0.1596
@TREND	0.001819	0.004151	0.438153	0.6645

EC = LNCPI_SA - (0.1073*LNTHB -0.0059*REAL_IM_SA + 0.1292*LNM2 + 0.0018*@TREND)

Table 2.13 Error correction model regression THB (2010Q1–2020Q4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.13546	0.24524	4.629993	0.0001
D(LNCPI_SA(-1))	-0.10605	0.142063	-0.7465	0.4614
D(LNCPI_SA(-2))	0.233379	0.132967	1.755163	0.0898
D(LNCPI_SA(-3))	0.488544	0.154344	3.1653	0.0036
D(LNTHB)	-0.03487	0.085435	-0.408147	0.6862
D(LNTHB(-1))	-0.278043	0.080385	-3.45889	0.0017
D(REAL_IM_SA)	-0.0093	0.003712	-2.505266	0.0181
D(LNM2)	-0.147637	0.076696	-1.924961	0.0641
D(LNM2(-1))	0.225122	0.074268	3.031224	0.0051

D(LNM2(-2))	-0.246906	0.076271	-3.237227	0.003
CointEq(-1)*	-0.400765	0.086856	-4.614153	0.0001

R-squared	0.662214	Mean dependent var	0.009104
Adjusted R-squared	0.559855	S.D. dependent var	0.013599
S.E. of regression	0.009022	Akaike info criterion	-6.36593
Sum squared resid	0.002686	Schwarz criterion	-5.91988
Log likelihood	151.0504	Hannan-Quinn criter.	-6.20051
F-statistic	6.469511	Durbin-Watson stat	2.055175
Prob(F-statistic)	0.00002		

Table 2.13 shows that the overall goodness of fit, adjusted R-square of 0.66; hence, the independent variable used in our model jointly accounted for 66% of the total variation in the CPI in Lao PDR. Hence, Thai baht, real import, and money supply are significant and explain the short-run variation of a CPI. The ECM coefficient is negative and significant, showing that the model has a self-adjustment of the short-run dynamics of the variables with their long-run value. Speed of adjustment to equilibrium is -0.40. This indicates that a deviation of the CPI from equilibrium is corrected as 40%. This reflects the situation in Lao PDR, wherein Thai baht affects the CPI in the short run owing to Lao PDR importing extensively from Thailand and Thailand has been the biggest trade partner for Lao PDR for over the past 10 years.

2.4.3 Results for exchange rate of US dollar with home country currency (USD)

Table 2.14 ARDL bounds test for cointegration USD (2005Q1-2020Q4)

K		10%		5%		2.5%		1%	
3		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F-stat	6.33	2.97	3.74	3.38	4.23	3.69	4.89	4.29	5.23
t- stat	-4.30	-2.57	-3.46	-2.86	-3.78	-3.13	-4.05	-3.43	-4.37

Table 2.14 indicates that the F-bounds test is in above to the upper and lower bounds test at the 1% level. This means that the null hypothesis of no cointegrating relationship can be rejected, which implies that CPI is cointegrated with the independent variables.

Table 2.15 Estimated long-run coefficients USD (2005Q1-2020Q4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNUSD	1.998421	0.255585	7.818998	0.0000
REAL_IM_SA	-0.001603	0.011925	-0.134464	0.8936
LNM2	0.540174	0.096314	5.608461	0.0000
@TREND	-0.019263	0.004368	-4.410372	0.0001

EC = LNCPI_SA - (1.9984*LNUSD -0.0016*REAL_IM_SA + 0.5402*LNM2 - 0.0193*@TREND)

Table 2.15 shows the US dollar and money supply are statistically significant. Hence, when there is a 1% change in the US dollar and money supply, consumer price will increase by 1.99% and 0.54%, respectively. This reflects the situation in Lao PDR in that Lao PDR is highly dependent on US dollar for trade and the Bank of Laos is in charge controlling the money supply.

Table 2.16 Error correction model regression USD (2005Q1-2020Q4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-7.11027	1.213742	-5.858139	0
D(LNCPI_SA(-1))	0.1397	0.098845	1.41332	0.1642
D(LNCPI_SA(-2))	0.237417	0.099904	2.376446	0.0216
D(LNUSD)	1.427766	0.227294	6.281588	0.0000
D(LNUSD(-1))	0.099179	0.228321	0.434383	0.666
D(LNUSD(-2))	-0.841088	0.220555	-3.813498	0.0004
D(LNUSD(-3))	0.389964	0.180057	2.165782	0.0354
D(REAL_IM_SA)	-0.02295	0.005541	-4.141992	0.0001
CointEq(-1)*	-0.409535	0.069851	-5.862998	0.0000
R-squared	0.618376	Mean dependent var		0.005834
Adjusted R-squared	0.558513	S.D. dependent var		0.023114

S.E. of regression	0.015358	Akaike info criterion	-5.37687
Sum squared resid	0.012029	Schwarz criterion	-5.06272
Log likelihood	170.3061	Hannan-Quinn criter.	-5.25399
F-statistic	10.32991	Durbin-Watson stat	2.143314
Prob(F-statistic)	0		

Table 2.16 shows that the overall goodness of fit, with an adjusted R-square of 0.61; hence, the independent variable used in our model jointly accounted for 61% of the total variation in the CPI in Lao PDR. The coefficient (Table 2.16) is negative and significant showing that the model has a self-adjustment of the short-run dynamics of the variables with their long-run value. The speed of adjustment to equilibrium is -0.40. This indicates that a deviation of the CPI from equilibrium is corrected is as high as 40%. The table also shows that the US dollar and real imports have a significant sign meaning that both have a short-run relationship effect with CPI.

Table 2.17 ARDL bounds test for cointegration USD (2010Q1–2020Q4)

K		10%		5%		2.5%		1%	
3		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F-stat	7.48	2.72	3.77	3.23	4.35	3.69	4.89	4.29	5.61
t- stat	-5.74	-2.57	-3.46	-2.86	-3.78	-3.13	-4.05	-3.43	-4.37

Table 2.17 indicates that the F-bounds test is in the above to the upper and lower bounds test at the 1% level. This means that the null hypothesis of no cointegrating relationship can be rejected, which implies that CPI is cointegrated with the independent variables.

Table 2.18 Estimated long-run coefficients USD (2010Q1–2020Q4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNUSD	0.57903	0.234503	2.46918	0.0207

REAL_IM_SA	-0.00136	0.005081	-0.26659	0.792
LNM2	0.269691	0.053282	5.06156	0.0000
@TREND	-0.00527	0.002408	-2.1902	0.0381

EC = LNCPI_SA - (0.5790*LNUSD -0.0014*REAL_IM_SA + 0.2697*LNM2 - 0.0053*@TREND)

Table 2.18 shows that the US dollar and money supply are statistically significant; hence, when there are changes in the US dollar and money supply by 1%, this will increase consumer price by 0.57% and 0.26%, respectively. This reflects the situation in Lao PDR in that Lao PDR is highly dependent on the US dollar for trade and the Bank of Laos is in charge controlling the money supply.

Table 2.19 Error correction model regression USD (2010Q1-2020Q4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.43697	0.497768	-4.89578	0
D(LNCPI_SA(-1))	0.286618	0.175949	1.628983	0.1159
D(LNCPI_SA(-2))	0.477674	0.149675	3.191407	0.0038
D(LNCPI_SA(-3))	0.458281	0.172709	2.653486	0.0136
D(LNUSD)	0.452386	0.206565	2.190037	0.0381
D(LNUSD(-1))	0.247013	0.191899	1.287202	0.2098
D(LNUSD(-2))	-0.61633	0.215631	-2.85827	0.0085
D(REAL_IM_SA)	-0.0157	0.004021	-3.90423	0.0006
D(REAL_IM_SA(-1))	-0.00818	0.003846	-2.12751	0.0434
D(REAL_IM_SA(-2))	-0.00263	0.004187	-0.62834	0.5355
D(REAL_IM_SA(-3))	-0.00783	0.004189	-1.8698	0.0733
D(LNM2)	-0.11553	0.087473	-1.32073	0.1986
D(LNM2(-1))	0.103021	0.07529	1.36831	0.1834
D(LNM2(-2))	-0.26717	0.084271	-3.17038	0.004
CointEq(-1)*	-0.88154	0.179747	-4.90433	0
R-squared	0.74274	Mean dependent var		0.009104
Adjusted R-squared	0.618546	S.D. dependent var		0.013599
S.E. of regression	0.008399	Akaike info criterion		-6.45644
Sum squared resid	0.002046	Schwarz criterion		-5.84819
Log likelihood	157.0416	Hannan-Quinn criter.		-6.23087
F-statistic	5.980467	Durbin-Watson stat		2.14898
Prob(F-statistic)	0.000025			

Table 2.19 shows that the overall goodness of fit which is adjusted R-square is 0.74 which means that the independent variable used in our model jointly accounted for 74% of the total variation in the CPI in Lao PDR. The ECM coefficient (Table 2.19) is negative and significant, indicating that the model has a self-adjustment of the short-run dynamics of the variables with their long-run value. Speed of adjustment to equilibrium is -0.88, which indicates that a deviation of the CPI from equilibrium is corrected as high as 88%. The table also shows that the US dollar, real import, and money supply have a significant sign. Therefore, all three variables have a short-run relationship effect with CPI.

2.5. Conclusion

Exchange Rate	2005Q1-2020Q4		2010Q1-2020Q4	
	Long Run	Short Run	Long Run	Short Run
NEER	-	NEER Real IM M2	M2	NEER M2
THB	-	Real IM	-	THB Real IM M2
USD	USD M2	USD Real IM	USD M2	USD Real IM M2

The objective of this paper is to analyze exchange rate pass-through to consumer price variation using the autoregressive distributed lag bounds test cointegration procedure for 2005Q1–2020Q4. Results found that in the long-run, variation in the CPI is mainly explained money supply and US dollar. In the short run, the coefficients of ECM(-1) are negative and

significant; hence, the model has a self-adjusting mechanism to adjust the short-run dynamics of the variable with their long-run value. There is a relationship shown between the exchange rate in all three cases (NEER, THB, USD) with the CPI. The amount of imports, which is a proxy for real domestic demand, was the main variable to explain the CPI in the short run for almost all cases and time periods sample. Thus, our hypothesis that Lao PDR is likely to depend on Thailand owing to the high value of trade has been rejected. Our results find support in our recent results from Chapter 1 in that Lao PDR is mainly dominated by the US dollar. Moreover the results reflect the situation in Lao PDR in that money supply is the key in controlling and affecting the country's CPI.

Finally, for future research we could use a more suitable proxy variable in the model such as the amount of import of electricity instead of total import. This is because Lao PDR uses electricity from hydropower, which has been a long-term staple for the country as well as one of the main export and import for years.

Chapter 3: Monetary Policy Rule in Lao PDR

This chapter examines the conduct of monetary policy in Lao PDR from 1986–2018 and focuses on the Bank of Lao PDR's response to inflation, interest rate-, monetary-, and exchange rate-based rules according to the Taylor, McCallum, and Ball rules, respectively. Empirical estimation of monetary policy rules, especially in less developed countries, is key in testing whether monetary policy targeting rules can provide an effective description of the behavior of monetary authorities and their stated objectives in Lao PDR.

3.1 Introduction

Taylor (2001) defines monetary policy rules as contingency plans that specify the circumstances wherein a central bank could change monetary policy instruments. Moreover, simply specifying a target does not constitute a policy rule. Depending on the instrument used, the policy rule can be an interest rate-based (Taylor.), monetary-based (McCallum), or exchange rate-based (Ball) rules. Operating under a monetary rule imposes accountability and transparency upon a central bank as policymakers must be specific about the rationale behind their policy actions (Poole, 1999). Hence, a record of the decisions will contain information that future decision-makers can study.

Analyzing monetary rules in developing countries has become increasingly important after economic reforms and subsequent transitions to new policy regimes. Several studies have been targeting inflation in many developing countries. However, studies on monetary policy rules are limited. This study aims to examine the conduct of monetary policy in Lao

PDR from 1986 to 2019. The study focuses on the Bank of Lao PDR's response to inflation, output gaps, and exchange rate based on the Taylor, McCallum, and Ball rules.

3.2 Literature Review

Analyses on monetary policy rules in developing countries have become pivotal after economic reforms to new policy regime. Since 2008, several developing countries have adopted inflation targeting to stabilize and lower inflation (Aizenman *et al.,*2011). However, studies focusing on developing countries (and lower) remain limited. On inflation targeting, Yazgan and Yilmazkuday (2007) demonstrate that Taylor's rule provides a reasonable description of central bank behavior in Israel and Turkey. Torres (2003) examines Taylor-type monetary policy rules for Mexico and finds that its monetary policy had been consistent with that of an inflation-targeting regime. Some studies find high responsiveness of policy rates to changes in the exchange rate and foreign interest rate. Using a standard open-economy reaction function, Mohanty and Klau (2004) demonstrate that in many emerging market economies, interest rate responds strongly to exchange rate shocks. Malik (2007) estimates a vector autoregressive model to identify objectives of monetary policy in Pakistan and demonstrates that monetary policy depends on foreign interest rate. Berument and Tasci (2004) estimate a forward-looking monetary policy rule for Turkey and find that the Turkish Central Bank responds to changes in foreign exchange reserves and output.

Clarida et. al (1997) estimate the monetary policy reaction for two groups of countries: G3 (Germany, Japan, and The USA) and the E3 (UK, France, and Italy) using data from

1979:10 and 1994:12, respectively. Results found that since 1979, each G3 central bank has pursued implicit inflation targeting. E3 central banks are mainly influenced by Germany's monetary policy.

Svensson (1998) surveys and discusses inflation targeting in the context of monetary policy rules. The paper provides a general conceptual discussion of monetary policy rules, attempts to clarify essential characteristics of inflation targeting, compares inflation targeting to other monetary policy rules, and draws some conclusions about the monetary policy of the European System of Central Banks.

Taylor (1999) examines monetary history from the perspective of recent research on monetary policy rules in the US and the effects of different monetary policy rules on the economy. The study suggests using both current and historical information as a quantitative measure of the size of past mistakes in monetary policy. Furthermore, it examines the effects of these mistakes and their relevance for monetary policy today as it provides evidence on the effectiveness of different monetary policy rules.

Williams (1999) computes efficient policy rules using the FRB/US large-scale open-economy macro-econometric model. Simple three-parameter policy rules excel at minimizing fluctuations in inflation, output, and interest rates. Increases in rule complexity yield only trivial reductions in aggregate variability. Under rational expectations, efficient policies smooth the interest rate response to shocks, use feedback from anticipated policy actions to stabilize inflation and output, and moderate movements in short-term interest rates. The policy should react to a multi-period inflation rate rather than the current quarter inflation rate.

Targeting price level, as opposed to the inflation rate, involves only small additional stabilization costs. These results are robust to parameter and model uncertainty and imposition of the non-negativity constraint on nominal interest rates. However, if formation of expectations is invariant to policy, as in backward-looking models, the expectations channel is shut off and performance of policies that are efficient under rational expectations may deteriorate markedly. In contrast, efficient policies, exploit systematic expectational errors.

Vegh (2001) indicates that policymakers increasingly view short-term nominal interest rates as a main instrument of monetary policy, often in conjunction with some inflation target. Interest rates on short-term indexed government debt (i.e., a real interest rate) have also been considered policy instruments. To understand the pros and cons of different policy rules and instruments, this paper derives some basic equivalences among different policy rules. Hence, under certain conditions, the following three rules are exactly equivalent: (i) a "k-percent" money growth rule, (ii) a nominal interest rate rule combined with an inflation target, and (iii) a real interest rate rule combined with an inflation target. However, these policy rules have become increasingly complex: the first rule requires no feedback mechanism, the second requires responding to the inflation gap, and the third involves responding to both inflation and output gaps. Furthermore, policy rules which respond to the output gap may avoid a deflationary adjustment.

Orphanides (2002) evaluates the nature of monetary policy during the 1970s through the lens of a forward-looking Taylor rule based on perceptions regarding the outlook for inflation and unemployment at the time policy decisions were made. Evidence suggests that

policy during the 1970s was essentially indistinguishable from a systematic, activist, forward-looking approach as is often identified with good policy advice in theoretical and econometric policy evaluation research. This highlights the unpleasant possibility that policy errors of the 1970s occurred despite use of a seemingly desirable policy approach. Though the resulting activist policies could have appeared highly promising, they proved to be counterproductive in retrospect.

Mohanty and Klau (2004) review the recent conduct of monetary policy and the central banks' interest rate-setting behavior in emerging market economies. Using a standard open-economy reaction function, we test whether central banks in emerging market economies consistently and predictably react to changes in inflation, output gap, and exchange rate. In most emerging market economies, interest rate responds strongly to the exchange rate. In some, response is higher than that of changes in the inflation rate or output gap. This result is robust to alternative specification and estimation methods. This highlights the importance of the exchange rate as a source of shock and supports the "fear of floating" hypothesis. Their evidence suggests that, in some countries, the central bank's response to a negative inflation shock might be weaker than that to a positive shock.

Aizenman *et al.* (2008) investigate inflation targeting (IT) in emerging markets, focusing on the role of the real exchange rate and the distinction between commodity and non-commodity exporters. IT emerging markets appear to follow a "mixed strategy," wherein both inflation and real exchange rates are important determinants of policy interest rates. However, the response to real exchange rates is more constrained than in non-IT regimes. Furthermore,

we find that the response to real exchange rates is strongest in countries following IT policies that are relatively intensive in exporting basic commodities and present a theoretical model that explains these empirical results.

Luengwilai (2012) analyzes monetary policy implementation under an IT regime in Thailand. The paper applies the Bayesian maximum likelihood estimation to a small open-economy model, proposed by Lubik and Schorfheide (2007). This study examines whether the Bank of Thailand (BOT) considers exchange rate movement, which is uncertain, in setting policy rate. This paper considers various types of the Taylor rule: contemporaneous, backward-looking, and forward-looking. The main finding is that BOT responds to exchange rate movement. The contemporaneous rule responding to nominal exchange rate movement well characterizes the policy rate set by the BOT. The BOT focuses more on the contemporaneous economic condition than lag of interest rate. Specifically, the rule illustrates that the BOT follows the Taylor principle, with inflation-response coefficient being 1.515 on average. Moreover, the BOT prioritizes exchange rate stabilization relative to output stabilization. Thus, the BOT has implemented a flexible IT policy with exchange rate concerns.

Perera and Jayawickrema (2014) aim to characterize the monetary policy decision-making process for Sri Lanka using standard Taylor-type monetary policy rules. Alternative monetary policy reaction functions are estimated for Sri Lanka over the period of 1996Q1–2013Q2. An open-economy reaction function is used in the analysis where the central bank is assumed to respond to changes in inflation, output gap, and exchange rate. A forward-looking

specification of the reaction function provides the most appropriate characterization of policymaking at the Central Bank of Sri Lanka. Results indicate that the size of the coefficient on the inflation gap has increased over time, reflecting greater focus on price stability. However, the response of monetary policy to output fluctuations has been greater than that to deviations in inflation reflecting the central bank's preference and lower sensitivity of output to interest rate changes.

Xaiyavong and Czerkawski (2014) review the recent conduct of monetary policy and the central bank's rule-based behavior in Lao PDR. Using different policy rules, we test whether the Bank of Lao PDR (BOL) reacts to changes in inflation, output gap, and exchange rate consistently and predictably. Our results indicate that, during the period from 1986 to 2011, the BOL used real monetary aggregates as the main policy instrument, implying that its monetary policy tends to suffer from instability in the demand for money either due to a high degree of dollarization or persistent changes resulting from financial innovation.

Salter (2014) is an introduction to contemporary discussions within monetary theory and policy. The paper focuses on comparing proposals for monetary policy rules. First, it presents an argument as to why monetary policy defined here broadly means adjusting money supply to influence the economy is desirable in the first place. It then presents an argument for why rules-based monetary policy is preferable to discretionary policy. Next, it discusses two kinds of rules: those that can be implemented with minimal changes to current monetary institutions (i.e., central banking) and those that would require significant institutional changes to implement. The discussion is primarily an effort to promote informed participation in the democratic process.

Heipertz *et al.* (2017) conduct research on monetary policy in small open economies and focus on "corner solutions": either currency rate is fixed by the central bank or left to market forces. We build an open-economy model with external habits to study the properties of a "new" class of monetary policy rules wherein the monetary authority uses exchange rate as the instrument. Different from the Taylor rule, the monetary authority announces the rate of expected currency appreciation by considering inflation and output fluctuations. We find that the exchange rate rule outperforms a standard Taylor rule in welfare, regardless of policy parameter values. The differences are driven by the following: (i) behavior of nominal exchange rate and interest rates under each rule and (ii) deviations from UIP owing to a time-varying risk premium.

Caporale *et al.* (2018) examines the Taylor rule in five emerging economies, namely, Indonesia, Israel, South Korea, Thailand, and Turkey. It investigates whether the monetary policy in these countries can be more accurately described by (i) an augmented rule including the exchange rate and (ii) a nonlinear threshold specification (estimated using GMM), instead of a baseline linear rule. Results suggest that the reaction of monetary authorities to deviations from the target of either inflation or output gap differs in size and/ or statistical significance of the coefficients in the high and low inflation regimes in all countries. Particularly, exchange rate has an impact in the former but not in the latter regime. Overall, an augmented nonlinear Taylor rule appears to capture the behavior of monetary authorities in these countries more accurately.

Taylor (2019) emphasizes the connection between inflation targeting and monetary policy rules. Inflation targeting is not enough; a policy procedure is necessary to achieve the target. One cannot design or evaluate a monetary policy rule without a target inflation rate. Hence, a symbiotic relationship between inflation targeting and monetary policy rules exists. Initially, the instrument in the policy rule was a monetary aggregate, a quantity, usually the money supply. Subsequently, research on monetary policy rules focused on another instrument of monetary policy—the interest rate—as velocity became more volatile. Hence, interest rate was more reliable as an instrument, at least for low levels of inflation. Interest rate rules work best within a band between very high inflation and deflation. Outside that band, the central bank should rely more on money growth rules.

3.3 Methodology and Data

In this chapter, we investigate three types of monetary policy rules, including interest-rate-, monetary-, and exchange-rate-based rules. These three rules are referred to as the Taylor (Taylor, 2001), McCallum (McCallum, 1988), and the Ball (Ball, 1998) rules, respectively. The key difference among them is the choice of instrument in the central bank's reaction function relative to changes in inflation, output, and exchange rate. Since 1986, the Lao economy experienced both sharp fluctuations in the main macroeconomic variables and structural changes. Considering the unstable nature of the economic environment in Lao PDR, the task of estimating a monetary policy rule is complicated. No single policy rule equation is likely to capture all the aspects of central bank behavior over the 1986–2018 period.

In the empirical analysis, we use 1986–2018 annual data. The starting point of the sample period is determined by the introduction of a New Economic Mechanism, which transforms the centrally planned economy into a market-oriented one. Data on real money growth and interest rate are obtained from the BOL's annual economic report. Interest rate is proxied by the one-year time deposit of the commercial bank. Data on real GDP and nominal exchange rate were obtained from World Bank. We then estimate the output gap, is measured by the difference between (log of) real GDP and its long-term trend, proxied by (log of) Hedrick–Prescott trend. Real exchange rate is measured by a real exchange rate of Lao kip against the US dollar from the world bank. Data on inflation are obtained from the World Bank's World Development Indicator Database. Consumer price index (CPI) inflation is measured by yearly changes in CPI.

Variable	Description	source
INR	Interest rate	BOL
CPI	Inflation	World bank
GDP	GDP	World bank
EX	Exchange rate	World bank
M2	Money supply	BOL

a. Taylor rule

The Taylor rule prescribes how a central bank should adjust its interest rate policy instrument systematically in response to increased inflation and macroeconomic activity. It provides a useful framework for the analysis of historical policy and for the econometric evaluation of specific alternative strategies that a central bank can use to base its interest rate decisions. Following Taylor (2001), an empirical model of the Taylor rule can be expressed as follows:

$$INR_t = \beta_0 + \beta_1 INR_t + \beta_2 OUTPUT_t + \beta_3 USD + \beta_4 USD_{t-1} + \beta_5 INR_{t-1} + \varepsilon_t \quad (3.1)$$

b. McCallum rule

The McCallum rule uses the growth rate of the monetary base as an instrument, rather than the short-term interest rate. Short-term interest rate has not been the most important instrument in conducting monetary policy in Lao PDR. Uncertainty in measuring real expected interest rates, shallow financial markets, and large investment shocks or net exports may make monetary aggregates a preferred instrument. Esanov *et al.* (2005) argue that directly estimating the original McCallum rule has a major statistical disadvantage as it drops a large number of observations to average the velocity of money over 4 years. Owing to this, the author estimates a modified McCallum rule wherein the interest-rate instrument from a Taylor-type rule is replaced by changes in a real monetary aggregate. Following Esanov *et al.* (2005), an empirical model of the McCallum rule can be formalized as follows:

$$M_{2,t} = \beta_0 + \beta_1 INR_t + \beta_2 OUTPUT_t + \beta_3 USD + \beta_4 USD_{t-1} + \beta_5 M_{2,t-1} + \varepsilon_t \quad (3.2)$$

c. Ball rule

The Ball rule uses the weighted average of the exchange rate and interest rate as an instrument of monetary policy. Ball (1998) argues that interest-rate-based Taylor rules are inefficient. Moreover, they stress that monetary policy affects the economy through the exchange rate and through interest rate channels. Ball constructs a simple model having an open-economy IS curve, a Phillips curve, and a link between the interest and exchange rates. Following Esanov *et al.* (2005), an empirical model of the Ball rule can be modified as follows:

$$\theta INR_t + (1-\theta)USD_t = \alpha GDP + \beta(INR_t + \delta USD_{t-1}) + \varepsilon_t \quad (3.3)$$

Here, θ is a weight that depends on model calibration, δ is the effect of an exchange rate appreciation on inflation, and both α and β depend on model calibrations. Calibration parameters from Ball (1998) were used. For a robustness test, we use different weights and check their effect on the estimated coefficients.

3.4 Empirical Results

3.4.1 Results for Taylor rules

$$\boldsymbol{INR_t = \beta_0 + \beta_1 CPI_t + \beta_2 OUTPUT_t + \beta_3 USD + \varepsilon_t \quad (3.1)}$$

Table 3.1 ARDL bounds test for the Taylor rule

K		10%		5%		2.5%		1%	
3		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)

F-stat	3.523	2.72	3.77	3.23	4.35	3.69	4.89	4.29	5.61
t- stat	-2.875	-2.57	-3.46	-2.86	-3.78	-3.13	-4.05	-3.43	-4.37

We can see that F-bounds test is in between the upper and lower bounds test at the 5% level. Hence, we can continue the ARDL test.

Table 3.2 Results for long-run relationship Taylor rule

Variable	Coefficient	Std Error	T-Statistic	Prob
CPI	-0.36193	0.256879	-1.408951	0.1842
Output	1.565808	0.130422	12.00573	0.0000
USD	-0.556886	0.088205	-6.31354	0.0000

EC = INR – (-0.3619*CPI + 1.5658*Output – 0.5569*USD)

Table 3.2 demonstrates that interest rate in Lao PDR is mainly explained by output gap and US dollar. This means that if both output gap and the US dollar increased by 1% , interest rate will increase and decrease by 1.56% and 0.55%, respectively.

Table 3.2 ECM regression for Taylor rule

Variable	Coefficient	Std Error	T-Statistic	Prob
C	-5.079899	0.891109	-5.700651	0.0001
D(INR(-1))	0.338059	0.184914	1.828198	0.0925
D(INR(-2))	-0.449163	0.137571	-3.264964	0.0068
D(INR(-3))	-0.270399	0.107565	-2.513811	0.0272
D(CPI)	-0.063302	0.098131	-0.645076	0.531
D(CPI(-1))	0.546698	0.112751	4.848709	0.0004
D(OUTPUT)	2.566069	1.116757	2.297787	0.0404
D(OUTPUT(-1))	5.913884	1.313878	4.501089	0.0007
D(OUTPUT(-2))	3.736712	0.526912	7.091713	0.0000
D(USD)	-0.475075	0.711379	-0.667823	0.5169
D(USD(-1))	6.027635	0.939016	6.419099	0.0000
D(USD(-2))	-2.894783	0.613829	-4.715948	0.0005
D(USD(-3))	1.145093	0.436461	2.623686	0.0222

CointEq(-1)*	-0.869633	0.207179	-4.197494	0.0012
R-squared	0.95727	Mean dependent var	0.027241	
Adjusted R-squared	0.920237	S.D. dependent var	0.814691	
S.E. of regression	0.230087	Akaike info criterion	0.205554	
Sum squared resid	0.794101	Schwarz criterion	0.865628	
Log likelihood	11.01947	Hannan-Quinn criter.	0.412281	
F-statistic	25.84937	Durbin-Watson stat	2.525457	
Prob(F-statistic)	0.000025			

Table 3.2 shows that overall goodness of fit, which is adjusted R-square, is 0.95. This means that the independent variable used in our model jointly accounted for 95% of total variation in the interest rate in Lao PDR. The ECM coefficient (Table 3.2) is negative and significant, which shows that the model has a self-adjustment of the short-run dynamics of the variables with their long-run value. Speed of adjustment to equilibrium is -0.87, which indicates that deviation of the CPI from equilibrium is corrected as high as 87%. Moreover, the table shows that the US dollar, output gap, and CPI present a significant sign. Hence, all three variables have a short-run relationship effect with interest rate.

3.4.2 Results for McCallum rule

$$M_{2,t} = \beta_0 + \beta_1 CPI_t + \beta_2 OUTPUT_t + \beta_3 USD + \varepsilon_t \quad (3.2)$$

Table 3.4 ARDL bounds test for the McCallum rule

K		10%		5%		2.5%		1%	
3		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F-stat	14.322	2.72	3.77	3.23	4.35	3.69	4.89	4.29	5.61
t- stat	-3.920	-2.57	-3.46	-2.86	-3.78	-3.13	-4.05	-3.43	-4.37

Table 3.4 indicates that the F-bounds test is in above to the upper and lower bounds test at the 1% level. This means that the null hypothesis of no cointegrating relationship can be rejected. This implies that money supply is cointegrated with the independent variables.

Table 3.5 Results for long-run relationship McCallum rule

Variable	Coefficient	Std Error	T-Statistic	Prob
CPI	-0.005294	0.256879	-1.214042	0.2464
Output	0.110061	0.000822	13.9062	0.0000
USD	-0.003212	0.000733	4.39302	0.0007

EC = M2 – (-0.0053*CPI + 0.1101*OUTPUT – 0.0032*USD)

Table 3.2 shows that money supply in Lao PDR is mainly explained by output gap and US dollar. Hence, if output gap and US dollar increase by 1%, interest rate will increase and decrease by 0.11% and 0.003%, respectively.

Table 3.6 ECM regression for McCallum rule

Variable	Coefficient	Std Error	T-Statistic	Prob
C	0.382014	0.018861	20.25443	0.0000
D(M2(-1))	0.070491	0.13105	5.378999	0.0001
D(M2(-2))	0.016098	0.004474	3.597669	0.0032
D(CPI)	-0.000426	0.000132	-3.231381	0.0066
D(CPI(-1))	0.00172	0.000168	10.22822	0.0000
D(CPI(-2))	0.00158	0.000192	8.22719	0.0000
D(CPI(-3))	0.002553	0.000336	7.602315	0.0000
D(OUTPUT)	0.113372	0.001825	62.11274	0.0000
D(USD)	-0.003173	0.000924	-3.432882	0.0045
D(USD(-1))	0.00362	0.001146	3.158381	0.0075
D(USD(-2))	-0.006188	0.000896	-6.902571	0.0000
D(USD(-3))	-0.004771	0.00069	-6.91232	0.0000
CointEq(-1)*	-0.319627	0.015688	-20.37464	0.0000
R-squared	0.999717	Mean dependent var		0.013768
Adjusted R-squared	0.999505	S.D. dependent var		0.014339

S.E. of regression	0.000319	Akaike info criterion	-12.9615
Sum squared resid	1.63E-06	Schwarz criterion	-12.3486
Log likelihood	200.01947	Hannan-Quinn criter.	-12.7696
F-statistic	4716.84937	Durbin-Watson stat	2.574403
Prob(F-statistic)	0.000025		

Table 3.6 shows that the overall goodness of fit, wherein adjusted R-square is 0.99. This means that the independent variable used in our model jointly accounted for 99% of the total variation in the interest rate in Lao PDR. The ECM coefficient as observed in Table 3.6 is negative and significant. This shows that the model has a self-adjustment of the short-run dynamics of the variables with their long-run value. Speed of adjustment to equilibrium is -0.32. This indicates that a deviation of the CPI from equilibrium is corrected as high as 32%. The table also shows that the US dollar, output gap, and CPI have a significant. Hence, all three variables have a short-run relationship effect with money supply.

3.4.3 Ball rule estimates into three results where $\theta = 0, 0.5$, and 1

CPIUSD = log (1+Inflation) + 0.5*log (exchange rate)

A. $\theta INR_t + (1-\theta)USD_t = \alpha GDP + \beta(INR_t + \delta USD_{t-1}) + \varepsilon_t$ (3.3) / $\theta = 0$

Table 3.7 ARDL bounds test for Ball rules $\theta = 0$

K		10%		5%		2.5%		1%	
2		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F-stat	20.322	3.17	4.14	3.79	4.85	4.41	5.52	5.15	6.36

t- stat	-7.719	-2.57	-3.21	-2.86	-3.53	-3.13	-3.8	-3.43	-4.1

Table 3.7 indicates that the F-bounds test is in above to the upper and lower bounds test at the 1% level. Hence, the null hypothesis of no cointegrating relationship can be rejected. This implies that dependent variable is cointegrated with the independent variables.

Table 3.8 Results for long-run relationship for Ball rules $\theta = 0$

Variable	Coefficient	Std Error	T-Statistic	Prob
OUTPUT	1.49836	0.081315	-18.38311	0.0000
CPIUSD	-1.235092	0.138469	-9.919611	0.0000

EC = INR – (1.4948*OUTPUT -1.2351*CPIUSD)

Table 3.8 indicates that money supply in Lao PDR is mainly explained by output gap and weight of exchange rate and consumer price. Therefore, if output gap and weight increase by 1%, interest rate will increase and decrease by 1.49% and 1.23%, respectively.

Table 3.9 ECM regression for Ball rules $\theta = 0$

Variable	Coefficient	Std Error	T-Statistic	Prob
C	-4.84977	0.545638	-8.888254	0.0000
D(INR(-1))	0.444339	0.159143	2.792078	0.0131
D(OUTPUT)	4.923837	0.968212	5.085497	0.0001
D(OUTPUT(-1))	2.184009	1.305037	1.673523	0.1137
D(OUTPUT(-2))	1.331787	0.624208	2.133561	0.0487
D(OUTPUT(-3))	1.359699	0.588204	2.311612	0.0344
D(CPIUSD)	1.674403	0.745838	2.244995	0.0393
D(CPIUSD(-1))	2.97737	0.77899	3.783581	0.0016
D(CPIUSD(-2))	0.489497	0.520202	0.94975	0.3607
D(CPIUSD(-3))	1.216089	0.448746	2.709971	0.0155
CointEq(-1)*	-1.426408	0.169849	-8.398099	0.0000
R-squared	0.890994	Mean dependent var	0.027241	
Adjusted R-squared	0.830435	S.D. dependent var	0.814691	
S.E. of regression	0.335475	Akaike info criterion	0.935161	

Sum squared resid	2.025788	Schwarz criterion	1.45379
Log likelihood	-2.559829	Hannan-Quinn criter.	1.097589
F-statistic	14.71285	Durbin-Watson stat	2.618692
Prob(F-statistic)	0.000001		

Table 3.9 indicates that overall goodness of fit, with an adjusted R-square of 0.89; hence, the independent variable used in our model jointly accounted for 89% of the total variation in the interest rate in Lao PDR. The ECM coefficient (Table 3.9) is negative and significant. Hence, the model has a self-adjustment of the short-run dynamics of the variables with their long-run value. Speed of adjustment to equilibrium is -1.42, indicating that a deviation of the CPI from equilibrium is corrected is as high as 142%. Moreover, the table also shows that the weight of the US dollar and CPI and output gap, have a significant sign. Therefore, all two variables have a short-run relationship effect with interest rate.

Table 3.10 ARDL bounds test for Ball rules $\theta = 0.5$

K		10%		5%		2.5%		1%	
2		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F-stat	20.8972	3.17	4.14	3.79	4.85	4.41	5.52	5.15	6.36
t- stat	-7.7192	-2.57	-3.21	-2.86	-3.53	-3.13	-3.8	-3.43	-4.1

Table 3.10 indicates that the F-bounds test is above the upper and lower bounds test at the 1% level. Hence, the null hypothesis of no cointegrating relationship can be rejected, implying that the dependent variable is cointegrated with the independent variables.

Table 3.11 Results for long–run relationship for Ball rules $\theta = 0.5$

Variable	Coefficient	Std Error	T-Statistic	Prob
OUTPUT	0.747418	0.040658	18.38321	0.0000
CPIUSD	-0.117546	0.069235	-1.697792	0.1089

EC = INRUSD– (0.7474*OUTPUT – 0.1175*CPIUSD)

Table 3.11 indicates that the weight of CPI and exchange rate is mainly explained by output gap. Hence, if output gap increases by 1%, weight of CPI and exchange rate will increase by 0.74%.

Table 3.12 ECM regression for Ball rules $\theta = 0.5$

Variable	Coefficient	Std Error	T-Statistic	Prob
C	-2.424885	0.272819	-8.888254	0.0000
D(INRUSD(-1))	0.444339	0.159143	2.792078	0.0131
D(OUTPUT)	2.461918	0.484106	5.085497	0.0001
D(OUTPUT(-1))	1.092005	0.652518	1.673523	0.1137
D(OUTPUT(-2))	0.665893	0.312104	2.133561	0.0487
D(OUTPUT(-3))	0.679849	0.294102	2.311612	0.0344
D(CPIUSD)	1.337201	0.372919	3.585768	0.0025
D(CPIUSD(-1))	1.251516	0.373263	3.35291	0.004
D(CPIUSD(-2))	0.244748	0.260101	0.940975	0.3607
D(CPIUSD(-3))	0.608044	0.224373	2.709971	0.0155
CointEq(-1)*	-1.426408	0.169849	-9.398099	0.0000

R-squared	0.886423	Mean dependent var	0.035146
Adjusted R-squared	0.823481	S.D. dependent var	0.499241
S.E. of regression	0.167738	Akaike info criterion	-0.451134
Sum squared resid	0.506447	Schwarz criterion	0.067496
Log likelihood	17.54144	Hannan-Quinn criter.	-0.288705
F-statistic	14.06229	Durbin-Watson stat	2.618692
Prob(F-statistic)	0.000001		

Table 3.12 indicates that overall goodness of fit, with an adjusted R-square is 0.88; hence, the independent variable used in our model jointly accounted for 88% of the total variation in weight of interest and exchange rates in Lao PDR. The ECM coefficient (Table 3.12) is negative and significant. Hence, the model has a self-adjustment of the short-run dynamics of the variables with their long-run value. Speed of adjustment to equilibrium is -1.42, indicating that a deviation of the CPI from equilibrium is corrected is as high as 142%. Moreover, the table also shows that the output gap and weight of CPI and exchange rate have

a significant sign. Therefore, all three variables have a short-run relationship effect with the weight of interest rate and the US dollar.

Table 3.13 ARDL bounds test for Ball rules $\theta = 1$

K		10%		5%		2.5%		1%	
2		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F-stat	20.8972	3.17	4.14	3.79	4.85	4.41	5.52	5.15	6.36
t- stat	-7.7192	-2.57	-3.21	-2.86	-3.53	-3.13	-3.8	-3.43	-4.1

Table 3.13 indicates that the F-bounds test is above the upper and lower bounds test at the 1% level. Hence, the null hypothesis of no cointegrating relationship can be rejected, implying that the dependent variable is cointegrated with the independent variables.

Table 3.14 Results for long-run relationship for Ball rules $\theta = 1$

Variable	Coefficient	Std Error	T-Statistic	Prob
OUTPUT	1.494836	0.081315	18.38321	0.0000
CPIUSD	-1.2355092	0.138469	-8.919611	0.0000

EC = INR – (1.4948*OUTPUT -1.2355*CPIUSD)

Table 3.14 indicates that interest rate in Lao PDR is mainly explained by the output gap and the weight of CPI and US dollar. Therefore, if output gap and weight of CPI and USD increase by 1% , interest rate will increase and decrease by 1.49% and 1.23%, respectively.

Table 3.15 ECM regression for Ball rules $\theta = 1$

Variable	Coefficient	Std Error	T-Statistic	Prob
C	-4.84977	0.545638	-8.888254	0.0000
D(INR(-1))	0.444339	0.159143	2.792078	0.0131

D(OUTPUT)	4.923837	0.968212	5.085497	0.0001
D(OUTPUT(-1))	2.184009	1.305037	1.6733523	0.1137
D(OUTPUT(-2))	1.331787	0.624208	2.1335561	0.0487
D(OUTPUT(-3))	1.359699	0.588204	2.311612	0.0344
D(CPIUSD)	1.674403	0.745838	2.244995	0.0393
D(CPIUSD(-1))	2.94737	0.77899	3.783581	0.0016
D(CPIUSD(-2))	0.489497	0.520202	0.940975	0.3607
D(CPIUSD(-3))	1.216089	0.448746	2.709971	0.0155
CointEq(-1)*	-1.426408	0.169849	-8.398099	0.0000

R-squared	0.890994	Mean dependent var	0.027241
Adjusted R-squared	0.830435	S.D. dependent var	0.814691
S.E. of regression	0.335475	Akaike info criterion	0.935161
Sum squared resid	2.025788	Schwarz criterion	1.45379
Log likelihood	-2.559829	Hannan-Quinn criter.	1.097589
F-statistic	14.71285	Durbin-Watson stat	2.618692
Prob(F-statistic)	0.000001		

Table 3.15 indicates that the overall goodness of fit, with an adjusted R-square of 0.89; hence, the independent variable used in our model jointly accounted for 89% of the total variation in the interest rate in Lao PDR. The ECM coefficient (Table 3.15) is negative and significant. Hence, the model has a self-adjustment of the short-run dynamics of the variables with their long-run value. Speed of adjustment to equilibrium is -1.42, indicating that a deviation of the CPI from equilibrium is corrected is as high as 142%. Moreover, the table also shows that the weight of CPI and US dollar, and output gap have a significant sign. Therefore, all two variables have a short-run relationship effect with money supply.

3.5 Conclusion

This paper reviews the conduct of monetary policy of Lao PDR and the role of the Bank of Lao PDR. Empirical evidence indicates that Lao PDR has been targeting money supply differently compared to many emerging countries, which target interest rate rule.

Money supply in Lao PDR composed neither deposits in the bank or cash. As Lao PDR is a dollarized economy, most of the money supply is in US dollar (more than 50%). This is a challenge that makes it difficult for the Bank of Laos to control the money supply. This results has a support with Chapter 1 and Chapter 2 in that Lao PDR work hard to stabilize the exchange rate between domestic currency (Kip) and the US dollar.

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