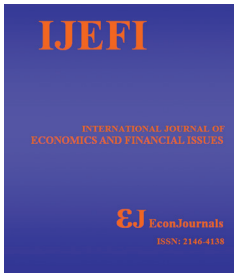

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The Relationship between Inflation, Exchange Rate, and Currency Substitution: Evidence from Panel Vector Error Correction Model Approach

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ABSTRACT

This study investigates the relationship between inflation, real exchange rate, and currency substitution in Southeast Asian economies based on the panel Vector Error Correction Model (VECM). Regarding the panel unit root testing result indicates that variables are stationary in the first difference which appropriate to be utilized of panel VECM technique. The empirical results suggest that there exists panel cointegration and long-run relationship between inflation, real exchange rate and currency substitution. Moreover, the evidence from both fully modified ordinary least square (FMOLS) and dynamic ordinary least square (DOLS) also confirmed the existence of long-run association between variables. Increasing of inflation rate and devaluation of domestic currency positively effect on currency substitution in the long-run. Furthermore, the result of short-run causal relationship based on panel granger causality reveals the bidirectional relationship between inflation and currency substitution and unidirectional relationship between exchange rate and currency substitution in Southeast Asia.

Keywords: Currency Substitution, Inflation Rate, Exchange Rate, Monetary Policy, Panel Vector Error Correction Model
JEL Classifications: E31, E52, F31

1. INTRODUCTION

Currency substitution or dollarization has been widely drawing attention over last few decades in the context of developing and transitional countries. Particularly, the countries experienced economic uncertainty and underdeveloped financial system. The phenomenon of using foreign currency or denominated asset, as a medium of exchange, unit of account and store of value in the economy has been notably concerned in Latin America, the former of the Soviet Union and some Asian countries. There are numbers of factors that make domestic resident substitutes the use of domestic currency. Regarding previous literatures, the factors affect currency substitution is mainly driven by economic imbalance and economic instability Agnor and Khan, (1996), Sharma et al. (2005), Yeyati (2006), Metin-Özcan and Us (2007) and Nidhiprabha, (2017). The economies with high historically economic instability tends to have more currency substitution more than those with stability Agnor and Khan (1996), Lebre de Freitas (2004). Foreign currency and dominated asset is the better choice to be held to avoid the loss of inflationary taxation when the inflation rate has been increased and large depreciation of domestic currency.

Numerous of literatures contents that changes in the degree of currency substitution determines the effectiveness of monetary policy through its transmission channels. As Cowan (2003) And (Yeyati, 2006) points that the monetary transmission instrument may not work properly to pursue the stability of monetary policy in dollarized economies. In heavily dollarized economy, the local currency is easily lost its value or depreciation again a major currency, which motivates to switch financial asset and liabilities shifts toward in the form of foreign currency. The more acceleration of devaluation on domestic currency the more exacerbates downward pressure on the exchange rate. To keep

exchange rate steady as the normal term, therefore, the central banks have to set the domestic currency interest rate at the level substantially higher than those dollarized assets Marcelin and Mathur (2016). In addition, De Nicoló at (2003) and Ildirim (2003) the high degree of currency substitution can be a volatilized on the macroeconomic stability and impinging on the central bank to conduct the monetary policy which in turn might lead to the loss of monetary independence and instability on demand for domestic currency.

Even though, growing literature has found that currency substitution was mainly influenced by macroeconomic instability and be an obstacle to the central bank to conduct monetary policy. It is difficult to conclude that currency substitution makes monetary policy less or inefficiency. In contrast, Berkmen and Cavallo (2010) contents that a country with high liability dollarization tends to be more actively involved in exchange rate stabilization. Soto (2009) provides some evidence that dollarization stabilizes domestic price and lead to higher economics growth to Ecuador. Reinhart et al., (2014) also supports that the high degree of currency substitution is not a major obstacle to monetary control or disinflation.

Numerous of literature have been conducted concerning the link between inflation, exchange rate and currency substitution in many economies, the conclusion on how those economic variables reacting response to the existence of high level of foreign currency and how level of using foreign currency response to interest rate and exchange rate fluctuation are still be unclear. Hence, this study attempt to provide a panel evidence on the relationship between inflation exchange rate and currency substitution in the case of Southeast Asian economies (i.e. Cambodia, Laos, Indonesia, Philippines and Vietnam) based on the panel vector error correction model (VECM). It explores to understand how these countries respond to the high degree of currency substitution through their inflation and exchange rate and Is it unidirectional or bidirectional relationship between variables?.

The remainder of this paper is structured as follow: Section 2 is briefly mentioned for dollarization in Laos. Section 3 review of existing literatures. Section 4 describes the analytical frameworks and results which includes: Data collection, panel integration, FMOLS, DOLS and Panel granger causality and Section 5 is conclusion.

2. DOLLARIZATION IN SOUTHEAST ASIA

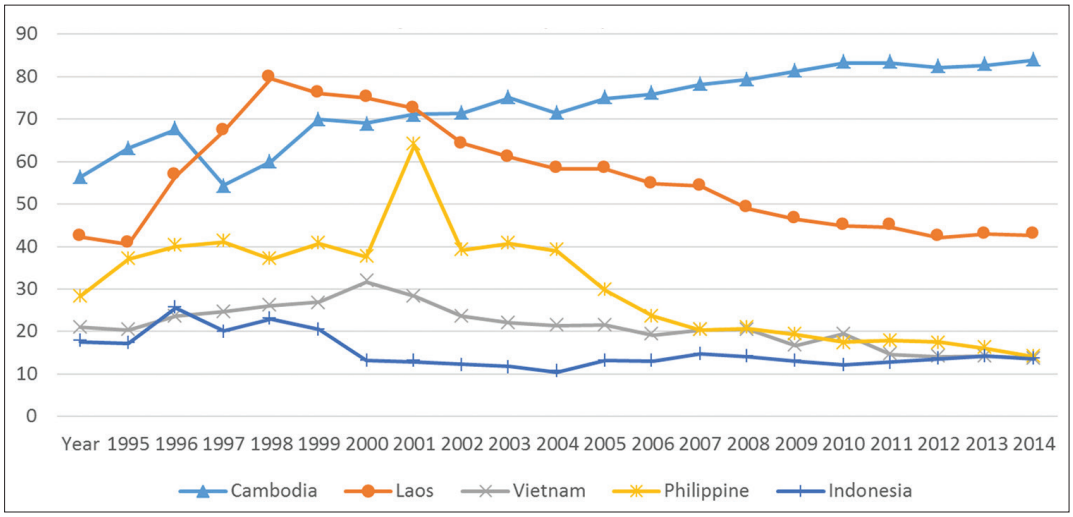
The high level of currency substitution is the historical accident that the people in Southeast Asia learn to live with. During the Asian financial crisis in 1997, Some of Asian nations decided to float their domestic currency to maintain their foreign reserve after the attacks of speculators which led to the explosion in the debt in the form of foreign currency, hyperinflation and the large depreciation of domestic currency of other Asian countries (Wade, 1998) and (Marcelin and Mathur, 2016). The degree of currency substitution has been rising sharply in Cambodia, Laos, and Philippines as the sign responses to the economic uncertainty and instability in this region. Some of these countries has been listed as the highest dollarized economy such as Cambodia and Laos which ever used foreign currency as the peak more than 80% of the currency in their economy during the Asian financial crisis. However, since the macroeconomic of these countries continue growing with the more stability, the degree of currency substitution seems to be permanently phenomena and steady remain as shown in Figure 1.

3. LITERATURE REVIEW

Currency substitution or dollarization has been analyzed extensively in the previous literature both in the least developed and developing economy. Earlier works on currency substitution demonstrated on the factor influences foreign currency demand instead of local currency. Agnor and Khan (1996) Examines the demand for domestic currency and foreign currency in developing countries by using the dynamic currency substitution model. The findings indicated that foreign interest rate and the expectation of exchange rate devaluation are an important factor to hold domestic currency or foreign currency. (Lebre de Freitas, 2004), Metin-Özcan and Us (2007) and Bahmani-Oskooee and Techaratanachai (2001) Also agree with Agnor and Khan (1996). Lebre de Freitas, (2004) and Vieira et al. (2012) contends that the dollarization is a rational response to the uncertainty of inflation in the future. However, the temporary increase of inflation might has the permanent effect of the use of foreign currency. The investigation on dollarization in Turkey economy by using vector auto regression model, the empirical evidence suggests that dollarization is mostly influenced by macroeconomic imbalance which can be measured by exchange rate depreciation volatility, inflation volatility and expectation of uncertainty Metin-Özcan and Us (2007). Schwartz and Skidelsky (2004) And Yeyati (2006) also highlight the cause of currency substitution is mainly influenced by the instability of financial risk and exchange rate uncertainty. More precisely, the empirical evidence based on monthly data provided by Neanidis and Savva (2009) examines the determinants of fidollarization in transition economies from short-run perspective, the empirical study reveals that the short-run effect of domestic currency depreciation on the foreign currency substitution is exacerbated in high-dollarization countries, and interest rate differentials effect the short-run dollarization.

Boyer and Kingston (1987), Engel (1987) and Uribe (1997) highlights that in the small opened economies, the real domestic variables can be effected by the foreign inflation and exchange rate, when the country takes foreign currency or foreign asset into account. Carranza et al. (2009) Using a panel data of more than hundred countries with the different degree of dollarization to investigate the exchange rate and inflation dynamics in the dollarized economy. The result revealed that the countries with higher dollarization shown higher inflation pass-through and the larger currency depreciation tend to generate more negative impact on the pass-through coefficient. Samreth (2011) and Sok Heng et al. (2012) investigates on the exchange rate movement in a dollarized economy in Cambodia, the finding analysis suggests

Figure 1: Foreign Currency Deposit/ M2



Source: International Monetary Fund (IMF)

that dollarization induces the depreciation of the Riel[1] And be a constraint on poverty reduction in Cambodia as its effect on the living standard of those low-income family who earns in domestic currency.

The high degree of currency substitution volatilizes the macroeconomic stability and impinging on the central bank to conduct the monetary policy. Cowan (2003) And Yeyati (2006) contents that the monetary transmission instrument may not work properly to pursue the stability of monetary policy in dollarized economies. There is some empirical evidence suggests that the domestic currency loses its value in response to higher inflation and depreciation of foreign currency due to lack of confidence in the domestic currency. That situation would change the good trader become the foreign currency trader as pointed by Agnor and Khan (1996), Berg, A., Berg and Borensztein (2000), Metin-Özcan and Us (2007), Chang (2006) and Airaudo (2014). In addition, Marcelin and Mathur (2016) contends that in the heavily dollarized economy, the sharp devaluation of domestic currency and financial liabilities shift toward foreign currency substitution, therefore exacerbate pressure on the exchange rate and domestic interest rate eventually.

Even though, many literatures had found that macroeconomic instability was mainly influenced by currency substitution and be an obstacle to the central bank to conduct monetary policy. It is difficult to conclude that currency substitution makes monetary policy less or inefficiency. De Nicoló et al. (2003) suggested that dollarization promotes financial deepening in the high dollarized economy. Berkmen and Cavallo (2010) investigates the causal relationship between exchange rate policy and liability dollarization, the finding suggests that a country with high liability dollarization tends to be more actively involved in exchange rate stabilization which supports the study by Soto (2009) found that dollarization stabilizes domestic price and thus lead to higher economic growth to Ecuador. Reinhart et al., (2014) affirm that the high degree of currency substitution is not a major obstacle to monetary control or disinflation.

1 Riel is Cambodia national currency.

4. ANALYTICAL FRAMEWORK AND RESULT

4.1 Data

This study uses panel data covering the period between 1995 and 2015, from the International Monetary Fund (IMF) and the annually monetary statistic report by the central bank of five ASEAN countries (Cambodia, Indonesia, Laos, Philippine, and Vietnam). According to the definition of currency substitution or dollarization given by the IMF, the degree of dollarization (FCD) can be measured by the proportion of foreign currency deposit to broad money, INF is the rate of inflation and EXC is real exchange rate of local currency per a unit of US dollar.

4.2 Panel Unit Root Tests

Prior analyze the association between variables, it is necessary to test for the stationarity of the data. In this study, we used a variety of panel unit root test approach such as: LLC (Levin, et al. 2002) and IPS (Im, et al. 2003) which are used intensively in panel analysis, the ADF-Fisher Chi-square Maddala and Wu (1999), PP-fisher Chi-square Choi (2001). The (LLC) bases on pooled data and it allows for heterogeneity in the intercept term. Meanwhile, IPS was developed to rectify the restrictive of LLC on the homogeneous nature of autoregressive unit root under the alternative hypothesis by adopting a heterogeneous unit root under the alternative hypothesis. The null hypothesis of all these tests are that there is a unit root, while the alternative hypothesis indicates there is no unit root. Let us consider the autoregressive model below:

$$\Delta y_{it} = \alpha_i + \beta_i y_{it-1} + \sum_{j=1}^{q_i} \delta_{ij} \Delta y_{it-j} + \varepsilon_{it} \quad (1)$$

Where =1, 2……N, represent countries in the panel; t=1, 2….T, refer to the period; β_i are the autore δ gressive coefficient,q_i is the number of lag, ε_{it} is represented the error term and assumed to be independent with normal distributed random variable and finite unit specific variance σ_i^2 . The Im, Pesaran, and Shin test is also base on the autoregressive model, but the IPS test allows auto

Table 1: Panel unit root testing result: Series in level

Test	FCD		INF		REX	
	Intercept	Trend	Intercept	Trend	Intercept	Trend
LLC	0.16597 (0.5659)	−1.91552 (0.0677))	−4.48241 (0.5400)	−1.00344 (0.1578)	−1.94633 (0.258)	−0.24770 (0.40220
IPS	0.69112 (0.7553)	−0.96894 (0.1663)	−0.41010 (0.2003)	−3.30855 (0.3244)	−2.67317 (0.4038)	−0.56645 (0.2855)
ADF	7.77627 (0.6507)	2.17974 (0.1146)	2.9762 (0.5429)	2.9 472 (0.4013)	2.5712 (0.1215)	12.5621 (0.2492)
PP	5.83225 (0.8292)	19.6366* (0.0329)	36.4040* (0.03051)	34.2114* (0.0302)	75.4148** (0.0000)	22.6334* (0.0122)

* and ** indicates significant level at 5% and 1% respectively. The value in brackets are the corresponding P value

Table 2: Panel unit root testing result: Series in first difference

Test	ΔFCD		ΔINF		ΔREX	
	Intercept	Trend	Intercept	Trend	Intercept	Trend
LLC	−9.18370**(0.0000)	−7.42998** (0.0000)	−13.3481** (0.0000)	−12.2170** (0.0000)	−4.05877** (0.0000)	−3.32558** (0.0004)
IPS	−8.39903** (0.0000)	−5.94156** (0.0000)	−11.0165** (0.0000)	−11.2667** (0.0000)	−3.87938** (0.0001)	−2.71123* (0.0081)
ADF	71.0081** (0.0000)	57.3258** (0.0000)	94.8284** (0.0000)	80.1548** (0.0000)	32.9836** (0.0003)	21.9924* (0.0151)
PP	119.137** (0.0000)	71.6300** (0.0000)	554.797** (0.0000)	95.9604** (0.0000)	35.1822** (0.0001)	30.7745** (0.0006)

* and ** indicates significant level at 5% and 1% respectively. The value in brackets are the corresponding *P* value

regressive coefficient β_i to vary across cross-section units and its test statistic is based on the average of Augment Dicky-Fuller statistic across the groups. The IPS statistic is written as below:

$$Z_{\bar{t}}=\sqrt{N}(\bar{t}-E(\bar{t}))/\sqrt{Var(\bar{t})} \quad (2)$$

Denote, $\bar{t}=1/N\sum_{i=1}^{Ni=1} t_{\rho i}$ $E(\bar{t})$ and $Var(\bar{t})$ are mean and variance of individual specific t_{pi} statistic respectively. The Fisher-PP and Fisher-ADF test assume that the individual unit root process across cross-section are units Maddala and Wu (1999), Choi (2001). The Fisher-ADF statistic test can be written as follow:

$$\gamma=-2\sum_{i=1}^{n}\log_e\pi_i\sim x^2 2N \text{ d.f} \quad (3)$$

Where N and π_i represent ρ-value for the test i and number of sample respectively. Choi (2001) suggested Fisher-PP test statistic:

$$Z=\frac{1}{\sqrt{N}}\sum_{i=1}^{n}\delta^{-1}(\pi_i)\sim N(0,1) \quad (4)$$

Where δ^{-1} is the inverse of the standard normal cumulative distribution.

Tables 1 and 2 reported the various of panel unit root test, which indicates that all variables are not stationary at the level I(0). However, these variables become stationary after transformed into the first difference I(1).

4.3. Panel Cointegration Test

The unit root testing result found that the variables are non-stationary at the level and they are integrated of order one. To examine the long-run cointegrating relationship among the set of variables, this study applied the Pedroni Residual Cointegration Tests. Pedroni (2004) As it allows for heterogeneity across an individual member of the panel. The equation for Pedroni cointegration test can be written as below:

$$FCD_{it}=\alpha_i+\partial_{it}+\beta_i INF_{it}+\beta_2 REX_{it}+\varepsilon_{it} \quad (5)$$

Where i=1, 2……N, represent countries in the panel; t=1, 2….T, refer to the period. The parameter α_i and ∂_i are country and time fix effect respectively.

Table 3: Pedroni Cointegration test result

Test	Without trend	With trend
Panel v-Statistic	0.139223	0.564646
Panel rho-Statistic	−0.136046	−1.052168
Panel PP-Statistic	−4.50263**	−4.19586**
Panel ADF-Statistic	−6.51793**	−4.19586**
Group rho-Statistic	−0.76456	0.468549
Group PP-Statistic	−4.41985**	−2.62678**
Group ADF Statistic	−5.13443**	−2.59217**

The null hypothesis is that the variables are not cointegrated. ** is the level of significant at 1%

Table 4: Panel cointegrated regression results

Independent variables	FMOLS	DOLS
INF	0.348*	0.0019**
	(0.047)	(0.0134)
REX	0.1729*	2.1568*
	(0.0421)	(0.0393)
R-square	0.8689	0.4188

*and **is significant level at 5% and 1% respectively. The value in brackets are the corresponding P value

Pedroni (2004) Suggested that there is two type of Panel Cointegration Test: Type 1, based on the within-dimension approach, includes four statistics such as Panel v-Statistic, Panel rho-Statistic, Panel-PP Statistic and Panel ADF-Statistic. Type 2, based on the between-dimension approach or (Group test) such as Group rho Statistic, Group PP-Statistic, and Group ADF Statistic. The result of panel cointegration testing is reported in Table 3 with the trend and without trend. The majority of testing statistic rejected the null hypothesis of no cointegration, that means the variables are cointegrated.

4.4. Panel Long-run Elasticity

Since all variable is cointegrated, we can estimate the associated long-run cointegration parameter by employing the FMOLS and DOLS. Both of this technique can deal with endogeneity and serial correlation problem (Pedroni, 2004). The panel FMOLS estimator is performing under following equation:

$$\hat{\beta}=\left[\sum_{i=1}^{N}\sum_{t=1}^{T}(X_{it}-\bar{X}_i)(X_{it}-\bar{X}_i)'\right]^{-1}\left[\sum_{i=1}^{N}\left(\sum_{t=1}^{T}(X_{it}-\bar{X}_{it})\hat{Y}_{it}-T\Delta_{\varepsilon\mu}\right)\right] \quad (6)$$

Table 5: Panel causality test result

Independent variable	Dependent variable		
	DFCD	DINF	DREX
DFCD	-	5.4541*(0.0484)	0.85161 (0.6532)
DINF	8.9748* (0.0113)	-	6.2193*(0.0121)
DEXC	11.1316* (0.0038)	2.5046 (0.2858)	-
ETC(-1)	−0.0006* (0.0432)	−0.0107** (0.0016)	−0.3042 (0.1738)

* and ** indicates significant level at 5% and 1% respectively. The value in brackets are the corresponding P value

Where $\hat{Y}_{it}$ is the endogeneity correlation term, and $\Delta\varepsilon\mu$ is the serial correlation correction term. The DOLS equation can be written in this form:

$$Y_{it}=\alpha_i+\beta_i X_{it-1}+\sum_{j=q_1}^{q_2} C_{ij}\Delta X_{it+j}+\mu_{it} \quad (7)$$

Where q_2 is the maximum lead length, q_1 is the maximum lag length, ΔX_{it+j} eliminates the effect of endogeneity of X_{it}, and μ_{it} is an error term. The result of FMOLS and DOLS are provided in Table 4, both FMOL and DOLS indicate that inflation rate has a significant positively effect on currency substitution in the long-run in Southeast Asian. The coefficient of independent variable can be considered as a long-run elasticity to dependent variables. The elasticity of inflation is 0.348 and 0.0019, suggests that increasing on inflation rate increases currency substitution in the domestic economy. The elastic of real exchange rate with respect to the currency substitution is 0.1729% and 2.1568%, which also have a positive impact on currency substitution in the long-run. This empirical result confirms the existence literature by Agnor and Khan (1996), Lebre de Freitas (2004), Metin-Özcan and Us (2007), Bahmani-Oskooee and Techaratanachai (2001), Lebre de Freitas (2004) and Vieira et al., (2012).

4.5. Panel Causality Test

Once again, the variables were jointly cointegrated, and there exists a positive long-run relationship on currency substitution in Southeast Asia. The next step performed is panel causality testing based on VECM to examine the causal relationship between variables. Engle and Granger (1987) Suggested two-step as follow: The first step is to estimate the long-run parameter in equation (6), then obtain the estimated residual (the error correction term (hereafter is ECT). In the second step, we estimate the panel Granger causality which includes the dynamic error correction that can be formulated as below:

$$\Delta FCD_{it}=\theta_{1j}+\sum_k \theta_{1ik}\Delta FCD_{it-k}+\sum_k \theta_{2ik}\Delta INF_{it-k}+\sum_k \theta_{3ik}\Delta REX_{it-k}+\varphi_{1i}ECT_{it-1}+\mu_{1it} \quad (8)$$

$$\Delta INF_{it}=\theta_{2j}+\sum_k \theta_{4ik}\Delta FCD_{it-k}+\sum_k \theta_{5ik}\Delta INF_{it-k}+\sum_k \theta_{6ik}\Delta REX_{it-k}+\varphi_{2i}ECT_{it-1}+\mu_{2it} \quad (9)$$

$$\Delta REX_{it}=\theta_{3j}+\sum_k \theta_{7ik}\Delta FCD_{it-k}+\sum_k \theta_{8ik}\Delta INF_{it-k}+\sum_k \theta_{9ik}\Delta REX_{it-k}+\varphi_{3i}ECT_{it-1}+\mu_{3it} \quad (10)$$

Where Δ is first difference and k is lag length determined by the Swartz Information Criterion, ECT_{it-1} is the lag error correction term, φ_i is the adjustment coefficient, and μ_{it} is the serial uncorrelated disturbance term. We applied the lag length selection based on the Schwarz Bayesian Criterion and lag 1 is the optimal lag structure for the estimation. The significant of causality result is determined by the Wald F-test. As reported in Table 5, it is evident that in the short-run, there is a bidirectional relationship between inflation rate and currency substitution, whereas there exists a unidirectional relationship between real exchange rate and currency substitution. Regarding the Error Correction Term, it is statically significant <5% level, when FCD and INF as dependent variables with the speed of adjustment of−0.0006 and−0.0107 respectively.

5. CONCLUSION

This study investigates the relationship between inflation, real exchange rate, and currency substitution by using the panel VECM. The data was picked up from five ASEAN countries which experienced economic uncertainty and economic instability during Asian financial crisis in 1997. Some of these countries has been listed as the highest dollarized economy in the world (Cambodia and Laos). The Pedroni cointegration suggests that there exists the association between variables. The result from the Fully Modified OLS and the Dynamic OLS reveals that both inflation rate and the real exchange rate has a positive and significantly impact on the currency substitution in the long-run. It is meaning that economic uncertainty and economic instability lead to the loss confident of holding domestic currency in Southeast Asia economies in the long run. Moreover, the evidence based on panel causality testing reveals that there exists the bidirectional relationship between inflation rate and currency substitution and the unidirectional relationship between real exchange rate and currency substitution in Southeast Asia economies.

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