【 研究ノート 】

Hysteresis Effects of Currency Substitution*

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Abstract

This paper investigates whether the hysteresis effects of currency substitution exist in Indonesia and Thailand using the ARDL model.　As a result, we show that there exist the hysteresis effects in currency substitution in these countries.　These results state that it is very important to make consideration the existence of currency substitution for selecting the optimal exchange rate system.

Keywords : Currency substitution, Hysteresis effects.
JEL classification numbers : C22, F31, F41.

1.　Introduction

The financial crisis, which began in 2007 in the US subprime market, has spread quickly to a number of advanced and emerging countries and the spillovers to the real economy have been severe.　In reaction to these matters, each country has employed various monetary relaxation policies.　However, the effectiveness of these policies is subject to currency substitution.

Currency Substitution means the phenomenon that domestic residents use foreign currency as a means of payments.　It is a common feature of high inflation economies such as Latin America countries, former Soviet Union transition countries and some Asian countries.　In condition of high inflation, the public wants to protect from high costs of using and holding domestic currency, and looks for alternatives, for example, the US dollar.[1][2]

There are little studies on currency substitution in Asian countries except for Sharma *et al.* (2005) and Kumamoto and Kumamoto (2008), however, it is said that currency substitution has progressed in Asian countries.　Therefore, analyzing currency substitution in Asian countries seems to be meaningful.

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[1]　See Giovannini and Turtelboom (1994) for surveys on currency substitution.

[2]　There are many previous studies on currency substitution in Latin America countries.　For example, Ortiz (1983) study currency substitution on Mexico, Ramirez-Rojas (1985) on Mexico, Argentina, and Uruguay, Fasano-Filho (1986) on Argentina, Rojas-Suárez (1992) on Peru, Rogers (1992) on Mexico, Clements and Schwartz (1993) on Bolivia, Miriam and Turner (2003) on Mexico, and Kumamoto and Kumamoto (2003a) on Argentina, Bolivia, Chile, Paraguay, Peru and Uruguay.

　And currency substitution in the transition countries is investigated by Mongardini and Mueller (2000) on Kyrgyz Republic.

Theoretical and empirical previous studies show that currency substitution could have significant effects on the independence of monetary policy and stability of exchange rate under a flexible exchange rate system.

In addition, currency substitution can affect the choice of intermediate targets of monetary policy. On the view that money is targeted because it determined the price level through transaction demand for money, currency substitution implies that foreign currency is part of the relevant concept of money.[3]

On the other hand, under a fixed exchange rate system, currency substitution could have significant effects on its sustainability. For example, using cash-in-advance model, Giovannini (1991) investigates the fluctuation of foreign exchange reserves in the fixed exchange rate system and show that higher currency substitution can lead to a higher variability of foreign exchange reserves.

Moreover, it is said that there exists an asymmetry in currency substitution, that is to say, the degree of currency substitution increases rapidly when macroeconomies are destabilized, while it decrease only slightly or does not decrease after macroeconomies are stabilized. This hysteresis phenomenon is known as "*ratchet effects*" in currency substitution.[4]

The purpose of this paper is to investigate empirically whether there are the ratchet effects or the hysteresis effects in currency substitution in Indonesia and Thailand using currency substitution-type money-in-the-utility-function model by incorporating network externalities established by Kumamoto and Kumamoto (2008).

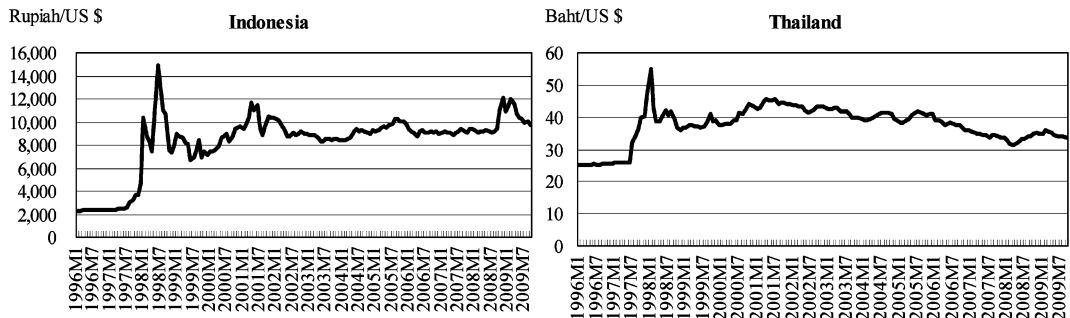Asian currency crisis occurred in 1997 had more severe ramifications in Indonesia and

Figure 1　Nominal Exchange Rates

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[3]　For these discussions, see Baliño *et al*. (1999).

[4]　There are many empirical studies investigating the ratchet effects in currency substitution. For example, Mongardini and Mueller (2000) study ratchet effects in currency substitution for Kyrgyz Republic, Kumamoto and Kumamoto (2003b) on Latin America countries (Argentina, Bolivia, Mexico, Paraguay, Peru and Uruguay), Us (2003) on Turkey, and Kumamoto and Kumamoto (2008) on Indonesia empirically using an autoregressive distributed lag (henceforth abbreviated ARDL) approach. Cuddington *et al*. (2002) incorporate network externalities into the money-in-the-utility-function model and estimate it by generalized method of moments (GMM) to show that network externalities are insignificant in explaining post-stabilization currency substitution patterns in Bolivia. Kumamoto and Kumamoto (2005) investigate ratchet effects in Mexico based on vector error correction model (VECM) approach.
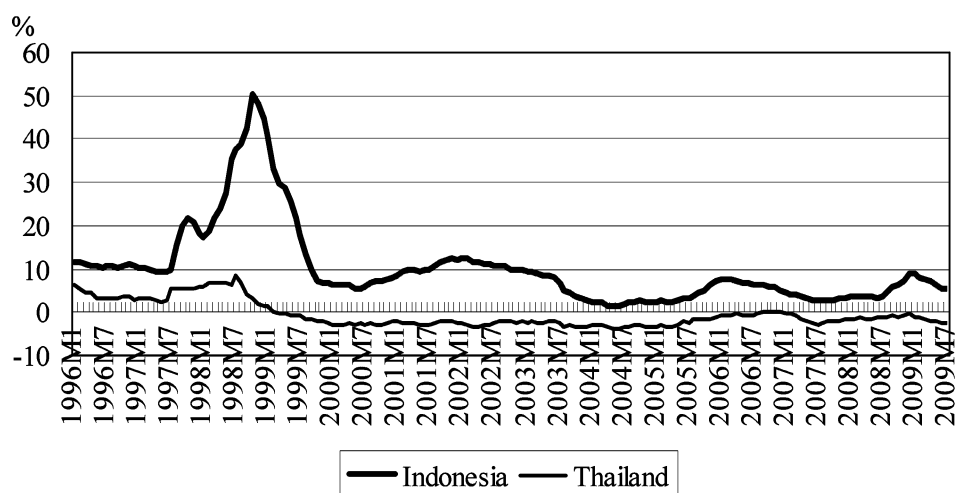
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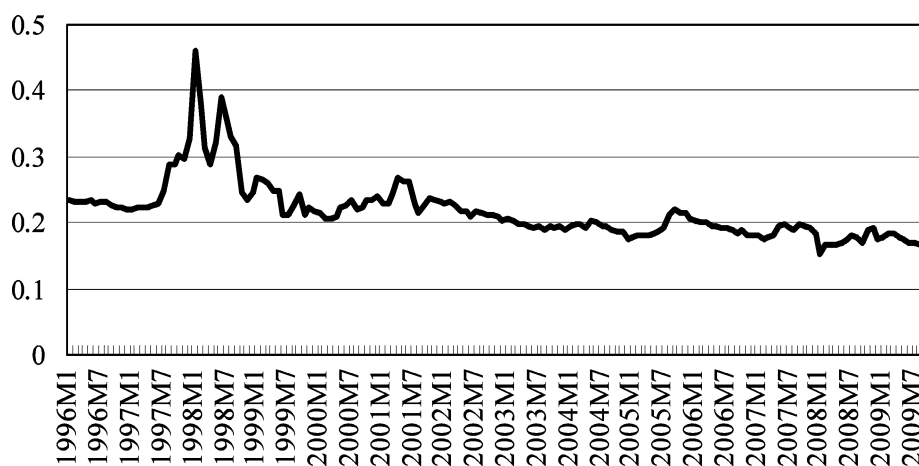**Figure 2**　Nominal Interest Rate Differential

Figure 3　The Ratio of Foreign Currency Deposits to Total Deposits in Indonesia
(Currency Substitution)

Thailand than in other countries in the region. Figure 1 to 3 show nominal exchange rate, nominal interest rate differential, and the ratio of foreign currency deposits to total deposits. From Figure 1, we can see that each nominal exchange rate (market rate at the end of periods) per US dollar soared dramatically from the beginning of 1997 to post-Asian currency crisis. Figure 2 shows that nominal interest rate differential between each market rate (three-months deposit rate) and US long-term government bond yield also expanded. Under these macroeconomic destabilization, the ratio of foreign currency deposits had risen. However, macroeconomic and financial stability have been restored since mid-1999. For example, each nominal exchange rate were 9,681 Rupiah and 33.5 Baht per the US dollar in September, 2009 and each nominal interest rate differential were about 5.4 and −2.6 percent in July, 2009. Regardless of these macroeconomic stability the ratio of foreign currency deposit to total

deposit has been remained constantly from about 17 to 25 percent in Indonesia since mid-1999. Data shown in Figure 1 and 2 are from IMF's *International Financial Statistics* (CD-ROM), and data on Figure 3 is from Bank Indonesia (http://www.bi.go.id/web/en).

　　The remainder of this paper is organized as follows. In section 2, we present the econometric model. Section 3 investigates empirically whether the ratchet effects or the hysteresis effects in currency substitution exist in Indonesia and Thailand. Section 4 concludes.

2.　Model Specification

　　We use the following ARDL (p, q_1, q_2) model specified by Kumamoto and Kumamoto (2008):

$$cs_t = \mu + \sum_{i=1}^{p} \alpha_i cs_{t-i} + \sum_{j=0}^{q_1} \beta_{1j}(i_{t-j} - i_{t-j}^*) + \sum_{j=0}^{q_2} \beta_{2j}\ Hysteresis_{t-j} + \varepsilon_t, \tag{1}$$

where cs_t denotes the degree of currency substitution, i_t and i_t^* are nominal interest rates on bonds issued at the end of period t, $Hysteresis_t$ is defined by k_t which is the variable that denotes the persistence effect in currency substitution, μ is a constant term and ε is a disturbance term at t.[5]

　　We rewrite equation (1) more compactly as

$$A(L,\ p)cs_t = \mu + B_1(L,\ q_1)(i_t - i_t^*) + B_2(L,\ q_2)\ Hysteresis_t + \varepsilon_t, \tag{2}$$

where L is a lag operator, and $A(L,\ p) = 1 - \alpha_1 L - \cdots - \alpha_p L^p$, $B_i(L,\ q_i) = \beta_{i0} + \beta_{i1}L + \cdots + \beta_{iq}L^{q_i}$, ($i = 1, 2$) are polynomials in the lag operator L.

　　After some rearrangements, we get the error correction model (henceforth abbreviated ECM) associated with the ARDL (p, q_1, q_2):

$$\Delta cs_t = \beta_{10}\Delta(i_t - i_t^*) + \beta_{20}\Delta Hysteresis_t - \sum_{j=1}^{p-1} \alpha_i^* \Delta cs_{t-j} - \sum_{j=1}^{q_1-1} \beta_{1i}^* \Delta(i_{t-j} - i_{t-j}^*)$$
$$- \sum_{j=1}^{q_2-1} \beta_{2i}^* \Delta(Hysteresis_{t-j}) - A(1,\ p)EC_{t-1} + \varepsilon_t, \tag{3}$$

where EC_t is the error correction term defined by $EC_t = cs_t - \{1/A(1,\ p)\}\mu - \{B_1(1,\ q_1)/A(1, p)\}(i_t - i_t^*) - \{B_2(1,\ q_2)/A(1,\ p)\}Hysteresis_t$. α_i^* and β_{ij}^* are given by

$$\alpha_1^* = \alpha_p + \alpha_{p-1} + \cdots + \alpha_3 + \alpha_2$$
$$\alpha_2^* = \alpha_p + \alpha_{p-1} + \cdots + \alpha_3$$
$$\vdots$$
$$\alpha_{p-1}^* = \alpha_p,$$

and

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[5]　In this paper, we suppose that the knowledge of using foreign currency as a means of payments at period t is represented by the maximum degree of currency substitution for the past one year;

$$k_t = \max_j cs_j,\ j = t-12,\ \cdots,\ t-1.$$

This assumption means that knowledge of using foreign currency is proportional to the largest amount of the currency substitution in the past, however, the economy as a whole forgets how to use the foreign currency to purchase goods as time passes.

$$\beta_{i1}^* = \beta_{iq_i} + \beta_{iq_{t-1}} + \cdots + \beta_{i3} + \beta_{i2}$$
$$\beta_{i2}^* = \beta_{iq_i} + \beta_{iq_{t-1}} + \cdots + \beta_{i3}$$
$$\vdots$$
$$\beta_{iq_{t-1}}^* = \beta_{iq_i}, \quad i = 1,\ 2.$$

The analytical procedure is as follows : first, we determine the lag length of equation (2) based on the Schwarz Bayesian Criterion (SBC), and estimate equation (1); next, we estimate the long-run coefficients based on the above results; finally, we require the short-run coefficients by estimating the ECM (3).

3. Empirical Results

The regression results are presented in Table 1.[6] The table presents the implied long-run estimates and the ECM representation of the short-run estimates. The result of determination of the optimal lag length empirically by maximizing the SBC leads to the ARDL (1, 0, 1) model for both countries.

From our estimation results, the degree of currency substitution in Indonesia and Thailand, had not been affected significantly by the reduction of interest rate differential, $i - i^*$, while the persistence effect in currency substitution, *Hysteresis*, had the expected sign and a significant effect on the degree of currency substitution in our sample period. These findings imply that in Indonesia households do not respond to reduction in nominal interest rate differential and

Table 1 Regression Results Using ARDL Procedure

Long-run Coefficients

Variables	Indonesia	Thailand
$i - i^*$	−0.102　(0.407)	−0.148　(0.125)
Hysteresis	0.478**　(0.236)	0.194***(0.012)
Const.	0.523***(0.153)	0.287***(0.012)

Short-run Coefficients

Variables	Indonesia	Thailand
$\Delta(i - i^*)$	−0.022　(0.090)	−0.051　(0.042)
Δ*Hysteresis*	0.513***(0.107)	0.237***(0.034)
Const.	0.112***(0.058)	0.098***(0.022)
EC (−1)	−0.215***(0.072)	−0.341***(0.076)
SEE	0.012	0.003
$\bar{R}^2$	0.193	0.368
DW	1.721	2.031
F-statistic	9.131	20.710

Notes : Sampling period monthly 2000M1 to 2008M8. *** and ** indicate significant at the 1% and 5% levels, respectively. Standard errors are given in parentheses.

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[6] These results were computed using the *Microfit 4.1* software for Windows, designed by Pesaran and Pesaran (1997).

continue to use foreign currency as a means of payments only because foreign currency is pronounced in the country.　These results are evidence of the hysteresis effects in currency substitution.[7]　The ECM coefficient, $EC(-1)$, is negative and highly significant.　F-statistic is also highly significant and the Durbin-Watson statistic does not indicate any sign of residual serial correlation.

4.　Conclusions

In this paper, we used the ARDL model to investigate whether the ratchet effects or the hysteresis effects in currency substitution exist in Indonesia and Thailand.　As a result, we showed that there exist the hysteresis effects in currency substitution in these Asian countries.

This result states that it is very important to make consideration the existence of currency substitution for selecting the optimal exchange rate system.　Therefore, we would need to investigate what type of the exchange rate system is desirable under this circumstance.

Moreover, it is interesting to investigate whether the hysteresis effect of currency substitution exist after the financial crisis.　These tasks are our future research direction.

Appendix.　Data Description

Due to the availability of data, sample periods are from January 2000 to August 2008 with monthly data.

The appropriate data on nominal balances of domestic money, M_t, or foreign money, M_t^*, would be a sum of residents' holdings of nominal balance of domestic money and deposits denominated in domestic money, or a sum of residents' holdings of nominal balance of the US dollar and deposits denominated in the US dollar, respectively.[8]　Unfortunately, it is difficult for us to collect data on holdings of nominal balance of the US dollar.　Therefore, we use data on holding of nominal balance of deposits denominated in the US dollar as a proxy for nominal balance of US money.[9]　To make correspond to this, we use data on holding of nominal balance of domestic deposit as a proxy for nominal balance of domestic money.　Data above are from Bank Indonesia (http://www.bi.go.id/web/en) for Indonesia and Bank of Thailand (http://www.bot.or.th/) for Thailand.

Data on nominal interest rates on domestic and foreign bonds are three-months deposit rate in each currency and US long-term government bond yield, respectively.

Data on nominal exchange rates are Rupiah and Baht per US dollar market rate at the end of period.　Data above are from IMF's *International Financial Statistics* (CD-ROM).

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[7]　It is necessary that asymmetric phenomenon is checked to verify the ratchet effects in currency substitution.　In other words, if the currency substitution increases when $\Delta k > 0$, and it does not decrease when $\Delta k < 0$, we can interpret that these results are evidence of the ratchet effects in currency substitution. However, we cannot observe the asymmetric phenomenon.

[8]　Residents mean the non-financial incorporated enterprises and households excluding the private banks, the central bank and the government.

[9]　By the availability of data, we can not discriminate whether the residents hold the deposits denominated in the US dollar as a means of payments for domestic transactions or for foreign transactions. Therefore, we might overestimate the degree of the currency substitution.

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