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# Money Demand Stability under Currency Substitution: Some Recent Evidence

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# Money Demand Stability Under Currency Substitution: Some Recent Evidence

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**Abstract:** This study deals with the issue of independent monetary policy and the stability of the domestic money demand function in the presence of currency substitution and capital mobility in five Asian economies. It is argued that money demand will be less stable and more difficult to control in the presence of international variables. The money demand function is derived using the portfolio balance approach. The results from the cointegration analysis reveal that capital mobility and currency substitution are significant factors in the domestic money demand equations for Indonesia, Korea, Malaysia, Singapore, and Thailand. The results also show that the US dollar, Japanese yen, and British pound are used significantly by domestic residents

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together with the domestic currency in Indonesia, Korea, Singapore and Thailand. However, in the case of Malaysia, despite the existence of currency substitution for the US dollar and Japanese yen, there is no evidence of currency substitution between the domestic currency and British pound. Therefore, for these countries to have an effective monetary policy, the monetary authorities should take into account the two international factors.

# I. Introduction

Once viewed as a pillar of macroeconomic models, the reputation of the demand function for real money balances has plummeted since the early 1980s. This development may be attributed to the destabilizing effects of financial innovation and deregulatory measures in many countries. These measures have changed the traditional payment patterns and have rendered the identification of the line between money and other liquid assets as all but impossible (Boughton, 1990). Despite these problems, there has been a renewed effort among economists to uncover the stable relationships in the money demand equation. This has been partly due to the rapid development in the cointegration literature, which has raised the possibility that models that combine a traditional steady-state function with a complex set of dynamics may be reasonably stable even over periods of substantial institutional change (Chowdhury, 1995).

A large number of papers have used cointegration analysis to examine the nature of the long-run money demand function in developed countries.[1] In contrast, very few studies have investigated the stability of the money demand function in the developing countries.[2] This study fills the gap in the literature by investigating the impact of international factors, measured by either capital mobility or currency substitution, on the stability of money demand in five Asian countries – Indonesia, Korea, Malaysia, Singapore and Thailand. The portfolio balance model is used to derive the money demand function and the cointegration analysis is employed to test whether domestic money demand is cointegrated with either the foreign interest rate or the expected depreciation rate of the home currency.

A consideration of money demand in these Asian open economies raises a number of issues not discussed in earlier studies. These relate to the appropriate rates of return that should be considered, as well as the currency denomination of the money stock.

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The availability of foreign currency denominated aassets for investment implies that the variety of assets available for portfolio diversification is wider. In the general Tobin-type model, where all relevant asset returns are included in every asset demand, the rate of return on foreign assets influences the demand for money. If foreign bonds are a relevant investment alternative, then their expected rate of return and the expected exchange rate appreciation should be included in the money demand equation (McKenzie, 1992). In addition, if foreign money is a relevant investment alternative, the rate of change of the exchange rate should also be included. The direct currency substitution literature that suggests portfolio shifts between domestic and foreign money focuses on the exchagne rate variable, while the capital mobility literature focuses on the foreign interest rate variable (McKinnon, 1982; Cuddington, 1983; Leventakis, 1993). If these variables turn out to be important in the money demand equation, their exclusion may lead the function to exhibit some parameter instability. Previous studies on money demand in these countries do not contain any reference to money demand in an open economy and to how open economy effects might influence the specification of the money demand equation. This study fills the void in the literature.

The paper is organized as follows. In Section II, the derivation of the money demand function based on the general portfolio model to incorporate both capital mobiity and currency substitution is discussed. The variables used in this study and the data sources are given in Section III. Section IV reports and analyses the estimation results. Finally, the paper ends with concluding remarks in Section V.

## II. Model Specification

The general portfolio balance model under two-country and four-assets is utilized in this paper. The model is extended from the original framework of three assets (domestic and foreign currencies are assumed to be perfectly substitutes) to cover the currency substitution factor by including the demand for foreign currency equation in the system. To outline the general framework, the aggregate demand functions for the corresponding assets can be described as functions of real wealth ($W/P$), real income ($y$) and the

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rates of return on each asset. Following Mizen and Pentecost (1996), we consider:

$$M/P = m(y, i, i^* + x, x, W/P)$$
$$m_1 > 0, m_2 < 0, m_3 < 0, m_4 < 0, m_5 > 0$$
$$B/P = b(y, i, i^* + x, x, W/P)$$
$$b_1 < 0, b_2 > 0, b_3 < 0, b_4 > 0, b_5 > 0$$
$$SM^*/P = n(y, i, i^* + x, x, W/P)$$
$$n_1 > 0, n_2 < 0, n_3 < 0, n_4 > 0, n_5 > 0$$
$$SB^*/P = f(y, i, i^* + x, x, W/P)$$
$$f_1 < 0, f_2 < 0, f_3 > 0, f_4 > 0, f_5 > 0$$
$$W = M + B + SM^* + SB^*$$

where *M*, *B*, *P*, and *i* denote the money supply, stock of bonds, price level, and the interest rate, respectively, an asterisk represents foreign country variables, S is the exchange rate, and *x* is the expected depreciation rate of the home currency. The expected rates of return of domestic and foreign bonds are the domestic interest rate and the foreign rate of interest adjusted for expected depreciation. The expected rate of return on foreign currency holding is the expected rate of depreciation of the domestic currency.

In the general portfolio balance model, where domestic and foreign money are assumed to be perfect substitutes, economic agents allocate their wealth among three financial assets: domestic money, domestic bonds, and foreign bonds. An economic agent's decision to hold a combination of assets depend on their expected rates of return. Therefore, the domestic money demand function should not only be explained by domestic variables but also the expected returns on foreign assets. As the model is extended by relaxing the assumption of perfect substitutability between domestic and foreign currencies, the expected depreciation rate of the home currency is included as another explanatory variable in the domestic money demand function. Domestic residents, in this framework, can also hold foreign currency in their portfolio.

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A distinction from the previous studies will be made here. Instead of looking at foreign variables as either 'rest-of-the world' or a two-country model, a third country will be added to the model. Since home residents are allowed to hold foreign as well as domestic money, it is up to the economic agents to decide which foreign currencies they want to hold in order to maximize their utility (returns). Following Cuddington (1983), Bergstrand and Bundt (1990) and Leventakis (1993), the extended model is as follows:

$$\ln(M/P)_t = c_0 + c_1 \ln y_t + c_2 i_t + c_3(i_t^* + x_t^*) + c_4 x_t^* + v_t \quad (1)$$

where an asterisk refers to foreign variable. The evidence of currency substitution is given by the coefficient of the expected depreciation rate of the domestic currency $c_4$, while capital mobility is captured by the rates of return on foreign bonds $c_3$. The coefficients, $c_3$ and $c_4$ which represent the effects of international variables on domestic demand for money, are expected to be negative based on the gross substitutability assumption, i.e., an increase in the rate of return of one asset will lead to an increase in quantity demanded for that asset and a reduction in demands for all other assets. Therefore, it is important to note that the sign restrictions on these coefficients are not a necessary condition if the assumption of gross substitutability does not hold. One of the advantages of the estimation equation derived from the portfolio balance model in Equation 1 is that it does not require that the variables directly measure the demand for foreign currency by home residents.[3]

In this study, as evidence for currency substitution, the long-run equilibrium relationship between domestic money demand and the expected rate of depreciation of the home currency is tested. The money demand function is expected to be more stable in the absence of currency substitution factors, i.e., when money demand and the expected depreciation rate are not cointegrated.

Note that Equation 1 cannot be estimated due to the possibility of high multicollinearity among the returns of domestic and foreign financial assets. Consider first the possibility of a collinearity problem

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between domestic interest rate ($i_t$ ) and foreign interest rate adjusted for expected depreciation ($i_t^* + x_t^*$), the two variables are highly correlated when there is high capital mobility. This possibility can be ruled out as the financial markets in this study are developing markets. There is a relatively high transaction cost associated with the movement of capital leading to a low degree of capital mobility. Additionally, in order to remove the collinearity between the rates of return of foreign bonds ($i_t^* + x_t^*$) and foreign money ($x_t^*$), the estimation equations can be rearranged such that domestic demand for money is a function of income, domestic interest rate, foreign interest rate, and the expected rate of depreciation. However, in doing so, the coefficient of the depreciation rate not only represents the effect of currency substitution but also captures in part the impact of capital mobility on the demand for money. The equations for estimation then can be expressed as:

$$\ln(M/P)t = b_0 + b_1 \ln y_t + b_2 i_t + b_3 i_t^* + b_4 x_t^* + u_t \qquad (2)$$

where $b_4 = (c_3 + c_4)$. The models investigated in this study can, therefore, be summarized as follows. Model Ia considers the United States as the foreign country. In this model the US interest rate and the expected depreciation rate of the domestic currency against the US dollar are added to the domestic money demand equation. The importance of Japan and the United Kingdom as foreign countries are examined in Model Ib and Ic, respectively.

Model Ia

$$\ln(M/P)_t = a_0 + a_1 \ln y_t + a_2 i_t + a_3 i_t^{\mathrm{us}} + a_4 x_t^{\mathrm{us}} + \varepsilon_t \qquad (3)$$

Model Ib

$$\ln(M/P)_t = a_0 + a_1 \ln y_t + a_2 i_t + a_3 i_t^{\mathrm{jp}} + a_4 x_t^{\mathrm{jp}} + \varepsilon_t \qquad (4)$$

Model Ic

$$\ln(M/P)_t = a_0 + a_1 \ln y_t + a_2 i_t + a_3 i_t^{\mathrm{uk}} + a_4 x_t^{\mathrm{uk}} + \varepsilon_t \qquad (5)$$

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Finally, in Model II, all three foreign countries are included.

Model II

$$\ln(M/P)_t = a_0 + a_1 \ln y_t + a_2 i_t + a_3 i_t^{us} + a_4 x_t^{us} + a_5 i_t^{jp} + a_6 x_t^{jp} + a_7 i_t^{uk} + a_8 x_t^{uk} + \varepsilon_t \quad (6)$$

## III. Data

This study uses quarterly data from 1980 to 1996 for Indonesia, Korea, Malaysia, Singapore and Thailand. The sample period ends before the start of the currency crisis which affected all five countries. The data are obtained from various issues of International Financial Statistics and the CD-ROM of the International Monetary Fund. The annual real income is converted to quarterly data using the interpolation method which fits a cubic spline curve to the input value, except for Korea where quarterly data is available. It is assumed that economic agents form their expectation following an AR(1) process, i.e.,

$$E_t(S_{t+1}) = gS_t + u_t \quad (7)$$

where $u_t$ is the error term with zero mean and constant variance. The expected rate of depreciation of the domestic currency is defined as $(E_t(S_{t+1}) - S_t)/S_t$where $S_t$ and $E_t(S_{t+1})$are the spot and expected future spot exchange rates at time t respectively. The interest rates used in this study are the three-month deposit rate and the treasury bill rate where it is available.

## IV. Estimation Results

The models are estimated using the Johansen cointegration procedure. Implementation of the Johansen procedure (Johansen, 1988; Johansen and Juselius, 1990) requires the determination of the order of integration of the variables enter the VAR model. This is determined using the Augmented Dickey and Fuller (1979, 1981) and Phillips-Perron [Perron (1988), Phillips and Perron (1988)] tests. Each

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individual time series is examined by estimating the following regression:

$$X_t = c_0 + b(t - T/2) + aX_{t-1} + v_t \qquad (8)$$

where $X_t$ is the series being considered. The null hypothesis of a unit root and no linear time trend, $H_0$:$a$=1,$b$=0, is tested using the test statistic $Z(_3)$ in levels and first differences. Moreover, four test statistics: $t_t$ , $t_u$ , $Z(t_t)$, and $Z(t_u)$, are used to test the null hypothesis $H_0$:$a$=1. The test statistics $t_t$ and $t_u$ are the Dickey-Fuller statistics and $Z(t_t)$ and $Z(t_u)$ are the Phillips-Perron statistics. In models where both a constant and a time trend are included, $t_t$ and $Z(t_t)$ are the test statistics used. For the model with only a constant mean, the test statistics $t_u$ and $Z(t_u)$ are used.

Table 1 reports the unit root test statistics for all series in level and first differences. Only two of the four test statistics, $t_t$ and $Z(t_t)$, are reported in order to save space. The results indicate that the expected depreciation rates of domestic currency ($x_t^{\mathrm{us}}$, $x_t^{\mathrm{uk}}$, and $x_t^{\mathrm{jp}}$) are all integrated of order zero, $I(0)$, regardless of the country considered. In addition, it is found that the log of real GDP ($\ln y_t$), the domestic interest rate ($i_t$), and the foreign interest rates ($i_t^{\mathrm{us}}$, $i_t^{\mathrm{uk}}$, and $i_t^{\mathrm{jp}}$) are all integrated of order one. For every country except Korea, the log of the real monetary aggregate, $\ln(M/P)_t$ , are found to be integrated of order 1 or $I(1)$. In the case of Korea, although the unit root hypothesis in levels is rejected at the 5% significance level, it cannot be rejected at the 10% level. Thus, it is concluded that the variable $\ln(M/P)_t$ for Korea is an $I(1)$ variable as well.

In order to investigate the impact of capital mobility and currency substitution on domestic money demand, the Johansen methodology (Johansen, 1988) is used to identify the number of cointegrating vectors among the variables in Equation 2.

The variables included in the money demand equation are the real monetary aggregate (M1), real GDP, the domestic interest rate, the foreign interest rate, and the expected depreciation rate. If these variables are cointegrated and the international factors are significant

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in the cointegrating vector, independent monetary policy practice is more difficult to accomplish and the domestic money demand is viewed as less stable. The effect of capital mobility on the domestic money demand is detected by the significance of coefficients $a_3$ and/or $a_4$. The significance of currency substitution as another explanatory variable in the money demand function is measured by $a_4$. The summary of the cointegration results and the hypotheses tests on different models are given in Tables 2–5.[4] The cointegration results are summarized in Table 2.5 Tables 3 and 4 show the hypotheses tests on Models 1 and 2, respectively; while Table 5A summarizes these results. The maximum eigenvalue and the trace test are the test statistics used to test for the significance of the number of cointegrating vectors. The null hypothesis of r vectors of cointegration against the alternative hypothesis of $r+1$ cointegrating vectors is tested using the maximum eigenvalue statistic. The alternative hypothesis is at least $r+1$ cointegrating vectors for the trace statistic.

### *Indonesia*

Table 2 reports the Johansen maximum likelihood estimation results for Indonesia. There are four cointegrating vectors in model Ia for Indonesia. This implies that there are long-run relationships among the domestic demand for money, US interest rate, and the expected depreciation rate of the domestic currency against the US dollar. Since multiple cointegrating vectors are found, it is ensured that the relationship between the real monetary aggregate and real GDP is positive in each of the cointegrating vectors. It is the only necessary sign restriction imposed in this framework. Moreover, the estimated coefficients of the US interest rate ($a_3$) and expected depreciation rate of the home currency ($a_4$) are tested and found to be significant at the 5% level. Thus, the two foreign variables are important in determining the long-run equilibrium money demand. Model Ib includes Japan as the foreign country. There are at least two cointegrating vectors in this model. Table 5 A reports the summary of hypothesis tests for the estimated coefficients of international variables ($a_3$ and $a_4$) which show that $a_4$ is significantly different from zero but $a_3$ is not at the 5% level of significance. Although the coefficient of the Japanese interest rate is insignificant, capital mobility and currency substitution factors are still valid in the long-run money demand equation because part of the effect of capital mobility is presented in terms of the

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expected depreciation rate. The UK interest rate and the expected depreciation rate of the home currency against the British pound are the two international variables in Model Ic. From Table 2, it is observed that there are at least two vectors of cointegration in this model. In addition, the results reported in Table 5A show the estimated coefficients $a_3$ and $a_4$ are both significant at the 5% level which suggest that there is evidence for the existence of capital mobility and currency substitution with respect to the UK variables in the long-run equilibrium money demand equation.

This leads to Model II where all three foreign countries, the United States, Japan, and United Kingdom, are included. Five cointegrating vectors are found using both maximum eigenvalue and trace statistics at the 5% level of significance. Table 4 reports the hypothesis tests of the estimated coefficients for each foreign country separately, i.e., $H_0$: $a_3 = a_4 = 0$ for the United States, $H_0$: $a_5 = a_6 = 0$ for Japan, and $H_0$: $a_7 = a_8 = 0$ for the United Kingdom. The results show that each of these null hypotheses can be rejected at the 5% level of significance. Moreover, each variable is also found to be individually significant at the 5% level. These results indicate that both capital mobility and currency substitution influence the determination of long-run money demand equilibrium. The domestic money demand is less stable under this condition since the foreign interest rate and the expected depreciation rate cannot be controlled by domestic authorities. As a result, it is more difficult for the policy makers in Indonesia to conduct an appropriate monetary policy and independent monetary policy is not guaranteed.

### *Korea*

The cointegration analysis for Korea is performed next and the summary of the estimation results is presented in Table 2. One cointegrating vector is identified in Model Ia. From Table 5A, the estimated coefficient of the US interest rate ($a_3$) is significantly different from zero at the 5% level but the estimated coefficient of the expected depreciation rate of the Korean won against the US dollar is significant only at the 10% level. When the United States is replaced by Japan as the foreign country in Model Ib, the results show the presence of two cointegrating vectors. For each vector, the sign restriction is satisfied, i.e., real money demand and real GDP are

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positively related. The results in Table 5A show that both estimated coefficients $a_3$ and $a_4$ are significant at the 5% level. This implies that there is a potential for currency substitution in Korea regarding the use of the Japanese yen. Beside, capital mobility is also found to be a crucial factor in the money demand equation as the Japanese interest rate is significant in the cointegrating vector.

In Model Ic, the UK is the foreign country. From Table 2, there are at least two vectors of cointegration in this model. The results reported in Table 3 indicate that the UK interest rate is not a significant variable but the expected depreciation rate is significant at the 5% level, i.e., $H_0$: $a_3 = 0$ cannot be rejected while $H_0$: $a_4 = 0$ is rejected. Note that this result does not imply that capital mobility is not a valid factor in money demand equation because part of the effect of capital mobility is captured by the expected depreciation rate variable.

There are at least five cointegrating vectors in Model II where all three foreign countries are considered. The results of hypothesis tests show that none of the foreign variables can be excluded from the cointegrating vectors. All estimated coefficients $a_3$, $a_4$, $a_5$, $a_6$, $a_7$ and $a_8$ are significant at the 5% level. The joint hypotheses $H_0$: $a_3 = a_4 = 0$, $H_0$: $a_5 = a_6 = 0$, and $H_0$: $a_7 = a_8 == 0$ are rejected individually at the 5% level as well. This implies that capital mobility and currency substitution factors are important for Korean policy makers to conduct monetary policy and the domestic money demand is less stable.

*Malaysia*

For Malaysia, the results for Model Ia show the presence of three cointegrating vectors. The sign restriction is satisfied in each of these cointegrating vectors. The estimated coefficients of the US interest rate ($a_3$) and the expected depreciation rate ($a_4$) are found to be significant at the 5% level. Thus, the domestic money demand is vulnerable to external shocks through variables influenced by the US economy and the US policy makers. In Model Ib, the US variables are replaced by Japanese variables. From the maximum eigenvalue statistic, the null hypothesis of zero cointegrating vectors cannot be rejected at the 5% level of significance. The trace statistic suggests

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that there are at most one cointegrating vector. However, at the 10% level of significance, both statistics indicate that there are two cointegrating vectors. Hence, it is concluded that there are two cointegrating vectors in this model. Moreover, the results reported in Table 5A show that the coefficients of the Japanese interest rate ($a_3$) and the expected depreciation rate of the home currency against the Japanese yen ($a_4$) are significantly different from zero at the 5% level. Thus, the two Japanese variables are significant in the cointegrating vectors and they have a critical impact on the determination of long-run money demand equilibrium. Model Ic considers the United Kingdom as the foreign country. The results in Table 2 suggest that there are two cointegrating vectors for this model. Also, the results of the hypothesis tests in Table 5A show that the UK interest rate and the expected depreciation rate of the domestic currency against the British pound are significant variables in the money demand equation. The two estimated coefficients, $a_3$ and $a_4$, are statistically significant at the 5% level.

Finally, all three foreign countries, the United States, Japan and United Kingdom, are included in Model II. There exist at least three cointegrating vectors in this model. The results of the hypothesis tests are reported in Table 4. All of the null hypotheses are rejected individually at the 5% significance level. From Table 5B, each of the estimated coefficients of international variables is significant except for the Japanese interest rate ($a_5$) and the expected depreciation rate of the home currency against the British pound ($a_8$). This implies that the capital mobility factor is crucial with respect to all three foreign countries. In Malaysia, the currency substitution factor, howeer, is present is terms of the US dollar and the Japanese yen but not the British pound.

### *Singapore*

For Singapore, the summary of the Johansen maximum likelihood estimation results is reported in Table 2. Once again, Model Ia shows that there are two cointegrating vectors. From Table 5A, the estimated coefficient of the US interest rate ($a_3$) is not statistically significant. However, the coefficient of the expected depreciation rate of the home currency ($a_4$) is significantly different from zero at the 5% level. Still capital mobility and currency substitution factors can

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affect the long-run money demand equilibrium through the expected depreciation rate.

In Model Ib, one cointegrating vector is present. The corresponding hypothesis test results reported in Table 5A show that both estimated coefficients of the Japanese interest rate ($a_3$) and the expected depreciation rate of the Singapore dollar against the Japanese yen ($a_4$) are statistically significant at the 5% level. Thus, there is evidence supporting the presence of capital mobility and currency substitution with respect to the Japanese variables for Singapore as well. For Model Ic, one cointegrating vector is found. Similar to what we have seen in Model Ia, the coefficient of the UK interest rate ($a_3$) is not significant but the coefficient of the expected depreciation rate against the British pound ($a_4$) is significant at the 5% level. The same conclusion can be made regarding the effects of capital mobility and currency substitution on the domestic money demand.

The more general model, Model II, is considered next. In this model, domestic residents are allowed to hold assets denominated in the domestic currency, US dollar, Japanese yen and British pound. It is concluded that there are at least four cointegrating vectors. The results of the hypothesis test presented in Table 4 show that variables of each of the foreign countries is significant at the 5% level. In addition, each of the estimated coefficients is also significantly different from zero. Both the capital mobility and currency substitution factors are valid variables, with respect to all three major currencies, in the long-run money demand equation. With the existence of international variables, the money demand is less stable in Singapore and independent monetary policy is not possible even under the flexible exchange rate system.

### *Thailand*

Table 2 reports the summary results of the tests for the number of cointegrating vectors for Thailand. The results show that there are two cointegrating vectors for Model Ia, one cointegrating vector for Model Ib, and three cointegrating vectors for Model Ic. Results from Table 5A show that for both the US and Japanese model, the foreign interest rates and expected depreciation of the home currency are

statistically significant. However, from Table 5A, the estimated coefficient of the UK interest rate is insignificant at the 5% level while the coefficient of the expected depreciation rate is statistically significant. Although the UK interest rate does not belong in the cointegrating vectors in Model Ic, capital mobility and currency substitution are crucial factors in the Thai money demand equation with respect to the three major economies.

Finally, Model II considers all three foreign countries, United States, Japan, and United Kingdom. From Table 2, at least four cointegrating vectors are found. The results of the hypothesis tests for Model II are reported in Table 4. All three joint hypotheses, $H_0$: $a_3 = a_4 = 0$, $H_0$: $a_5 = a_6 = 0$, and $H_0$: $a_7 = a_8 = 0$, are rejected individually at the 5% level of significance. Table 5B also reports that each estimated coefficient is found to be significant at the 5% level except for the coefficient of the UK interest rate. Hence, it is concluded from the last model that capital mobility and currency substitution are important factors in the money demand equation with respect to the US dollar, Japanese yen, and British pound for Thailand. The effectiveness of monetary policies can be affected by these two factors and the domestic money demand is less stable due to the transmission of international shocks.

## V. Conclusion

Using a portfolio balance approach, this study investigates the importance of international factors, measured by capital mobility and/or currency substitution, on the stability of the domestic money demand function in five Asian countries. In the presence of either capital mobility or currency substitution, it is argued that domestic money demand will become less stable. Consequently, independent monetary policy cannot be guaranteed by adopting the flexible exchange rate regime. In addition, the effectiveness of domestic monetary policy can be affected through the transmission of external shocks. The use of the portfolio balance model cannot completely distinguish between the effects of capital mobility and currency substitution. While the effects of currency substitution are captured by the expected depreciation rate of the home currency, capital mobility

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effects are presented in terms of either the foreign interest rates or the expected depreciation rate partially.

Based on the results obtained from this study, capital mobility and currency substitution are found to be significant factors in Indonesia, Japan, Korea, Malaysia, Singapore and Thailand. The existence of capital mobility is captured by the validity of foreign interest rate and/or the expected depreciation rate of the home currency in the long-run money demand equation. In the presence of currency substitution, the expected depreciation rate of the domestic currency must belong in the cointegrating vector, i.e., there must be a linear long-run relationship among variables in the specified money demand equation including the expected depreciation rate. As a result, it is impossible for these countries to conduct independent monetary policies. An increase in the US interest rate, for instance, can have an effect on the domestic money demand. And since these domestic countries do not have control over the US interest rate, the effectiveness of domestic monetary policies will be affected by US monetary policies. Moreover, because the domestic money demand is responsive to international variables, they become less stable as the transmission of external shocks is possible through capital mobility and currency substitution. It is important for monetary authorities to realize and take into account the effects of capital mobility and currency substitution in order to provide an effective monetary policy for their country.

We find that the US dollar, Japanese yen, and British pound are used significantly by domestic residents together with the domestic currency in Indonesia, Korea, Singapore, and Thailand. In Malaysia, despite the existence of currency substitution for the US dollar and Japanese yen, there is no evidence of currency substitution between the domestic currency and British pound. The paper, therefore, shows that in order for monetary authorities of these countries to conduct effective monetary policies, the two international factors need to be taken into account.

## Notes

[1]See Sriram (1999) for a detailed discussion of the literature.
[2]For a list of several studies in this area, see Calvo et al. (1992).

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[3]Such data are not available and almost impossible to accurately approximate, especially in the case of currency substitution in developing country.

[4]In order to conserve space, the results from the Johansen maximum likelihood estimation are not presented here, but are available on request.

[5]Implementation of the Johansen procedure requires that the lag length must be identified for the VAR model for each country. A system of 4-lag VAR models is tested down until the optimal lag length can be obtained using the likelihood ratio test, i.e., the order of the general unrestricted VAR model is reduced by one lag until the null hypothesis can be rejected at the 5% significance level by the likelihood ratio statistics. To conserve space, the results are not reported here but are available from the authors.

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# Appendix

## Table 1: Unit Root Test Statistics

| | ADF test | | Phillips-Perron test | | | |
|---|---|---|---|---|---|---|
| | Level | First difference | Level | | First difference | |
| Series | $\tau_t$ | $\tau_t$ | $Z(\Phi_3)$ | $Z(\tau_t)$ | $Z(\Phi_3)$ | $Z(\tau_t)$ |
| *Indonesia* | | | | | | |
| $\ln(M/P)_t$ | −2.07 | −6.30 | 3.46 | −2.60 | 20.15 | −6.35 |
| $\ln(y)_t$ | −1.15 | −7.95 | 1.13 | −0.88 | 35.34 | −8.39 |
| $i_t$ | −1.40 | −5.24 | 1.96 | −1.87 | 13.36 | −5.17 |
| $i_t^{us}$ | −2.47 | −7.52 | 3.81 | −2.65 | 28.60 | −7.52 |
| $i_t^{uk}$ | −1.97 | −6.88 | 2.54 | −2.22 | 23.61 | −6.87 |
| $x_t^{us}$ | −8.35 | −13.74 | 35.37 | −8.41 | 207.64 | −20.38 |
| $x_t^{uk}$ | −8.05 | −13.29 | 32.38 | −8.05 | 187.41 | −19.36 |
| $x_t^{jp}$ | −8.22 | −15.30 | 34.03 | −8.25 | 222.74 | −21.10 |
| *Korea* | | | | | | |
| $\ln(M/P)_t$ | −3.90 | −9.97 | 7.59 | −3.90 | 53.96 | −10.38 |
| $\ln(y)_t$ | −2.81 | −11.44 | 3.42 | −2.61 | 81.15 | −12.73 |
| $i_t$ | −2.91 | −8.27 | 5.19 | −2.88 | 34.18 | −8.27 |
| $x_t^{us}$ | −9.77 | −14.89 | 39.95 | −8.73 | 198.76 | −19.59 |
| $x_t^{uk}$ | −6.79 | −10.45 | 23.15 | −6.75 | 79.22 | −12.58 |
| $x_t^{jp}$ | −7.18 | −12.47 | 25.69 | −7.16 | 123.26 | −15.70 |
| *Malaysia* | | | | | | |
| $\ln(M/P)_t$ | −0.50 | −8.13 | 2.97 | −0.64 | 33.64 | −8.20 |
| $\ln(y)_t$ | −0.59 | −7.07 | 1.65 | −0.68 | 24.53 | −7.00 |
| $i_t$ | −1.63 | −4.56 | 2.40 | −2.18 | 9.67 | −4.40 |
| $x_t^{us}$ | −7.76 | −11.72 | 31.68 | −7.95 | 137.54 | −16.56 |
| $x_t^{uk}$ | −7.06 | −11.16 | 24.58 | −7.01 | 109.99 | −14.83 |
| $x_t^{jp}$ | −6.88 | −12.26 | 24.02 | −6.93 | 122.96 | −15.67 |
| *Singapore* | | | | | | |
| $\ln(M/P)_t$ | −2.84 | −9.10 | 3.93 | −2.67 | 45.38 | −9.52 |
| $\ln(y)_t$ | −2.17 | −9.05 | 2.10 | −1.99 | 44.31 | −9.41 |
| $i_t$ | −1.90 | −9.42 | 2.04 | −1.95 | 44.82 | −9.46 |
| $x_t^{us}$ | −9.14 | −12.83 | 44.13 | −9.37 | 189.52 | −19.39 |
| $x_t^{uk}$ | −6.79 | −10.65 | 22.51 | −6.70 | 93.96 | −13.71 |
| $x_t^{jp}$ | −6.48 | −12.14 | 21.52 | −6.56 | 115.62 | −15.20 |
| *Thailand* | | | | | | |
| $\ln(M/P)_t$ | −2.76 | −8.83 | 4.25 | −2.78 | 39.00 | −8.82 |
| $\ln(y)_t$ | −1.57 | −6.81 | 1.42 | −1.65 | 23.04 | −6.78 |
| $i_t$ | −2.03 | −5.15 | 3.52 | −2.65 | 12.79 | −5.06 |
| $x_t^{us}$ | −7.74 | −12.51 | 30.02 | −7.75 | 153.32 | −17.51 |
| $x_t^{uk}$ | −7.02 | −10.64 | 23.99 | −6.93 | 94.24 | −13.72 |
| $x_t^{jp}$ | −8.04 | −12.46 | 32.39 | −8.04 | 168.88 | −18.35 |

*Note*: The critical value at the 5% level for $\tau_t$ and $Z(\tau_t)$ is -3.50 and the critical value at the 5% level for $Z(\Phi_3)$ is 6.73 (Dickey and Fuller, 1981, p. 1063).

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**Table 2: Number of Cointegrating Vectors**

| | Model | | | |
|---|---|---|---|---|
| Country | Ia | Ib | Ic | II |
| Indonesia | 4 | 2 | 2 | 5 |
| Korea | 1 | 2 | 2 | 5 |
| Malaysia | 3 | 2* | 2 | 3 |
| Singapore | 2 | 1 | 1 | 4 |
| Thailand | 2 | 1 | 3* | 4 |

*Note*: * Number of cointegrating vectors concluded by λ-max and λ-trace statistics at 10% level of significance. At 5% significance level, there is no cointegrating vector according to λ-max statistic but there is one cointegrating vector indicated by λ-trace statistic.

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**Table 3: Hypothesis Tests in Model I**

| | The null hypothesis | | |
|---|---|---|---|
| Country | $H_0$: $a_3 = 0$ | $H_0$: $a_4 = 0$ | $H_0$: $a_3 = a_4 = 0$ |
| *Model Ia* | | | |
| Indonesia | $\chi^2(4) = 34.89$* | $\chi^2(4) = 24.45$* | $\chi^2(8) = 57.21$* |
| Korea | $\chi^2(1) = 26.53$* | $\chi^2(1) = 3.54$** | $\chi^2(2) = 26.92$* |
| Malaysia | $\chi^2(3) = 22.44$* | $\chi^2(3) = 44.72$* | $\chi^2(6) = 75.29$* |
| Singapore | $\chi^2(2) = 1.66$*** | $\chi^2(2) = 13.71$* | $\chi^2(4) = 14.49$* |
| Thailand | $\chi^2(2) = 6.54$* | $\chi^2(2) = 41.38$* | $\chi^2(4) = 51.22$* |
| *Model Ib* | | | |
| Indonesia | $\chi^2(2) = 0.06$*** | $\chi^2(2) = 22.59$* | $\chi^2(4) = 29.57$* |
| Korea | $\chi^2(2) = 7.08$* | $\chi^2(2) = 37.84$* | $\chi^2(4) = 41.18$* |
| Malaysia | $\chi^2(2) = 12.91$* | $\chi^2(2) = 8.43$* | $\chi^2(4) = 24.64$* |
| Singapore | $\chi^2(1) = 8.88$* | $\chi^2(1) = 8.96$* | $\chi^2(2) = 13.81$* |
| Thailand | $\chi^2(1) = 13.62$* | $\chi^2(1) = 14.28$* | $\chi^2(2) = 24.79$* |
| *Model Ic* | | | |
| Indonesia | $\chi^2(2) = 4.62$** | $\chi^2(2) = 8.57$* | $\chi^2(4) = 10.57$* |
| Korea | $\chi^2(2) = 1.24$*** | $\chi^2(2) = 10.54$* | $\chi^2(4) = 24.80$* |
| Malaysia | $\chi^2(2) = 11.29$* | $\chi^2(2) = 21.31$* | $\chi^2(4) = 36.04$* |
| Singapore | $\chi^2(1) = 0.50$*** | $\chi^2(1) = 22.41$* | $\chi^2(2) = 22.42$* |
| Thailand | $\chi^2(3) = 3.42$*** | $\chi^2(3) = 9.31$* | $\chi^2(6) = 18.61$* |

*Notes*: * Rejected at the 5% significance level; ** rejected at the 10% significance level; *** cannot be rejected.

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## Table 4: Hypothesis Tests in Model II

| | The null hypothesis | | |
|---|---|---|---|
| Country | $H_0$: $a_3 = a_4 = 0$ | $H_0$: $a_5 = a_6 = 0$ | $H_0$: $a_7 = a_8 = 0$ |
| Indonesia | $\chi^2(10) = 70.36$* | $\chi^2(10) = 66.11$* | $\chi^2(10) = 71.45$* |
| Korea | $\chi^2(10) = 57.94$* | $\chi^2(10) = 74.18$* | $\chi^2(10) = 138.39$* |
| Malaysia | $\chi^2(6) = 60.06$* | $\chi^2(6) = 39.62$* | $\chi^2(6) = 32.40$* |
| Singapore | $\chi^2(8) = 56.16$* | $\chi^2(8) = 58.41$* | $\chi^2(8) = 103.56$* |
| Thailand | $\chi^2(8) = 65.60$* | $\chi^2(8) = 72.11$* | $\chi^2(8) = 20.65$* |

*Notes*: * Rejected at the 5% significance level; ** rejected at the 10% significance level; *** cannot be rejected.

## Table 5A: Summary of Hypotheses Tests (Model I)

| | Models | | | | | |
|---|---|---|---|---|---|---|
| | Ia | | Ib | | Ic | |
| Country | $i_t^{us}$ | $x_t^{us}$ | $i_t^{jp}/i_t^{gm}$ | $x_t^{jp}/x_t^{gm}$ | $i_t^{uk}$ | $x_t^{uk}$ |
| Indonesia | S | S | NS | S | S* | S |
| Korea | S | S* | S | S | NS | S |
| Malaysia | S | S | S | S | S | S |
| Singapore | NS | S | S | S | NS | S |
| Thailand | S | S | S | S | NS | S |

*Note*: S indicates significant at 5% and S* indicates significant at 10%. NS indicates that the variable is not significant. NS indicates that the variable is not significant. $i_t^{us}$., $i_t^{jp}$ and $i_t^{uk}$, are US, Japanese and UK interest rates. $x_t^{us}$, $x_t^{jp}$, and $x_t^{uk}$ are the expected depreciation rates of domestic currency against US dollar, Japanese yen, and British pound, respectively.

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## Table 5B: Summary of Hypotheses Tests (Model II)

| | Model II | | | | | |
|---|---|---|---|---|---|---|
| Country | $i_t^{us}$ | $x_t^{us}$ | $i_t^{jp}/i_t^{gm}$ | $x_t^{jp}/x_t^{gm}$ | $i_t^{uk}$ | $x_t^{uk}$ |
| Indonesia | S | S | NS | S | S | S |
| Korea | S | S | S | S | S | S |
| Malaysia | S | S | NS | S | S | NS |
| Singapore | S | S | S | S | S | S |
| Thailand | S | S | S | S | NS | S |

*Note*: S indicates significant at 5% and S* indicates significant at 10%. NS indicates that the variable is not significant. $i_t^{us}$, $i_t^{jp}$ and $i_t^{uk}$, are US, Japanese and UK interest rates. $x_t^{us}$, $x_t^{jp}$, and $x_t^{uk}$ are the expected depreciation rates of domestic currency against US dollar, Japanese yen and British pound, respectively.

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