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International Reserve Holdings in ASEAN5 Economies

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International Reserve Holdings in ASEAN5 Economies

Eliza Nor[α], M. Azali[Ω], Siong-Hook Law[β]

Abstract - This paper examines international reserve holdings in five ASEAN economies during the period of 1970-2005 using the autoregressive distributed lag (ARDL) bounds testing approach proposed by Pesaran, Shin, and Smith (2001). These countries had increased their international reserve holdings after the 1997 Asian financial crisis. The majority of these countries had also experienced consistent current account surplus during the same period. Thus, the present study attempts to investigate the existence of long run relationship between reserve holdings and the current account. The empirical results indicate that current account surplus leads to the rise in international reserve holdings in Indonesia, Malaysia, and Singapore.

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I. Introduction

After the Asian financial crisis in 1997-1998, the five ASEAN countries, namely Indonesia, Malaysia, the Philippines, Singapore, and Thailand, had increased their holdings of international reserves. International reserves holdings in ASEAN5 economies had been increasing since in the early 1990s but a sharp rise was observed after the crisis. Among the ASEAN5, Singapore showed the highest international reserve holdings both in terms of US dollars and when reserves are scaled to GDP. This is followed by Malaysia. In 2005, Singapore's international reserves stood at US$116 billion (104% of GDP) while the international reserves of Malaysia were recorded at US$70 billion (63% of GDP). In Indonesia, international reserve holdings increased by more than 100% after the crisis from US$17 billion (9% of GDP) in 1997 to US$35 billion (18% of GDP) in 2003 and 2004. The Philippines showed the lowest reserves in terms of US dollars (US$16 billion). International reserves of Thailand rose from US$29 billion in 1998 to US$51 billion in 2005, an increase by 76% in seven years.

Besides the high international reserve holdings, these countries also experienced consistent current account surplus (with some exception in the cases of the Philippines and Thailand) at least until 2005. The rise in international reserve holdings during the period with current account surplus is associated with the problem of savings-investment imbalance in the region since countries with current account surplus have higher savings than investment. The savings-investment gap had widened, especially in Malaysia and Singapore, reflecting the rise in their current account surplus in recent years.

Based on the above discussion, it can be inferred that high international reserve holdings in the ASEAN5 economies coincided with the period with current account surplus. An interesting question that this study attempts to answer is whether current account surplus leads to the rise in international reserve holdings in these countries. Therefore, the main objective of the present study is to empirically analyze the impact of current account imbalance on international reserve holdings in the ASEAN5 economies.

This study differs from the previous studies in two aspects. First, the study utilizes the autoregressive distributed lag (ARDL) bounds testing approach to cointegration to analyze the behavior of international reserve holdings. This methodology has not been widely applied in this area of research. Previous studies on international reserve holdings for individual countries usually employ the Ordinary Least Square (OLS) and the cointegration techniques developed by Engle and Granger (1987), Johensen (1988), and Johensen and Juselius (1990). One of the advantages of the ARDL approach to cointegration over previous cointegration techniques is that the former can be applied to studies with small sample sizes (Mah 2000).

Second, most studies on international reserve holdings for developed and developing countries are based on cross-country or panel data analysis. Only a few studies are conducted for individual countries. Even though there are studies that analyze the behavior of international reserve holdings for individual Asian countries, for instance, China (Huang, 1995; Wei and Zhu, 2000), India (Ramachandran, 2004, 2006; Ramachandran and Srinivasan, 2007; Prabheesh, Malathy, and Madhumati, 2008), Korea (Aizenman, Lee, and Rhee, 2007; Jo, 2007; Ra, 2007), Pakistan (Khan and Ahmed, 2005), and Taiwan (Huang and Shen, 1999), there is still a limited number of studies on international reserve holdings for individual ASEAN countries. Therefore, the present study attempts to fill up this gap in the literature.

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The remainder of this paper is organized as follows. Section II reviews recent empirical literature on international reserve holdings. Section III summarizes the data and methodology to be employed in this study. The major findings are presented in Section IV. The final section concludes the paper.

II. Review of Empirical Literature

This section provides a review of some empirical literature on international reserve holdings for individual countries. There has been an increasing number of studies using time series data since in the 1990s. Individual-country studies have addressed the following issues associated with international reserve holdings: (1) the transactions, precautionary, and mercantilist motives for holding reserves; (2) monetary disequilibrium and reserve holdings; (3) the opportunity cost of holding reserves; (4) the role of reserves as a buffer stock.

For instance, Elbadawi (1990) estimates the model of international reserve holdings for Sudan during 1971-1982 and he discovers that international reserve holdings in Sudan exhibits constant return to scale and the variability measure is positive and significant, reflecting the precautionary motive for holding reserves. A study by Prabheesh, Malathy and Madhumati (2008) for India during 1983-2005 also supports the precautionary motive for holding reserves against the current account and capital account vulnerabilities. Studies by Karfakis (1997) on Greece (during 1976-1992) and Wei and Zhu (2000) on China (during January 1994 to December 1998) suggest that the international reserve holdings in these countries serve the role in the balance of payments adjustment process. These findings also support the precautionary motive for holding reserves. Applying the seasonal error correction model, Huang and Shen (1999) analyze the behavior of international reserve holdings in Taiwan during 1961Q1-1995Q2. Their findings suggest that precautionary motive is not an important determinant of reserve holdings in Taiwan.

Using quarterly data for the period 1985Q1-1997Q4, Badinger (2004) finds strong economies of scale for holding reserves in Austria and he concludes that the transactions motive represents the foreign exchange demand by the private sector.

Aizenman, Rhee, and Lee (2007) analyze the precautionary motive for holding reserves for Korea during 1994-2003 by including variables such as short term external debt and foreign portfolio holdings. The empirical results suggest that the Korean holding of international reserves after the 1997 financial crisis supports the precautionary motive for holding reserves. In contrary, Jo (2007) finds that the Korean holding of international reserves during the period after the crisis is to maintain export competitiveness which supports the mercantilist motive for holding reserves.

Besides the precautionary and mercantilist motives, opportunity cost also affects international reserve holdings in Korea. For instance, Ra (2007) applies the dynamic ordinary least square (DOLS) and Johensen and Juselius (1990) cointegration approach to estimate reserve model for Korea during 1990-2005 and he concludes that the opportunity cost for holding reserves is inversely related to international reserve holdings during the pre-crisis and the whole sample period.

Some studies on international reserve holdings test the theory of monetarist approach to balance of payments by including monetary disequilibrium as an added regressor in reserve equation. For instance, Ford and Huang (1994) examine international reserve holdings in China during 1952-1991 and their empirical results suggest that domestic monetary disequilibrium significantly affects reserve holdings and the monetary authority takes appropriate action to restore reserves to their desired level. Monetary disequilibrium also significantly affects international reserve holdings in Pakistan during 1982Q1-2003Q2 (Khan and Ahmed, 2005).

Following Frenkel and Jovanovic (1981), Cifarelli and Paladino (2006) estimate the model of international reserve holdings based on the buffer stock model using the Johensen cointegration approach for ten Asian and Latin American emerging economies. Their empirical results suggest that high international reserve holdings in these countries is associated with the "fear of floating" and mercantilist motive. Similarly, Ramachandran and Srinivaran (2007) and Ramachandran (2004, 2006) utilize the buffer stock model to analyze the behavior of international reserve holdings for India and they discover that this model predicts well the reserve model for India.

III. Data, Empirical Model, and Methodological Issues

a) Data

This study utilizes annual data covering the period of 1970-2005. Reserves, current account balance, and total external debt are scaled by GDP. This is to allow comparison across different sizes of economy (Cheung and Xing, 2007). Following Edison (2003), export volatility is measured by standard deviation of real export receipts. Data on international reserves (excluding gold), real GDP per capita, imports, exports, and current account balance are obtained from the International Financial Statistics (IMF, 2007) and data on total external debt are collected from World Development Indicators (World Bank, 2007) and Key Indicators of Developing Asian and Pacific Countries (ADB, various issues).

b) Empirical Model of International Reserve Holdings

Following Frenkel (1974a), international reserve holdings is a function of a scale variable, propensity to

import, and the variability measure. The scale variable is expected to have a direct relationship with international reserve holdings since it is expected that the international reserve holdings should increase with a rise in the volume of international transactions. Marginal propensity to import can have a positive or negative relationship with reserve holdings. A positive relationship indicates that propensity to import acts as a proxy for the openness of an economy (Frenkel, 1974b) while a negative relationship indicates that the variable becomes a proxy for the marginal cost of adjustment (Huang, 1995).

Besides these three explanatory variables, two additional variables are included in the model: current account balance and total external debt. The relationship between international reserves and current account balance is based on the theories presented by Dunn and Mutti (2000), McCauley (2003), and Taniuchi (2006). It has been argued that emerging economies accumulate reserves during the period with current account surplus through foreign exchange market intervention to avoid serious appreciation of their currencies. Specifically, the monetary authorities purchase foreign currencies and sell domestic currency to maintain stable exchange rates. This action would help these countries to retain their export competitiveness. On the other hand, when the current account is in deficit, central banks would sell foreign currencies (purchase domestic currency). This would result in the decline in international reserve holdings.

The inclusion of total external debt in the model is in line with the theories developed by Aizenman, Rhee, and Lee (2004) and Alfaro and Kanczuk (2007). Aizenman and Marion (2004) argue that countries with high cost of tax collections and sovereign risk tend to hold reserves and borrow externally. When output is not stable, external debt can be used to ease consumption. Under the event of default on external debt and thus, no access to external borrowing, international reserves can be used to ease consumption, provided that creditors have no access to country's international reserves.

Aizenman et al. (2004) extends the model on international reserve holdings suggested by Aizenman and Marion (2004) by taking into account the effect of abrupt short term capital reversals that reduces output and leads to financial crisis. International reserves may reduce the impact of crisis and thus improving welfare. The model accounts for the impact of the failure of a country to make external debt repayments on output. Reduction in output, in turn, could increase the probability of recession.

Alfaro and Kanczuk (2007) develop a stochastic equilibrium model of international reserve holdings based on the framework proposed by Eaton and Gersowitz (1980), Arellano (2006), and Aguiar and Gopinath (2006). They incorporate the decision to hold both reserves and debt in their model. They argue that both reserves and debt can be used to smooth consumption, even though after the country has defaulted.

The relationship between international reserves and external debt can be positive or negative. If the relationship is positive, the latter is a complement for the former. Otherwise, the latter becomes a substitute for the former (Eaton and Gersowitz, 1980).

Based on the theories presented above, the proposed model of international reserve holdings for ASEAN5 economies is developed as follows:

$$\ln R_t = \beta_0 + \beta_1 \ln YCAP_t + \beta_2 \ln PIM_t + \beta_3 \ln XVOL_t + \beta_4 \ln CA_t + \beta_5 \ln DEBT_t + \varepsilon_t \quad (1)$$

Where $\ln R$ is the ratio of international reserves to GDP; $\ln YCAP$ is the real GDP per capita (scale variable); $\ln PIM$ is the average propensity to import (imports/GDP); $\ln XVOL$ is the variability in real export receipts; $\ln CA$ is the ratio of current account balance to GDP; and $\ln DEBT$ is the ratio of total external debt to GDP. All variables are expressed in logarithms.

c) Methodology

In this study, the following procedures were used. Firstly, stationary tests were performed to identify the order of integration of the variables. These is done since the ARDL bounds test requires that the dependent variable to be $I(1)$ and the independent variables to be either $I(0)$ or $I(1)$. The following stationary tests were carried out: the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller 1979) and KPSS test (Kwiatkowski, Phillips, Schmidt, and Shin, 1992).

Secondly, the ARDL bounds test developed by Pesaran, Shin, and Smith (2001) was applied to investigate the existence of cointegration relationship between international reserve holdings and its determinants. Following Pesaran et al. (2001), the vector auto-regression (VAR) of order p of international reserve holdings in the ASEAN5 economies is developed as follows:

$$w_t = \beta + \sum_{i=1}^{p} \alpha_i x_{t-i} + \varepsilon_t \quad (2)$$

Where w_t is the vector of dependent variable (the ratio of international reserves to GDP) and x_t is the vector consisting of both the dependent variable and independent variables (real GDP per capita, propensity to import, export volatility, the ratio of current account balance to GDP, and the ratio of total external debt to GDP). β is a constant term, α is the vector of parameters of lag i, t is time or trend term, and ε is the vector of error terms.

The error correction model of the ARDL model can be expressed as:

$$\Delta w_t = \beta_0 + \beta_1 \tau + \phi_1 w_{t-1} + \phi_2 z_{t-1} + \sum_{i=1}^{p} \eta_i \Delta w_{t-i} + \sum_{i=0}^{p} \lambda_i \Delta z_{t-i} + \varepsilon_t \quad (3)$$

The third and the fourth expressions containing θs on the right-hand side correspond to the long run relationship. The remaining expressions with the summation sign represent the short-run dynamics of the model, where Δ is the first difference operator. We develop the Unrestricted Error Correction model based on the assumptions made by Pesaran et al. (2001) in Case III, that is, unrestricted intercepts and no trends. In this case, it is assumed that $\beta_0 \neq 0$ and $\beta_1 = 0$.

Thus, the unrestricted error correction model (UECM) based on equation (1) is developed as follows:

$$\begin{aligned} \ln \Delta R_t = {} & \beta_0 + \delta_1 \ln R_{t-1} + \delta_2 \ln YCAP_{t-1} \\ & + \delta_3 \ln PIM_{t-1} + \delta_4 \ln XVOL_{t-1} \\ & + \theta_5 \ln CA_{t-1} + \delta_6 \ln DEBT_{t-1} \\ & + \sum_{k=1}^{a} \lambda_{1,k} \Delta \ln R_{t-k} + \sum_{k=0}^{b} \lambda_{2,k} \Delta \ln YCAP_{t-k} \\ & + \sum_{k=0}^{c} \lambda_{3,k} \Delta \ln PIM_{t-k} + \sum_{k=0}^{d} \lambda_{4,k} \Delta \ln XVOL_{t-k} \\ & + \sum_{k=0}^{e} \lambda_{5,k} \Delta \ln CA_{t-k} + \sum_{k=0}^{e} \lambda_{6,k} \Delta \ln DEBT_{t-k} \\ & + \varepsilon_t \end{aligned} \quad (4)$$

The long run elasticities are calculated by dividing the coefficient of the first lag of the independent variable by the coefficient of the first lag of the dependent variable (Bardsen, 1989). There are three steps in the ARDL bounds test. First, equation (2) is estimated using Ordinary Least Square (OLS). Second, Wald tests are conducted to test for the existence of long run relationship between international reserve holdings and its determinants. This test is performed by imposing restrictions on the long run coefficients of $\ln R$, $\ln YCAP$, $\ln PIM$, $\ln XVOL$, $\ln CA$, and $\ln DEBT$. The null and alternative hypotheses for equation (2) are constructed as follows:

$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$
(There is no long run level relationship)
$H_1: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq 0$
(There is long run level relationship)

The computed F-statistic from the Wald test is compared with the critical values from Pesaran et al. (2001) and Narayan (2005). The lower critical value assumes that the regressors are integrated of order zero or I(0) while the upper critical value assumes that the regressors are integrated of order one or I(1). If the calculated F-statistic from the Wald test is greater than the upper critical value, the null hypothesis of no long run relationship will be rejected. If the calculated statistic is less than the lower critical value, the null hypothesis will not be rejected. If the calculated value falls within the upper and lower critical values, the result of the test is inconclusive. The selection of model is based on the Hendry's (1991) general to specific approach.

IV. Discussion of Findings

a) Stationary Test Results

The results of the ADF and KPSS tests both with and without trend are presented in Table 1. The lag lengths for the ADF and KPSS tests are selected using the Aikake Information Criteria (AIC) and the Newey-West bandwith, respectively. The results of the tests indicate that the dependent variables ($\ln R$) at level are non-stationary. When the tests are performed at first difference, $\ln R$ of each country is found to be stationary. On the other hand, some of the independent variables are found to be stationary at level ($I(0)$) while some of them are stationary at first difference ($I(1)$). In short, the dependent variable ($\ln R$) is $I(1)$ while the dependent variables are either $I(0)$ or $I(1)$.

Table 1 : Stationary Test Results

		ADF Test		*KPSS Test*	
Countries	*Variables*	*Without Trend*	*With Trend*	*Without Trend*	*With Trend*
Indonesia	ln*R*	-2.5894 (0)	-2.7151 (3)	0.7469 (4)***	0.1284 (12)*
	Δln*R*	-7.1632 (0)***	-7.1507 (0)***	0.1186 (3)	0.0692 (3)
	ln*YCAP*	-1.8357 (0)	-1.6083 (1)	0.7003 (5)**	0.1522 (4)**
	Δln*YCAP*	-4.2539 (0)***	-4.4740 (0)***	0.2592 (2)	0.0614 (1)
	ln*PIM*	-2.6035 (0)	-2.4747 (0)	0.5183 (4)**	0.0886 (2)
	Δln*PIM*	-6.2176 (0)***	-6.3073 (0)***	0.1909 (4)	0.0990 (5)
	ln*XVOL*	-2.9575 (3)*	-3.1817 (3)	0.3392 (4)	0.0900 (2)
	Δln*XVOL*	-4.7629 (4)***	-4.6808 (4)***	0.0559 (1)	0.0541 (1)
	ln*CA*	-3.4726 (0)**	-3.6843 (1)**	0.3494 (3)*	0.1265 (2)*
	Δln*CA*	-6.2626 (1)***	-6.1594 (1)***	0.0574 (3)	0.0568 (3)
	ln*DEBT*	-1.5970 (0)	-2.0373 (0)	0.4426 (5)*	0.0954 (4)
	Δln*DEBT*	-5.5772 (0)***	-5.4902 (0)***	0.1002 (0)	0.0994 (0)
Malaysia	ln*R*	-0.8448 (0)	-3.0273 (1)	0.7191 (4)**	0.1494 (3)**
	Δln*R*	-5.4116 (0)***	-4.6284 (3)***	0.3083 (17)	0.0479 (3)
	ln*YCAP*	-1.2830 (0)	-3.9935 (8)**	0.7088 (5)**	0.0760 (4)
	Δln*YCAP*	-4.8785 (0)***	-4.9762 (0)***	0.1450 (2)	0.0573 (1)
	ln*PIM*	-1.1162 (0)	-3.2815 (0)*	0.6672 (5)**	0.0919 (2)
	Δln*PIM*	-6.7491 (0)***	-6.6427 (0)***	0.0741 (3)	0.0742 (3)
	ln*XVOL*	-2.4267 (0)	-4.0789 (0)**	0.7611 (4)*	0.0679 (2)
	Δln*XVOL*	-8.7104 (0)***	-8.7890 (0)***	0.0983 (5)	0.0832 (6)
	ln*CA*	-2.8432 (1)*	-3.1344 (1)	0.2369 (3)	0.1121 (2)
	Δln*CA*	-5.3593 (0)***	-5.3020 (0)***	0.0772 (3)	0.0350 (2)
	ln*DEBT*	-2.8438 (4)*	-5.1456 (1)***	0.4369 (5)*	0.1629 (4)**
	Δln*DEBT*	-4.8104 (1)***	-2.8438 (4)*	0.2899 (9)	0.0646 (5)
The Philippines	ln*R*	-2.3289 (7)	-1.6614 (1)	0.3539 (4)*	0.1540 (4)**
	Δln*R*	-4.1801 (1)***	-4.5065 (3)***	0.0874 (2)	0.0888 (2)
	ln*YCAP*	-1.5139 (2)	-2.5819 (1)	0.4908 (4)**	0.1004 (4)
	Δln*YCAP*	-3.5720 (1)**	-3.4970 (1)*	0.1300 (2)	0.1299 (2)*
	ln*PIM*	-0.3981 (1)	-1.7441 (3)	0.6116 (5)**	0.1414 (4)*
	Δln*PIM*	-7.4357 (0)***	-7.3442 (0)**	0.0971 (1)	0.0808 (1)
	ln*XVOL*	-2.3405 (0)	-3.1354 (0)	0.3543 (4)*	0.0605 (3)
	Δln*XVOL*	-6.1865 (1)***	-6.1484 (1)***	0.1421 (2)	0.0714 (3)
	ln*CA*	-2.3576 (0)	-3.5552 (8)*	0.2803 (4)	0.1295 (3)*
	Δln*CA*	-5.6565 (1)***	-5.6648 (1)***	0.3190 (13)	0.0517 (3)
	ln*DEBT*	-1.9695 (1)	-1.7296 (1)	0.4473 (5)*	0.1588 (4)**
	Δln*DEBT*	-3.5720 (0)**	-3.6962 (0)**	0.1982 (1)	0.0722 (1)
Singapore	ln*R*	-1.0722 (0)	-3.0143 (3)	0.6739 (5)**	0.1443 (1)*
	Δln*R*	-6.4146 (0)***	-6.4339 (0)***	0.0568 (3)	0.0483 (3)
	ln*YCAP*	-2.5184 (0)	-2.0608 (0)	0.7117 (5)**	0.1829 (4)**
	Δln*YCAP*	-4.9678 (0)***	-5.4095 (1)***	0.4133 (1)*	0.0563 (3)
	ln*PIM*	-2.2061 (1)	-2.2511 (1)	0.1440 (4)	0.1257 (4)*
	Δln*PIM*	-6.4658 (0)***	-6.3652 (0)***	0.0894 (1)	0.0834 (1)
	ln*XVOL*	-2.0599 (0)	-3.5777 (1)**	0.7238 (4)**	0.0559 (2)
	Δln*XVOL*	-4.3766 (4)***	-4.2830 (4)**	0.1125 (7)	0.0996 (7)
	ln*CA*	-0.8656 (5)	-4.0348 (0)**	0.6985 (4)**	0.1675 (2)**
	Δln*CA*	-9.1313 (0)***	-9.9914 (0)***	0.1986 (2)	0.0900 (4)
	ln*DEBT*	-0.5104 (1)	-3.4085 (8)*	0.6217 (5)**	0.0971 (4)
	Δln*DEBT*	-4.5197 (0)***	-4.4880 (0)***	0.1015 (0)	0.0774 (1)
Thailand	ln*R*	-1.5991 (3)	-3.4756 (5)*	0.4502 (5)**	0.1349 (3)*
	Δln*R*	-3.9509 (0)***	-3.9824 (0)**	0.2009 (4)	0.1023 (4)
	ln*YCAP*	-0.8808 (1)	-3.2503 (7)*	0.6978 (5)**	0.1039 (4)
	Δln*YCAP*	-3.3534 (0)**	-3.3489 (0)*	0.1123 (3)	0.0953 (3)
	ln*PIM*	-0.3187 (1)	-3.3760 (0)*	0.7002 (5)**	0.0799 (3)
	Δln*PIM*	-8.0132 (0)***	-7.9276 (0)***	0.1078 (4)	0.0620 (4)
	ln*XVOL*	-2.5199 (0)	-2.9578 (0)	0.6360 (4)**	0.1003 (2)
	Δln*XVOL*	-5.0097 (2)***	-4.9118 (2)***	0.1225 (3)	0.0436 (2)
	ln*CA*	-2.5909 (0)	-2.6527 (0)	0.2106 (3)	0.1302 (10)*
	Δln*CA*	-4.7351 (2)***	-4.6790 (2)***	0.0648 (3)	0.0663 (3)
	ln*DEBT*	-1.6802 (1)	-1.1560 (1)	0.5342 (5)**	0.1312 (4)*
	Δln*DEBT*	-3.3324 (0)**	-3.5846 (0)**	0.2231 (4)	0.0942 (3)

1. ADF = augmented Dickey-Fuller; KPSS = Kwiatkowski, Phillips, Schmidt, and Shin
2. Critical values for ADF and KPSS tests are taken from MacKinnon (1991) and Kwiatkowski, Phillips, Schmidt, and Shin (1992), respectively.
3. The null hypothesis for ADF test is that the series is non-stationary while the null hypothesis for the KPSS test is that the series is stationary.
4. ln$R$ = ratio of international reserves to GDP, logged; lnYC = real GDP per capita, logged; lnPIM = average propensity to import (imports/GDP), logged; lnXPV = volatility of real export receipts, logged; lnCA = ratio of current account balance to GDP, logged; ln$EXTD$ = ratio of total external debt to GDP, logged.
5. Figures in parentheses are the lag lengths.

***, **, and * indicate significant at 1%, 5%, and 10% level respectively.

b) ARDL Bounds Test Results

Table 2 presents the results of the UECM for the long run coefficients based on equation (2). The goodness of fit of the models (adjusted R-squared) and the standard error of regression remain superior in all models. The short run coefficients of the UECM results are presented in Table 3. Diagnostic tests such as Breusch-Godfrey serial correlation test, ARCH test, Ramsey RESET specification test, Jacque-Bera normality test, and stability tests (CUSUM and CUSUM of Square tests) are performed to test for the adequacy of the models. All models have passed these tests. The results of diagnostic tests are summarized in the lower panel of Table 2 and in the Appendix.

Table 4 summarizes the results of the ARDL bounds tests based on equation (2). The calculated F-statistics for all five countries are greater than the upper critical values at least at 5% and 10% levels of significance based on Pesaran et al. (2001) and Narayan (2005), respectively. Therefore the null hypothesis of no cointegration can be rejected for all cases and we conclude that there is a long run level relationship between international reserve holdings and its determinants for Indonesia, Malaysia, the Philippines, Singapore, and Thailand.

The long run elasticities calculated based on equation (2) are presented in Table 5. GDP per capita (ln$YCAP$) is significant and positive in the cases of Indonesia and Thailand. The positive relationship indicates that international reserve holdings rise with the rise in the volume of international transactions.

Propensity to import (lnPIM) is significant in affecting reserve holdings in all sample countries except in the case of Indonesia. The coefficient sign is positive for Malaysia and the Philippines but negative in the cases of Singapore and Thailand. Therefore, lnPIM represents the openness of the economy for the first two countries and the variable acts as a marginal cost of adjustment for the last two countries.

The relationship between export volatility and international reserve holdings is positive and significant only in the case of Indonesia. This implies that international Diagnostic tests such as Breusch-Godfrey serial correlation test, ARCH test, Ramsey RESET specification test, Jacque-Bera normality test, and stability tests (CUSUM and CUSUM of Square tests) are performed to test for the adequacy of the models. All models have passed these tests. The results of diagnostic tests are summarized in the lower panel of Table 2 and in the Appendix.

Cointegration can be rejected for all cases and we conclude that there is a long run level relationship between international reserve holdings and its determinants for Indonesia, Malaysia, the Philippines, Singapore, and Thailand.

Reserve holdings rise with an increase in the volatility of export receipts in this country.

Table 2 : Long Run Coefficients of the UECM results Based on Equation (4)

Variable	*Indonesia*	*Malaysia*	*Philippines*	*Singapore*	*Thailand*
	(-2.1898)	(-0.4408)	(-1.4424)	(0.3177)	(-2.0436)
lnR_{t-1}	-1.2229***	-0.9573***	-1.1027***	-0.6052**	-0.1525*
	(-4.0165)	(-4.1352)	(-4.1347)	(-2.5103)	(-1.8436)
ln$YCAP_{t-1}$	0.9284**	0.1334	2.1489	-0.0154	0.6830*
	(2.4470)	(0.3111)	(1.3812)	(-0.1076)	(1.7939)
lnPIM_{t-1}	0.4991	0.7429*	1.8541***	-0.2856**	-0.7276**
	(1.1606)	(1.9218)	(4.7293)	(-2.2295)	(-2.4968)
ln$XVOL_{t-1}$	0.2357***	0.0060	0.1322	-0.0182	0.0049
	(3.0022)	(0.0647)	(1.2375)	(-0.5969)	(0.0996)
lnCA_{t-1}	0.6853***	0.2614***	0.0830	0.3304***	-0.1170
	(3.2721)	(3.9370)	(0.4646)	(3.3574)	(-1.6733)
ln$DEBT_{t-1}$	0.2010	-0.0775	-1.2785***	0.0507	-0.0664
	(0.7600)	(-0.6501)	(-4.3313)	(0.9053)	(-0.4091)
Adjusted R^2	0.6255	0.5948	0.6568	0.5940	0.6032
AIC	0.1190	-1.0397	0.2640	-2.7159	-1.5221
Std. e rror of regression	0.2208	0.1234	0.2374	0.0534	0.0970
F-statistic	4.1436	3.9353	4.6023	4.1215	4.2430
Probability (F statistic)	- 0.0041	0.0046	0.0024	0.0032	0.0027
Diagnostic Tests					
Serial correlation test	1.1752 [0.3395]	2.5919 [0.1102]	0.8293 [0.4543]	0.4653 [0.6367]	2.1512 [0.1509]
ARCH test	0.3353 [0.7179]	0.3188 [0.7296]	1.2901 [0.2911]	0.7360 [0.4881]	0.3770 [0.6894]
Normality test	2.8036 [0.2462]	0.1290 [0.9376]	0.4377 [0.8034]	1.9393 [0.3792]	2.8626 [0.2390]
Ramsey RESET test	1.0885 [0.3145]	2.8330 [0.1130]	1.9510 [0.1745]	0.0513 [0.9502]	0.5078 [0.6118]

1. ln$R$ = ratio of international reserves to GDP, logged; ln$YCAP$ = real GDP per capita, logged; lnPIM = average propensity to import (imports/GDP), logged; ln$XVOL$ = volatility of real export receipts, logged; lnCA = ratio of current account balance to GDP, logged; and ln$DEBT$ = ratio of total external debt to GDP, logged.
2. Figures in parentheses ( ) and square brackets [ ] are the *t*-statistics and *p*-values, respectively.
3. Serial correlation test, ARCH test, and Ramsey RESET test are performed at lag two.

***, **, and * indicate significant at 1%, 5%, and 10% levels, respectively.

Current account balance shows a significant positive impact on international reserve holdings in Indonesia, Malaysia, and Singapore. The positive relationship implies that a rise in the current account surplus leads to a rise in international reserve holdings in these countries. The impact of current account balance on international reserve holdings is highest in Indonesia followed by Singapore and Malaysia. A 1% increase in the current account surplus would result in the rise in international reserve holdings by 0.56%, 0.54% and 0.27% in Indonesia, Singapore, and Malaysia, respectively. These results are consistent with the fact that these countries were experiencing huge current account surplus in recent years.

Table 3 : Short Run Coefficients of the UECM Results Based on Equation (4)

Variable	*Indonesia*	*Malaysia*	*The Philippines*	*Singapore*	*Thailand*
$\Delta\ln R_{t-1}$	0.2749	0.4647**	0.2868		
	(1.1370)	(2.4577)	(1.0874)		
$\Delta\ln R_{t-2}$	0.2692		0.1915	0.4111*	0.2582
	(1.4359)		(0.9590)	(1.8851)	(1.4885)
$\Delta\ln YCAP_t$			8.4343**		
			(2.6870)		
$\Delta\ln YCAP_{t-1}$			-6.8786***	0.3222	-0.5912
			(-3.0537)	(0.6022)	(-0.6875)
$\Delta\ln YCAP_{t-2}$	1.6767	0.8387		0.6555	-1.0757
	(0.5617)	(0.9892)		(1.3310)	(-1.1739)
$\Delta\ln PIM_t$		0.3914	2.8458***	0.5840**	0.2865
		(1.6840)	(4.4545)	(2.1778)	(1.4784)
$\Delta\ln PIM_{t-1}$	-0.6127	-0.5043*		-0.1498	0.6609**
	(-1.4620)	(-1.7538)		(-0.7252)	(2.5833)
$\Delta\ln PIM_{t-2}$	-1.2790***		-0.8981		
	(-3.0423)		(-1.7067)		
$\Delta\ln XVOL_t$	0.0784	0.1253*	0.0648		0.0403
	(1.0973)	(1.9253)	(0.6224)		(1.0290)
$\Delta\ln XVOL_{t-1}$		0.0517	-0.2476**	-0.0646*	
		(0.8245)	(-2.4697)	(-2.0402)	
$\Delta\ln XVOL_{t-2}$		0.0778			
		(1.2901)			
$\Delta\ln CA_t$	0.2956***	0.1092**	0.3420**	0.4863***	
	(3.1830)	(2.1795)	(2.6390)	(3.7741)	
$\Delta\ln CA_{t-1}$	-0.4551**	-0.1020*		-0.0886*	0.0955
	(-2.8044)	(-1.7916)		(-2.0426)	(1.6974)
$\Delta\ln CA_{t-2}$	-0.2775**				
	(-2.2608)				
$\Delta\ln DEBT_t$			-1.0426	-0.1097	
			(-1.5846)	(-1.2318)	
$\Delta\ln DEBT_{t-1}$	0.3230	0.3005	1.3289*		-0.3516
	(0.9458)	(1.3821)	(1.9200)		(-1.6553)
$\Delta\ln DEBT_{t-2}$	0.8284				-0.6572**
	(1.5786)				(-2.8988)

Notes: 1. $\ln R$ = ratio of international reserves to GDP, logged; $\ln YCAP$ = real GDP per capita, logged; $\ln PIM$ = average propensity to import (imports/GDP), logged; $\ln XVOL$ = volatility of real export receipts, logged; $\ln CA$ = ratio of current account balance to GDP, logged; and $\ln DEBT$ = ratio of total external debt to GDP, logged.

2. Figures in parentheses ( ) are t-statistics.

***, **, and * indicate significant at 1%, 5%, 10% levels, respectively.

Table 4 : Results of the ARDL Bounds Test Based on Equation (4)

Country	*Computed F-Statistic*
Indonesia	4.1940**(*)
Malaysia	3.9031**(*)
The Philippines	4.5439**(**)
Singapore	4.1094**(*)
Thailand	5.0941***(**)

Unrestricted Intercept and No Trend	Critical Values			
	Pesaran et al. (2001)		*Narayan (2005)*	
Significance level	*Lower Bound* (k=5)	*Upper Bound*	*Lower Bound* (k=5; n=35)	*Upper Bound*
1%	3.41	4.68	4.26	6.04
5%	2.62	3.79	3.04	4.44
10%	2.26	3.35	2.51	3.76

1. Critical values are taken from Pesaran et al (2001), Table CI(iii) Case III, p. 300, and Narayan (2005), Table in the Appendix, Case III, p. 1988.
2. * outside and inside parenthesis indicate significance levels based on Pesaran et al. (2001) and Narayan (2005), respectively.
3. k and n denote the number of regressors and observations, respectively.

***, **, and * indicate significant at 1%, 5%, and 10% levels, respectively.

Table 5 : Long Run Elasticities Based on Equation (4)
(Dependent Variable: Reserves/GDP (lnR))

	Indonesia	Malaysia	The Philippines	Singapore	Thailand
ln*YCAP*	0.7591**	0.1393	1.9488	-0.0254	4.4796*
ln*PIM*	0.4081	0.7761*	1.6814***	-0.4718**	-4.7719**
ln*XVOL*	0.1928***	0.0062	0.1199	-0.0301	0.0322
ln*CA*	0.5604***	0.2730***	0.0752	0.5459***	-0.7672
ln*DEBT*	0.1644	-0.0810	-1.1594***	0.0838	-0.4357

ln*YCAP* = real GDP per capita, logged; ln*PIM* is average propensity to import (imports/GDP), logged; ln*XVOL* = volatility of real export receipts, logged; ln*CA* = ratio of current account balance to GDP, logged; and ln*DEBT* = ratio of total external debt to GDP, logged.
***, **, and * indicate significant at 1%, 5%, and 10% levels, respectively.

In the case of the Philippines, the current account recorded deficits since 1987 until 2001, except in 1998. The current account of the Philippines shifted to surplus after 2002 and remained in surplus until, at least, to 2005. However, the surplus totaling to only US$3 billion during 2003-2005. This surplus was relatively small as compared to the surplus in the rest of sample countries. This fact may explain the insignificant impact of current account balance on reserve holdings in the Philippines.

The insignificance of current account balance in Thailand may be associated with the inverse movement between international reserves and the current account. The ratio of reserves to GDP in Thailand was moving upward (from 26% in 1998 to 30% in 2002-2005) while the ratio of current account balance to GDP was moving downward (from 13% in 1998 to 4% in 2004). Furthermore, the Thailand's current account had shifted to a deficit amounting to US$7.8 billion in 2005.

International reserve holdings would decline with the rise in the total external debt holdings in the Philippines. In other words, total external debt is a substitute for international reserves in this country. A 1% increase in total external debt would lead to the decline in international reserve holdings by 1.2% in the Philippines. Total external debt is not significant in the rest of the countries.

Total external debt does not have any significant effect on international reserve holdings in the cases of Indonesia, Malaysia, Singapore, and Thailand. Some possible explanation for such findings can be offered. Indonesia was able to reduce its total external debt burden from US$151 billion (97% of GDP) in 1998-1999 to an average of US$136 billion (74% of GDP) during 2001-2004. The reduction is mainly due to the reduction in the long term debt of the private sector from US$55 billion in 1998 to an average of US$32 billion in 2001-2004 (Asian Development Bank, various issues). The government has taken steps in rescheduling its external debt and also the external debt of the private sector. Under the Paris Club and London Club Agreements, the government was allowed to reschedule its external debt repayments. Besides, the Frankfurt Agreement was signed on the 4th June of 1998 to assist the private sector in resolving its external debt burden (Kusumaningtuti, 2004).

In the case of Malaysia, there had been a decline in the private sector's long term external debt from US$18 billion in 2000 to an average of US$14 billion during 2001-2004 (ADB 2006). There are at least two reasons that could explain the insignificance of total external debt in Singapore. First, the Singaporean government has not taken any external financing since 1996. This may be due to the policy of the government to maintain budget surplus. The government budget has been in consistent surplus since 1988 (ADB various issues). Second, even though the levels of external debt have grown in recent years, Singapore is a net creditor in all trade credit transactions, debt securities, FDI-related loans, and loans to other non-residents (Kapur, 2005).

The short run causality based on equation (2) is presented in Table 6. In the short run, ln*YCAP* is significant only in the case of the Philippines while lnPIM is significant in all sample countries. ln*XVOL* is significant in affecting international reserve holdings in the cases of the Philippines and Singapore. ln*CA* is significant in all of the ASEAN countries except Thailand while ln*DEBT* debt does not show significant impact on international reserve holdings in the short run except in the case of Thailand.

Table 6 : Short Run Causality Based on Equation (4)

	Indonesia	*Malaysia*	*Philippines*	*Singapore*	*Thailand*
Δln*YCAP*	0.3155	0.9786	5.5498**	0.9798	1.2033
	[0.5826]	[0.3373]	[0.0157]	[0.3956]	[0.3245]
Δln*PIM*	4.6425**	3.6751**	10.013***	2.9755*	3.7690**
	[0.0270]	[0.0486]	[0.0017]	[0.0780]	[0.0442]
Δln*XVOL*	1.2041	1.4650	3.0543*	4.1624*	1.0588
	[0.8981]	[0.2616]	[0.0771]	[0.0572]	[0.3179]
Δln*CA*	6.5017***	3.7047**	6.9643**	7.1919***	2.8811
	[0.0049]	[0.0476]	[0.0186]	[0.0054]	[0.1078]
Δln*DEBT*	1.9684	1.9103	1.9886	1.5174	6.3103***
	[0.1741]	[0.1859]	[0.1714]	[0.2348]	[0.0089]

1. ln*YCAP* is real GDP per capita, logged; ln*PIM* is average propensity to import (imports/GDP), logged; ln*XVOL* is volatility of real export receipts, logged; ln*CA* is the ratio of current account balance to GDP, logged; ln*DEBT* is the ratio of total external debt to GDP, logged.
2. Δ is the first difference operator.
3. Figures in square brackets [ ] are the p-values.

***, **, and * indicate significant at 1%, 5%, and 10% levels, respectively.

V. Conclusion

This paper examines the behavior of international reserve holdings in the ASEAN5 economies, namely Indonesia, Malaysia, the Philippines, Singapore, and Thailand, during the period of 1970-2005. The ARDL bounds testing approach developed by Pesaran et al. (2001) is utilized to test for the existence of cointegration relationship between international reserve holdings and its determinants (GDP per capita, average propensity to import, export volatility, current account balance/GDP, and total external debt/GDP). The empirical results indicate that there is a long run relationship between international reserve holdings and its determinants in the five ASEAN economies.

An important conclusion can be drawn from the empirical findings is that current account balance is significant and positively related to international reserve holdings in Indonesia, Malaysia, and Singapore. In other words, current account surplus leads to the rise in international reserve holdings in these countries.

Current account surplus is the excess savings by the private sector. Therefore, it is expected that the private sector will use these savings to finance their investment. However, due to the less developed financial markets in the region, the private sector may have limited ability to transform their savings into investment. As a result, the public sector acts as an intermediary for the private sector to recycle the savings into investment. In particular, the public sector has transformed these savings into investment in foreign currency assets in the form of the build up of international reserves (Genberg, McCauley, Park, and Persaud, 2005, p. 13).

The build up of reserves represents the investment in foreign currency assets, especially the US dollar denominated assets, by central banks. This is because nearly 70% of international reserves are denominated in the US dollars (World Bank, 2005; Genberg et al., 2005, p. 30). These reserves are usually invested in high liquidity and low return assets such as the US treasury bills and bonds (Oh, Park, Park, and Yang, 2003; World Bank 2005). Such investment of reserves represents capital outflows from East Asia to the US. These outflows of savings could be a loss of opportunities to these countries since the returns on reserves may be lower than the returns on alternative investments at home. Therefore part of reserves may be used to finance investment at home such as on health, education, and infrastructure. Such investment may minimize the savings-investment imbalance and promote long term economic growth in these countries.

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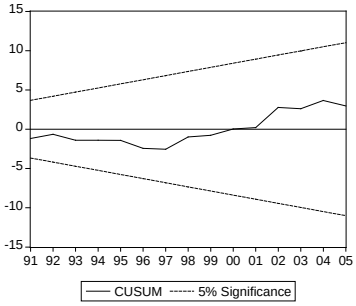
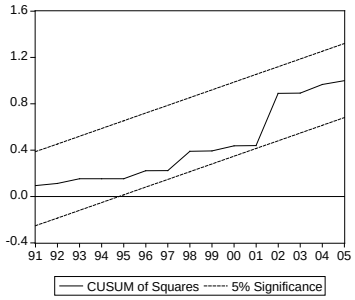
Appendix

Stability tests

Indonesia





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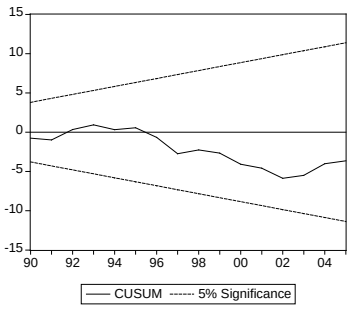

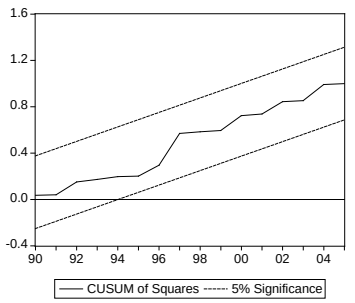

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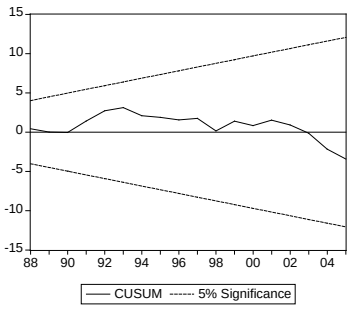
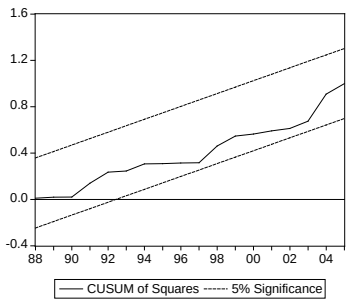
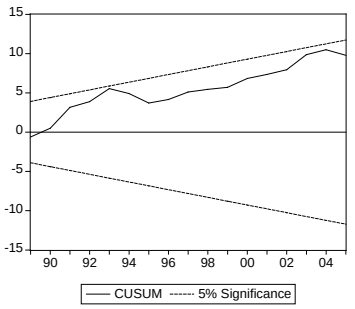
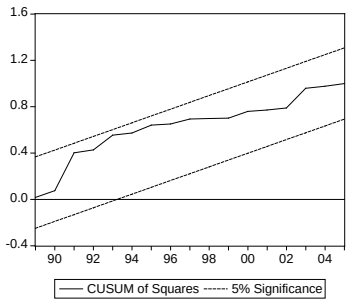


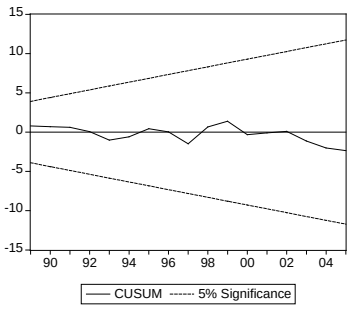


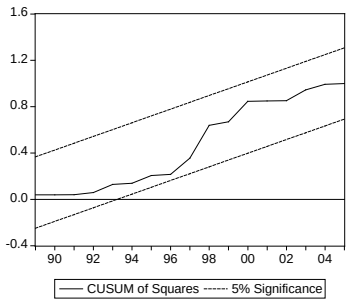
Singapore





Thailand





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