International Reserves, Current Account Imbalance and Short Term External Debt: A Comparative Study

Eliza Nor (Corresponding author)
School of Management, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia
E-mail: eliza.nor@usm.my

M. Azali
Department of Economics, Faculty of Economics and Management
University Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia
E-mail: azali@econ.upm.edu.my

Siong-Hook Law
Department of Economics, Faculty of Economics and Management
University Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia
E-mail: lawsh@econ.upm.edu.my

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Abstract

This paper examines the behavior of international reserve holdings in East Asia, ASEAN5, and non-ASEAN countries during the period 1970-2005 using panel cointegration and FMOLS. The panel cointegration tests find the existence of long run relationship between international reserve holdings and its determinants. The panel group FMOLS results indicate that current account balance is statistically significant and exert a positive impact on international reserve holdings in East Asia, ASEAN5 and non-ASEAN countries while short term external debt shows a positive and negative impact on international reserve holdings in ASEAN5 and non-ASEAN countries, respectively.

Keywords: International reserves, Current account imbalance, Short term external debt, East Asia

1. Introduction

East Asian economies have been holding high level of international reserves since the 1997 East Asian financial crisis. Among the East Asian countries, China, Japan, Hong Kong, Korea, Malaysia, Taiwan, and Singapore are ranked among the top reserve holders. Even though reserves can provide liquidity and returns, there are several implications associated with high reserve holding. High reserve holdings in these countries in recent years reflect the prudence in their economic policies, high growth prospect, and surplus in their trade accounts. At the same time, high reserves are associated with the global external payments imbalances (World Bank, 2005).

The present paper analyzes the behavior of international reserve holdings in three groups of East Asian countries namely East Asia (Indonesia, China, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand), ASEAN5 (Indonesia, Malaysia, the Philippines, Singapore, and Thailand), and non-ASEAN countries (China, Japan, Korea, and Taiwan) using panel cointegration and Fully Modified Ordinary Least Squares (FMOLS). The study includes Indonesia, the Philippines, and Thailand because, like the rest of the countries, these ASEAN countries have also increased their international reserve holdings after the crisis.

Previous studies on international reserve holdings using pooled cross section and time series data have analyzed the behavior of international reserve holdings using data from developed countries (for instance, Bahmani-Oskooee, 1984, 1985; Edwards, 1984b; Flood & Marion, 2002; Bahmani-Oskooee & Brown, 2004) and developing countries (for instance, Iyoha, 1976; Edwards, 1984a, 1985; Aizenman & Marion, 2003; Mendoza, 2004; Zhou, 2005; Ra, 2006). Studies that compare the behavior of international reserve holdings for both developed and developing countries include Frenkel (1980), Bahmani-Oskooee (1987), Lane and Burke (2001), Choi and Beak

(2004), Aizenman and Lee (2005), and Choi, Sharma, and Sromqvist (2006). Gosselin and Parent (2005) and Cheung and Xing (2007) analyze international reserves in eight and ten Asian countries, respectively.

Nor, Azali and Law (2009) investigate the behavior of international reserve holdings in the context of nine East Asian countries using panel cointegration and FMOLS. The present paper extends the study by Nor, Azali and Law (2009) by comparing the determinants of international reserve holdings for three groups of East Asian countries; namely East Asia, ASEAN5 and non-ASEAN countries.

Even though studies by Gosselin and Parent (2005) and Cheung and Xing (2007) have analyzed the behavior of international reserve holdings in the Asian context, comparison between different groups of countries have not been made. Therefore, the study intends to fill up this gap in the literature. The present study also differs from previous studies in a way that it allows comparison among the determinants of international reserve holdings among the East Asia, ASEAN5, and the non-ASEAN countries. The ASEAN countries consist of countries that were seriously hit by the 1997 Asian crisis. On the other hand, the majority of non-ASEAN countries were not badly affected by the crisis (except Korea). By incorporating two different explanatory variables namely export volatility and short term external debt, the study intends to assess the precautionary motive of these countries in holding international reserves. In other words, the study intends to answer the following question: Do the ASEAN5 and the non-ASEAN countries hold high international reserves in order to meet the precautionary motive against export volatility and short term capital flow reversals?

The remainder of this paper is organized as follows. Section Two presents the trend in international reserve holdings in East Asia, ASEAN5, and non-ASEAN countries. Section Three summarizes the methodology and data to be employed in this study. The major findings are presented in Section Four. The last section concludes the paper.

2. Trends in international reserve holdings

This section discusses the trends in international reserve holdings in East Asia, ASEAN5, and the non-ASEAN countries. Figure 1 presents the trends in international reserve holdings in billion US dollars for the three groups of East Asian countries. These groups of countries had increased their international reserves holding especially after the 1997 financial crisis. East Asia shows the highest holdings of international reserves followed by the non-ASEAN countries. This is not surprising since East Asia consists of all the nine East Asian countries with high international reserve holdings. The total amount of reserves held in the non-ASEAN countries is very close to the total reserves held in East Asia because the former group consists of China and Japan, the top two reserve holders in the world.

3. Methodology and data

This section begins with a brief discussion on the model of international reserve holdings to be applied in this study. The discussion will then proceeds with the methodology to be used in this study. Three types of tests will be carried out. The first test is the panel unit root test. This test will be performed in order to test the order of integration of the variables. The second test is the panel cointegration test which will allow us to detect the existence of long run relationship between international reserves and its determinants. The final test is the Fully Modified Ordinary Least Squares (FMOLS). FMOLS will present the elasticity of each of the variables and the direction of their impact on international reserves.

3.1 Model of international reserve holdings

The basic model of international reserve holdings for this study is based on the theory proposed by Frenkel (1974a) where international reserve holding is a function of a scale variable, propensity to import, and the variability measure. The scale variable represents the volume of international transactions. Therefore, the relationship between the scale variable and international reserve holdings is expected to be positive. Propensity to import can have a positive or negative impact on international reserve holdings. If the relationship is positive, the variable acts as a proxy for openness of an economy (Frenkel, 1974b). Otherwise, it acts as marginal cost of adjustment (Heller, 1966). The variability measure is expected to have a positive relationship with international reserve holdings given the role of reserves play as a buffer stock in dealing with the fluctuations in international transactions (Frenkel & Jovanovic, 1981).

We extend the basic model by incorporating two additional variables: current account balance and short term external debt. Current account balance is included in the model to take into account the surge in current account surplus of the nine East Asian countries, especially after the 1997-98 financial crisis. In addition, the relationship between international reserves and current account in East Asia has been widely discussed recently (see among others, Genberg, McCauley, Park, & Persaud, 2005; Tanuichi, 2006; Eichengreen & Park, 2006; International Relations Committee Task Force, 2006), indicating the growing importance of the issue. However, there is limited

empirical evidence to support this relationship. The relationship between current account balance and international reserve holdings for this study is established based on the theories presented by Dunn and Mutti (2000) and Taniuchi (2006).

The study also incorporates short term external debt as a determinant of international reserve holdings for East Asian countries. Recently, the importance of external debt in explaining international reserve holdings in emerging market economies has been widely discussed in both the empirical and theoretical literature related to international reserves. Recent papers that discuss the relationship between external debt and international reserves include Garcia (1999), Aizenman and Marion (2003, 2004), Aizenman, Lee, & Rhee (2004, 2007), Jeanne and Ranciere (2006), Jeanne (2007), and Alfaro and Kanczuk (2007). The incorporation of this variable as explanatory variable would reflect the importance of the precautionary motive for holding reserves in East Asia after the 1997-98 financial crisis as highlighted by the recent theories on international reserve holdings. Both current account balance and short term external debt can exert either a positive or negative impact on international reserve holdings.

Based on the theories summarized above, the model of international reserve holdings to be estimated in this study is as follows:

$$\ln R_{it} = \alpha_i + \theta_i \tau + \delta_{11} \ln YC_{it} + \delta_{12} \ln PIM_{it} + \delta_{13} \ln XPV_{it} + \delta_{14} \ln CA_{it} + \delta_{15} \ln STD_{it} + \varepsilon_{it} \quad \text{.....(1)}$$

where lnR is the ratio of international reserves to GDP; lnYC is the real GDP per capita (scale variable); lnPIM is the average propensity to import (imports/GDP); lnXPV is the variability in real export receipts; lnCA is the ratio of current account balance to GDP; lnSTD is the ratio of short term external debt to GDP; τ is the time trend and ε is the error term. All variables are expressed in logarithms.

3.2 Panel unit root tests

The panel unit root tests to be employed include the Levin, Lin, and Chu (LLC) and the Im, Pesaran, and Shin (IPS) tests.

3.2.1 Levin, Lin, and Chu (LLC) test

Consider the following regressions:

$$\text{(a)} \quad \Delta Y_{it} = \lambda Y_{it-1} + \varepsilon_{it} \quad \text{.....(2)}$$

$$\text{(b)} \quad \Delta Y_{it} = \alpha_{0i} + \lambda Y_{it-1} + \varepsilon_{it} \quad \text{.....(3)}$$

$$\text{(c)} \quad \Delta Y_{it} = \alpha_{0i} + \alpha_{1i}\tau + \lambda Y_{it-1} + \varepsilon_{it}, \quad -2<\lambda\leq 0 \text{ for } i=1,\ldots,N \quad \text{.....(4)}$$

where τ is the trend term.

The error term is assumed to be uncorrelated and is given by:

$$\varepsilon_{it} = \sum_{j=1}^{\infty} \phi_{ij} \varepsilon_{it-j} + \mu_{it} \quad \text{.....(5)}$$

The following hypotheses will be tested for models 1, 2, and 3:

Model (1):

$H_0 : \lambda = 0$

$H_a : \lambda < 0$

Model (2):

$H_0 : \lambda = 0$ and $\alpha_{0i} = 0$

$H_a : \lambda < 0$ and $\alpha_{0i} \in R$

Model (3):

$H_0 : \lambda = 0$ and $\alpha_{1i} = 0$

$H_a : \lambda < 0$ and $\alpha_{1i} \in R$

There are three steps to be followed in the panel unit tests proposed by Levin et al. (2002). The first step is to perform the following regression:

$$\Delta Y_{it} = \alpha_{vi} f_{vi=1} + \lambda_i Y_{it-1} + \gamma_i \sum_{L=1}^{P_i} \phi_{iL} \Delta Y_{t-i} + \varepsilon_t \qquad v=1, 2, 3 \quad \text{.....(6)}$$

In Step 2, we calculate the ratio of long-run to short-run standard deviations. The long run variance for Model 1 is given by:

$$\hat{\sigma}^2_{Yi} = \frac{1}{T-1} \sum_{t=2}^{T} \Delta Y_{it}^2 + 2 \sum_{L=1}^{\ddot{K}} W_{\overline{K}L} \left[\frac{1}{T-1} \sum_{t=2+L}^{T} \Delta Y_{it} \Delta Y_{it-L} \right] \quad \text{.....(7)}$$

The ratio of long-run standard deviation to the standard deviation of the error term is $s_i = \sigma_{Yi} / \sigma_{\varepsilon i}$ and the estimate of the above ratio is given by. $\hat{s}_i = \hat{\sigma}_{Yi} / \hat{\sigma}_{\varepsilon i}$. The third step is to calculate the panel test statistics. $\hat{e}_{it} = \lambda \eta_{it-1} + \tilde{\varepsilon}_{it}$ is the error term estimated based on the pooled cross-section time series data. The total number of observations is $N\tilde{T}$ where the average number of observations for each individual in the panel and the average lag order for each ADF regression are given by $\tilde{T} = T - \bar{p} - 1$ and $\bar{p} \equiv \frac{1}{N}\sum_{i=1}^{N} p_i$ respectively. The t-statistic to test the null of $\lambda = 0$ is:

$$t_\lambda = \frac{\hat{\lambda}}{STDEV(\hat{\lambda})} \quad \text{.....(8)}$$

where

$$\hat{\lambda} = \frac{\sum_{i=1}^{N}\sum_{t=2+p_i}^{T} \tilde{\eta}_{it-1}\tilde{e}_{it}}{\sum_{i=1}^{N}\sum_{t=2+p_i}^{T} \tilde{\eta}_{it-1}} \quad \text{.....(9)}$$

$$STDEV(\hat{\lambda}) = \hat{\sigma}_{\tilde{\varepsilon}}\left[\sum_{i=1}^{N}\sum_{t=2+p_i}^{T}\tilde{\eta}_{it-1}^2\right]^{-1/2} \quad \text{.....(10)}$$

$$\hat{\sigma}_{\tilde{\varepsilon}}^2 = \left[\frac{1}{N\tilde{T}}\sum_{i=1}^{N}\sum_{t=2+p_i}^{T}(\tilde{e}_{it} - \hat{\lambda}\tilde{\eta}_{it-1})^2\right] \quad \text{.....(11)}$$

t_λ calculated above can be applied for Model 1 since the t-statistic in Model 1 follows the normal distribution. On the other hand, the t-statistics for Models 2 and 3 deviate to negative infinity. Thus, the following adjusted t-statistic will be applied:

$$t_\lambda^* = \frac{t_\lambda - N\tilde{T}\hat{S}_N\hat{\sigma}_{\tilde{\varepsilon}}^{-2}STDEV(\hat{\lambda})\mu_{m\tilde{T}}}{\sigma_{m\tilde{T}}^*} \quad \text{.....(12)}$$

3.2.2 Im, Pesaran, and Shin (IPS) test

Im, Pesaran, and Shin (2003) propose a panel unit test based on the average of the Dickey-Fuller test statistics. The test allows for the presence of serial correlation. Consider the following regression:

$$Y_{it} = (1-\vartheta_i)\eta_i + \vartheta_i Y_{i,t-1} + e_{it} \quad \text{.....(13)}$$

$$\Delta Y_{it} = \alpha_1 + \lambda_i Y_{i,t-1} + e_{it} \quad \text{.....(14)}$$

where $\Delta Y_{it} = Y_{it} - Y_{i,t-1}$; $\alpha_1 = (1-\vartheta_i)\eta_i$; $\lambda_i = -(1-\vartheta_i)$. Below are the null and alternative hypotheses of a unit root:

$H_0 : \lambda_i = 0$, for all i
$H_a : \lambda_i < 0$, for $i = 1, 2, \ldots, N_1$
$H_a : \lambda_i = 0$, for $i = N_1+1, N_1+2, \ldots, N$

where λ_i is allowed to differ across individuals. $T \to \infty$ and followed by $N \to \infty$. The t-bar statistic is defined as:

$$\tilde{t} = \frac{1}{N}\sum_{i=1}^{N}\tilde{t}_{iT} \quad \text{.....(15)}$$

where $\tilde{t}_{iT}$ is the individual t-statistic. By assuming that T_i differs across individuals and $\tilde{t}_{iT}$ is independently distributed across individual, the standardized t-bar statistic is:

$$\tilde{t}_{std} = \frac{\sqrt{N}\{\tilde{t} - E(\tilde{t}_T)\}}{\sqrt{Var(\tilde{t}_T)}} \quad \text{.....(16)}$$

where $\tilde{t}$ is as defined by (4.39), $E(\tilde{t}_T)$ and $Var(\tilde{t}_T)$ are the mean and variance of $\tilde{t}_{iT}$, respectively.

3.3 Panel cointegration

Pedroni (1997) develops seven test statistics for panel cointegration. Four of them are panel or within-dimension. These statistics are computed by adding up the numerator and denominator terms separately like the usual time

series statistics. The second group of statistics is the group or between-dimension statistics. These statistics are computed by pooling the data along the between dimension of the panel. In the first step, the ratio that corresponds to the usual time series statistic is computed. Next, the standardized sum of the whole ratio is calculated for over the *N* dimension of the panel. The seven statistics developed by Pedroni (1997) are presented below:

Panel *v*-statistic

$$Z_v = T^2 N^{3/2}\left(\sum_{i=1}^{N}\sum_{T=1}^{T}\widehat{L}_{11i}^{-2}\widehat{\varepsilon}_{It-1}^{2}\right)^{-1} \quad \text{.....(18)}$$

Panel rho-statistic

$$Z_{rho} = TN^{1/2}\left(\sum_{i=1}^{N}\sum_{T=1}^{T}\widehat{L}_{11i}^{-2}\widehat{\varepsilon}_{It-1}^{2}\right)^{-1}\sum_{i=1}^{N}\sum_{T=1}^{T}\widehat{L}_{11i}^{-2}(\widehat{\varepsilon}_{It-1}^{2}\Delta\hat{\varepsilon}_{it} - \lambda_{\hat{i}}) \quad \text{.....(19)}$$

Panel pp-statistic

$$Z_{pp} = \left(\widetilde{\sigma}_{NT}^{2}\sum_{i=1}^{N}\sum_{T=1}^{T}\widehat{L}_{11i}^{-2}\widehat{\varepsilon}_{It-1}^{2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{T=1}^{T}\widehat{L}_{11i}^{-2}(\widehat{\varepsilon}_{It-1}^{2}\Delta\hat{\varepsilon}_{it} - \lambda_{\hat{i}}) \quad \text{.....(20)}$$

Panel adf-statistic:

$$Z_{adf} = \left(s_{NT}^{2}\sum_{i=1}^{N}\sum_{T=1}^{T}\widehat{L}_{11i}^{-2}\widehat{\varepsilon}_{It-1}^{*2})^{-1/2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{T=1}^{T}\widehat{L}_{11i}^{-2}\widehat{\varepsilon}_{It-1}^{2}\Delta\hat{\varepsilon}_{it}^{*} \quad \text{.....(21)}$$

Group rho-statistic:

$$\widetilde{Z}_{rho} = TN^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\widehat{\varepsilon}_{It-1}^{2}\right)^{-1}\sum_{t=1}^{T}(\widehat{\varepsilon}_{It-1}^{2}\Delta\hat{\varepsilon}_{it} - \lambda_{\hat{i}}) \quad \text{.....(22)}$$

Group pp-statistic

$$\widetilde{Z}_{pp} = N^{-1/2}\sum_{i=1}^{N}\left(\widehat{\sigma}_{i}^{2}\sum_{t=1}^{T}\widehat{\varepsilon}_{It-1}^{2}\right)^{-1/2}\sum_{t=1}^{T}(\widehat{\varepsilon}_{It-1}^{2}\Delta\hat{\varepsilon}_{it} - \lambda_{\hat{i}}) \quad \text{.....(23)}$$

Group adf-statistic

$$\widetilde{Z}_{adf} = N^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\widehat{s}_{i}^{*2}\varepsilon_{It-1}^{*2}\right)^{-1/2}\sum_{t=1}^{T}(\widehat{\varepsilon}_{It-1}^{*}\Delta\hat{\varepsilon}_{it}^{*} - \lambda_{\hat{i}}) \quad \text{.....(24)}$$

where

$$\widehat{\lambda}_i = \frac{1}{T}\sum_{s=1}^{k_i}\left(1-\frac{s}{k_i+1}\right)\sum_{t=s+1}^{T}\widehat{\mu}_{it}\widehat{\mu}_{it-s}\ ;\ \ \widehat{s}_i^{\,2} \equiv \frac{1}{T}\sum_{t=1}^{T}\widehat{\mu}_{it}^{2}\ ;\ \ \hat{\sigma}_i^{2} = \hat{s}_i^{2} + 2\hat{\lambda}_i\ ;\ \ \widetilde{\sigma}_{NT}^{2} \equiv \frac{1}{N}\sum_{i=1}^{N}\hat{L}_{11i}^{-2}\hat{\sigma}_i^{2}$$

$$\widehat{s}_i^{*2} \equiv \frac{1}{t}\sum_{t=1}^{T}\widehat{\mu}_{it}^{*2}\ ;\ \ \widehat{s}_{NT}^{*2} \equiv \frac{1}{N}\sum_{i=1}^{N}\hat{s}_i^{*2}\ ;\ \text{and}\ \ \hat{L}_{11i}^{2} = \frac{1}{T}\sum_{i=1it}^{T}\hat{n}_{it}^{2} + \frac{2}{T}\sum_{s=1}^{k_i}\left(1-\frac{s}{k_i+1}\right)\sum_{t=s+1}^{T}\hat{n}_{it}n_{it-s}\ .$$

3.4 Fully modified ordinary least squares (FMOLS)

The FMOLS methodology presented in this section has been developed by Pedroni (1996, 2004). Consider the following regression

$$Y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it} \quad \text{.....(25)}$$

$$x_{it} = x_{it-1} + e_{it} \qquad \text{or} \qquad e_{it} = x_{it} - x_{it-1} = \Delta x_{it}$$

where the vector of errors is stationary with asymptotic covariance matrix Ω_i. Ω_i is defined below:

$$\Omega_i = \begin{bmatrix}\Omega_{11i} & \Omega'_{21i}\\ \Omega_{21i} & \Omega_{22i}\end{bmatrix} \quad \text{.....(26)}$$

where Ω_{11i} is a scalar of long run variance of the errors ε_{it}; Ω_{22i} is m x m vector of long run covariance among the errors e_{it}; Ω_{21i} is m x 1 vector of long run covariance between ε_{it} and e_{it}. Ω_i differs across individual members in the panel and it can be defined as

$$\Omega_i = \Omega_i^c + \Theta_i + \Theta_i \quad \text{.....(27)}$$

where Ω_i^c is the contemporaneous covariance and Θ_i is the weighted sum of covariances. The FMOLS estimator is

$$\beta_{FMOLS} - \beta = \left(\sum_{i=1}^{n} \hat{R}_{22i}^{-2} \sum_{t=1}^{T} (x_{it} - \bar{x}_{it})^2 \right)^{-1} \sum_{i=1}^{N} \hat{R}_{11i}^{-2} \hat{R}_{22i}^{-2} \left(\sum_{t=1}^{T} (x_{it} - \bar{x}_i) m_{it}^* - T\hat{\lambda}_i \right) \quad (28)$$

where $m_{it}^* = m_{it} - \frac{\hat{R}_{21i}}{\hat{R}_{22i}} \Delta x_{it}$ and $\hat{\lambda}_i \equiv \hat{\Theta}_{21i} + \hat{\Omega}_{21i}^c - \frac{\hat{R}_{21i}}{\hat{R}_{22i}} (\hat{\Theta}_{21i} + \hat{\Omega}_{21i}^c)$. β_{FMOLS} converges to the true value at the rate of $T(N)^{1/2}$ and its distribution is presented below:

$$T\sqrt{N}(\beta_{FMOLS}^* - \beta) \to N(0, \upsilon) \quad (29)$$

where $\upsilon = \begin{matrix} 2 \; iff \; \bar{x}_i = \bar{y}_i = 0 \\ 6 \; else \end{matrix}$ as $T \to \infty$ and $N \to \infty$. Below is the pooled panel FMOLS statistic

$$t_{FMOLS} = (\beta_{FMOLS} - \beta) \left(\sum_{i=1}^{n} \hat{R}_{22i}^{-2} \sum_{t=1}^{T} (x_{it} - \bar{x}_i)^2 \right)^{-1/2} \to N(0,1) \quad (30)$$

t_{FMOLS} is standard normal as $T \to \infty$ and $N \to \infty$.

3.4 Data

This study utilizes annual data covering the period of 1970-2005. Export volatility is measured by the standard deviation of real export receipts (Edison, 2003). Real export receipts were calculated as the nominal exports deflated by the respective countries' consumer price index. All absolute values are expressed in million US dollars. Sources of data are summarized in Table 1.

4. Discussion of findings

Prior to performing panel cointegration tests, we performed panel unit root test using Im, Pesaran, and Shin (IPS) (2003) and Levin, Lin, and Chu (LLC) (2002) procedures. The results of IPS and LLC indicate that all variables are I(1) or stationary at first difference (Table 2). Therefore, we proceed with panel cointegration tests. The results of panel cointegration are presented in Table 3.

Table 4 presents the results of FMOLS for East Asia, ASEAN5 and the non-ASEAN countries. GDP per capita (lnYC) appears with a positive sign and significant in these groups of countries implying that the higher the volume of international transactions, the higher the international reserve holdings. Propensity to import (lnPIM) and export volatility (lnXPV) also appear with positive coefficients but significant only in the first two groups of countries. Positive coefficient of lnPIM indicates that an economy with high degree of openness would hold high international reserves. A positive relationship between lnXPV and lnR in East Asia and ASEAN5 suggests that these groups of countries are concerned with the volatility in export receipts and thereby would increase their international reserve holdings as their export volatility increases.

Current account balance (lnCA) appears with a positive coefficient in East Asia, ASEAN5, and non-ASEAN countries. The result implies that current account surplus leads to high international reserve accumulation in these groups of countries.

Short-term external debt (lnSTD) is inversely related to international reserve holdings in the ASEAN5 countries, indicating the role of short-term external debt as a substitute for international reserves. This result is consistent with the findings by Lane and Burke (2001) who find an inverse relationship between international reserve holdings and short term external debt for emerging economies.

Unlike in the ASEAN5 countries, short term external debt shows a positive relationship with international reserve holdings in the non-ASEAN countries. This result suggests that short term external debt is a complement for international reserves. In other words, a rise in short term external debt supports the precautionary motive for holding reserves. Such precautionary actions taken by the non-ASEAN countries may explain the ability of these countries to weather the adverse impact of short term capital flow reversals during the 1997 crisis.

The insignificance impact of short term debt in East Asia may due to the negative and positive impact of short term debt in ASEAN5 and the non-ASEAN countries, respectively. The impact is cancelled out for East Asia since this group consists of the combination of ASEAN5 and the non-ASEAN countries.

5. Conclusion and policy implications

This paper analyzes the determinants of international reserve holdings in three groups of East Asian countries namely East Asia, ASEAN5, and the non-ASEAN countries for the period 1970-2005 using panel cointegration tests developed by Pedroni (1997, 2004) and FMOLS (Pedroni, 1996, 2000). The empirical results suggest the existence

of long run relationship between international reserve holdings and its determinants (real GDP per capita, propensity to import, real export volatility, the ratio of current account balance to GDP, and the ratio of short term external debt to GDP).

The following conclusions can be drawn from the findings. First, current account balance is positive and significant in East Asia, ASEAN5 and non-ASEAN countries. This implies that a rise in current account surplus leads to international reserve accumulation in these groups of countries. This is because during the period with current account surplus, monetary authorities intervene in foreign exchange market through the purchase of foreign currencies and the sale of domestic currency (Dunn & Mutti, 2000; Taniuchi, 2006). Even though current account surplus is the excess savings by the private sector, the private sector has limited means to transform their savings into investment abroad since most of the East Asian countries are still developing their financial markets and systems. As a result, the public sector converts the savings into investment in foreign currency assets in the form of the build up of international reserves (Genberg et al., 2005, p. 13).

Second, the ASEAN5 and the non-ASEAN countries show different motive in holding international reserves. While short term external debt is a complement for international reserves in the non-ASEAN countries, the variable acts as a substitute for international reserves in the ASEAN5 economies. This result suggests that the non-ASEAN countries take a precautionary action by holding international reserves against short term capital flow reversals. On the other hand, in ASEAN5, short term debt is used to finance international transactions. The ASEAN5 economies also hold international reserves in order to protect against volatility in export receipts. In summary, both the ASEAN5 and the non-ASEAN countries show some differences in their motive of holding international reserves.

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Table 1. Data and Sources

Data	Source(s)
Consumer price index	International Financial Statistics (IMF, 2007) Directorate General of Budget, Accounting, and Statistics, Republic of Taiwan (2008)
Current account balance	International Financial Statistics (IMF, 2007) Bank of Japan (1994).
Current account balance (as percent of GDP)	World Development Indicators (World Bank, 2007)
Exports (line 70..d) Imports, cif (line 71..d) Total reserves minus gold (line 1l.d)	International Financial Statistics (IMF, 2007)
Short-term external debt	Key Indicators of Developing Asian and Pacific Countries (ADB, various issues)
GDP Real GDP per capita	World Development Indicators (World Bank, 2007) Groningen Growth and Development Center and the Conference Board (2007)

Table 2. Results of Panel Unit Root

Panel A: East Asia								
	Constant				**Constant and trend**			
	IPS		**LLC**		**IPS**		**LLC**	
Variable	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference
lnR	0.48	-9.84***	-0.51	-9.38***	0.20	-8.38***	-0.18	-5.79***
lnYC	1.04	-8.59***	-0.42	-9.23***	-1.22	-7.77***	1.42	-7.81***
lnPIM	0.05	-16.22***	0.55	-17.67***	-0.17	-14.00***	2.51	-14.94***
lnXPV	-0.44	-14.362***	0.99	-13.72***	-0.21	-11.65***	6.53	-8.99***
lnCA	-0.41	-13.84***	1.19	-8.03***	-0.63	-11.11***	2.88	-3.51***
lnSTD	0.88	-11.48***	84.46	-13.24***	-0.36	-10.66***	-0.87	-12.35***
Panel B: ASEAN5								
	Constant				**Constant and trend**			
	IPS		**LLC**		**IPS**		**LLC**	
Variable	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference
lnR	0.86	-8.30***	-0.17	-9.39***	-1.17	-7.62***	-0.05	-6.81***
lnYC	0.73	-6.75***	-1.93**	-7.98***	0.16	-5.82***	-0.12	-7.07***
lnPIM	0.48	-13.79***	-0.13	-15.05***	-0.41	-11.83***	0.21	-12.56***
lnXPV	0.52	-10.42***	2.03	-9.68***	0.17	-9.37***	6.09	-8.18***
lnCA	-1.12	-9.21***	2.94	-2.04**	-0.73	-12.48***	11.19	-12.44***
lnSTD	-1.27	-9.85***	-2.11**	-12.40***	-1.03	-9.33***	13.09	-11.98***
Panel C: Non-ASEAN Countries								
	Constant				**Constant and trend**			
	IPS		**LLC**		**IPS**		**LLC**	
Variable	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference
lnR	1.22	-5.56***	1.07	-3.56***	-1.17	-6.65***	0.82	-5.50***
lnYC	0.68	-5.37***	-1.79**	-4.98***	-0.02	-5.17***	1.21	-3.83***
lnPIM	-0.34	-8.96***	1.57	-9.40***	0.67	-7.81***	3.59	-8.28***
lnXPV	-1.25	-9.90***	-0.52	-9.80***	-0.49	-7.01***	11.40	-4.47***
lnCA	-0.92	-10.45***	1.539	-10.58***	-0.99	-9.89***	-2.02**	-9.78***
lnSTD	1.58	-6.30***	75.61	-5.87***	-1.22	-5.69***	7.96	-4.99***

Note: *** and ** indicate significant at 1% and 5% levels, respectively. The null hypothesis for both the IPS and LLC tests is that the series is non-stationary. lnR is the ratio of international reserves to GDP, logged; lnYC is real GDP per capita, logged; lnPIM is average propensity to import (imports/GDP), logged; lnXPV is volatility of real export receipts, logged; lnCA is the ratio of current account balance to GDP, logged; and lnSTD is the ratio of short term external debt to GDP, logged.

Table 3. Results of Panel Cointegration Tests

Panel A: East Asia				
	Without Time Dummies		**With Time Dummies**	
Statistic	**Constant**	**Constant + Trend**	**Constant**	**Constant + Trend**
Within group				
Panel v-statistic	-0.23	0.09	-0.16	-1.12
Panel rho-statistic	1.09	0.41	-0.06	0.53
Panel pp-statistic	-0.59	-3.03***	-2.46**	-2.95***
Panel adf-statistic	-1.39	-2.63***	-2.38**	-3.32**
Between group				
Group rho-statistic	1.62	1.18	0.90	1.46
Group pp-statistic	-0.86	-3.72***	-2.34**	-2.76***
Group adf-statistic	-1.87	-3.52***	-2.45**	-3.59***
Panel B: ASEAN5				
	Without Time Dummies		**With Time Dummies**	
Statistic	**Constant**	**Constant + Trend**	**Constant**	**Constant + Trend**
Within group				
Panel v-statistic	0.50	0.62	0.25	-0.61
Panel rho-statistic	-0.31	-0.14	-0.13	0.59
Panel pp-statistic	-2.43**	-4.03***	-2.54**	-1.95
Panel adf-statistic	-3.16***	-3.74***	-2.60***	-2.22**
Between group				
Group rho-statistic	0.40	0.56	0.58	1.34
Group pp-statistic	-2.46**	-4.45***	-2.63	-1.79
Group adf-statistic	-3.64***	-4.14***	-2.76***	-2.24**
Panel C: Non-ASEAN countries				
	Without Time Dummies		**With Time Dummies**	
Statistic	**Constant**	**Constant + Trend**	**Constant**	**Constant + Trend**
Within group				
Panel v-statistic	-0.50	-0.07	0.42	-0.12
Panel rho-statistic	1.51	0.52	-0.50	-0.58
Panel pp-statistic	1.36	-0.59	-2.04**	-3.19***
Panel adf-statistic	1.04	-0.36	-1.81*	-3.04***
Between group				
Group rho-statistic	1.66	0.85	0.12	0.10
Group pp-statistic	1.47	-0.60	-1.94*	-3.00***
Group adf-statistic	1.26	-0.65	-1.70*	-2.98**

Note: *, ** and *** indicate significant at 10%, 5% and 1% levels, respectively. Critical values for 10%, 5% and 1% levels of significance are 1.64, 1.96 and 2.56, respectively. v-statistic has the critical value of 1.64 while the rho-statistic, pp-statistic, and adf-statistic have the critical value of -1.64. The null hypothesis for Pedroni's panel cointegration test is that there is no cointegration.

Table 4. Results of Panel Group FMOLS

Variable	East Asia	ASEAN5	Non-ASEAN Countries
lnYC	0.78***	0.79***	0.77***
	(7.51)	(5.06)	(5.60)
lnPIM	0.55**	0.57***	0.53
	(2.43)	(3.32)	(-0.06)
lnXPV	0.09***	0.10***	0.08
	(4.00)	(4.63)	(0.81)
lnCA	0.23***	0.17***	0.31***
	(4.48)	(3.67)	(2.62)
lnSTD	0.00	-0.03***	0.04***
	(-0.44)	(-3.58)	(3.34)

Note: ** and *** indicate significant at 5% and 1% levels, respectively. The null hypothesis is $\beta_i = 0$. Figures in parentheses ( ) are t-statistics. lnGDPC is real GDP per capita, logged; lnPIM is average propensity to import (imports/GDP), logged; lnXPV is volatility of real export receipts, logged; lnCA is the ratio of current account balance to GDP, logged; lnSTD is the ratio of short term external debt to GDP, logged.

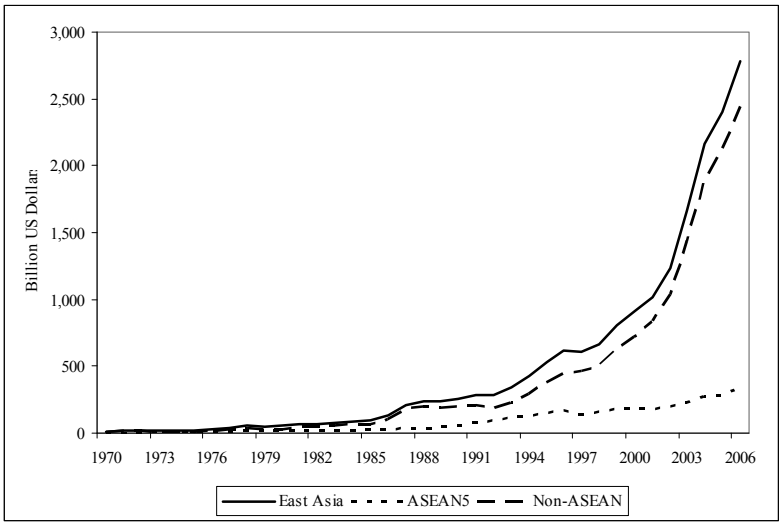

Figure 1. East Asia, ASEAN5, and non-ASEAN Countries: International Reserves (in Billion US dollars) (Source: Lane and Milesi-Ferretti, 2009)