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INTERNATIONAL RESERVES, CURRENT ACCOUNT IMBALANCE AND EXTERNAL DEBT: EVIDENCE FROM MALAYSIA

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ABSTRACT

The purpose of the study is to analyze both the short-run and long-run demand for international reserves in Malaysia for the period 1970-2004. The autoregressive distributed lag (ARDL) bounds testing approach proposed by Pesaran, Shin, and Smith (2001) is used to test for the existence of cointegration relationship between the demand for international reserves and its determinants. The empirical results suggest that current account balance and short-term external debt significantly affect the demand for international reserves both in the long run and short run.

JEL Classification: E58, F39

Keywords: International reserves, Current account imbalance, Short-term external debt, Malaysia

1. INTRODUCTION

The theory of demand for international reserves had been established by an influential contribution of Heller (1966). Since then, the theory has been refined and extended. Built on this theory, empirical studies on the demand for international reserves have become important, especially during the period after the collapse of the Bretton Woods system in 1972. During the 1970s and 1980s, studies in this area usually used cross-country data and generally compared the behaviour of reserve demand between fixed and floating exchange rate systems or between developed and developing countries. See for instance, Frenkel (1974, 1980), Hipple (1975), Edwards (1983), and Bahmani-Oskooee (1987).

Since the 1990s until present, there has been an increasing number of studies on the demand for international reserves that use time series data and focus on individual countries. Even though more attention has been paid to country-specific studies, there is still a lack of studies on individual South East Asian countries. Therefore the present study attempts to fill up this gap in the literature.

Malaysia is a an interesting case study since it has substantially increased its holdings of international reserves since after the 1997-98 East Asian financial crisis. During the crisis, Malaysia experienced a reduction in its international reserves by US$6.2 billion or 23%. The decline could be associated with the short term capital reversals during the crisis, where the monetary authorities helped to finance short-term external debt of the banking sector. After the crisis, international reserves in Malaysia showed an increasing trend. The figure rose from US$20 billion in 1997 to US$70 billion by end of 2005, an increase by 3.5 times in eight years. An increase in the demand for international reserves after the crisis may be due to the fact that the authorities realized the importance of international reserves in moderating the impact of abrupt short term capital reversals on the economy during the crisis. Thus, the objective of the study is to investigate the factors that led to the sizeable increase in international reserve holdings of Bank Negara Malaysia.

2. LITERATURE REVIEW

This section is divided into two parts. The first part reviews the theory of demand for international reserves. The second part presents the

empirical review of the literature on the demand for international reserves.

2.1 THEORY OF DEMAND FOR INTERNATIONAL RESERVES

Basically, central bank holds international reserves to fulfill the following motives: transactions, precautionary, and/or mercantilist. The theory of demand for international reserves are developed based on these motives. Frenkel and Jovanovic (1981) developed a buffer stock model for optimal level of international reserves based on the theory of transactions and precautionary demand for money (see Frenkel and Jovanovic, 1980). They argue that there are two type of costs involved for holding reserves: the opportunity cost and the cost of adjustment. The opportunity cost of reserves is the forgone earnings from alternative investment, while the cost of adjustment is the cost incurred due to reserve depletion. High level of reserves would increase the opportunity cost but reduce the cost of adjustment. The optimal level of reserves is reached when both costs are minimized. The effect of sovereign risk on the precautionary demand for international reserves was first introduced by Ben-Bassat and Gottlieb (1992). In their model, the cost of reserve depletion can be considered as the cost of probability of default on external debt. Reduction in international reserves may lead to a perception that a country is not able to repay its external debt. This in turn may result in the difficulty of the country in obtaining future external borrowings. A rise in international reserves would reduce the default risk while a rise in external debt would increase the risk. However, an increase in international reserves from external borrowing is beneficial only when both the levels of reserves and debt are relatively low. High level of external debt may lead to a rise or a decline in international reserves. In other words, external debt may act as a complement or a substitute for international reserves.

More recently, the theory of precautionary demand for international reserves has become popular in explaining the high demand of international reserves in emerging markets. Aizenman and Marion (2003) depart from the buffer stock model of the demand for international reserves by assuming international reserves as precautionary savings and they take into consideration a country with some difficulty in obtaining foreign capital from the international capital markets and facing the problem of tax collection. Given these problems, a country with precautionary reserves would be beneficial.

An alternative theory of the demand for international reserves has also been developed recently. For instance, Aizenman and Lee (2006) attribute the large hoarding of international reserves in emerging markets to the theory of monetary mercantilism. They argue that monetary mercantilism is associated with competitive exchange rate devaluation. Neighboring countries may also take similar action by increasing their level of international reserves to increase their export competitiveness, thereby resulting in competitive hoarding of reserves. Even though monetary mercantilism may allow a country to maintain nominal exchange rates at a desired level, inflationary pressure may result in the appreciation of the real exchange rate, thereby reducing export competitiveness of the home country.

2.2 EMPIRICAL STUDIES ON THE DEMAND FOR INTERNATIONAL RESERVES

This section reviews some empirical studies on the demand for international reserves during 1990-2007. Empirical studies can be divided into two categories: cross-country and individual- country analyses. Cross-country studies usually group countries into developed and developing countries. Even though many studies on individual countries have concentrated on Asian countries, most of them use time series data from the following countries: (1) China/Taiwan (Ford and Huang, 1994; Huang, 1995; Huang and Shen, 1999; Wei and Zhu, 2000); (2) Korea (Aizenman, Lee and Rhee, 2007; Ra, 2007; Jo, 2007); and (3) India (Ramachandran, 2004, 2006; Ramachandran and Srinivasan, 2007; Shegal and Chandran, 2007; Prabheesh, Malathy, and Madhumati, 2008). In the subsequent paragraphs, we will first review some of the empirical studies that employ cross-country data. We will then proceed with the review of the studies on individual countries.

2.2.1 CROSS-COUNTRY STUDIES

Lane and Burke (2001) analyzed the demand for international reserves for one hundred and two developed and developing countries covering the period 1981-1995 and found that smaller developed countries held higher reserves than larger countries and highly indebted developing countries held less reserves. Using panel data for twenty developed countries during the period of 1971-1997, Flood and Marion (2002) concluded that the buffer stock model worked well in the era of high capital mobility.

Edison (2003) estimated the demand for international reserves for one hundred and twenty two emerging market economies during 1980-1996. He used real GDP per capita and population as proxies for scale variable and export volatility as a proxy for variability measure. The results from multiple regression indicated that the demand for international reserves were positively related to the size of the economy and trade openness. However, the variability measure, even though correctly signed, was not significant.

Based on the results from panel regression for more than one hundred emerging economies, Aizenman & Marion (2003) came up with the following conclusions: (1) countries with high sovereign risk & high cost of tax collection hold high level of reserves; (2) countries facing political corruption hold low level of reserves; and (3) demand for international reserves in emerging markets can be explained by the precautionary motive.

Using Kalman Filter approach, Bahmani-Oskooee and Brown (2004) analyze the demand for international reserves for nineteen industrial countries and found that the reserve demand functions are not stable over time.

2.2.2 INDIVIDUAL COUNTRY STUDIES

Elbadawi (1990) estimated the demand for international reserves for Sudan during 1971-1982. The results indicated that the demand for reserves in Sudan exhibited constant returns to scale and the variability measure was positive and significant, reflecting the precautionary motive for reserve holdings. Ford and Huang (1994) examined the demand for international reserves in China during 1952-1991. They concluded that domestic monetary disequilibrium significantly affected reserve demand and the monetary authority was responsive to correct deviation from desired levels of reserves from the preceding period.

Huang and Shen (1999) applied the seasonal error correction model to estimate the demand for international reserves in Taiwan during 1961Q1-1995Q2. Their results suggested that the monetary authorities were slow to adjust to the desired level of reserves from the previous period. Furthermore, the precautionary motive was not an important determinant of reserve demand in Taiwan. Using quarterly data for the period 1985Q1-1997Q4, Bandinger (2004) found strong economies of scale in holding reserves in Austria and concluded that the transactions motive represented the foreign exchange demand by the private sector.

The precautionary motive for holding reserves has been tested using quarterly data for Korea during 1994-2003 (see Aizenman, Rhee, and Lee, 2007). Their results suggest that the Korean holding of international reserves is consistent with the precautionary motive since variables such as short-term external debt and foreign portfolio holdings are found to be significant in affecting reserve demand after the 1997-98 East Asian financial crisis.

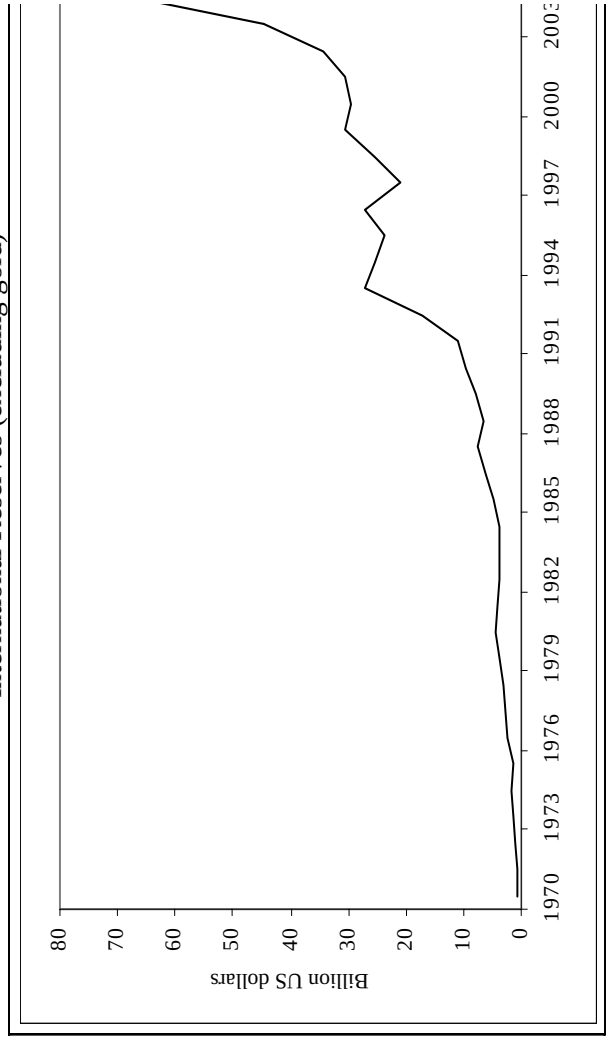
Following Frenkel and Jovanovic (1981), Ramachandran (2004, 2007) and Ramachandran and Srinivaran (2006) utilized the buffer stock model to analyze the demand for international reserves for India and they found that this model predicts well the reserve demand for India. Similarly, Cifarelli and Paladino (2006) also estimated the reserve demand based on the buffer stock model using the Johensen cointegration approach for ten emerging economies in Asia and Latin America. They attributed the high demand for international reserves in these countries to the "fear of floating" as well as the mercantilist motive.

3. TRENDS IN INTERNATIONAL RESERVES IN MALAYSIA

Figure 1 presents the trend in international reserves of Malaysia during 1970-2004. International reserves in Malaysia showed an increasing trend from 1970 to 1993. The amount increased from US$616 million in 1970 to US$27 billion in 1993, an increase by forty four times in twenty three years. The figure declined from US$27 billion in 1996 to US$21 billion in 1997 (during the crisis period), a reduction of 23%. After the crisis, the Malaysian international reserve position showed an improvement. The level of reserves was around US$30 billion during 1999-2001. The reserves showed a dramatic increase in 2003-2005 and by end of 2005, the figure stood at US$70 billion, an increase by 6% compared to the year before.

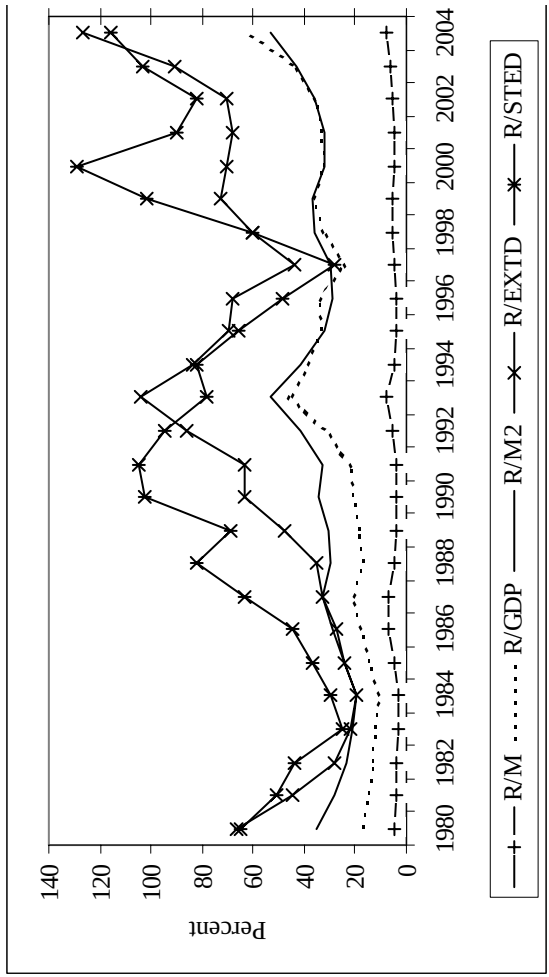
Figure 2 presents the trends in the Malaysian international reserves as scaled to imports, GDP, M2, total external debt, and short term external debt. A few years prior to the crisis, the ratios of reserves/GDP (R/GDP), reserves/M2 (R/M2), reserves/total external debt (R/EXTD), and reserves/short term external debt (R/STD) showed a declining trend. This indicated the weakening of the international reserve position of the central bank prior to the crisis. After the crisis, the trends of these ratios reversed. This is due to the huge reserve accumulation

FIGURE 1
International Reserves (excluding gold)



Source of Data: IMF, International Financial Statistics

FIGURE 2
International Reserves as Scaled to Imports, GDP, M2, Total External Debt, an Short-term External Debt



by Bank Negara Malaysia since the crisis. The ratio of reserves/imports (R/M) was quite stable during 1980-2004.

4. THEORETICAL FRAMEWORK AND MODEL SPECIFICATION

4.1 THE BASIC MODEL

Theoretically, the demand for international reserves is a function of a scale variable, variability measure, and propensity to import. Following Frenkel (1974), the functional form of the demand for international reserves is given by:

$$R = \beta Y^{\delta_1} P^{\delta_2} V^{\delta_3} \quad (1)$$

where R is international reserves; b is a constant; Y is a scale variable; P is propensity to import; V is the variability measure; d_i is the elasticity of the demand for international reserves with respect to the scale variable, propensity to import, and variability measure.

A scale variable (such as import, real GDP, GDP per capita, or total population) is usually used to represent the volume of international transactions. A scale variable represents the potential relation between reserves and the volume of trade since the monetary authorities who own reserves do not directly get involved in trade (Huang, 1995). This variable is expected to have a positive relationship with the demand for international reserves because reserve holdings should increase with an increase in the volume of international transactions (Aizenman and Marion, 2003). According to Huang (1995), the marginal propensity to import is expected to have a negative relationship with the demand for international reserves. This is because the marginal cost of adjustment is inversely related to marginal propensity to import (MPI). If MPI is high, the adjustment cost would be low. The low adjustment cost is associated with the use of expenditure reducing policy that reduces the need to maintain high reserves. Therefore, the higher the MPI, the lower the demand for international reserves. However, Frenkel (1974) argued that most empirical studies utilized data on average propensity to import (imports/GDP), which is a proxy for a country's openness. High openness means high vulnerability to external shocks. Thus, the higher the openness of the economy, the higher the demand for international reserves.

The variability measure (variability in the balance of payments or export receipts) is expected to have a positive relationship with the demand for international reserves. This relationship arises from the idea that reserves play a role as a buffer stock in dealing with the fluctuations in international transactions (Frenkel and Jovanovic, 1981). Higher variability means that reserves reach their lower limit more frequently and thus there would be a rise in the cost of adjustment. To minimize such cost, central banks should hold high level of reserves (Aizenman and Marion, 2004).

Recent studies that have included these variables are Bandinger (2004), Choi and Beak (2004), Aizenman and Lee (2005), Gosselin and Parent (2005), Khan and Ahmad (2005), Choi, Sharma and Stromqvist (2006), and Bird and Mandilaras (2008).

4.2 DEMAND FOR INTERNATIONAL RESERVES AND THE CURRENT ACCOUNT

The relationship between the demand for international reserves and the current account for this study is established based on the theory presented by Dunn and Mutti (2000) and Dooley, Folkert-Landau and Garber (2003).

Disequilibrium in the balance of payments due to current account imbalance (current account deficit or surplus) may affect the exchange rates of a country. Current account surplus is usually associated with the inflows of foreign currencies in the domestic economy due to the payments received from exports. Such inflows would result in an increase in the demand for domestic currency. This in turn, may result in the appreciation of the exchange rate. During the period with current account surplus, the central bank intervenes in the foreign exchange market through the purchase of foreign currencies and the sale of domestic currency (Dunn and Mutti, 2000). Such action may avoid serious appreciation of the domestic currency, which in turn may allow the home country to retain its export competitiveness.

The purchase of foreign exchange in the foreign exchange market by the central bank during the period with current account surplus would result in the rise in the international reserve holdings of the central bank (McCauley, 2003). The rise in the demand for international reserves may be an inadvertent consequence of current account surplus. Dooley, Folkert-Landau and Garber (2003) argue that the rise in the international reserve holdings of central banks of the East Asian emerging economies

is the result of an export-led growth strategy pursued by these economies. From this argument, it can be inferred that the rise in the demand for international reserves of these countries may be associated with the policy of maintaining current account surpluses through export promotions.

Bird and Mandilaras (2008) attribute the relationship between the demand for international reserves and current account to the theory that has been advanced by Machlup (1966). Machlup (1966) argues that the rise in the international reserve holdings of the central bank may not be explained by conventional factors, for instance, the ratio of reserves to import. He makes an analogy between his wife's need for clothes and the central bank's holdings of international reserves. This theory is known as the Mrs Machlup's Wardrobe hypothesis. With regard to this hypothesis, central banks may increase their holdings of international reserves throughout the years without having any specific motive for doing so.

The relationship between the demand for international reserves and current account surplus can be positive or negative. If central banks purchase foreign exchange in the foreign exchange market during a period with current account surplus, there would be a rise in the country's international reserves (Dunn and Mutti, 2000). On the other hand, a negative relationship arises when a surplus provides a signal that a country has become less exposed to external shocks. As a result, there would be a decline in the demand for international reserves (Aizenman, Lee and Rhee, 2007). When a country experiences a current account deficit, the central bank sells foreign exchange (purchases domestic currency) in the foreign exchange market (Dunn and Mutti, 2000). This would lead to the decline in the international reserve holdings of the central bank.

4.3 DEMAND FOR INTERNATIONAL RESERVES AND EXTERNAL DEBT

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 the country's international reserves.

Aizenman, Lee, and Rhee (2004) extended the model on the demand for international reserves suggested by Aizenman and Marion (2004) to include 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 may improve the country's welfare. The model accounts for the impact of the failure of a country to make external debt repayments on output, which, in turn, could increase the probability of recession.

The model assumes an emerging market economy with two periods, where output is subject to a productivity shock in the second period. The country can borrow externally in the first period. However, there is a limit on its external borrowing since there is a possibility of default in the second period. The country may adopt different type of exchange rate regimes (fixed exchange rate or managed float). In the first period, the country borrows at a specified rate and owes interest plus principal in the second period. The country will default if it faces a serious reduction in output in the second period. If the country defaults, creditors can expropriate some of its export revenues or resources. However, creditors do not have access to the country's international reserves. The country will repay its debt if the cost of repayment is less than the cost of penalty. In the second period, the amount of fund transfer to creditors is given by:

$$T_2 = \min\left[(1+i)D, \beta Y_2\right], \qquad 0 < \beta < 1 \tag{2}$$

where T is the amount of resource transfer; i is interest cost on debt; D is the amount of external debt; β is the cost of penalty; and Y is the output level. Output in period t (t = 1, 2) is given by:

$$Y_1 = 1 \qquad 0 \le p \le 1$$

$$Y_2 = \begin{cases} 1+\lambda & \text{prob} = 0.5 \\ 1-\lambda & \text{prob} = 0.5(1-p) \\ (1-\lambda)(1-v) & \text{prob} = 0.5p \end{cases} \tag{3}$$

where λ is the productivity shock in the second period and ν is the rate of further decline in output.

In the first period, the country borrows D amount of external debt and the amount of reserves accumulated is R. The country experiences output shock of λ or - λ at the beginning of period 2. If the country defaults partially on its debt, it faces a more serious outcome. The output would drop from 1-λ to (1-λ)(1-ν).

The interest cost on external debt depends on the condition that the expected return on the debt is equal to the risk-free rate of return:

$$E[T_2] = (1 + i_f)D \tag{4}$$

where i_f is the risk-free rate. Based on the above assumptions, for debt level D, partial default would occur in period 2 under bad economic conditions. This leads to an additional reduction in output with probability p. If , the expected fund transfer to creditors is:

$$E[T_2] = 0.5[(1+i)D + (1-p)\beta(1-\lambda) + p\beta(1-\lambda)(1-\nu)] \tag{5}$$

$D \leq \frac{0.5[(1+i)D + (1-p)\beta(1-\lambda) + p\beta(1-\lambda)(1-\nu)]}{1+i_f}$ The maximum amount of debt borrowed, D_{max}, equals the expected repayment when the debt reaches the level that could encourage partial payment regardless economic conditions:

$$D_{\max} = \frac{0.5[(1+\lambda)\beta + (1-p)\beta(1-\lambda) + p\beta(1-\lambda)(1-\nu)]}{1+i_f} \tag{6}$$

It is assumed that there are no fiscal considerations and the initial level of debt and reserves are zero. In this model, it is not necessary to hold reserves after period 2. The representative agents face the following budget constraints:

(7)

where *H, L, VL* refer to the patterns of consumption in period 2 (high, low, and very low respectively). The level of external debt and reserves are chosen to maximize the agents utility:

$$\max\left\{U(A_1)+\frac{0.5}{1+d}\left[U(A_{2,H})+(1-p)U(A_{2,L})+pU(A_{2,VL})\right]\right\} \quad (8)$$

where d is the discount rate. Partial payments could result in credit rationing (for example, the difficulty in obtaining trade credit). Probability p depends on the ratio of partial default/international reserves. For,

$$D(1+i) > \beta(1-\lambda) \quad (9)$$

partial payments occur when consumption is low (a state with a reduction in output or when 1 is negative). Partial payment (P_L)is the difference between the agreed repayment amount and the actual repayment in state

$$L:\ P_L = D(1+i) - \beta(1-\lambda) \quad (10)$$

The probability that partial payment would lead to the reduction in output is given by:

$$p = \begin{cases} p[\dfrac{P_L}{(1+i_f)R}] & if \quad P_L \geq 0 \\ 0 & if \quad P_L < 0 \end{cases} \tag{11}$$

External debt can have either a positive or negative relationship with the demand for international reserves. A positive relationship indicates that an increase in external debt leads to an increase in international reserves. On the other hand, a negative relationship indicates the role of external debt as a replacement for international reserves. In this case, external debt can be used to finance external transactions (Eaton and Gersowitz, 1980).

4.4 EMPIRICAL MODEL OF THE DEMAND FOR INTERNATIONAL RESERVES

Based on the above theory, the model of the demand for international reserves for this study is developed as follows:

$$\ln R_t = \beta_0 + \beta_1 \ln YC_t + \beta_2 \ln PIM_t + \beta_3 \ln XPV_t + \beta_4 \ln CA_t + \ln STD_t + \varepsilon_t \tag{12}$$

where ln$R$ is real reserves, logged; b_0 is a constant; lnYC is real GDP per capita (scale variable), logged; lnPIM is the average propensity to import (imports/GDP), logged; lnXPV is the variability in export receipts, logged; lnCA is real current account balance, logged; and lnSTD is real short-term external debt, logged.

5. METHODOLOGY

5.1. UNIT ROOT TESTS

Unit root tests are performed in order to test for the presence of unit roots and to identify the order of integration of the variables. Unit root

tests to be applied in this study are the Augmented Dickey Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests.

5.2. ARDL BOUNDS TEST

Following Pesaran, Shin and Smith (2001), the vector auto-regression (VAR) of order *p* is developed for the demand for international reserves in Malaysia:

$$v_t = \beta + \sum_{i=1}^{p} \lambda_i z_{t-i} + \varepsilon_t \tag{15}$$

where z_t is the vector consisting of both the dependent variable (real reserves) and independent variables (real GDP per capita, propensity to import, export volatility, real current account balance, and real short term external debt). b is the constant term, l is the vector of parameters of lag *i*, *t* is time or trend term, and e is the vector of error terms. The dependent variable must be I(1) while the independent variables can either be *I*(0) or *I*(1) (Pesaran, Shin and Smith, 2001).The error correction model of the ARDL model can be expressed as:

$$\Delta v_t = \beta_0 + \beta_1 t + \theta_1 v_{t-1} + \theta_2 w_{t-1} + \sum_{i=1}^{p} \eta_i \Delta v_{t-i} + \sum_{i=0}^{p} \lambda_i \Delta w_{t-i} + \varepsilon_t \tag{16}$$

The third and the fourth expressions containing qs 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 D is the first difference operator. We develop the Unrestricted Error Correction model based on the assumptions made by Pesaran, Shin and Smith, 2001 in Case III, that is, unrestricted intercepts and no trends. In this case, it is assumed that $b_0 \neq 0$ and $b_1=0$. Therefore the following Unrestricted Error Correction Model based on (10) is developed:

$$\begin{aligned}\Delta \ln R_t = {} & \delta_{10} + \lambda_{11} \ln R_{t-1} + \lambda_{12} \ln YC_{t-1} + \lambda_{13} \ln PIM_{t-1} \\ & + \lambda_{14} \ln XPV_{t-1} + \lambda_{15} \ln CA_{t-1} + \lambda_{16} \ln STD_t \\ & + \sum_{k=1}^{a} \alpha_{11,k} \Delta \ln R_{t-k} + \sum_{k=1}^{b} \alpha_{12,k} \Delta \ln YC_{t-k} \\ & + \sum_{k=1}^{c} \alpha_{13,k} \Delta \ln PIM_{t-k} + \sum_{k=1}^{d} \alpha_{14,k} \Delta \ln XPV_{t-k} \\ & + \sum_{k=1}^{e} \alpha_{15,k} \Delta \ln CA_{t-k} + \sum_{k=1}^{f} \alpha_{16,k} \Delta \ln STD_{t-k} + \varepsilon_{1t}\end{aligned} \tag{17}$$

Following Bardsen (1989), the long run elasticities are calculated by dividing the coefficient of independent variables at the first lag (multiplied with a negative sign) by the coefficient of the first lag of the dependent variable. There are three steps in the ARDL Bounds test. First, (17) is estimated using Ordinary Least Square (OLS). Second, Wald tests are conducted to test the existence of long run relationship between the demand for international reserves and its determinants. This test is performed by imposing restrictions on the long run coefficients of real reserves, real GDP per capita, propensity to import, export volatility, real current account balance, and real short-term external debt. The null and alternative hypotheses for (17) are constructed as follows:

$$H_0 : \lambda_{11} = \lambda_{12} = \lambda_{13} = \lambda_{14} = \lambda_{15} = \lambda_{16} = 0$$
$$H_A : \lambda_{11} \neq \lambda_{12} \neq \lambda_{13} \neq \lambda_{14} \neq \lambda_{15} \neq \lambda_{16} \neq 0$$

Third, the computed F-statistic is compared with the critical value from Table CI(iii) in Pesaran, Shin and Smith, 2001) and Table for Case III in 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.

6. DATA AND RESULTS OF THE UNIT ROOT TESTS

6.1 DATA

This study utilizes annual data covering the period 1970-2004. The reason for using annual data is due to the difficulty in obtaining higher frequency data (monthly or quarterly data). Volatility in export receipts is the three-year rolling standard deviation of real export receipts. All variables are expressed in real terms as we deflate the nominal reserves, imports, exports, current account balance, and short-term external debt by the US consumer price index. Real GDP and real GDP per capita are expressed in constant 2000 US dollars. All absolute values are expressed in million US dollars.

Data on reserves do not include gold. This is because some studies (for example, Edison, 2003; Aizenman and Marion, 2003, 2004; and Aizenman, Lee and Rhee, 2007) utilize series from line 11.d (total reserves minus gold) from IMF *International Financial Statistics*. According to Edison (2003), gold is no longer the main asset in reserve holdings. Presently, gold consists of only about 3% of total reserves in emerging market countries. He suggests that gold be valued at constant price (instead of market price) if the focus is on reserve buildup. This technique would remove the effect of valuation. Furthermore, the amount of gold held by the sample countries (measured in million fine troy) is quite stable over time. Appendix A summarizes the data used in this study and their sources.

6.2 RESULTS OF UNIT ROOT TESTS

Table 1 presents the results of unit root tests performed at level and first difference for the series ln*R,* ln*YC,* ln*PIM,* ln*XPV,* ln*CA*, and ln*STD*. Based on the results of the ADF and KPSS tests, it can be concluded that ln*R,* ln*YC,* ln*PIM,* and ln*STD* are stationary at first difference, while ln*XPV* and ln*CA* are stationary at level. Since the dependent variable (ln*R*) is I(1) and the independent variables are either I(0) or I(1), we can proceed with the ARDL Bounds test.

TABLE 1

Panl A Constant

	ADF		KP
Variables	Level	First Difference	Level
*ln*R	0.9891 (8)	-2.8108 (8)*	0.6852 (5)**
ln*YC*	-1.2656 (0)	-4.7974 (0)***	0.6910 (5)**
ln*PIM*	-1.7299 (4)	-3.1197 (7)**	0.4057 (3)*
ln*XPV*	-3.8300 (1)***	-6.7967 (0)***	0.7132 (4)**
ln*CA*	-4.3520 (0)***	-9.2730 (0)***	0.0920 (2)
ln*STD*	-2.0068 (0)	-5.6979 (0)***	0.5226 (4)**

Panel B Constant and Trend

	ADF		KP
Variables	Level	First Difference	Level
lnR	-2.9786 (7)	-3.6008 (1)*	0.1299 (11)**
lnYC	-3.8698 (8)**	-4.8875 (0)***	0.0700 (4)
lnPIM	-3.5131 (7)*	-4.8284 (1)***	0.0639 (3)
lnXPV	-4.0012 (0)**	-6.8636 (0)***	0.0738 (1)
lnCA	-4.2745 (0)**	-9.1584 (0)***	0.0921 (2)
lnSTD	-1.8217 (1)	-5.8516 (0)***	0.1654 (4)**

Notes: *** , **, and * indicate significant at 1%, 5%, and 10% levels respectively. The null hypothesis for ADF te stationary while the null hypothesis for KPSS test is that the series is stationary. The critical values for ADF and MacKinnon (1996) and Kwiatkowski, Phillips, Schmidt, and Shin (1992), Table 1, respectively.

TABLE 2
UECM Results

Panel A: Long Run Coefficients		
Variable	Coefficients	*t*-statistics
Constant	-2.9127	-1.4123
$\ln R_{t-1}$	-0.8607***	-4.1349
$\ln YC_{t-1}$	0.8295**	2.8394
$\ln PIM_{t-1}$	0.5723*	1.9067
$\ln XPV_{t-1}$	0.4735***	3.7615
$\ln CA_{t-1}$	0.3375***	5.4771
$\ln STD_{t-1}$	0.0154**	2.3093

Panel B: Short Run Coefficients			
Variable	Coefficients		*t*-statistics
$\Delta\ln R_{t-2}$	-0.2933		-1.4615
$\Delta\ln YC_t$	4.5025***		4.3237
$\Delta\ln YC_{t-2}$	1.3139		1.5393
$\Delta\ln PIM_t$	-1.3999***		-3.4438
$\Delta\ln PIM_{t-1}$	-0.9232***		-4.3958
$\Delta\ln XPV_t$	0.3331***		4.7137
$\Delta\ln XPV_{t-1}$	0.1976**		2.9354
$\Delta\ln XPV_{t-2}$	0.3791***		4.0242
$\Delta\ln CA_t$	0.0533**		2.3000
$\Delta\ln CA_{t-1}$	-0.2003***		-5.3460
$\Delta\ln STD_t$	0.0234**		2.5139
$\Delta\ln STD_{t-1}$	0.0145		1.6626
R^2	0.8612	*F*-statistics	4.4798
AIC	-1.2976		

Note: ***, **, and * indicate significant at 1%, 5%, and 10% levels, respectively. Figures in parenthesis are *t*-statistics. ln*R* is real reserves, logged; ln*YC* is real GDP per capita, logged; ln*PIM* is average propensity to import (imports/GDP), logged; ln*XPV* is volatility of real export receipts, logged; ln*CA* is real current account balance, logged; ln*STD* is real short-term external debt, logged.

TABLE 3
Results of Diagnostics Tests

Test	Results	
	$F(1)$	$F(2)$
Breusch-Godfrey Serial Correlation LM Test	0.2882 [0.6012]	2.3123 [0.1451]
ARCH LM Test	0.1648 [0.6877]	1.1785 [0.3231]
Normality Test	3.9318 [0.1400]	
Ramsey RESET Test	0.0370 [0.8507]	

Note: Figures in square brackets [ ] are p-values

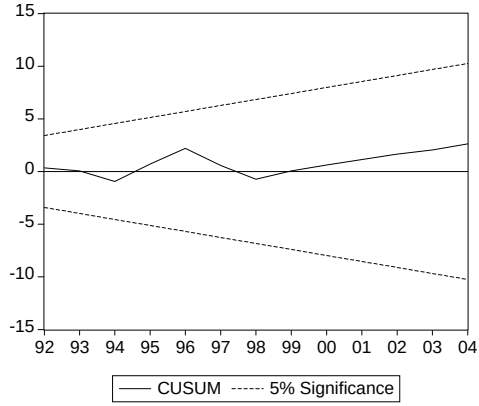
7. EMPIRICAL RESULTS AND INTERPRETATION

Table 2 presents the unrestricted error correction model based on Equation (17). The goodness of fit of the model (the R-squared) is reasonably high (0.86) and the standard error of regression and the Akaike's Information Criterion remain low. The model has also passed several diagnostic tests as summarized in Table 3 and Figure 3.

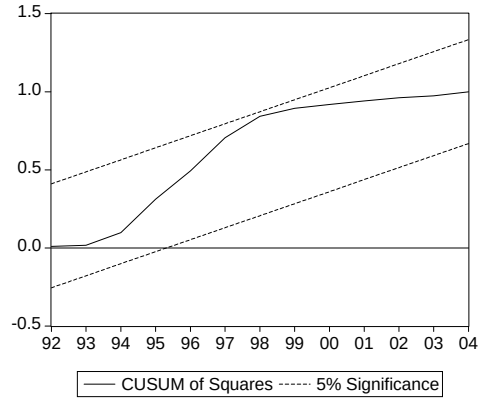
Wald tests based on bounds testing approach are conducted to test for the existence of a long run relationship. The results are summarized in Table 4. The computed F-statistic is 6.48 and greater than the upper critical values at 1% significance level based on both Pesaran, Shin and Smith, (2001)and Narayan (2005). Therefore, the null hypothesis of no cointegration can be rejected and we conclude that there is a long run relationship between the demand for international reserves (real reserves) and its determinants.

Table 5 presents the long-run elasticities and the short-run causality based on Equation 17. All variables are significant and positively related to the demand for international reserves in the long run. ln*YC* shows the greatest impact on reserve demand in the long run. A 1% increase in the volume of international transactions leads to a rise in the demand for international reserves by 0.96%. This result is in contrast with that of Cheung and Xing (2007), who find insignificant impact of GDP per capita on reserve demand in Malaysia during 1980-2004. The positive coefficient of ln*PIM* indicates that the higher the openness of the economy, or the higher the exposure to external shock, the higher the demand for international reserves. This result is also in contrast with Cheung and Xing (2007), whose result suggest that propensity to import does not assert any impact on reserve demand in Malaysia. Demand

FIGURE 3
Stability Tests
CUSUM



CUSUM of Squares



for international reserves is positively related to the volatility in export receipts. In other words, the demand for international reserves increases with the rise in the volatility of international transactions. The coefficient of ln*CA* is 0.39 indicating that a 1 percent increase in current account surplus leads to the accumulation of international reserves by 0.39 percent This result is in contrast with the findings by Bird and Mandilaras (2008), who find insignificant effect of current account balance for emerging economies.

TABLE 4
Results of the ARDL Bounds Tests

Computed *F*-statistic		6.4754***		
Unrestricted Intercept & No Trend	Critical Value			
	Pesaran et al (2001)		Narayan (2005)	
Significance Level	Lower Bound	Upper Bound	Lower Bound	Upper Bound
	$k = 5$		$k = 5$; $n = 35$	
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

Note: *** indicates significant at 1% level. 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. k and n are the number of regressors and observations, respectively.

TABLE 5
Long-run Elasticities and Short-run Causality
Dependent Variable: Real Reserves (ln*R*)

Variable	Long-run Elasticities	Short-run Causality
*ln*YC	0.9637**	9.3488***
ln*PIM*	0.6650*	10.223***
ln*XPV*	0.5501***	10.268***
ln*CA*	0.3921***	15.7896***
ln*STD*	0.0178**	4.7269**

Note: ***, **, and * indicate significant at 1%, 5%, and 10% levels, respectively. ln*R* is real reserves, logged; ln*YC* is real GDP per capita, logged; ln*PIM* is average propensity to import (imports/GDP), logged; ln*XPV* is volatility of real export receipts, logged; ln*CA* is real current account balance, logged; ln*STD* is real short term external debt, logged.

Short-term external debt is significant and positively related to reserve demand, indicating the importance of precautionary demand for reserves in moderating the impact of short term capital flow reversals during the crisis.

The short-run causality is calculated using the Wald test by testing the joint significance of the short-run variables which are expressed in the first difference. Based on the short-run results, all variables, namely GDP per capita, propensity to import, export volatility, current account balance and short-term external debt are found to be significant in affecting reserve demand in the short-run.

8. CONCLUSIONS AND POLICY IMPLICATIONS

This paper examined the long run and short run demand for international reserves in Malaysia for the period of 1970-2004. The empirical results indicate that there is a long run and short run relationship between international reserves and GDP per capita, average propensity to import, export volatility, current account balance, and short-term external debt.

Two important conclusions can be drawn based on the empirical findings. First, current account balance is positively related to the demand for international reserves. This implies that an increase in the current account surplus leads to a rise in the demand for international reserves. After the crisis, current account has consistently recorded surpluses, at least until 2004. These surpluses are an important source of foreign exchange for the country. An increase in foreign exchange receipts leads to an increase in reserve accumulation. The rise in international reserves during the period with current account surplus is associated with the purchase of foreign currencies and the sale of domestic currency by the monetary authorities in the foreign exchange market.

The Central Bank has to incur opportunity cost for choosing to hold reserves. This opportunity cost of reserves is the difference between the returns on reserves and the returns on alternative investment. To reduce the opportunity cost, part of the reserves may be invested for economic development such as health, infrastructure, and education. Investment in infrastructure includes the new investment in, and the maintenance of, electricity, telecommunications, roads, railroads, water and sanitation.

Secondly, short-term external debt are positively related to the demand for international reserves. This result suggests that the

government is holding reserves for precautionary purposes or as self-insurance against future crises. To reduce the impact of a crisis, it is advisable that the government hold a high level of reserves. Meanwhile, the private sector may reduce the level of short-term external debt by increasing the average maturity of their external debt. This action may mitigate the probability of abrupt short-term capital reversals during turbulent times.

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