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HOARDING OF INTERNATIONAL RESERVES: A COMPARISON OF THE ASIAN AND LATIN AMERICAN EXPERIENCES

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Hoarding of International Reserves: A Comparison of the Asian and Latin American Experiences*

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Abstract

We examine the empirical determinants of the demand for international reserves and compare the experiences of some Asian and Latin American economies. Our empirical results indicate that different vintages of the model of international reserves give different inferences about the appropriate level of international reserves. The developed and developing economies have equations of the demand for international reserves that are quite different from each other. Further, the Asian economies and the Latin American economies have different empirical determinants of the demand for international reserves. Our results highlight the complexity of evaluating whether an economy is holding an excessive or deficient level of international reserves – the inference can be heavily dependent on the choice of a benchmark model. A direct comparison affirms the perception that the Asian economies tend to hold more international reserves than the Latin American economies.

Keywords: Foreign Exchange Reserves, Macro Determinants, Financial Factors, Institutional Variables, Excessive Hoarding of International Reserves
JEL Classification: F31, F33, F34, F36

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1. Introduction

The recent Asian financial crisis of 1997-98 is quite different from some previous crises including the 1982 Mexican debt crisis and the 1994 Tequila crisis. Prior to the Asian financial crisis, the so-called "First Generation" and "Second Generation" crisis models were developed to offer some insight into the earlier crises. While the First Generation models focus on the inconsistency between fundamentals and a pre-assigned fixed exchange rate, the Second Generation models highlight the role of public information, the self-fulfilling crisis, and the trade-off between credibility and flexibility when devaluation entails a fixed cost (Flood and Garber, 1984; Flood and Marion, 1999; Krugman, 1979; Obstfeld, 1995, 1996). While these models offer a useful interpretation of crises observed in Latin America in the 1970s-80s and other crises, the 1997-98 crisis in East Asia has led to the "Third Generation" models that focus on the role of balance sheet factors and financial sector weaknesses, as well as the possibility of bailouts by international financial institutions, central banks, and governments (Krugman, 1999; Corsetti, Pesenti and Roubini, 1999; Chang and Velasco, 1999; Dooley, 1997).

An astonishing development in the aftermath of the 1997-98 Asian Financial crisis has been the large-scale build-up of international reserves among Asian economies – even among those who were not affected by the crisis. China, perhaps, is the one of the most dramatic cases – its holding of international reserves increased by more than five times between 2000 and 2006.[1] Japan, the developed economy in the region, saw its international reserves increase by more than 1.5 times during the same period. Indeed, the 1996 top ten list of global international reserve holders had five Asian economies but the 2006 list had eight. As of 2006, the eight Asian economies on the top ten list accounted for 59% of the world's total international reserves.

While there may be a number of precautionary reasons for holding international reserves, the recent steep increase in holdings of international reserves, nonetheless, has raised concerns in both policy and academic circles. It is because excessive accumulation of international reserves can distort both global and domestic balances, and thus, can be a serious threat to the stability of the world economy. It is perceived that some economies are holding international reserves at a level that is difficult to rationalize by conventional factors (Jeanne and Ranciere, 2006; Rodrik 2006). One commonly used yardstick of international reserve adequacy is the reserves-to-imports ratio. The oft-used rule of thumb is to maintain international reserves worth three months of imports. At the end of 2006, the Asian economies China, Taiwan, Japan, India, Malaysia, and Korea, for example, had international reserves that covered 16.21, 15.79, 11.73, 14.97, 7.52, and 7.41 months of imports.

In contrast, we do not observe such an upsurge of international reserve holdings after the previous crises in Latin America. Figure 1 compares the amounts of international reserves held by East Asian and Latin American economies. It is apparent that, during the last 20 years, the Asian economies tended to hold more international reserves than the Latin American economies. Although Latin American economies

[1] During the same period, Russia's holding of international reserves increased by more than 10 times!

have been increasing their holdings of international reserves in the last few years – possibly due to the increase in commodity prices – the gap between the two regions appears to be expanding. Indeed, at the end of 2006, the Latin American region had an average reserves-to-imports ratio of 5.02 while the Asian region had an average ratio of 6.89.[2]

Against the backdrop, a natural set of questions to ask is: "Why do economies in these two regions display such dissimilar international reserve holding behaviors?" and "Is the observed difference driven by the differences in their economic conditions?" The theme of our paper is to empirically assess the determinants of the demand for international reserves and to compare the Asian and Latin American economies' holdings of international reserves in the post-Asian financial period. The choice of the sample period is motivated by the fact that, after the Asian crisis, these economies show dramatic discrepancies in their holdings of international reserves.

The game plan is the following. First, we determine an empirical framework for evaluating holdings of international reserves. The existing literature, however, offers a few alternative specifications of the demand for international reserves. Instead of selecting a model *a priori*, we opt to conduct the comparison based on a few commonly used specifications. Further, we generate the empirical estimates from two sets of data – one comprises data from developed and developing economies and the other consists of data from selected Asian and Latin American economies. Second, we use the alternative empirical specifications obtained from different theories and from different samples of economies to compare and contrast the international reserve holding behaviors of the Asian and Latin American economies.

The reminder of the paper is organized as follows. In the next section, we offer a brief review of the literature on the demand for international reserves. Section 3 presents the basic empirical equations and the related estimation results. The comparison exercise is reported in Section 4. Some concluding remarks are given in Section 5.

2. A Brief Review on the Determinants of International Reserves

The theoretical reasons for holding international reserves range from transaction demand, precautionary motives, collateral asset argument, and mercantilist behavior. Although numerous studies have attempted to unravel the relevance of these factors, the debate on the determinants of international reserves is far from settled. The difficulty of explicating international reserve holding behavior may be attributed to the anecdotal view that the role and functionality of international reserves have evolved along with developments in global financial markets. For instance, the holding of international reserves is now increasingly susceptible to capital account transactions because of the continuing financial globalization and innovative advancements in international capital markets. The recent financial crisis also signified the importance of expectations, policy credibility, and institutional structures in determining the adequate level of international reserves.

[2] The top five largest Latin American holders of international reserves: Bolivia, Brazil, Venezuela, Peru, and Argentina and their reserves-to-imports ratio are, respectively, 11.34, 10.67, 9.38, 7.78, and 7.43.

In the following exercise, we group the determinants of international reserves into three categories: traditional macro variables, financial variables, and institutional variables. Readers familiar with the effects of these variables on demand for international reserves may wish to proceed directly to Section 3.

The group of traditional macro variables consists of the propensity to import, volatility of real export receipts, international reserve volatility, the opportunity cost of holding international reserves, real *per capita* GDP, and population. These variables have been commonly considered as determinants since the 1960s. In the early stage of theorization, the demand for international reserves is mainly attributed to the need for accommodating imbalances arising from trade account transactions, which are the main type of balance of payments transactions before the development of the modern international capital market.

Heller (1966) argues that the demand for international reserves should be negatively related to the marginal propensity to import because a higher propensity to import (m) implies a smaller marginal cost of balance of payments adjustment (i.e., $1/m$), and, thereby, a lower demand for international reserves. However, most empirical exercises – including Heller (1966)– use the average, and not the marginal, propensity to import. Frenkel (1974a) points out that the average propensity to import, i.e., the imports-to-GDP ratio, measures trade openness and, therefore, should have a positive effect on the demand for international reserves because of the precautionary holding to accommodate external shocks through trade channels.

The role of international reserve volatility is illustrated by the buffer stock model of international reserves. Extending the model for cash holding, Frenkel and Jovanovic (1981) illustrate the effect of international reserve volatility in a stochastic inventory control setting. In some studies, the volatility of real export receipts is used as an alternative proxy for the uncertainty of balance of payments (Kelly, 1970).

The opportunity cost of holding international reserves, which is commonly measured by the difference between the local interest rate and the US interest rate, has been included in models to compare the costs and benefits of holding international reserves (Heller, 1966; Frenkel and Jovanovic, 1981). The effect of the opportunity cost is quite inconspicuous in the empirical literature because of the difficulty in assigning a single interest rate for international reserve assets while accounting for their risks.[3]

Following Aizenman and Marion (2003), Edison (2003), and Lane and Burke (2001), real *per capita* GDP and population are included to capture the size effect on international reserve holding. In view of the Baumol (1952) square-root rule for transaction demand, we expect these size variables to have a negative coefficient.

The second group of explanatory variables includes money supply, external debts, and capital flows. The use of money in explaining the hoarding of international reserves can be dated back to the 1950s. Courchene and Youssef (1967), for example, appeal to the monetarist model of balance of payments to

[3] In our exercise, due to data availability, we use the differentials between the US Treasury bill rates and domestic lending rates.

justify the use of money in their international reserve regression (Johnson, 1958).[4] More recently, de Beaufort Wijnholds and Kapteyn (2001) argue that money stock in an economy is a proxy for potential capital flight by domestic residents and, therefore, can be a measure of the intensity of the "internal drain."[5]

The implications of external debts and capital flows on the holding of international reserves have received considerable attention after the Asian financial crisis. While capital inflows can enhance economic growth by supplementing domestic savings and/or financial intermediaries and improving the efficiency of domestic financial markets, a sudden capital flow reversal can devastate an economy, trigger a crisis, and cause significant output losses.[6] Generally, developing economies with inefficient and immature financial sectors are vulnerable to the adverse effect of capital reversals. Thus, it is conceived that economies with a high level of exposure to external financing, whether they are debts, FDI, or portfolio flows, should hold a high level of international reserves to reduce its vulnerability to financial crises and to boost confidence in their currencies (Aizenman et al., 2007; Feldstein, 1999).[7]

Dooley, et al. (2005) offers an alternative view on the link between capital flows and international reserves. These authors argue that under the current international financial architect (the "Bretton Woods II system"), emerging market economies accumulate international reserves to secure FDI inflows from the center country, i.e., the United States. In other words, the economies in the "periphery" hold international reserves to ensure importation of financial intermediaries from abroad. According to this view, capital inflows are positively correlated with holdings of international reserves.

The effect of capital flows on international reserve accumulation, however, is not unambiguous. Besides the insurance motive, international reserves can be viewed as a substitute for external financing. In this case, an economy may hold a lower level of international reserves if it has secured access to international capital markets and, thus, the correlation between the two variables is negative.

Lane and Milesi-Ferretti (2006) note that the types, volumes, and directions of capital flows have changed over time. Hence, the use of an aggregate variable may not capture the differential effects of different types of capital flows. In the following, we examine the individual effects of net external liabilities (i.e., external liabilities minus assets) in debt financing, portfolio equity financing, and FDI, as well as their growth rates.

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4 One version of the "global monetarism" argues that an increase in international reserves is driven by an excess demand for money, which implies a balance of payments surplus whereas a fall in international reserve holding is caused by an excess supply of money, which implies a balance of payments deficit.

5 de Beaufort Wijnholds and Kapteyn (2001) refer to the research on the Early Warning System and argue that the international reserves-to-M2 ratio is a reasonable measure of international reserve adequacy.

6 Edwards (2004) analyzes the sudden stop of capital inflows and current account performance in the last three decades. Caballero and Panageas (2004) suggest that international reserve accumulation is not the best insurance against sudden stops.

7 In general, it is suggested to cover one year amortized value of various types of liabilities over a wide range of possible outcomes. The role of short-term external debts is brought to the center stage by the popular Greenspan-Guidotti-rule (Greenspan, 1999).

The third group of explanatory variables is institutional variables. It has been argued that institutional characteristics like corruption, political stability, and capital controls affect the holding of international reserves. Aizenman and Marion (2003, 2004) and Alfaro et al. (2003), for example, show that holdings of international reserves are influenced by political uncertainty and corruption. Our empirical exercise includes a selected group of institutional variables pertaining to financial openness and political/societal conditions.

3. Demand for International Reserves

In this section, we estimate the demand for international reserves. The explanatory variable we considered is a scaled measure of international reserves given by $r_{i,t} = R_{i,t} / GDP_{i,t}$, where $R_{i,t}$ is a generic notation of economy i's holding of international reserves and $GDP_{i,t}$ is economy i's gross domestic product at time t. Both variables are measured in US dollars. Scaling international reserves facilitates comparison across countries of different sizes. For brevity, we call the ratio $r_{i,t}$ international reserves. The sample period covers 1999 to 2005. The choice of the post-Asian financial crisis period is motivated by the sharp difference between the Asian and Latin American economies' behaviors noted in Section 1. Further, there is evidence that the demand for international reserves changes after the crisis and, thus, the focus on the post-crisis period is relevant for the current discussion (Cheung and Ito, 2007).

3.1 Model Specifications

Following the discussion in the previous section, we consider three groups of explanatory variables. They are denoted by $X_{i,t}$ $(=\{x_{i,k,t}; k = 1,..., N_x\})$ that contains the traditional macro variables, $Y_{i,t}$ $(=\{y_{i,k,t}; k = 1,..., N_y\})$ the financial variables, and $Z_{i,t}$ $(=\{z_{i,k,t}; k = 1,..., N_z\})$ the institutional variables.

In addition to these variables, we include some dummy variables to account for other characteristics of an economy. The first type is the exchange rate regime dummy variable. The common wisdom suggests that economies with fixed exchange rates and crawling pegs have incentives to hold international reserves to fight against exchange rate market pressures. The second type is a geographic dummy variable. Its inclusion is motivated by the folklore that economies in certain geographic regions such as East Asia tend to hoard high levels of international reserves especially after the Asian financial crisis. The third type is the crisis dummy variable. The variable is meant to capture the effects of a currency crisis, a banking crisis, or a twin crisis on hoarding of international reserves. The fourth type is an interaction variable that assumes a value of one if the economy is located in a region which is inflicted by a crisis. This dummy variable is included to evaluate the possible contagion effect of crises on international reserve accumulation. The dummy variables that capture other characteristics of the economies are collected under $D_{i,t}$ $(=\{d_{i,k,t}; k = 1,..., N_d\})$.

The effects of these variables on hoarding of international reserves are studied using the following cross-sectional regression equations:

$$r_i = c + X_i' \alpha + \varepsilon_i \quad (1)$$

$$r_i = c + X_i' \alpha + D_i' \delta + \varepsilon_i \quad (2)$$

$$r_i = c + X_i' \alpha + Y_i' \beta + D_i' \delta + \varepsilon_i \quad (3)$$

$$r_i = c + X_i' \alpha + Y_i' \beta + Z_i' \gamma + D_i' \delta + \varepsilon_i \quad (4)$$

The variables r_i, X_i, Y_i, Z_i, and D_i are, respectively, the period averages of $r_{i,t}$, X_{it}, $Y_{i,t}$, $Z_{i,t}$, and $D_{i,t}$. The use of period averages allows us to avoid complexity that arises from unknown and, possibly varying, dynamics and focus on the (time-)average behavioral relationship. The coefficient vectors α, β, γ, and δ are conformable to their associated explanatory variables. The intercept and disturbance term are given by c and ε_i, respectively.

Specification (1) is an international reserve demand equation of the 1970s vintage. The economy characteristic dummy variables are included in specification (2). Specification (3) includes the financial variables (Y_i) that are often referred to in the recent discussion on the demand for international reserves. The effects of institutional factors (Z_i) are examined in specification (4). These four specifications allow us to gauge the relative contributions of these different groups of explanatory variables.

3.2 Estimation Results

Note that we have a quite a large group of explanatory variables under consideration. Table A.1 in the Appendix lists these variables, their definitions, and their sources. Some summary statistics are given in Table A.2. As expected, not all of these variables show up significant in the regression analyses. We adopted a general to specific approach to investigate the determinants of international reserves. Starting with all the candidate variables, we dropped those insignificant ones and kept only the significant estimates.

In anticipation of their different types of demand behavior, we estimated the international reserve demand equations separately for developed and developing economies (Frenkel 1974b). Table 1 presents the estimation results from 22 developed and from 76 developing economies. The estimation results pertaining to the regression equations (1) to (4) are given under the columns labeled (1) to (4). It is quite evident that the developed and developing economies have different patterns of demand for international reserves.

For developed economies, the traditional macroeconomic variables population and international reserve volatility are found to be significant. The population variable captures the size effect. The negative estimates are suggestive of the economies of scale effect – the larger the population size, the smaller the (*per capita*) demand for international reserves. The positive effect of international reserve volatility is

consistent with the precautionary motive. A larger amount of international reserves is held when an economy is facing a higher level of uncertainty represented by the variability of its international reserves (Frenkel and Jovanovic, 1981).[8]

Interestingly, economies with crawling peg exchange rate regimes tend to hold more international reserves. The result corroborates the "unstable middle" hypothesis, which suggests crawling peg regimes are more prone to currency crises than flexible or fixed exchange rate regimes (Willett, 2003). With a weak credibility of maintaining a crawling peg, an economy has to hold a large amount of international reserves to pre-empt speculative attacks. The finding is supportive of the notion of precautionary holdings.

Among the financial variables, the net value of portfolio liabilities is a significantly negative determinant. The negative sign suggests that these economies regard international reserves and portfolio flows as substitutes. The substitutability effect appears to be a debtor economy's phenomenon because the dummy variable for the creditor economies, those which provide portfolio financing, is not found to be statistically significant.

The relevance of financial openness is confirmed by the significance of the Chinn-Ito index reported in column (4).[9] Its positive coefficient estimate underlines the precautionary motive to guard against adverse capital flows under an open capital account regime. The finding appears consistent with the recent trend of financial globalization.

The results of the developing economies presented in the last four columns contrast quite starkly with those of the developed economies. For developing economies, the opportunity cost of holding international reserves is the only significant macroeconomic variable that affects the demand for international reserves. Specifically, a high opportunity cost deters hoarding of international reserves. The result is in accordance with the observation that, in recent years, the developing economies increase their holdings of international reserves when their opportunity costs of holding reserves decrease as a result of their domestic bond yields declining at a pace faster than the US interest rate.

Interestingly, developing economies with a fixed/pegged exchange rate arrangement tend to hold less international reserves.[10] The result does not seem intuitive. On the other hand, if economies with a crawling peg hold more international reserves – the so-called "unstable middle" hypothesis – then those

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8 A dummy variable was constructed for Japan's international reserve volatility, which is an extreme outlier.

9 A larger value of this measure means a higher level of capital account openness. The index is a reciprocal of regulatory restrictions on cross-border financial transactions and is based upon the IMF's categorical enumeration reported in *Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER)*. See Chinn and Ito (2006) for a detailed discussion. The index is viewed as a *de jure* index on capital account openness.

10 In this study, the Reinhart-Rogoff (2002) index is used to construct the exchange rate regime dummy variable. Their index ranges from 1 "no separate legal tender," to 14 "Freely falling" (with increasing flexibility of exchange rate movement) and is a "*de facto*" index in contrast to the IMF's "*de jure*" exchange rate regime classification. In this paper, we aggregate these categories into three: namely "floating," "Crawling Peg," and "Fixed/Pegged."

with a fixed one may appear to hold less. Among the regional dummy variables, the one for Latin American economies is statistically significant – the one for East Asian economies is insignificant. That is, among the developing economies in the sample, the Latin American economies tend to hold fewer international reserves.

Among the financial variables, the ratio of net portfolio liabilities and the M2 variable are significant. The estimated effect of net portfolio liabilities is qualitatively similar to the one for developed economies but is larger in magnitude. The result suggests that external equity financing for developing economies has a larger effect than for developed ones. The significant money effect (M2/GDP) is in accordance with the monetary interpretation of the balance of payments and also with the view that money supply is a proxy for internal drains of international reserves (de Beaufort Wijnholds and Kapteyn, 2001). Given the increasing degree of global financial integration, the result lends support to the inter-link between domestic money supply and international reserve holdings.

The only significant institutional variable for the data of developing economies is the dummy variable that is a proxy for the presence of a leftist government. It is found that an economy with a leftist government, on average, holds fewer international reserves. The result corroborates the observation that developing economies with a leftist government tend to spend more and incur current account deficits and, thus, hold a lower level of international reserves (Roubini and Sachs, 1989).

A few observations are noteworthy. First, our results attest the differences between the developed and developing economies. Indeed, Cheung and Ito (2007) show that these two groups of economies have different demand functions of international reserves in the current sample period and other historical periods. Further, these demand functions exhibit a considerable degree of variability across history periods.

Second, the different vintages of the international reserve demand equation have different explanatory powers. The earliest vintage represented by specification (1) that focuses on macroeconomic variables offers the least explanatory power. For developed economies, the group of macroeconomic variables explains 28% of the variability of their international reserves. For the developing economies, the group only explains 10%. An intricate observation is that, despite the widespread use of the reserves-to-imports ratio, the trade openness variable is insignificant for both developed and developing economies.

Third, the more recent vintages represented by specifications (2), (3), and (4) offer a substantial improvement in explaining international reserves. For developed economies, including either the exchange rate regime or the capital account openness variable offers a noticeable increase in the adjusted R-squares estimate of the regression. For developing economies, the inclusion of financial variables increases the adjusted R-squares estimate from 13% to 61%. The large incremental improvement attests the relevance of these financial variables in explaining international reserves of these developing economies.

As observed in Section 2, the modeling of international reserve holding behavior evolves with the changing role and functionality of international reserves. When trade is the main channel through which the economies interact with each other, macroeconomic variables including trade openness are perceived

to be the main factors determining the demand for international reserves. With globalization and advances in the world financial market, capital account transactions play an increasing role in determining the holding of international reserves. Our empirical results, indeed, show that the effects of financial and institutional factors outweigh those of the macroeconomic variables in the new millennium.

Since the developed and developing economies behave differently, is it possible that the Asian and Latin American economies have different international reserve demand equations? To address the question, we consider the sample of Asian economies and the sample of Latin American economies separately. The results of fitting model (4) to each of the two groups are given in Table 2. Again, only significant estimates are reported. A caveat is in order – the sample sizes are quite small and, thus, the results should be interpreted with caution.[11]

The fitted models for these two groups of economies are quite different. The only common explanatory variable is the M2 variables. In both cases, the M2/GDP ratio coefficient estimate is significantly positive. Interestingly, the significant variables in Table 2 are quite different from those in Table 1. For the Asian economies, the import propensity variable is significantly positive – a result in accordance with the theory. The developed Asian economies tend to hold a lower level of international reserves. For the Latin American economies, the crawling peg dummy variable is the other significant explanatory variable in the regression.

4. Comparison

The results in the previous section clearly show that different vintages of the model of international reserves perform differently. Even for a given set of explanatory variables, the fitted international reserve demand equations are quite different across different types of economies. The fitted models for developed economies are different from the corresponding ones for developing economies. The Asian and Latin American economies also have different fitted equations of the demand for international reserves. Given these different specifications, which one is the proper benchmark for assessing the question of whether an economy holds an excessive amount of international reserves? Conceivably, different benchmarks can lead to different inferences about an economy's holding. In the following subsections, we discuss the implications of using a few benchmarks for assessing the Asian and Latin American economies' holdings of international reserves.

4.1 Developed or Developing Economies

In our sample, most of the Asian and Latin American economies are members of the group of developing economies. It is natural to use the specification for the developing economies to compare the holdings of international reserves. Suppose the estimated demand for international reserves of developing economies is given by

$$r_{i,dp} = \hat{c}_{dp} + W_{i,dp}' \hat{\alpha}_{dp} + \hat{\varepsilon}_{i,dp} \equiv \hat{r}_{i,dp} + \hat{\varepsilon}_{i,dp}; \quad i = 1, 2, 3, \text{and } 4 \tag{5}$$

[11] The economies included in the Asian and Latin American samples are given in Table A.3 of the Appendix.

where the subscript *i* indicates the equation is based on model 1, 2, 3, or 4 given in Section 3.1, the subscript *dp* indicates that it is a demand equation of the developing economies, $W_{i,dp}$ contains the significant variables, $\hat{\alpha}_{dp}$ contains the corresponding estimates, and $\hat{r}_{i,dp}$ is the predicted level of international reserves.

Alternatively, the comparison can be based on the specification for the developed economies. Suppose the estimated demand for international reserves of developed economies is given by

$$r_{i,dd} = \hat{c}_{dd} + W_{i,dd}' \hat{\alpha}_{dd} + \hat{\varepsilon}_{i,dd} \quad (6)$$

where the subscript *dd* indicates that it is a demand equation of the developed economies and the vectors $W_{i,dd}$ and $\hat{\alpha}_{dd}$ contain the significant variables and their coefficient estimates. To generate a predicted value for a developing economy, we apply this economy's data to (6). We label this predicted value $\tilde{r}_{i,dp}$. The variable $\tilde{r}_{i,dp}$ allows us to assess the level of international reserves that a developing economy is expected to hold if it behaves like a developed economy.

For each developing economy in the Asian and Latin American sample, we have three different international reserve variables: a) $r_{i,dp}$, the actual value, b) $\hat{r}_{i,dp}$, the predicted value obtained from (5), and c) $\tilde{r}_{i,dp}$, the predicted value obtained from (6). By comparing these three variables, we can assess an economy's holding of international reserves relative to other economies and the implication of an economy is being viewed as a developing or a developed economy. For convenience, we label $\hat{r}_{i,dp}$ the simple prediction and $\tilde{r}_{i,dp}$ the cross prediction.

We generate the two predicted values based on models (1) to (4) for Latin American economies and plot them in Panels A to D of Figure 2. In each panel, we also include the actual holdings of international reserves. These graphs include economies that have data to generate both simple and cross predicted values. The economies are arranged in descending order (from the left to the right on the x-axis) according to their real *per capita* GDP in US dollars.

For each Latin American developing economy, both the simple and cross predicted values of international reserves vary quite substantially across the four model specifications. Panel A of Figure 2 shows that the three international reserve variables show a distinct pattern under model (1) that includes only macroeconomic variables as the explanatory variables. On average, the simple predicted value is the largest and the cross predicted value is the smallest. Compared with other developing economies with similar economic characteristics, these Latin American economies tend to hold a lower level of international reserves. However, these Latin American economies tend to hold a higher level of international reserves compared with developed economies. Did these Latin American developing economies hold too many or too few international reserves? The answer depends on whether they are compared with other developing economies or with developed economies.

Panels 2 and 3 suggest that the simple and cross predicted values from models (2) and (3) are quite comparable with the actual values. Visually, it is quite difficult to discern the differences between these three international reserve variables.

The predicted values from model (4) that includes all four types of explanatory variables display an unusual pattern (Panel D, Figure 2). While both simple and cross predicted values are quite variable, the intricate result is that a few economies have negative predicted levels of international reserves! Indeed, the negative values are mostly from the set of cross predicted values. That is, given their economic characteristics, if these developing Latin American economies were being treated as developed economies, they are expected to hold a very low level of international reserves, and even a negative one – that is, to "lend" out international reserves. While a negative level of international reserves is a highly impossible situation, the result suggests that there is a cost for being a developing Latin American economy in terms of holding of international reserves.

To offer a precise comparison of the three international reserve variables ($r_{i,dp}$, $\hat{r}_{i,dp}$, and $\tilde{r}_{i,dp}$), Table 3 presents their numerical values from all four model specifications. Recall that the international reserve variable is defined as a ratio of international reserves to GDP. The numbers confirm that, on average, these Latin American economies are deemed to hold a deficient amount of international reserves compared with other developing economies but an excessive amount compared with developed economies according to model (1). The difference between the predicted and actual values ranges from a few percentage points to 20 percentage points.

As indicated by the graphs, the predicted and actual values are quite similar for models (2) and (3). Indeed, under these two model specifications, the average values of these three international reserve variables are quite close to each other even though the cross predicted value is always the smallest.

The difference between the actual and cross predicted values exhibits a large variation under model (4). There are seven economies that have a difference larger than 10% and two of these seven economies have a difference larger than 20%. According to both the simple and cross predicted values, these Latin American economies tend to hold too many international reserves. Indeed, the average cross predicted value suggests these economies as a group should hold a negative level of international reserves.

Figure 3 contains the graphs of the three international reserve variables for Asian economies. The format is the same as the ones in Figure 2 – only economies with data to generate both simple and cross predicted values are included and they are arranged in descending order (from the left to the right on the x-axis) according to their real *per capita* GDP in US dollars. Similarly, Table 4 contains the numerical values of these three variables.

It is quite apparent that the pattern of actual, simple predicted and cross predicted values of international reserves in each panel of Figure 3 is quite different from the pattern in the corresponding panel of Figure 2. A closer examination reveals some peculiar behavior displayed by Hong Kong, Singapore, and China. Both Hong Kong and Singapore, the two renowned small open economies in Asia, hold a very high level of international reserves – Hong Kong's holding of international reserves is more than 60% of its GDP and Singapore's is over 90%! Under models (1) and (2), both the simple and cross predicted values suggest that these two economies hold an excessive amount of international reserves (Panels A and B, Figure 3). Interestingly, in Panels C and D, only the cross predicted value indicates that Hong Kong and Singapore hold too many international reserves.

The China case is quite unexpected. In all four cases under consideration, China is deemed to hold too few international reserves by both the simple and cross predicated values. The degree of under-hoarding implied by the simple predicted value is quite moderate but the one implied by the cross predicated value is very substantial. The results suggest that China's actual holding of international reserves is slightly lower than developing economies that have similar economic conditions. However, when the developed economies are used as a benchmark, China's holding is far less than what it is supposed to be.[12]

Besides the three noted economies, the behavior of the other Asian economies is quite comparable to that of the Latin American economies. Specifically, the simple predicted values track the actual holdings quite well even though the actual holdings are usually less than the corresponding predicted values. The cross predicted values, on the other hand, tend to indicate these economies are holding too many international reserves. Similar to the case of Latin American economies, some Asian economies have a cross predicted value that is negative.

The numerical values of the actual holdings and the two predicted international reserve values in Table 4 underscore the unique behavior of Hong Kong, Singapore, and China. Specifically, Hong Kong and Singapore are quite often judged to hold excessive international reserves. China's actual holdings are quite small compared with the predicted values. Note that these three economies – especially China – have a substantial impact on the average value of the Asian economies' degree of over- and under-hoarding.

In sum, with the exception of Hong Kong, Singapore, and China, the international reserve holdings of developing Latin American and Asian economies are quite comparable to those of other developing economies. However, compared with developed economies with similar economic conditions, the models suggest that these economies tend to hold too many international reserves.

4.2 An Asian Phenomenon?

Compared with some previous crises, the buildup of international reserves observed after the 1997-98 Asian financial crisis is quite phenomenal. Since the Latin American economies were involved in a few previous crises including the 1982 Mexican debt crisis and the 1994 Tequila crisis, it would be interesting to directly compare the behaviors of the Asian and Latin American economies. To this end, we modify the framework in the previous subsection and assess the consequences of treating an Asian economy as a Latin American economy and vice versa.

For each developing Asian economy, we generate the simple and cross predicted values of the holding of international reserves from the two specifications reported in Table 2. In this case, the simple predicted value is from the Asian economies' estimated demand for international reserves. The cross predicted value is from the equation fitted to Latin American data. Similarly, for each Latin American economy, we construct its simple and cross predicted values from, respectively, the fitted Latin American and Asian equations of demand for international reserves.

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[12] A quick check on the data reveals that the under-hoarding inference is mainly driven by China's volatile international reserve holdings.

For each Latin American or Asian economy, Figure 4 presents its actual holding of international reserves, the simple predicted value, and the cross-predicted value subject to data availability. Table 5 presents the numerical values of these three variables. A few observations are in order. First, the differences between the actual international reserve holdings and their simple predicted values are quite small, indicating the demand for international reserves equations fitted to the Asian and Latin American economies perform quite well.

Second, the cross predicated values indicate that the Latin American economies, compared with the Asian economies, tend to hold too few international reserves. The level of deficiency can be as high as 20% of an economy's GDP (Antigua and Barbuda and Panama). If these Latin American economies behave like an average Asian economy, then nine of the 28 economies have a level of international reserves that is lower than the level they are expected to hold by 10% or more.

Third, the cross predicted values suggest that the Asian economies are holding too many international reserves. Five Asian economies – namely Singapore, Hong Kong, Malaysia, Thailand, and Korea over-hoard international reserves by an amount that is larger than 10% of their GDPs. Among these five economies, Singapore and Hong Kong are not directly affected by the Asian financial crisis while the other three are. The extreme case is Singapore – the economy's over-hoarding is close to 80% of its GDP. The next one is Hong Kong, its level of excessive holding equals to 43% of its GDP. The amount of excessive international reserves held by China, compared with the hype in the media, is relatively moderate at the 4.5% level.

All in all, the results in Figure 4 and Table 5 are supportive of the view that, compared with Latin American economies with similar economic characteristics, Asian economies tend to hold a higher level of international reserves. It is worth noting that the over-hoarding phenomenon is quite prominent for a few economies including Singapore and Hong Kong.

5. Concluding Remarks

Against the backdrop of the astonishing growth of global international reserves and the recent advances in modeling the demand for international reserves, we examine the empirical determinants of international reserve holdings. Several empirical equations motivated by different vintages of the theory of international reserves are estimated. In addition to the specifications for developed and developing economies, we consider the demand for international reserves in the Asian and Latin American regions. While both regions experienced an increase in their holdings of international reserves after the 1997-98 Asian financial crisis, some Asian economies are perceived to have accumulated international reserves at a scale much larger than that of the Latin American economies.

Our exercise illustrates the complexity of modeling the demand for international reserves. Different vintages of the theory give different inferences about the appropriate level of international reserves. The developed and developing economies have equations of the demand for international reserves that are quite different from each other. Further, the Asian economies and the Latin American economies

have different empirical determinants of the demand for international reserves. In general, the estimation results underscore the importance of financial and institution factors in the post-Asian financial crisis period. The macroeconomic factors – including trade openness – play a relatively limited role in explaining the holding of international reserves in the new millennium.

The comparison of international reserve accumulation behaviors depends on the choice of a benchmark specification. Indeed, our results show that the inference about whether an economy is holding an excessive or deficient level of international reserves can be heavily affected by the choice of a benchmark model. For either Asian or Latin American economies, their degrees of over- or under-hoarding are quite moderate when the benchmark is the general specification for developing economies. However, if the benchmark is the demand for international reserves of developed economies, then economies in both regions tend to have held too much international reserves. Three Asian economies, namely Singapore, Hong Kong, and China are the exceptions to these general results. Singapore and Hong Kong, the two open economies in Asia, are quite often found to be holding an excessive amount of international reserves. The results for China do not corroborate the usual claim that the country holds too many international reserves – an accusation that is popularized by commentators. Indeed, in most specifications considered in the exercise, China is deemed to have held a deficient level of international reserves.

A direct comparison shows that the Asian economies and the Latin American economies have a region-specific empirical demand function of international reserves. Further, the results affirm the perception that the Asian economies tend to hold more international reserves than the Latin American economies. That is, on the average, a Latin American economy is expected to hold more international reserves if it behaves like an Asian economy that has similar economic characteristics. On the other hand, Asian economies are likely to hold less international reserves if they act as a typical Latin American economy.

The difference in the accumulation of international reserves in the two regions warrants further investigation in the future. For instance, what are the factors, besides those considered in the current study, that explain the difference in the accumulation behavior? Does the difference in the holdings of international reserves have implications for the stability of these economies? While these questions are beyond the scope of the current study, the answers should provide some useful insight on the international reserve accumulation mechanism and the related policy implications.

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Table 1. Demand for International Reserves, 1999-2005

	Developed Economies				Developing Economies			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Population (in log)	-0.02	-0.017	-0.017	-0.026				
	[0.007]***	[0.006]**	[0.007]**	[0.004]***				
International reserve volatility	0.009	0.007	0.007	0.01				
	[0.004]*	[0.004]*	[0.004]11%	[0.003]***				
Opportunity cost					-0.394	-0.364	-0.111	-0.117
					[0.142]***	[0.127]***	[0.044]**	[0.047]**
Crawling peg regime		0.131	0.136	0.122				
		[0.011]***	[0.010]***	[0.008]***				
Fixed/Pegged regime						-0.021	-0.037	-0.05
						[0.047]	[0.024]	[0.027]*
Latin America						-0.091	-0.073	-0.077
						[0.029]***	[0.022]***	[0.023]***
Net portfolio liabilities			-0.018	-0.029			-0.701	-0.717
			[0.015]	[0.012]**			[0.045]***	[0.049]***
M2 / GDP							0.203	0.201
							[0.029]***	[0.029]***
De jure capital acct. openness				0.055				
(Chinn-Ito index)				[0.016]***				
Leftist government								-0.065
								[0.027]**
Number of Observations	22	22	22	22	76	76	76	76
Adj. R-squares	0.28	0.65	0.65	0.83	0.1	0.13	0.61	0.63

Notes: Robust standard errors are given in brackets. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. The column headings (1), (2), (3), and (4) correspond to the model specifications (1), (2), (3), and (4) in the text. Constant terms are omitted for brevity.

Table 2. The Asian and Latin American Economies' International Reserve Demand Equations, 1999-2005

	Asia	Latin America
Import propensity	0.251	
	[0.033]***	
Industrial country dummy	-0.126	
	[0.029]***	
Dummy for crawling peg		0.035
Exch. rate regime		[0.021]*
M2 as a ratio to GDP	0.107	0.072
	[0.018]***	[0.020]***
Constant	0.025	0.077
	[0.039]	[0.018]***
Number of Observations	25	28
Adjusted R-squares	0.75	0.54

Notes: Robust standard errors given in brackets. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Because of their extreme values, dummy variables for Singapore and Guyana were included in the regression.

Table 3. The Latin American Economies' International Reserves – Actual Holdings, Simple Predicted Values, and Cross Predicted Values, Averages of 1999-2005

		Model (1)				Model (2)			
	r_i	$\hat{r}_i$	$r_i - \hat{r}_i$	$\tilde{r}_i$	$r_i - \tilde{r}_i$	$\hat{r}_i$	$r_i - \hat{r}_i$	$\tilde{r}_i$	$r_i - \tilde{r}_i$
Argentina	10.4%	20.5%	-10.1%	5.9%	4.6%	12.1%	-1.7%	5.4%	5.0%
Bolivia	14.6%	19.0%	-4.5%	5.3%	9.2%	12.9%	1.7%	18.0%	-3.4%
Brazil	7.5%	3.5%	4.0%	5.7%	1.9%	-1.5%	9.0%	5.2%	2.3%
Chile	19.6%	24.3%	-4.7%	4.4%	15.2%	17.8%	1.8%	4.1%	15.5%
Colombia	12.3%	20.9%	-8.6%	3.1%	9.2%	14.6%	-2.3%	2.9%	9.3%
Costa Rica	9.6%	18.2%	-8.6%	6.8%	2.8%	12.1%	-2.4%	19.3%	-9.6%
Dominican Republic	3.9%	17.3%	-13.4%	5.4%	-1.6%	11.3%	-7.4%	18.1%	-14.2%
Ecuador	6.0%	22.6%	-16.6%	4.6%	1.5%	14.1%	-8.1%	4.3%	1.8%
Guatemala	10.6%	21.4%	-10.8%	5.0%	5.6%	15.0%	-4.4%	17.7%	-7.1%
Haiti	3.7%	17.1%	-13.4%	5.2%	-1.5%	11.0%	-7.3%	4.8%	-1.1%
Honduras	24.0%	18.8%	5.2%	5.8%	18.2%	12.7%	11.4%	18.4%	5.6%
Jamaica	17.2%	19.9%	-2.7%	7.8%	9.4%	13.7%	3.5%	20.1%	-2.9%
Mexico	8.0%	23.2%	-15.2%	8.7%	-0.7%	16.7%	-8.7%	7.9%	0.1%
Nicaragua	12.7%	21.6%	-8.9%	6.2%	6.5%	15.2%	-2.5%	18.8%	-6.1%
Panama	7.5%	24.1%	-16.6%	7.3%	0.2%	15.4%	-8.0%	6.6%	0.9%
Paraguay	13.3%	14.6%	-1.4%	6.1%	7.2%	8.8%	4.5%	5.6%	7.7%
Peru	17.3%	20.3%	-2.9%	3.9%	13.4%	14.0%	3.3%	16.8%	0.5%
Uruguay	15.0%	7.8%	7.2%	7.4%	7.6%	2.5%	12.5%	19.7%	-4.8%
Venezuela, RB	17.1%	18.0%	-1.0%	6.4%	10.7%	12.0%	5.1%	18.9%	-1.8%
Average	9.8%	16.3%	-6.5%	6.5%	3.3%	10.0%	-0.2%	7.9%	1.9%

Table 3. Continued

		Model (3)				Model (4)			
	r_i	$\hat{r}_i$	$r_i - \hat{r}_i$	$\tilde{r}_i$	$r_i - \tilde{r}_i$	$\hat{r}_i$	$r_i - \hat{r}_i$	$\tilde{r}_i$	$r_i - \tilde{r}_i$
Argentina	10.4%	11.3%	-0.8%	5.5%	4.9%	11.7%	-1.3%	-7.3%	17.7%
Bolivia	14.6%	15.5%	-1.0%	18.7%	-4.2%	17.1%	-2.5%	12.3%	2.2%
Brazil	7.5%	5.0%	2.5%	5.0%	2.6%	-0.3%	7.8%	-11.5%	19.0%
Chile	19.6%	25.1%	-5.5%	4.5%	15.1%	26.9%	-7.3%	-5.7%	25.3%
Colombia	12.3%	10.7%	1.6%	3.1%	9.2%	12.3%	-0.1%	-16.8%	29.1%
Costa Rica	9.6%	12.5%	-2.9%	20.0%	-10.4%	14.1%	-4.4%	12.9%	-3.3%
Dominican Republic	3.9%	12.1%	-8.3%	18.8%	-15.0%	7.2%	-3.3%	0.5%	3.4%
Ecuador	6.0%	6.2%	-0.2%	4.5%	1.5%	0.1%	5.9%	-6.3%	12.3%
Guatemala	10.6%	11.3%	-0.7%	18.4%	-7.8%	12.9%	-2.3%	15.5%	-5.0%
Haiti	3.7%	12.2%	-8.5%	5.1%	-1.4%	13.7%	-10.0%	-0.5%	4.2%
Honduras	24.0%	14.2%	9.8%	19.2%	4.9%	15.8%	8.3%	4.3%	19.8%
Jamaica	17.2%	15.6%	1.5%	20.9%	-3.7%	10.7%	6.5%	21.0%	-3.8%
Mexico	8.0%	5.8%	2.2%	7.5%	0.5%	7.3%	0.7%	0.0%	8.0%
Nicaragua	12.7%	13.5%	-0.8%	19.5%	-6.8%	15.1%	-2.4%	19.0%	-6.3%
Panama	7.5%	18.8%	-11.4%	6.9%	0.6%	19.1%	-11.6%	8.4%	-0.9%
Paraguay	13.3%	8.6%	4.7%	5.9%	7.4%	10.1%	3.2%	0.9%	12.4%
Peru	17.3%	10.9%	6.4%	17.5%	-0.1%	12.5%	4.8%	16.2%	1.2%
Uruguay	15.0%	13.4%	1.5%	20.5%	-5.5%	14.8%	0.2%	20.5%	-5.5%
Venezuela, RB	17.1%	7.4%	9.7%	19.5%	-2.4%	9.0%	8.1%	10.7%	6.4%
Average	9.8%	8.0%	1.9%	7.8%	2.0%	7.2%	2.6%	-3.4%	13.2%

Notes: The table presents, for each developing Latin American economy, the actual average level of international reserves over the period of 1999 to 2005 under the column labeled r_i. The simple predicted values and the cross predicted values are given under the columns labeled $\hat{r}_i$ and $\tilde{r}_i$, respectively. See the text for the definitions of these variables. A positive entry in the column either labeled "$r_i - \hat{r}_i$" or "$r_i - \tilde{r}_i$" implies over-hoarding while a negative implies under-hoarding. The real US dollar GDP weighted averages are reported in the row "average."

Table 4. The Asian Economies' International Reserves – Actual Holdings, Simple Predicted Values, and Cross Predicted Values, Averages of 1999-2005

		Model (1)				Model (2)			
	r_i	$\hat{r}_i$	$r_i - \hat{r}_i$	$\tilde{r}_i$	$r_i - \tilde{r}_i$	$\hat{r}_i$	$r_i - \hat{r}_i$	$\tilde{r}_i$	$r_i - \tilde{r}_i$
China	23.0%	25.8%	-2.8%	157.2%	-134.2%	26.2%	-3.1%	137.2%	-114.1%
Hong Kong	68.1%	25.4%	42.7%	11.8%	56.3%	25.8%	42.3%	10.5%	57.6%
India	13.6%	23.4%	-9.8%	21.4%	-7.8%	26.0%	-12.4%	32.0%	-18.4%
Indonesia	16.0%	20.8%	-4.8%	0.6%	15.4%	23.6%	-7.6%	0.8%	15.2%
Korea	22.9%	25.2%	-2.2%	31.7%	-8.7%	27.7%	-4.7%	27.9%	-4.9%
Lao PDR	10.3%	16.4%	-6.1%	6.0%	4.3%	19.6%	-9.3%	5.5%	4.8%
Malaysia	41.9%	25.3%	16.6%	13.7%	28.1%	25.7%	16.2%	12.2%	29.6%
Philippines	20.0%	23.8%	-3.9%	1.8%	18.2%	26.4%	-6.5%	1.8%	18.1%
Singapore	95.9%	25.8%	70.0%	15.7%	80.1%	28.3%	67.6%	14.0%	81.9%
Sri Lanka	10.3%	22.9%	-12.7%	3.8%	6.5%	25.6%	-15.3%	16.6%	-6.4%
Thailand	29.2%	25.3%	3.9%	5.8%	23.4%	27.8%	1.4%	5.3%	23.8%
Average	26.3%	24.9%	1.4%	75.5%	-49.2%	26.4%	0.0%	68.3%	-42.0%

Table 4. Continued

		Model (3)				Model (4)			
	r_i	$\hat{r}_i$	$r_i - \hat{r}_i$	$\tilde{r}_i$	$r_i - \tilde{r}_i$	$\hat{r}_i$	$r_i - \hat{r}_i$	$\tilde{r}_i$	$r_i - \tilde{r}_i$
China	23.0%	39.7%	-16.7%	129.3%	-106.3%	33.7%	-10.7%	167.8%	-144.7%
Hong Kong	68.1%	61.1%	7.0%	10.6%	57.6%	61.5%	6.7%	13.8%	54.4%
India	13.6%	21.8%	-8.3%	31.3%	-17.7%	23.8%	-10.2%	16.8%	-3.2%
Indonesia	16.0%	17.2%	-1.2%	0.8%	15.2%	19.1%	-3.1%	-8.0%	24.0%
Korea	22.9%	18.8%	4.1%	26.4%	-3.4%	20.6%	2.3%	20.7%	2.3%
Lao PDR	10.3%	14.7%	-4.5%	5.8%	4.5%	10.3%	0.0%	-12.5%	22.8%
Malaysia	41.9%	25.8%	16.0%	11.7%	30.2%	26.1%	15.7%	0.9%	41.0%
Philippines	20.0%	22.4%	-2.5%	1.9%	18.0%	24.4%	-4.4%	-12.3%	32.3%
Singapore	95.9%	93.9%	1.9%	15.2%	80.6%	97.1%	-1.2%	20.8%	75.0%
Sri Lanka	10.3%	20.8%	-10.5%	17.4%	-7.1%	16.3%	-6.0%	2.7%	7.5%
Thailand	29.2%	28.4%	0.7%	5.1%	24.0%	30.2%	-1.0%	-9.0%	38.1%
Average	26.3%	33.0%	-6.7%	64.7%	-38.4%	26.3%	31.6%	-5.2%	75.4%

Notes: The table presents, for each developing Asian economy, the actual average level of international reserves over the period of 1999 to 2005 under the column labeled r_i. The simple predicted values and the cross predicted values are given under the columns labeled $\hat{r}_i$ and $\tilde{r}_i$, respectively. See the text for the definitions of these variables. A positive entry in the column either labeled "$r_i - \hat{r}_i$" or "$r_i - \tilde{r}_i$" implies over-hoarding while a negative implies under-hoarding. The real US dollar GDP weighted averages are reported in the row "average."

Table 5. The Actual Holdings of International Reserves and their Predicted Values Generated from Results in Table 2

	r_i	$\hat{r}_i$	$r_i - \hat{r}_i$	$\tilde{r}_i$	$r_i - \tilde{r}_i$
Asia					
China	23.0%	24.8%	-1.7%	18.6%	4.5%
Hong Kong	68.1%	66.7%	1.5%	25.1%	43.0%
India	13.6%	13.3%	0.3%	15.6%	-2.0%
Indonesia	16.0%	14.7%	1.3%	11.3%	4.7%
Korea, Rep.	22.9%	19.3%	3.6%	12.9%	10.1%
Lao PDR	10.3%	13.0%	-2.7%	9.0%	1.3%
Malaysia	41.9%	41.5%	0.4%	17.4%	24.5%
Pakistan	8.6%	11.4%	-2.8%	10.9%	-2.4%
Philippines	20.0%	22.0%	-2.1%	11.9%	8.0%
Singapore	95.9%	95.9%	0.0%	16.1%	79.7%
Sri Lanka	10.3%	18.0%	-7.7%	14.1%	-3.9%
Thailand	29.2%	29.7%	-0.6%	15.9%	13.3%
Latin America					
Antigua and Barbuda	12.3%	15.0%	-2.6%	31.4%	-19.0%
Argentina	10.4%	9.9%	0.5%	9.2%	1.2%
Bolivia	14.6%	15.1%	-0.5%	15.1%	-0.6%
Brazil	7.5%	11.5%	-4.0%	11.4%	-3.9%
Chile	19.6%	11.5%	8.1%	15.9%	3.7%
Colombia	12.3%	9.8%	2.5%	10.7%	1.6%
Costa Rica	9.6%	14.2%	-4.5%	18.9%	-9.3%
Dominica	14.9%	14.1%	0.8%	28.2%	-13.3%
Dominican Republic	3.9%	13.9%	-10.0%	18.7%	-14.8%
Ecuador	6.0%	9.3%	-3.2%	12.2%	-6.2%
El Salvador	13.0%	10.8%	2.1%	17.7%	-4.7%
Grenada	18.9%	16.2%	2.7%	33.0%	-14.1%
Guatemala	10.6%	13.4%	-2.8%	13.1%	-2.5%
Guyana	37.4%	37.4%	0.0%	39.4%	-2.0%
Haiti	3.7%	10.6%	-6.9%	15.5%	-11.8%
Honduras	24.0%	14.7%	9.4%	21.8%	2.3%
Jamaica	17.2%	15.1%	2.1%	22.2%	-5.1%
Mexico	8.0%	9.8%	-1.8%	13.3%	-5.3%
Nicaragua	12.7%	14.1%	-1.4%	19.9%	-7.2%
Panama	7.5%	13.5%	-6.0%	27.6%	-20.1%
Paraguay	13.3%	9.5%	3.8%	17.5%	-4.2%
Peru	17.3%	13.5%	3.8%	10.3%	7.0%
St. Kitts and Nevis	16.9%	17.0%	-0.1%	33.7%	-16.9%
St. Lucia	13.9%	14.0%	-0.1%	28.2%	-14.3%
St. Vincent and the Grenadines	15.7%	14.4%	1.3%	28.4%	-12.7%
Suriname	14.0%	11.2%	2.9%	20.0%	-5.9%
Uruguay	15.0%	15.4%	-0.5%	14.5%	0.5%
Venezuela, RB	17.1%	12.7%	4.4%	9.4%	7.7%

Notes: The table presents, for each developing economy, the actual average level of international reserves over the period of 1999 to 2005 under the column labeled r_i. The simple predicted values and the cross predicted values computed from results in Table 2 are given under the columns labeled $\hat{r}_i$ and $\tilde{r}_i$, respectively. See the text for the definitions of these variables. A positive entry in the column either labeled "$r_i - \hat{r}_i$" or "$r_i - \tilde{r}_i$" implies over-hoarding while a negative implies under-hoarding.

Figure 1. Holdings of International Reserves - East Asia vs. Latin America

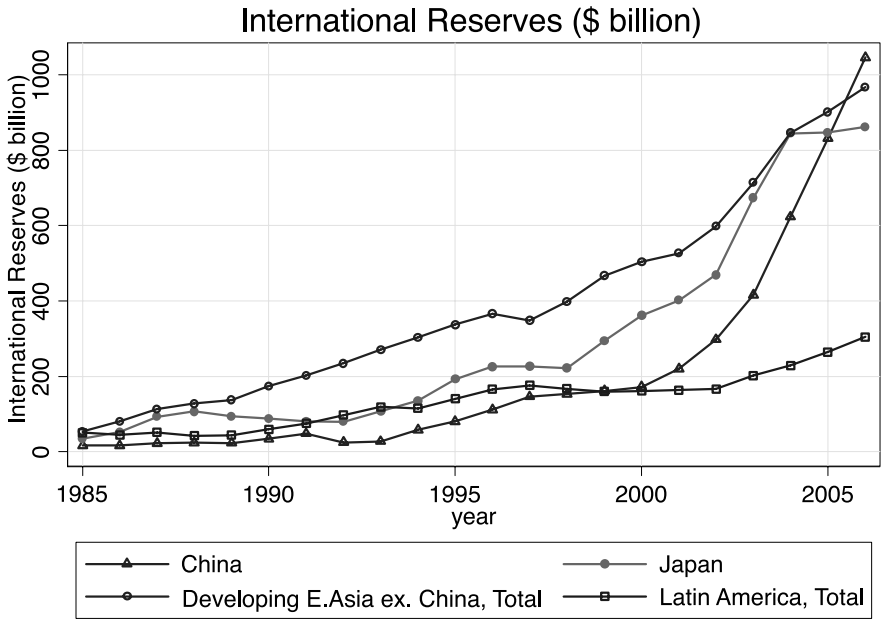
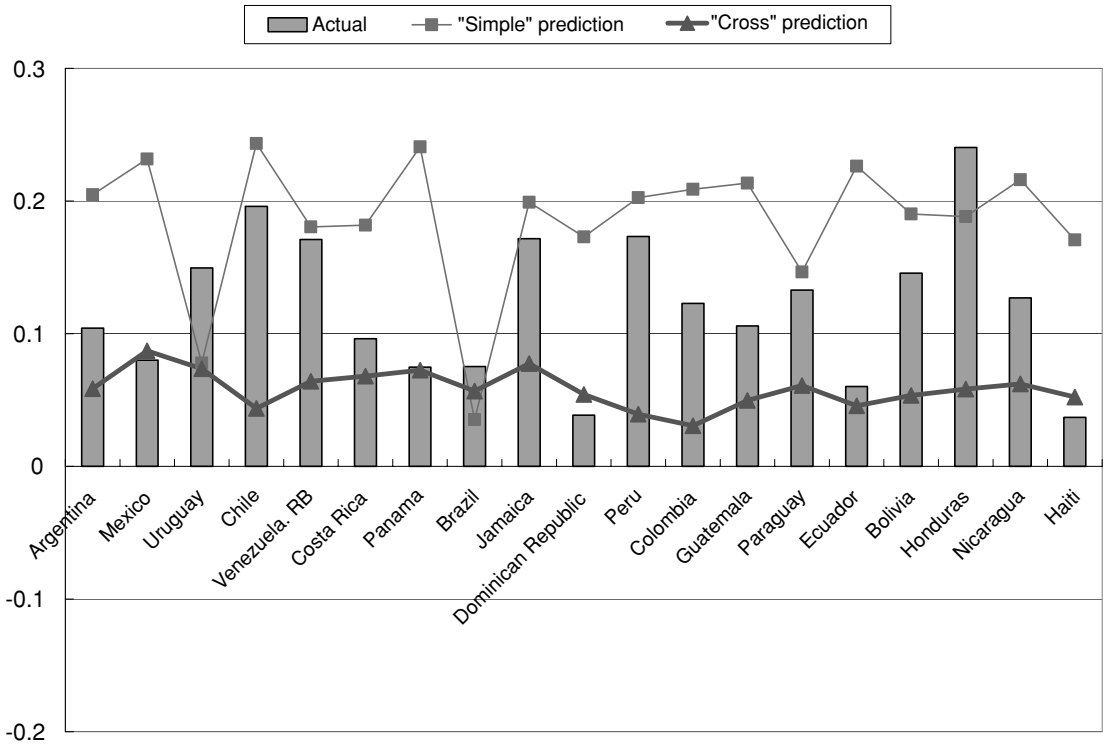
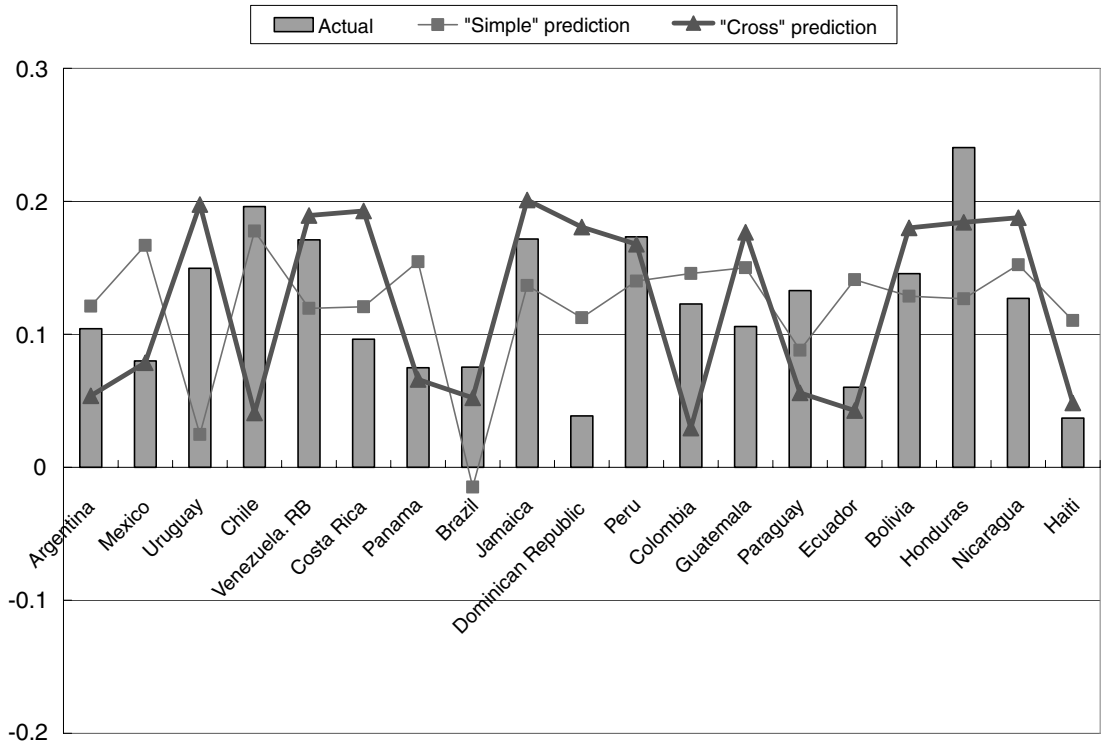


Figure 2. The Latin American Economies' International Reserves – Actual Holdings, Simple Predicted Values, and Cross Predicted Values, Averages of 1999-2005

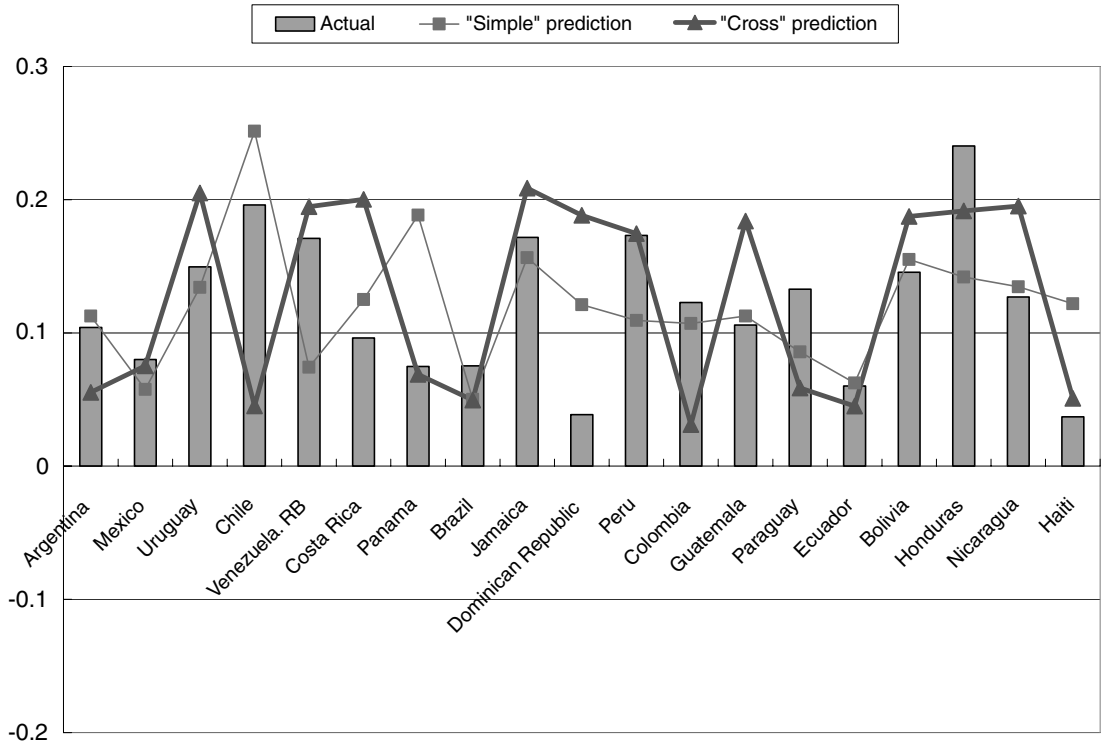
A. Model (1)



B. Model (2)



C. Model (3)



D. Model (4)

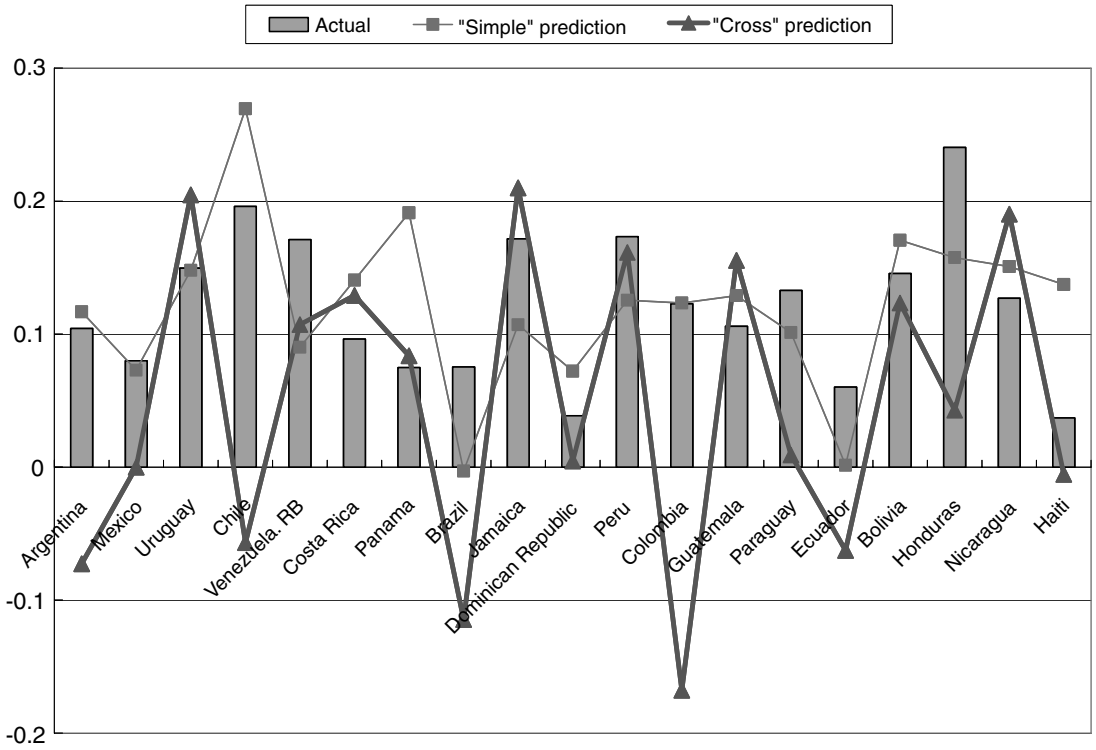
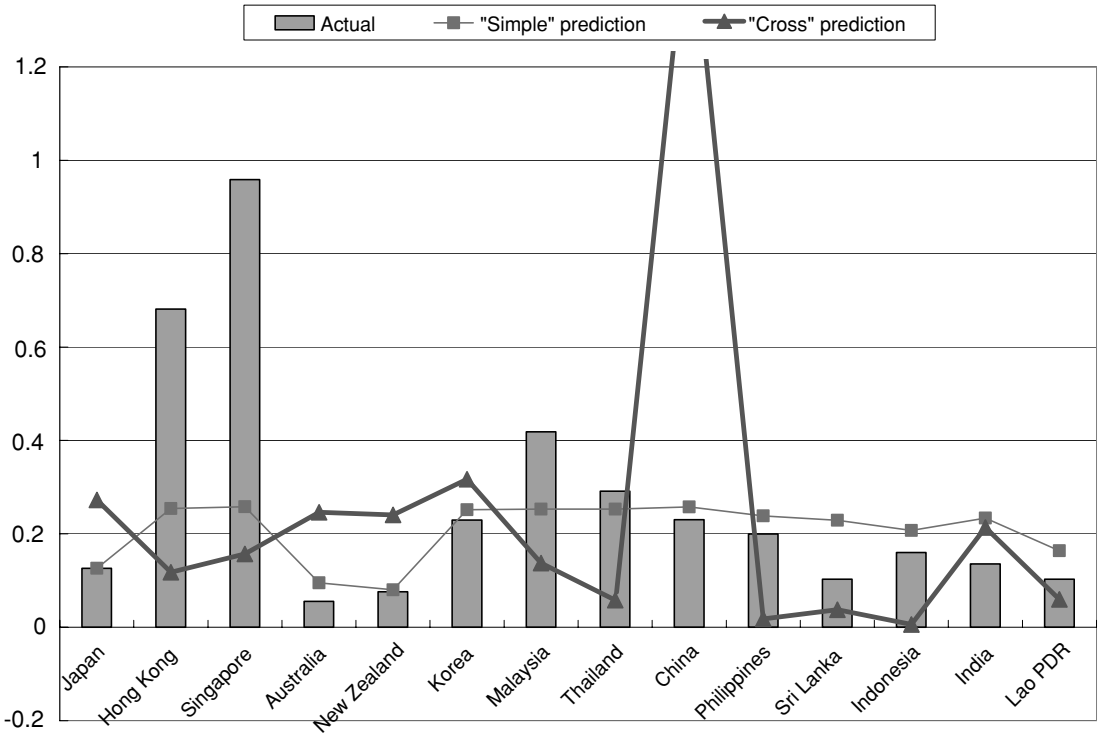
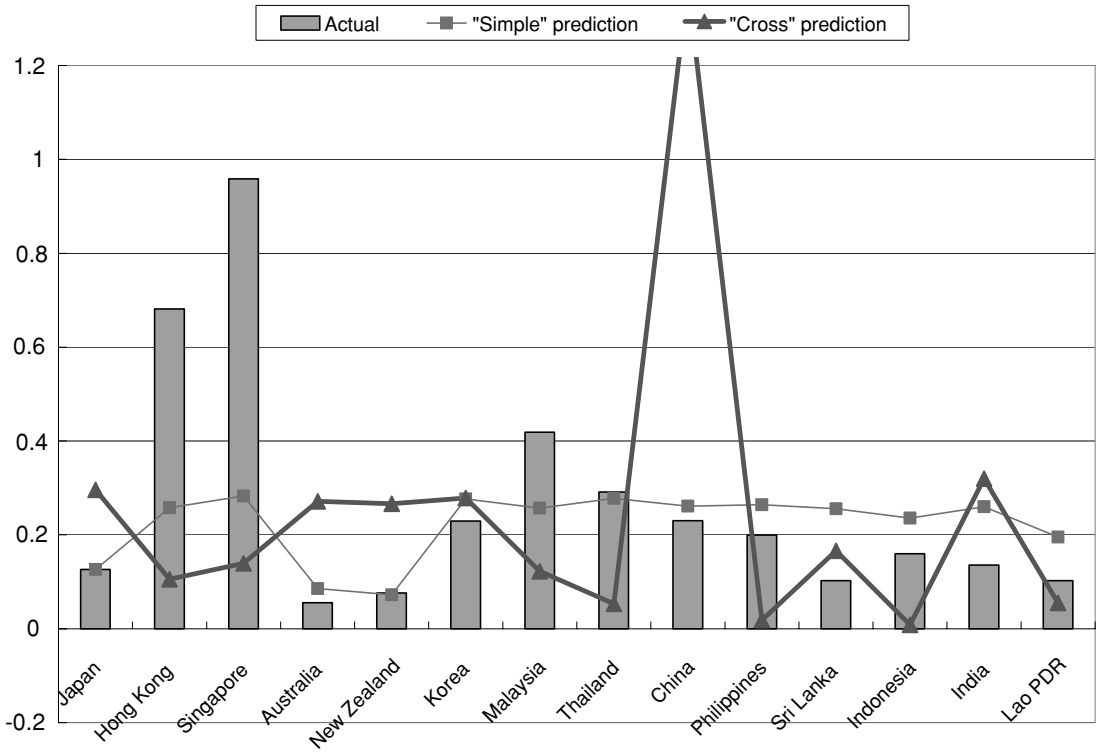


Figure 3. The Asian Economies' International Reserves – Actual Holdings, Simple Predicted Values, and Cross Predicted Values, Averages of 1999-2005

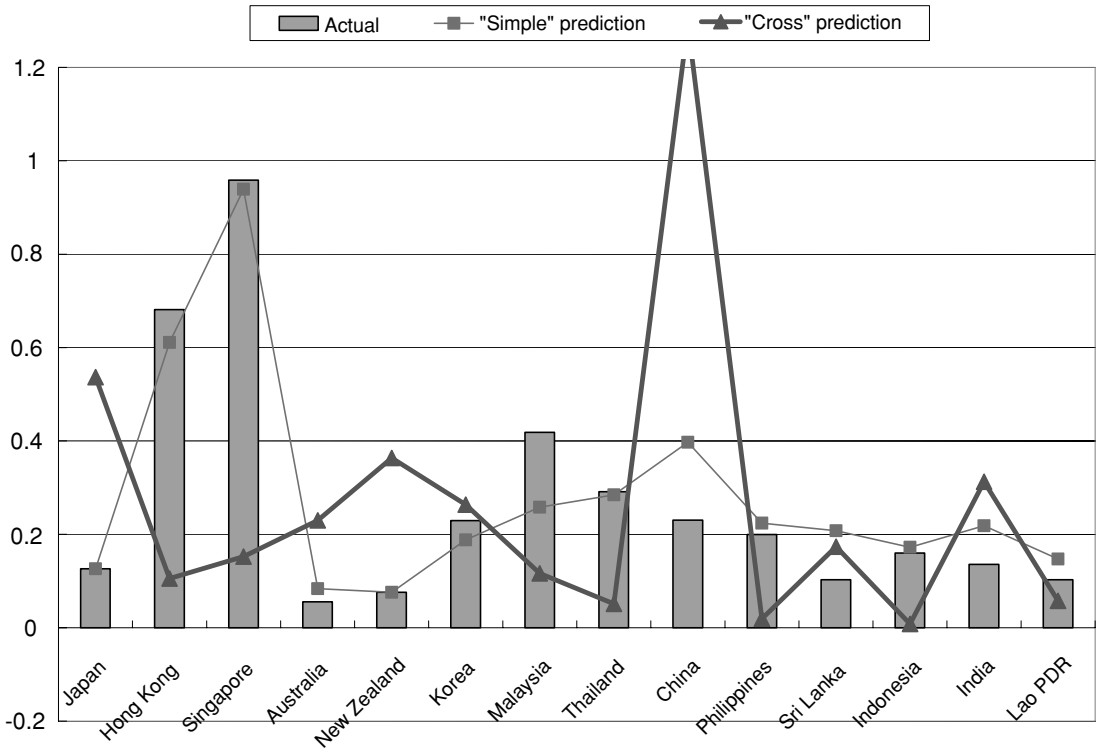
A. Model (1)



B. Model (2)



C. Model (3)



D. Model (4)

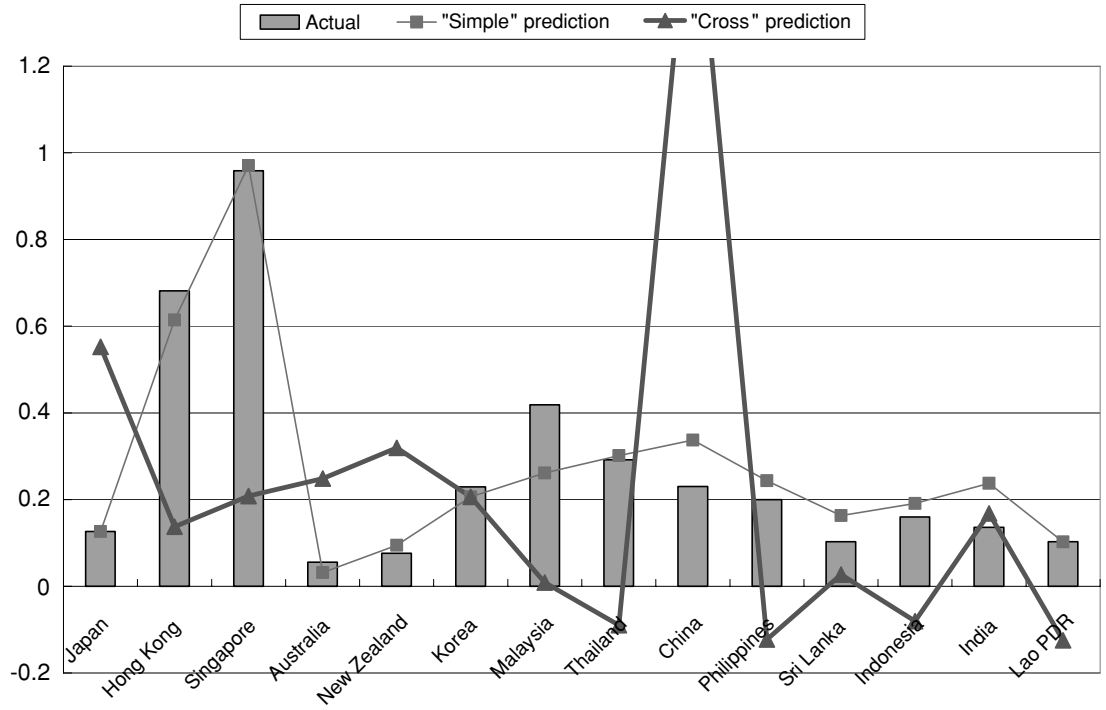
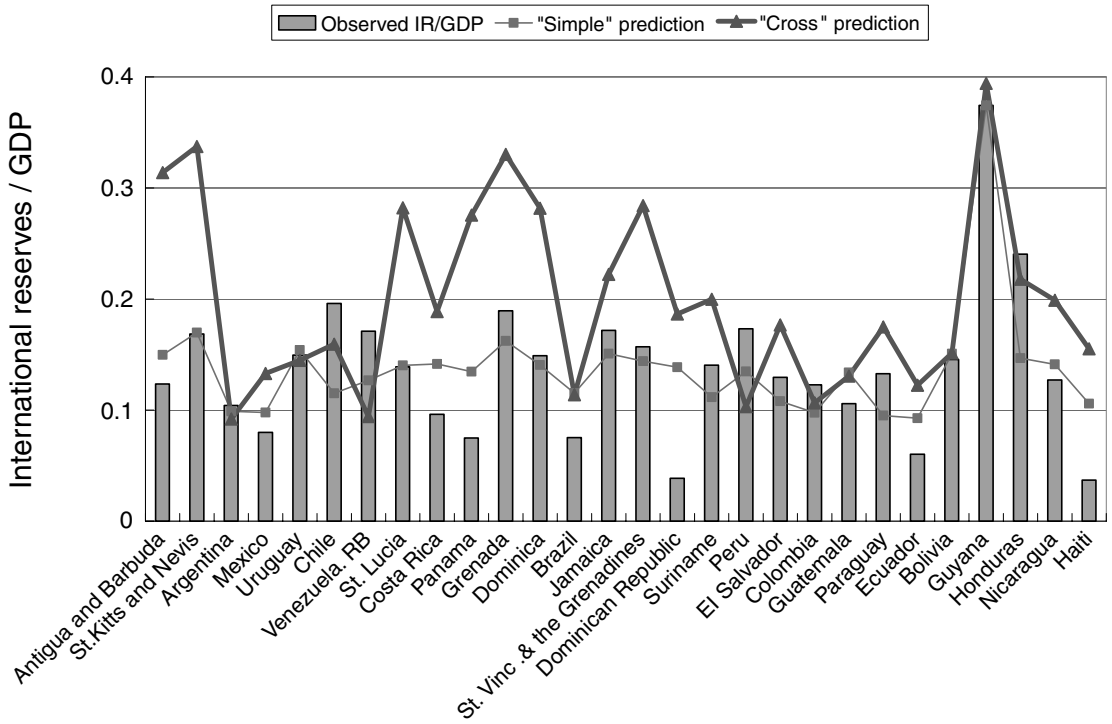
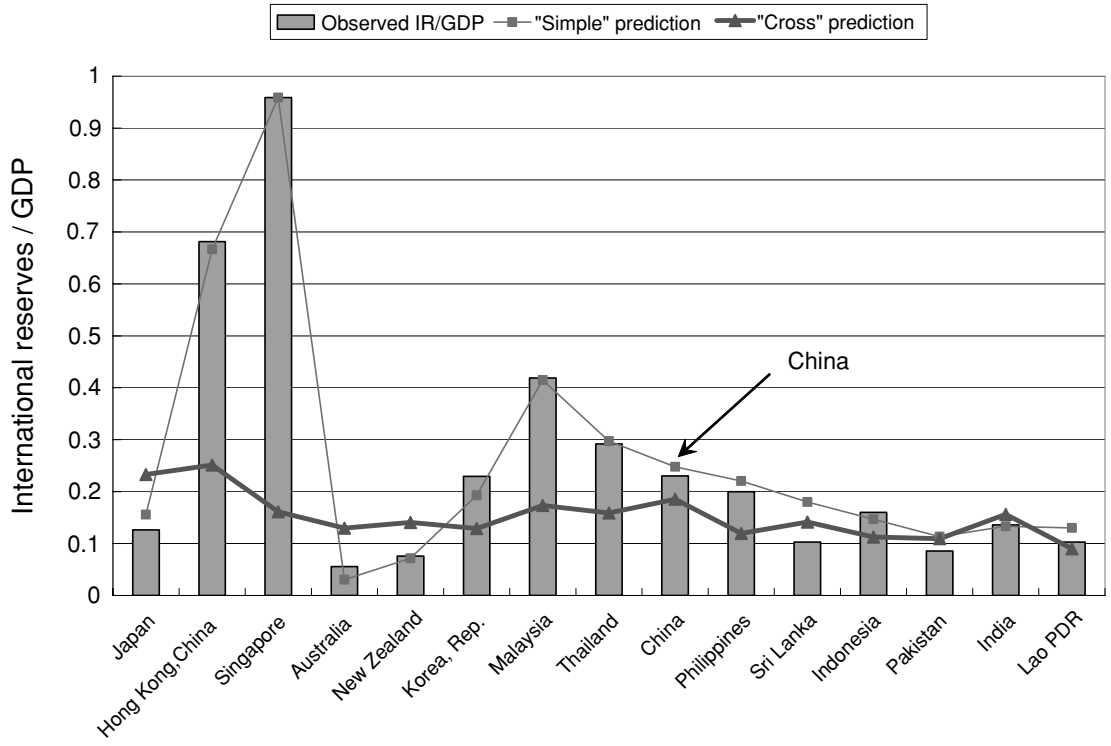


Figure 5. The Actual Holdings of International Reserves and their Predicted Values Generated from Results in Table 2

A. Latin America



B. Asia


Observed IR/GDP
"Simple" prediction
"Cross" prediction
International reserves / GDP
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
China
Japan
Hong Kong,China
Singapore
Australia
New Zealand
Korea, Rep.
Malaysia
Thailand
China
Philippines
Sri Lanka
Indonesia
Pakistan
India
Lao PDR

Appendix

Table A.1 Definitions and Sources

Variables	**Definitions**	**Sources**
1. Dependent variables		
R_GDP	total international reserves (including gold)/current GDP	WDI
2. Variables in "X" – "Macro variables"		
RYPC_US	*per capita* GDP in constant US dollars	WDI
POP	population	WDI
PIMP	propensity to import	IFS
RES_VOL	international reserve volatility	IFS
EXP_VOL	volatility of export receipts	IFS
DIFINT	opportunity cost of holding international reserves	WDI, IFS
3. Variables in "Y" – "Financial variables"		
M2Y	M2 to current GDP	WDI, IFS
NET_DEBT	net debt liabilities / current GDP	LM
NET_FDI	net FDI liabilities / current GDP	LM
NET_PORTFOLIO	net portfolio equity liabilities / current GDP	LM
D_DEBT_LIAB	growth rate of net debt liabilities / current GDP	LM
D_FDI_LIAB	growth rate of net FDI liabilities / current GDP	LM
D_PORTFOLIO_LIAB	growth rate of net portfolio liabilities / current GDP	LM
4. Variables in "Z" – "Institutional variables"		
KAOPEN	capital account openness	CI
DEFACTO_FININT	*de facto* financial openness = (Total external assets + liabilities) / current GDP	LM
CORRUPT	corruption [0, 6]	ICRG
BQ	bureaucratic quality [0, 6]	ICRG
LAO	law and order [0, 6]	ICRG
LEFT	dummy variable for left-wing government	DPI2004
PLURAL	dummy variable for parliament with plural electoral system	DPI2004
5. Dummies ("D")		
ER_CRAWL	dummy variable for the crawling peg exchange rate regime	RR
ER_FIX	dummy variable for the fixed exchange rate regime	RR
CRISIS	dummy variable for a currency crisis	Authors' calculations
BANKCRISIS	dummy variable for a banking crisis	CK
OIL	dummy variable for oil exporting countries	Authors' calculations

Notes: The source codes are: BDL: Beck, Demirgüc-Kunt, and Levine (2001, updated in later years); CI: Chinn and Ito (2006); CK: Caprio and Klingebiel (2003); DPI2004: Database of Political Institutions, Beck et al. (2001); ICRG: *International Country Risk Guide;* IFS: IMF's *International Financial Statistics*; IMF: Other IMF databases; LM: Lane and Milesi-Ferretti (2006); RR: Reinhart and Rogoff (2002); and WDI: *World Development Indicators*.

Table A.2 Summary Statistics: 1999 - 2005

	Developed	Developing	Asia	Latin America
International reserves / GDP	0.07	0.13	0.26	0.19
X (macro) variables				
Population in millions	38.42	23.52	186.65	44.76
International reserve volatility[1]	0.06	0.08	0.14	0.01
Real *per capita* GDP (in log US$)	10.05	7.82	7.31	7.29
Propensity to import	0.35	0.34	0.51	0.42
Opportunity cost	0.03	0.20	0.08	0.17
Y (financial) variables				
M2 / GDP	0.89	0.41	0.81	0.47
Net portfolio liabilities /GDP[2]	0.08	0.00	-0.01	-0.02
Net debt liabilities /GDP[2]	0.14	0.33	0.24	0.37
Net FDI liabilities /GDP[2]	-0.02	0.33	0.22	0.26
Z (institutional) variables				
Leftist government (0/1)[3]	0.45	0.19	0.25	0.23
Parliament/Plural elect. sys. (0/1)[3]	0.55	0.52	0.80	0.69
Corruption index [0, 6][4]	4.45	2.55	2.33	2.35
Democracy index [0, 1][5]	5.47	2.76	3.48	3.44
Gov't fractionalization [0, 1][6]	3.80	1.97	2.56	1.92
De jure KA-openness (Chinn and Ito)[7]	0.76	0.51	0.44	0.44
De facto KA-openness (Lane and Milesi-Ferretti)	0.28	0.19	0.29	0.25

Notes:

1. International reserve volatility and export volatility are normalized by the period average of international reserves and exports, respectively.
2. "Net liabilities" = (liabilities minus assets) of an external financial asset per GDP.
3. The variables for leftist government and parliament with plural electoral system are zero-one dummy variables.
4. For political/societal variables: anti-corruption, law and order, and bureaucratic quality, higher values indicate better conditions. For example, a higher value of corruption index indicates an environment with stronger anti-corruption measures and enforcement.
5. The democracy index is also known as the political constraint index – a higher value means a more democratic system.
6. A higher value for government fractionalization means a more fractionalized government.
7. The *de jure* KA openness variable ranges between -1.8 and +2.6 (Chinn and Ito, 2006). A higher value indicates a more open capital account.

Table A.3 List of Economies in the Asian and Latin American Samples

The Asian Sample	The Latin American Sample
Australia	Argentina
Bangladesh	Bolivia
Bhutan	Brazil
Cambodia	Chile
China	Colombia
Fiji	Costa Rica
Hong Kong	Dominican Republic
India	Ecuador
Indonesia	El Salvador
Japan	Guatemala
Korea	Haiti
Lao PDR	Honduras
Malaysia	Mexico
Maldives	Nicaragua
New Zealand	Panama
Pakistan	Paraguay
Papua New Guinea	Peru
Philippines	Uruguay
Samoa	Venezuela, RB
Singapore	Antigua and Barbuda
Solomon Islands	Dominica
Sri Lanka	Grenada
Thailand	Guyana
Tonga	Jamaica
Vietnam	St. Kitts and Nevis
	St. Lucia
	St. Vincent and the Grenadines
	Suriname

Biographical Notes

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Yin-wong Cheung is a professor in the Economics Department at the University of California in Santa Cruz. He is also a professor of the University of Hong Kong, a Research Fellow of the CESifo in Germany, a board member of the Methods in International Finance Network in Europe, and a Guest Professor of the Shandong University. He has published articles related to econometrics, applied econometrics, exchange rate dynamics, asset pricing, output fluctuation, and economic issues in Asian economies. Cheung is listed among the Top 1000 Economists and was the president of Chinese Economic Association in North America.

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Hiro Ito is assistant professor of economics at Portland State University, Oregon. His areas of focus are financial development, financial globalization, and macroeconomic interlinkages between countries. He has recently published in the Journal of Development Economics, the Journal of International Money and Finance, and the Review of International Economics. Ito received his Ph.D. in economics from University of California, Santa Cruz and M.A. in international relations from the Paul H. Nitze School of Advanced International Studies (SAIS) of Johns Hopkins University in Washington, D.C. Before joining PSU, he was a visiting instructor at Claremont McKenna College, California.