Are All Measures of International Reserves Created Equal?  
An Empirical Comparison of International Reserve Ratios

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Abstract:  
Using available annual data of 174 economies since 1957, we examine the similarities and differences of seven international reserve ratios. While individual international reserve ratios display substantial variations across economies, they are associated with an economy’s characteristics including geographic location, income level, stage of development, degree of indebtedness, and exchange rate regime. The association pattern varies across time and type of international reserve ratios. Interestingly, there is only limited evidence that Asian and non-Asian economies have significantly different international reserve hoarding behavior. Our results suggest that the inference about whether an economy is hoarding too many or too few international reserves depends on the choice of international reserve ratio. Further, different international reserve ratios exhibit different persistence profiles, but the evidence of dependence on structural characteristics is rather weak.

JEL:  F30, F40  

Keywords:  International Reserve Ratios, Structural Characteristics, Cross-Economy Analysis

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1. Introduction

The 1997 East Asian financial crisis has inspired new insights into the causes of financial crises. The so-called third generation of financial crisis models developed to explicate the 1997 crisis in East Asia highlight, for instance, the importance of the sudden stops and reversals of capital flows, balance sheet factors, and the role of financial sector weaknesses, which are not explicitly incorporated in the previous two generations of models.¹

In the aftermath of the crisis, economies in the region appear to have pursued preemptive policies against future speculative attacks and sharply boosted their international reserves. For instance, China, Japan, Korea, Malaysia and Taiwan, those economies that are commonly mentioned in the recent discussion of the extraordinary and puzzling accumulation of international reserves, increased their international reserves by, respectively, 388%, 133%, 107%, 119% and 138% between 2000 and 2005.² Some commentators relate the policy of building up international reserves to the observation that economies with a high level of international reserves survived the Asian financial crisis better than those with a low level (Feldstein, 1999; Fischer, 1999).

The steep increase in international reserves is generally difficult to reconcile with conventional measures of international reserve adequacy. One traditional indicator of the adequacy of international reserves is the reserves-to-imports ratio. The rule of thumb is to maintain international reserves worth three months of imports. At the end of 2005, the international reserves held by the five aforementioned economies covered approximately 15, 19, 10, 7, and 17 months of their imports respectively. Admittedly, the three-month rule is not based on rigorous theoretical evidence, but for most observers the quoted reserves-to-imports ratios appear to be at an excessively high level. Although they help deter speculative attacks, excessive hoarding of international reserves can induce internal imbalances and hinder the restoration of the global balance.

The traditional models of demand for international reserves are motivated by

¹ Leading examples of the third generation models include Krugman (1999), Corsetti, Pesenti and Roubini (1999), Chang and Velasco (1999) and Dooley (2000). In brief, the first generation models focus on situations in which fundamentals are inconsistent with preserving a fixed exchange rate (Krugman, 1979; Flood and Garber, 1984). The second generation models bring out the role of coordination, the possibility of self-fulfilling crises, and the presence of multiple equilibriums (Obstfeld, 1995, 1996).

² At the end of 2005, Japan, China, Taiwan, and Korea were the four largest holders of international reserves. China overtook Japan to become the largest holder of international reserves in 2006.
precautionary demand and trade financing. The recent literature extends the precautionary motive and considers international reserve accumulation a policy to avoid crisis-induced output losses and investment contractions (Aizenman et al., 2004 and Lee, 2004). These models offer an additional reason for why the hoarding of international reserves is related to an economy’s income level. Foreign liabilities are also deemed to be important determinants of the demand for international reserves. For instance, the popular Greenspan-Guidotti rule recommends that developing economies should hold sufficient international reserves to cover their short-term external debts. In general, it is advisable to cover the one year amortized value of various types of liabilities over a wide range of possible scenarios (Greenspan, 1999).

With increased global capital mobility, capital account transactions play an important role in determining the level of international reserves. Capital flights and flow reversals can trigger a crisis and amplify its adverse economic impacts. Calvo (1996) and de Beaufort Wijnholds and Kapteyn (2001) argue that the money stock in an economy is a proxy for potential capital flight by domestic residents. Thus, a reserves-to-money ratio is a good indicator of an economy’s ability to withstand the internal drain of international reserves. In some earlier studies, the link between international reserves and money is motivated by the monetary interpretation of balance of payments: see, for example, Courchene and Youssef (1967) and Johnson (1958).

Dooley et al. (1995) report that the classification of capital flows into long-term and short-term categories is quite illusive. Capital reversals can happen to both short-term portfolio flows and perceived long-term foreign direct investment (FDI). One implication is that the discussion of capital reversals should be based on gross instead of net capital inflows.

Even a cursory glance at the recent literature leads to several international reserve ratios that are deemed important for assessing the adequacy of international reserves. With a multitude of measures, which one should we use? The answer to the question depends on whether we have a theory on the optimal level of an international reserve ratio. Apparently, there is no generally accepted theory yet. For example, we do not have a model that explains the wide variation of, say, reserves-to-imports ratios across economies.

It is not our intention to address the question of “optimal” international reserve ratios.

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3 See, for example, Grubel (1971) for a survey of the pre-1970 studies. Flood and Marion (2002) review the theory and provide some recent empirical evidence.

4 The rule follows from the former Federal Reserve Chairman Alan Greenspan’s comments on Pablo Guidotti’s insight into the role of external debts in 1999. Guidotti is a former Argentinean Deputy Minister of Finance.
Rather, our objective is to empirically compare these international reserve ratios. Are the advocated measures of international reserves related to the structural characteristics of an economy, such as its geographic location and stage of development? For instance, it is commonly perceived that developing and Asian economies hold relatively more international reserves than other economies. Another issue of interest is whether these international reserve ratios provide essentially the same information on an economy’s (relative) level of international reserves. If they do, then we should stay with one measure and focus on the determination of its optimal level rather than working with several measures. However, if these ratios offer different assessments, then we have to address the question of which ratio should be used to evaluate the adequacy of an economy’s holding of international reserves.

To offer some insight into the above issues, we use a large sample of economies to evaluate the differences and similarities of various international reserve ratios. The empirical issues to be investigated are as follows. (a) Does the value of an international reserve ratio depend on an economy’s structural characteristics? (b) Are these dependence relations stable across different international reserve ratios and time-invariant? (c) Do these international reserve ratios provide similar rankings of an economy’s level of international reserves relative to other economies’? (d) Do these international reserve ratios display a similar degree of persistence?

In the next section, we introduce the seven international reserve ratios and the five structural characteristics of an economy that are considered in the current exercise. Some preliminary analyses of the data on international reserve ratios and their interactions with structural characteristics are also presented. Section 3 analyzes the international reserve ratios in terms of their dependence on structural characteristics, their relative rankings, and their persistence profiles. Concluding remarks are offered in Section 4.

2. **Data and Preliminary Analyses**

In this and the next section, we study the annual data on international reserves including gold of 174 economies from 1957 to 2004. Due to data availability, some exercises are based on a smaller sample of economies and a shorter time period. Let \( R_{i,t} \) be economy i’s holding of international reserves \( R \) at time \( t \). In most of the subsequent analyses, the subject of our investigation is an international reserve ratio defined by
\[ r_{i,t} = \frac{R_{i,t}}{Z_{j,t}} \]

where \( Z_{j,t} \) is the normalizing variable \( j \) at time \( t \). Based on the existing literature, we consider seven normalizing variables: a) imports, b) total foreign liabilities, c) short-term external debts, d) cumulative (gross) FDI inflows, e) money supply M2, f) population, and g) nominal GDP in US dollar. Data on international reserves, FDI inflows, nominal exchange rates, and M2 were from *International Financial Statistics*, imports data were from the *Directions of Trade* database, data on total foreign liabilities were from Lane and Milesi-Ferretti (2006), and short-term external debts were from the *Joint BIS-IMF-OECD-WB Statistics on External Debt* database. The short-term external debts consist of liabilities to banks, debt securities issued abroad, and non-bank trade credits that have maturity of one year or less.

We focus on five structural characteristics of an economy and examine their degrees of association with the seven aforementioned international reserve ratios. These characteristics are a) geographic region, b) income level, c) level of indebtedness, d) stage of development, and e) exchange rate regime.

For geographic region, the economies are grouped into five regions: a) Asia, Pacific and South Asia, b) Europe and Central Asia, c) Latin America and Caribbean, d) Middle East and North Africa, and e) Sub-Saharan Africa. Partly due to the hype surrounding international reserve holdings among Asian economies, we also compare the behavior between Asian and non-Asian economies.

The income levels follow the World Bank classification: a) low income, b) middle income, and c) high income categories.\(^5\)

Data on the level of indebtedness are from the *World Development Indicators* that classifies economies into three indebtedness categories: a) severely indebted, b) moderately indebted, and c) less indebted.\(^6\)

The stage of development is identified by the IMF classification of developed and developing economies.

Our exchange rate regime classification is based on the scheme proposed by Reinhart and Rogoff (2002). To facilitate analysis, we grouped their categories into three broad classifications.

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\(^5\) The “Middle income” group consists of the “lower middle” and the “upper middle” subgroups. The “high income” group is a combination of the “high income OECD” and the “high income non-OECD” subgroups.

\(^6\) We did not consider the category “not classified.”
of (a) rigid, (b) limited flexibility, and (c) floating exchange rate arrangements.\footnote{“Rigid” comprises a) no separate legal tender, b) pre-announced peg/currency board c) pre-announced horizontal band $\leq \pm 2\%$, d) \textit{de facto} peg, e) pre-announced crawling peg, and f) pre-announced crawling band $\leq \pm 2\%$. “Limited flexibility” comprises a) \textit{de facto} crawling peg, b) \textit{de facto} $\pm 2\%$ crawling band, c) pre-announced crawling band $> \pm 2\%$, d) \textit{de facto} crawling band $\geq \pm 2\%$, and e) moving band $\leq \pm 2\%$. “Floating” comprises a) managed floating, and b) freely floating.}

Section A of Appendix 1 lists the economies under these classifications of structural characteristics. The economies under the exchange rate regime characteristic are listed for three sub-periods because most economies adopted more than one regime during the full sample period. Section B of Appendix 1 gives the pair-wise contingency coefficient estimates between these characteristics. The contingency coefficient is derived from the usual contingency table test statistic; the significance of the former follows from that of the latter. One benefit of using the contingency coefficient is that it allows us to gauge the strength of association. The coefficient assumes a value between 0 and 1; 0 implies no association and 1 perfect association. Section A of Appendix 4 gives a brief description of the contingency table test and the corresponding contingency coefficient. In general there is a moderate correlation between these structural characteristics – the contingency coefficient estimates are between 0.4 and 0.6. The association between the Asia and non-Asia classification and other structural characteristics appears the weakest. With the obvious exception of geographic region, the Asian and non-Asian economies do not exhibit large differences in income, indebtedness, or stage of development.

2.1 \textit{Aggregate International Reserves}

By the end of 2004, there were more than US$4,100 billion global international reserves – approximately half of them were accumulated between 2000 and 2004. To gain a general picture, we first examine the levels of international reserves $R_{it}$’s. Figures 1 to 5 present the distributions of international reserves sorted by individual structural characteristics. The first four figures give the snapshots of four selected years: 1985, 1996, 2000 and 2004. Because of data availability, Figure 5 graphs the distributions across exchange rate regimes at 1975, 1985, 1995, and 2000.

Figure 1 plots the shares of global international reserves of the five geographic regions. As expected, the “Asia, Pacific, and South Asia” region accounts for an increasing share of global international reserves. It surpassed the “Europe and Central Asia” region and became the region that held the largest share of global international reserves in 1996. In 2004, it accounted
for 64% of the world’s international reserves.

Figures 1.a to 1.c provide additional information on the rising clout of Asian economies. Figure 1.a shows that the share of global international reserves held by Asian economies jumped significantly from 17% in 1985 to 60% 2004. With Japan as the only developed economy in our Asian sample, the Asian developing economies appear to be significant contributors to the increase in Asia’s share of global international reserves.

Figure 1.b focuses on the role of Asian developing economies in the hoarding of international reserves. The share of global international reserves accumulated by Asian developing economies advanced from 12% in 1985 to 39% in 2004. In contrast, the share of non-Asian developing economies only inched up from 18% to 21% in the same period. Among developed economies, Japan (the only developed economy in our Asia sample) and non-Asian developed economies displayed opposite trends in their shares of global international reserves. From 1985 to 2004, Japan’s share increased 4-fold, while the share held by non-Asian developed economies declined steadily from 65% to 19%.

Figure 1.c highlights the shares of global international reserves held by selected Asian economies. By 2004, half of the world’s international reserves were held by a handful of Asian economies: China (15%), Japan (21%), and the Asian newly industrialized economies (16%). Specifically, China’s international reserves experienced significant growth in the new millennium, with its share of global international reserves almost doubled between 2000 and 2004. In stark contrast, the share of non-Asian economies declined drastically from 83% in 1985 to 40% in 2004.

Figure 2 reveals that, over time, there has been a shift of global international reserves from high-income economies to middle-income economies. For instance, the share of global international reserves held by middle-income economies jumped from 23% in 1985 to 47% in 2004, while the share held by high-income economies dropped steadily from 74% to 47% in the same period. Although the share of low-income economies doubled from 3% to 6% over the 20-year span, it remained quite small compared to the shares of the other two income groups.

Among economies with external debts, Figure 3 shows that the share of international reserves increased with the level of indebtedness. The gaps between the severely indebted group and the other two groups widened over time. The observation is in accordance with the view that

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8 The Asian newly industrialized economies (NICs) comprise Hong Kong, Singapore, South Korea, and Taiwan.
heavily indebted economies have strong motivation to hoard international reserves as a means of reducing the risk of speculative attacks.

Figure 4 decomposes the holdings of global international reserves between developed and developing economies. The share of developing economies doubled from 30% in 1985 to 60% in 2004 at the expense of developed economies. As indicated in Figure 1.b, the increase is mainly driven by some developing economies in Asia.

Figure 5 presents the shares of global international reserves held by economies with different exchange rate regime arrangements. Except for 1975, the group of economies with floating rates held the largest share of global international reserves; these economies accounted for 37% to 49% of global international reserves between 1985 and 2000. Theoretically speaking, an economy with exchange rate flexibility should require less international reserves because it does not have to defend its currency. The observed high percentage held by the floaters may reflect “fear of floating” – that is, an economy with de jure exchange rate flexibility may actually not want to see wild fluctuations in its exchange rate. The economies under the limited flexibility classification saw their share came down steady from 58% to 14% in the last quarter of the 20th century. The economies with rigid exchange rate arrangements, in contrast, saw a dramatic upturn in their share of global international reserves from 12% in 1985 to 37% in 2000.

2.2 International Reserve Ratios and Structural Characteristics

We now examine the international reserve ratios \( r_{ij,t} \) \( (= R_{ij,t}/Z_{jt}) \). At time \( t \) and for a given normalizing variable \( j \), we compute the average international reserve ratio of economies with the same structural characteristic. A canonical form of the average is denoted by \( r_{j,t} = \frac{\sum_{i=1}^{N_{C}} r_{ij,t}}{N_{C}} \), where \( N_{C} \) is the number of economies sharing a common structural characteristic \( C \). For instance, if income level is the structural characteristic under consideration, then \( C \) can be low-, middle- or high-income. Appendix 2 presents the time series plots of \( r_{j,t} \) for each of the five structural characteristics and for each of the seven international reserve ratios. Because of the presence of some extreme observations, we have two sets of graphs for the reserves-to-short-term-external-debts ratio. The extreme observations are excluded from the

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9 In each of these four years, the numbers of economies that fall under the three exchange rate groups are, respectively, (a) 47, 32, 48 and 56 for the rigid group, (b) 39, 40, 50 and 42 for the limited flexibility group, and (c) 12, 23, 14 and 27 for the floating group.
second set of graphs.

A summary of these graphs is in order. For most international reserve ratio types, the “Asia, Pacific, and South Asia” and “Middle East and North Africa” regions held higher levels of international reserves than the other three regions, especially in recent years (Figure A2.1). An obvious exception is the “Sub-Sahara region,” which had a larger reserves-to-M2 ratio in, say, the post-1990s period.

When the Asian group is compared with the non-Asian group, the general impression is that the Asian group’s reserve ratios are higher than the non-Asian group’s ratios – the exception again is the reserves-to-M2 ratio for which the Asian group’s ratio is slightly lower after, say, 1995.

When the economies are classified according to their levels of income, the ranking of international reserve ratios depends on the choice of the normalizing variable. For instance, the high-income group has the smallest ratio when short-term external debts are the normalizing variable but the largest ratio when population is used. Further, the evolution of the ratios from different income groups displays considerable variation across the normalizing variables.

For the level of indebtedness, the severely indebted economies tend to have an international reserve ratio that is higher than those of the less indebted and the moderately indebted economies when total foreign liabilities, short-term external debts, and population are the normalizing variables. For other normalizing variables, the rankings of these three groups are not that clear-cut, even though the less indebted economies usually have a smaller ratio than the other two groups.

Between the developed and developing economies, the latter tends to have a larger international reserve ratio when total foreign liabilities, cumulative FDI inflows, M2, and GDP are the normalizing variables. According to the reserves-to-population ratio, however, the developed economies hold more international reserves than developing economies. In the later part of the sample period, the developing economies tend to have a reserves-to-imports ratio larger than that of the developed economies. Note that data on the short-term external debts of developed economies are not available.

With respect to exchange rate arrangements, the group of economies with limited exchange rate flexibility has a higher international reserve ratio than the other two groups in the later part of the sample – the only exception is the case in which population is the normalizing
factor. The relative ranking between the rigid and floating groups is not unambiguous. Using the end of the sample period as a reference point, there is no substantial evidence that, compared with the rigid group, the floating group has either a larger or a smaller ratio.

In general, these graphs are suggestive of the possibility that the pattern of international reserve accumulation is associated with the selected structural characteristics even though the nature of association varies across the structural characteristics and across the types of international reserve ratios. A more formal analysis of the relationship between structural characteristics and hoarding of international reserves is presented in Section 3.

2.3 The Variation of Time Averages Across Economies

The cross-economy variation of international reserve ratios is examined using the time average of $r_{i,j,t}$ that is given by $\bar{r}_{i,j} = \frac{1}{T} \sum_{t=1}^{T} r_{i,j,t}$, where $T$ is the sample period. Table 1 reports the cross-sectional average, median, standard deviation, coefficient of variation, skewness, and kurtosis of $\{r_{i,j,}\}_{i=1,...,N}$, where $N$ is the number of economies. For completeness, we present the frequency distribution of $\{r_{i,j,}\}$ in Appendix 3.

The cross-economy average of the international reserves-to-imports ratio is 4.52: that is, on the average, the level of international reserves will suffice to cover slightly more than four and half months of imports. The median is 3.88 months. These figures are quite close to the rule of thumb that suggests a three-month coverage. The positive skewness is in accordance with the result that the average is larger than the median. These ratios are leptokurtic with a sample kurtosis of larger than 3, indicating that they are more peaked about the mean and have fatter tails than a normally distribution ratio. The peakedness suggests a relatively larger proportion of economies have their ratios close to the mean value. The “fat” tails, however, suggest that “extreme” values occur quite often. Indeed, the reserves-to-imports ratio has the smallest skewness and kurtosis among the seven types of international reserve ratios, which are all positive skewed and leptokurtic.

With respect to total foreign liabilities, the cross-economy average of international reserves is 26.94% of total foreign liabilities while the median is 15.32%. For short-term external debts, the cross-economy average reaches 13.2 times of amortized annual liabilities and is thus well above the one-year coverage suggested by the Greenspan-Guidotti rule. The distribution of the reserves-to-short-term-external-debts ratio is quite skewed to the right. The median ratio,
nonetheless, is at a high level of 3.6. In fact, the majority of the economies (132 of 150) have an international reserve ratio that exceeds the Greenspan-Guidotti one-year rule. It is important, however, to note that short-term external debts only include short-term debt securities, trade credits, and bank liabilities. Equity-based foreign liabilities that can be subject to sudden capital reversals are not included in this measure.

The average level of international reserves is 7.25 times of cumulative FDI inflows and the median is 1.58 times. Indeed, this ratio has the most skewed distribution among the seven international reserve ratios. Despite the high skewness, 61% of the economies have enough international reserves to cover all of their cumulative FDI inflows during the sample period. Even though FDI is perceived to be non-volatile, many economies are well covered for FDI flow reversals.

On the average, economies hold international reserves that are about one third of their M2 figures. Apparently, the average international reserve holding suffices to handle mild internal drains caused by domestic capital flight. As mentioned earlier, compared with developing economies, developed economies tend to have a lower international reserves-to-M2 ratio. In fact, six of the ten economies with the smallest ratios of reserves-to-M2 are OECD economies.

The average international reserve holding per capita is also quite skewed. The cross-economy per capita average is US$755 (and the median is US$202), Singapore, for example, stands at the high per capita level of US$12,586 and Sudan, in contrast, at the low level of US$5,430. Indeed, about 35% of economies have less than US$100 of international reserves per capita and 20% of economies have more than US$1,000 per capita.

During the sample period, these economies on the average hold international reserves equal to 14% of their GDPs measured in US dollar. The median holding level is at the 11% mark. Unexpectedly (at least for the authors), Lebanon is the largest holder of international reserves according to this measure; its reserves-to-GDP ratio is 1.0574. In contrast, Sudan’s international reserves are less than 2% of its GDP measured in US dollars.

The dispersion of each individual international reserve ratio is quite wide. The coefficient of variation suggests the reserves-to-cumulative-gross-FDI-inflows ratio has the largest degree of variation and the reserves-to-imports ratio has the smallest variability. A detailed examination of

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10 Lebanon holds a high level of gold reserves, three times larger than its non-gold international reserves. Further, from 1980 to 1991, the value of its international reserve holding was larger than its GDP.
these summary statistics gives the impression that the economies that display an extremely large or small ratio are more likely to be developing economies.

The summary statistics reported in Table 1 and the figures in Appendix 3 reveal that the time averages of international reserve ratios exhibit substantial cross-economy variations. Further, their distributions contain outliers and are quite different from the normality assumption. Thus, a statistical study of the ratios should account for these data properties.

3. Ratio Comparison

3.1 Dependence on Structural Characteristics

The preliminary analysis in Section 2 shows that international reserve ratios display a high degree of cross-economy variability, and at the same time show some discernable patterns with respect to various structural characteristics. In this subsection, we offer a formal assessment of the association between these ratios and structural characteristics. Given the non-normality and the presence of outliers noted in the previous section, a nonparametric procedure is adopted.

For each type j international reserve ratio, we rank the time averages \( \{ r_{i,j} \}_{i=1,\ldots,N} \). Then we assign a LOW or HIGH label to each time average \( r_{i,j} \), depending on whether it is below or above the median of \( \{ r_{i,j} \} \). A non-parametric contingency table test of independence is used to test the null hypothesis that the LOW and HIGH rankings are independent of an economy’s structural characteristics. Section A of Appendix 4 describes the test procedure and the related contingency coefficient. The test is conducted for time averages computed from the full sample period (1957-2004) and from the two sub-periods (1957-1989 and 1990-2004). Table 2 reports the contingency coefficients and Appendix 5 presents the corresponding observed proportions of economies with a LOW and HIGH label.

Panel A in Table 2 contains results for the four structural characteristics: (a) region, (b) income, (c) indebtedness, and (d) stage of development. Under the region category, we also compare the behavior of Asian and non-Asian economies. Panel B presents results for the exchange rate regime effect.

3.1.1 Region

The contingency table analysis indicates that an economy’s geographic region has implications for its holding of international reserves. With the exception of the reserves-to-M2
ratio, the geographic location is significantly related to the magnitudes of the international reserve ratios in the three sample periods. Indeed, among the 20 contingency coefficients under the “region” heading, only the two computed for the reserves-to-M2 ratios are insignificant at the 10% level. Despite a large number of significant relations between an economy’s international reserve ratio and the region in which it is located, the contingency coefficients are all less than 0.5, with 16 of them less than 0.4. That is, the association between these two attributes, although significant, is not that strong in absolute terms.

The breakdown of economies in LOW and HIGH proportions in the full sample period (Table A5.1, Appendix 5) indicates that the sources of significant contingency coefficients vary across international reserve ratios. Despite the much-heralded accumulation of the Asian economies, the distribution of the economies in the “Asia, Pacific, and South Asia” region between the LOW and HIGH categories is quite even compared with those in the other four regions. The largest difference between the LOW and HIGH proportions observed for this region is 24% under the reserves-to-short-term-external-debts ratio. However, for the same ratio, the “Europe and Central Asia” region has a larger gap between the LOW and HIGH classifications.

The “Middle East and North Africa” economies tend to have a large international reserve ratio. In four of the six significant cases, this group has the largest gap between the LOW and HIGH proportions: in fact, over 80% of economies in this group have a HIGH international reserve ratio label. The breakdowns in the two sub-periods (Tables A5.2 and A5.3, Appendix 5) give a similar distribution pattern. It is noted that more than 50% of the economies in the “Middle East and North Africa” region have a HIGH label in all seven ratios under consideration. For the other four regions, different international reserve ratios give different relative distributions between the LOW and HIGH groups.

The contingency table test results reported in Table 2 do not suggest that the Asian and non-Asian economies have different types of international reserve hoarding behavior. Only one of the 20 contingency coefficients is significant at the 10% level. Most of the contingency coefficients are quite small – 16 of them are less than 0.2. The significant dependence relation is found in the second sub-period with respect to the reserves-to-GDP ratio. The observed proportions indicate that the dependence is mainly driven by non-Asian economies (Table A5.3, Appendix 5). The HIGH category is 24% larger than the LOW category for the non-Asian economies, and is 6% less for the Asian economies. In other cases, the proportions of Asian
economies in the HIGH and LOW categories are quite close to the 50-50 benchmark for independence.

3.1.2 Income Level

The level of income is the second most influential structural characteristic that affects the accumulation of international reserves. Significant contingency coefficients are found for all the seven international reserve ratios in the full sample period. In the two sub-periods, 9 of the 13 statistics are significant. Two of the four insignificant statistics are from the reserves-to-imports ratio, indicating that income level has no discernable association with the holding of international reserves relative to imports. The other two insignificant statistics are related to the reserves-to-cumulative-gross-FDI-inflows ratio in the second sub-period and the reserves-to-M2 ratio in the first sub-period. The contingency coefficients pertaining to the level of income characteristic have an order of magnitude comparable to those reported for the region characteristic.

The observed proportions presented in Appendix 5 indicate that the dependence of international reserve ratios on income levels is largely driven by the behavior of low- and high-income economies. Compared with the 50-50 benchmark and the economies in the other two income groups, the middle-income economies tend to be more evenly distributed between the LOW and HIGH categories.

The low- and high-income economies tend to give different LOW and HIGH distributions. For instance, in the full sample period when international reserves are measured relative to imports, foreign liabilities, cumulative FDI inflows, and population, the low-income economies tend to have a small international reserve ratio while the high-income economies tend to have a high ratio. However, the opposite is true when short-term external debts and M2 are used to normalize international reserves.

3.1.3 Level of Indebtedness

The classification of international reserve ratios depends on the level of indebtedness when the normalizing factor is either total foreign liabilities, short-term external debts, population, or GDP in the full sample and the two sub-periods. As data on short-term external debts are available only in the second sub-period, the contingency coefficients pertaining to this
ratio are the same for the full sample and the second sub-period. Appendix 5 shows that the severely-indebted economies, compared with the less indebted economies, tend to hold a higher level of reserves relative to foreign liabilities or short-term external debts, which is consistent with the recommendation of holding sufficient international reserves to service short-term obligations.

3.1.4 Developed versus Developing Economies

The international reserve accumulation of the developed economies and developing economies appears different. The contingency coefficient is significant a) in all three sample periods when the normalizing factor is M2 or population, b) in the full sample and one of the sub-periods when the normalizing factor is cumulative FDI inflows or GDP, and c) in the second sub-period when the normalizing factor is total foreign liabilities. Again, there is no result for the short-term-external-debts ratio because data for the developed economies are not available.

The observed proportions reported in Appendix 5 suggest that the significant results are mainly driven by the skewed distribution of LOW and HIGH ratios among developed economies. At least for the full sample, whether the developed economies have a high or low international reserve ratio depends on which normalizing factor is used. For instance, when imports, cumulative FDI flows, and population are the normalizing factors, the developed economies tend to have a large ratio. For the other ratios, they tend to have a small ratio.

3.1.5 Exchange Rate Regime

Compared with the other four structural characteristics, the exchange rate arrangement is the one that experiences the most variation during the sample period. Under the Bretton Woods system, fixed exchange rates were the norm. With the demise of the Bretton Woods system and after the transition period from 1971 to 1973, some economies, especially developed economies, have adopted a flexible exchange rate policy. However, throughout our sample period, there are economies switched back and forth between floating and fixed rates. Further, there is a discrepancy between de jure and de facto exchange rate arrangements. The “fear of floating” phenomenon points to the observation that despite the official stance of a floating or limited floating regime, some economies continue to actively manage their exchange rates.

In view of these developments, we divide the period in which we have data on exchange
rate arrangements into three sub-periods. The first is the Bretton Woods period from 1957 to 1972. For the post-Bretton Woods period, we consider an “early period” from 1973 to 1989 and a “recent period” from 1990 to 2001. To determine an economy’s exchange rate arrangement, we rely on the most frequently observed arrangement because some economies altered their exchange rate arrangements several times within each sub-period.

The empirical association between exchange rate regime choices and international reserve holdings is reported in panel B of Table 2. The corresponding observed LOW and HIGH proportions are given in Table A5.4 in Appendix 5. The results attest to the effects of the exchange rate regime on international reserve holding behavior.

During the Bretton Woods period, we do not have sufficient data to conduct the tests for the reserves-to-short-term-external-debts, reserves-to-population, and reserves-to-GDP ratios. For the other four ratios, the LOW/HIGH rankings are significantly associated with an economy’s exchange rate regime. Panel I of Table A5.4 shows that these dependence relations are mainly driven by the fact that in the four cases that we have data, all of the economies with floating rates have an international reserve ratio lower than the median. The economies with rigid exchange rate arrangements, in contrast, have the highest proportion of “HIGH” ranking in three of four cases.

In the post Bretton Woods era, the dependence between exchange rate regimes and ranking of international reserves is not time invariant. In the 1973-89 period, significant dependence relations are detected for the reserves-to-cumulative-gross-FDI-inflows, reserves-to-population, and reserves-to-GDP ratios. In the 1990-2001 period, the reserves-to-short-term-external-debts and the reserves-to-population ratios are not associated with exchange rate regimes.

The proportions reported in panels II and III of Table A5.4 give some clues on the differences in hoarding behavior. Among the ratios that display a significant relationship with exchange rate regimes, the economies with floating rates tend to have the highest percentage of the LOW label. The two exceptions are the reserves-to-cumulative-FDI-inflows and reserves-to-population ratios in the 1973-1989 sample. In these two cases, economies with rigid exchange rate regimes have the highest percentage of LOW label. The results are broadly in line with the belief that, compared with others, floaters require a lower level of precautionary demand for international reserves.
One interesting observation is that for all the six international reserve ratios that are significantly associated with an economy’s exchange rate arrangement, the economies that have limited exchange rate flexibility tend to give the largest proportion of HIGH ratios. Why is an economy that adopts a regime of limited flexibility likely to hold a high level of international reserves? If the “unstable middle” hypothesis (Willett, 2003) that suggests crawling peg regimes are more susceptible to currency crisis than the flexible or fixed exchange rate regimes is true, then an economy with limited exchange rate flexibility has the incentive to hold a high level of precautionary demand for international reserves.

3.1.6 A Subsection Summary

In the previous subsections, we found significant associations between the chosen structural characteristics and the relative magnitudes of international reserve ratios. The geographic location and income effects are pervasive and are detected in all the seven international reserve ratios. It is also noted that for some structural characteristics, such as the exchange rate regime, the pattern of associations is not constant over time.

In addition to the time average $r_{i,j,.}$, we also investigated the associations between these structural characteristics and the variance, the skewness, and the kurtosis of international reserves. In general, the empirical associations between structural characteristics and the variance of international reserve ratios are broadly similar to those of the average. Compared with averages and variances, the third and fourth moments yield a substantially smaller number of significant cases and less discernable patterns among specific pairs of structural characteristics and international reserve ratios. For brevity, these results are not reported but are available upon request.

3.2 Rankings across Economies

When commenting on the adequacy of an economy’s international reserves, economists and policymakers often have in mind a certain normalizing factor such as the number of months of imports. Could the level of international reserves held by an economy be deemed excessive according to one ratio but deficient according to another? Because we do not know the optimal level of an international reserve ratio, we modify the question to whether it is possible that the level of international reserves held by an economy is relatively high according to one ratio but
Given a multitude of international reserve ratios, do they provide similar information about an economy’s level of international reserves relative to other economies’ holdings? Suppose the type $j$ international reserve ratio indicates that an economy has a relatively high level of international reserves. Does another ratio, say the type $j^*$ ratio, also suggest the economy has a relatively high level of international reserves? If it does, then it is likely that different international reserve ratios offer similar information on whether an economy’s international reserve holding is excessive. If it does not, then we have to decide which international reserve ratio is relevant in assessing the adequacy of international reserves.

3.2.1 Rank Correlation: The Entire Sample of Economies

The rank correlation is a non-parametric measure of association. It is used to assess whether different ratios provide similar rankings of an economy’s level of international reserves. Again, consider the time averages $\{r_{i,j}\}_{i=1,\ldots,N}$. Let $r_{i,j}$ be the rank of $r_{i,j}$ among $N$ economies. Then, for the type $j$ and type $j^*$ international reserve ratios, their degree of association is measured using the correlation between $\{r_{i,j}\}$ and $\{r_{i,j^*}\}$. A rank correlation close to one indicates that the two ratios tend to give similar rankings: that is, a relatively large international reserve ratio $r_{i,j}$ will tend to imply a relatively large ratio $r_{i,j^*}$. A rank correlation close to zero suggests that the ranking of an economy’s international reserve ratio $r_{i,j}$ bears no implication for the ranking of its other ratio $r_{i,j^*}$. If the rank correlation is negative, then a large $r_{i,j}$ implies a small $r_{i,j^*}$. The rank correlation is used to ensure the inference is robust to non-normality and outliers. A brief technical description of the rank correlation is given in Section B of Appendix 4.

The rank correlation estimates calculated from three sample periods (1957-2004, 1957-1989, and 1990-2004) are presented in Table 3. Again, note that we do not have data on short-term external debts for the 1957-1989 period.

For the full sample period from 1957 to 2004, 18 of the 21 rank correlation coefficients are statistically significant and they are all positive. Thus, in general, if one ratio indicates that an economy has a high level of international reserves, the other ratios are likely to give a high
Although these estimates suggest that the rankings of these international reserve ratios tend to move in tandem, the strength of co-movement requires further scrutiny. If the magnitude of the rank correlation estimate is used as a proxy for the intensity of association, then the pattern of co-variation is diverse. The significant estimates range from a low of 0.1865 between the reserves-to-cumulative-gross-FDI-inflows and reserves-to-population ratios to a high of 0.7524 between the reserves-to-GDP and reserves-to-total-foreign-liabilities ratios. There are 6 estimates above 0.5 and 12 estimates below 0.5. Thus, while the rankings of these ratios tend to move in the same direction, the evidence confirms that they have unique behavior that is not captured by other ratios. Thus, it is possible that different ratios give different assessments of the relative international reserve holding positions, and thus of the adequacy of international reserves.

To gain further insight into the issue, we list the top 10 and bottom 10 economies for each of the seven international reserve ratios in Table 4. The rankings are based on the averages over the 1957-2004 period. Most of the top 10 and bottom 10 economies are developing economies. Developed economies are well represented only in the case of reserves-to-M2 ratio where they account for six of the bottom 10 spots. Despite their reputation as large holders of international reserves, Asian economies are not very visible in the top 10 lists. For instance, China, Hong Kong, and Singapore appear in the top 10 list in only two of the seven international reserve ratios. Indeed, only a few economies show up three times in these lists. The result reinforces the general impression that each international reserve ratio has its own unique extreme value membership.

The data in the 1957-1989 sample give a smaller number of significant rank correlation estimates – 11 of 15 estimates are significant. Three of the four insignificant estimates are related to the reserves-to-cumulative-gross-FDI-inflows ratio. Among the significant estimates, eight of them are larger than 0.5.

For the 1990-2004 sample, there are only two insignificant estimates, both of which are associated with the reserves-to-population ratio. In contrast to results in the first sample, most of the significant estimates are less than 0.5. That is, the degree of association between these ratios tends to decline across the two sample periods. Further, the rank correlation estimate between the reserves-to-population and reserves-to-M2 ratios is significantly negative; hence, an economy with a large reserves-to-population ratio tends to have a small reserves-to-M2 ratio.

11 The top 10 and bottom 10 economies in the 1957-1989 and 1990-2004 periods are presented in Appendix 6.
In sum, these results show that in most instances the rankings of these international reserve ratios tend to move in the same direction but the association of these rankings is not very strong. In passing, it is noted that both the number of significant cases and the magnitude of correlation are reduced substantially if actual ratios, rather than their ranks, are used to conduct the analysis.

3.2.2 Developed versus Developing Economies and Asian versus non-Asian Economies

To illustrate the possibility that the degree of association between these international reserve ratios varies between different groups of economies, we present two sets of results in Tables 5 and 6. Table 5 reports the rank correlation estimates computed from developed and developing economies and Table 6 reports those from Asian and non-Asian economies.

The international reserve ratios of developed economies appear to have a strong degree of association. Indeed, the developed economies have a rank correlation estimate larger than that of the developing economies in 13 of the 15 cases in which we have estimates for both groups of economies. Further, it is more likely to have a significant estimate in Table 5 than in Table 3. One possible reason is that the correlation between developed economies is different from the one between developing economies. Thus, if we mix the two groups together, the resulting correlation is weaker than the correlation within each individual group.

The contrast between Asian and non-Asian economies is quite obvious (Table 6). The international reserve ratios of Asian economies tend to display a weaker degree of association than those of non-Asian economies. Specifically, in 13 of 21 cases the Asian rank correlation estimates are smaller than the non-Asian estimates. The Asian economies also have a higher frequency of significant negative estimates – four for Asian economies versus one for non-Asian economies. Thus, compared with Non-Asian economies, the rankings of Asian economies’ international reserves could be quite sensitive to the choice of normalizing variables.

3.2.3 Rank Correlation: A Summary

In this subsection, we examine the relative rankings of the seven international reserve ratios. The results in Tables 3, 4, 5, and 6 illustrate that in terms of their rankings the international reserve ratios share some commonalities but also display certain idiosyncrasies that are not captured by others.
It is conceivable that the economies face different economic and political realities and thus have different responses to similar conditions. The results buttress the idea that the seven international reserve ratios, which measure international reserves with respect to different aspects of an economy, could offer different views on the adequacy of international reserve holdings. For instance, it is possible that an economy is deemed to have accumulated an excessive level of international reserves according to one ratio, but have a moderate amount of hoarding according to the other ratio. Is there one ratio that is more relevant than another for evaluating the adequacy of international reserve holdings? The answer depends on the specific circumstances that an economy is facing and the relevant models of demand for international reserves – these are the issues beyond the scope of the current study.

3.3 Persistence Pattern

In this subsection, we compare the persistence patterns of the seven international reserve ratios. It is well known that the presence of unit root persistence has significant implications for both theoretical and empirical models. For instance, a persistent process is suggestive of the dominance of permanent instead of transitory shocks. In the current exercise, the augmented Dickey-Fuller (ADF) unit root test is used to assess persistence. Specifically, we apply the test to individual time series \( \{ r_{i,t} \} \) for each economy and each international reserve ratio type. Section C in Appendix 4 gives a brief description of the ADF test.

Before discussing the unit root test results, we note that the standard unit root tests are notorious for their inability to offer a sharp inference to differentiate a unit root process from a stationary but highly persistent one. It is quite inconceivable that these international reserve ratios drift around without bounds – a property implied by unit root persistence. Thus, we prefer to interpret non-rejection of the unit root hypothesis as an indication of strong persistence rather than as an unambiguous evidence of a unit root in the data.

Table 7 presents the proportions of economies for which the unit root null is rejected at the 10% level of significance. Only the full sample period from 1957 to 2004 is considered because the sample sizes of the two sub-periods are too short to yield reliable estimates. Panel A of Table 7 summarizes the results for all of the economies in the sample. The rejection proportions vary quite widely among the seven ratios; from 9.50% to 48.50%. The reserves-to-population ratio is the only series that has a rejection proportion less than the 10%
level of significance. In contrast, the reserves-to-cumulative-gross-FDI-inflows ratio yields the highest proportion of rejection, indicating that it has the lowest average degree of persistence among all ratios. Three other international reserve ratios have a rejection proportion larger than 20%, with the remaining two between 10% and 20%.

To formally assess the dependence between rejection frequencies and ratio types, we apply the contingency table test to the sample of 107 economies that have data on all the seven international reserve ratios. The test statistic is significant at the 1% level and the associated contingency coefficient estimate is 0.28. That is, the nonparametric test confirms that the choice of normalizing factor is related to the rejection frequency of the resulting international reserve ratio.

Panel B of Table 7 lists the rejection percentages of each category of the four structural characteristics: region, income, indebtedness and stage of development. The exchange rate regime characteristic is not included because most economies changed their exchange rate arrangements during the 1957-2001 period.

With a few exceptions, the rejection proportions of individual categories are quite close to the corresponding overall rejection proportions in Panel A. The largest variation of rejection frequencies across different categories within individual structural characteristics is found with data on the reserves-to-total foreign liabilities ratio.

Another observation is that within each of the four structural characteristics, the rankings of the rejection frequencies vary across international reserve ratios. For example, the “Asia, Pacific and South Asia” region has the highest rejection rate among the five regions when international reserves are normalized by short-term external debts but has the lowest rejection rate when the normalizing factor is M2. Indeed, for a given structural characteristic, we do not have an economy group that has the highest (or the lowest) rejection frequency for all the seven international reserve ratios.

Is the persistence profile related to an economy’s structural characteristics? Table 8 presents the contingency coefficients of rejection frequencies and structural characteristics. The evidence of dependence is quite limited. In general, these contingency coefficients are small and only 3 of them are statistically significant. Compared with the results in Table 2, the implication of structural characteristics for persistence is much weaker than for the magnitude of international reserve ratios.
In sum, the seven international reserve ratios display different persistence profiles. The result adds to the perception that there are intrinsic differences between the ratios. Unlike the relative magnitude, the persistence pattern of international reserve ratios is only weakly related to structural characteristics.

4. **Concluding Remarks**

Usually, the level of international reserves is measured against some economic variables including imports and foreign liabilities. In this study, we examine the similarities and differences of seven international reserve ratios that are mentioned in the recent discussion of the hoarding of international reserves. Our exercise is empirical, and the results allow us to provide facts that are beyond the anecdotal hype about international reserve accumulation.

One basic observation is that every one of these international reserve ratios displays substantial variations across economies. Notwithstanding high variability, the average international reserve ratios are associated with an economy’s structural characteristics. In addition to the difference between developed and developing economies, the hoarding of international reserves is found to be related to an economy’s geographic location, income level, degree of indebtedness, and exchange rate regime. The pattern of dependence varies across time and international reserve ratios. Interestingly, there is only limited evidence that the Asian and the non-Asian economies have different reserve hoarding behavior.

Besides their average magnitudes, the international reserve ratios exhibit different persistence profiles. We do not have an answer to the question of, say, why persistence differs across international reserve ratios. There is also only weak evidence of the association between persistence and structural characteristics.

Both their variability and dependence on an economy’s characteristics pose a challenge to building models of international reserves. Do we have a “grand” theory that explains the vast differences of international reserve holdings across economies and across time? Our tentative answer is “quite unlikely.” For instance, the recent studies including Aizenman and Lee (2005), de Beaufort Wijnholds and Kapteyn (2001), Garcia and Soto (2004), and Lee (2004) fall short of explaining the recent build-up of international reserves. One approach to address the question, which is not very satisfactory, is to assume that some economies operate sub-optimally and they tend to hold excessive or insufficient international reserves. Alternatively, we can construct
different models for economies with different structural characteristics and for different time periods. The task is further complicated by the fact that the pattern of dependence on structural characteristics is not the same for different international reserve ratios.

On the policy front, our results suggest that the level of international reserves is related to some structural characteristics of an economy. Thus, the notion of the adequacy of international reserves depends on the choice of international reserve ratio and on an economy’s characteristics. The actual level of holding is not sufficient to assert over- or under-hoarding of international reserves. The difficulty in defining the optimal level of international reserves is recognized by policymakers. For instance, in relation to China’s international reserve holding, one Chinese official argued that there is “no unified benchmark on the appropriate amount of foreign exchange reserve an economy should hold in both theory and practice” and “it could not be said to be ‘excessive’ or ‘deficient.’”

Even though the seven international reserve ratios have some commonalities, they do not necessarily agree upon whether an economy is holding too many international reserves. Indeed, the economies that garner the highest (or lowest) ranks in one international reserve ratio usually do not get the highest (or lowest) ranks in another ratio.

Given a multitude of international reserve ratios, which one should we consider? Apparently, the different international reserve ratios offer different perceptions of an economy’s level of international reserves. A series of questions follows. Which one should be used to assess the adequacy of international reserves? Which ratio should be used for designing policies? Do we have a theory on the trade-off between these ratios? Should we form a weighted ratio to assess the adequacy of international reserves? Another interesting theoretical issue is why some economies hold a level of international reserves that is high according to one yardstick but not so according to another. These questions warrant further investigation.

So far, our empirical findings lead to more questions than answers. This is partly because the exercise is an empirical one that does not get much guidance from theory; the theory of the demand for international reserves is silent on most of the issues considered here. Despite these drawbacks, our empirical findings buttress the complexity behind the discussion of the adequacy of international reserves and the challenges one may face in building a general theory of international reserves. One possible implication of our results for assessing the adequacy of international reserves is that policymakers should consider a range of international reserve ratios and use a weighted average to determine the optimal level of holding. 

12 Xinhua News Agency (2004).
international reserves is that, in paraphrasing Frankel (1999), no single international reserve ratio is right for all economies at all times.
Appendix 1  Groupings of Economies and Their Associations

A.  Economics listed under various structural characteristic classifications

I.  Region Classification

Region 1: Asia, Pacific and South Asia (32 economies)
Australia, Bangladesh, Bhutan, Cambodia, China, Fiji, Hong Kong, India, Indonesia, Japan, Korea, Laos, Macao, Malaysia, Maldives, Federated States of Micronesia, Mongolia, Myanmar, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Sri Lanka, Taiwan, Thailand, Tonga, Vanuatu, Vietnam.

Region 2: Europe and Central Asia, (42 economies)
Albania, Armenia, Austria, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Macedonia, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Tajikistan, Turkey, Ukraine, United Kingdom.

Region 3: Latin America and the Caribbean, (34 economies)
Anguilla, Argentina, Aruba, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela.

Region 4: Middle East and North Africa, (17 economies)
Algeria, Bahrain, Djibouti, Egypt, Israel, Jordan, Kuwait, Lebanon, Libya, Malta, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, United Arab Emirates, Yemen.

Region 5: Sub-Sahara Africa, (44 economies)
Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Côte d’Ivoire, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, São Tomé and Príncipe, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

II.  Income Classification

Low-income economies (57 economies)
Angola, Armenia, Azerbaijan, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Cameroon, Central African Republic, Chad, Comoros, Congo, Côte d’Ivoire, Eritrea, Ethiopia, Gabon, Gambia, Georgia, Ghana, Guinea-Bissau, India, Indonesia, Kenya, Kyrgyz Republic, Laos, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Pakistan, Rwanda, São Tomé and Príncipe, Senegal, Sierra Leone, Solomon Islands, Sudan, Tajikistan, Tanzania, Togo, Uganda, Ukraine, Vietnam, Yemen, Zambia, Zimbabwe.
Middle-income economies (79 economies)
Albania, Algeria, Anguilla, Argentina, Bahrain, Belarus, Belize, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Cape Verde, Chile, China, Colombia, Costa Rica, Croatia, Czech Republic, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Estonia, Fiji, Gabon, Grenada, Guatemala, Guyana, Honduras, Hungary, Jamaica, Jordan, Kazakhstan, Korea, Latvia, Lebanon, Libya, Lithuania, Macedonia, Malaysia, Maldives, Mauritius, Mexico, Federated States of Micronesia, Morocco, Namibia, Oman, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Romania, Russia, Samoa, Saudi Arabia, Seychelles, Slovak Republic, South Africa, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Swaziland, Taiwan, Thailand, Tonga, Trinidad and Tobago, Tunisia, Turkey, Uruguay, Vanuatu, Venezuela.

High-income economies (35 economies)
Aruba, Australia, Austria, Baham, Barbados, Canada, Cypru, Denmark, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Kuwait, Macao, Malta, Netherlands Antilles, Netherlands, New Zealand, Norway, Portugal, Qatar, Singapore, Slovenia, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States.

III. Indebtedness Classification

Less-Indebted Economies (37 economies)
Angola, Argentina, Benin, Brazil, Burundi, Cameroon, Central African Republic, Chad, Comoros, Congo, Côte d’Ivoire, Ecuador, Ethiopia, Gabon, Guinea-Bissau, Guyana, Indonesia, Jordan, Kyrgyz Republic, Laos, Liberia, Madagascar, Malawi, Mauritania, Myanmar, Nicaragua, Niger, Nigeria, Pakistan, Peru, Rwanda, São Tomé and Príncipe, Sierra Leone, Sudan, Tajikistan, Tanzania, Zambia.

Moderately-indebted Economies (41 economies)
Algeria, Belize, Bolivia, Bosnia and Herzegovina, Bulgaria, Burkina Faso, Cambodia, Chile, Colombia, Croatia, Estonia, Gambia, Ghana, Haiti, Honduras, Hungary, Jamaica, Kenya, Lebanon, Malaysia, Mali, Mauritius, Moldova, Mongolia, Mozambique, Panama, Papua New Guinea, Philippines, Russia, Samoa, Senegal, St. Vincent and the Grenadines, Thailand, Togo, Tunisia, Turkey, Uganda, Uruguay, Venezuela, Zimbabwe, Yemen.

Severely-indebted Economies (56 economies)
Albania, Anguilla, Armenia, Azerbaijan, Bahrain, Bangladesh, Belarus, Bhutan, Botswana, Cape Verde, China, Costa Rica, Czech Republic, Djibouti, Dominica, Dominican Republic, Egypt, El Salvador, Equatorial Guinea, Eritrea, Fiji, Georgia, Grenada, Guatemala, India, Kazakhstan, Korea, Latvia, Lesotho, Libya, Lithuania, Maldives, Macedonia, Mexico, Morocco, Namibia, Nepal, Oman, Paraguay, Poland, Romania, Saudi Arabia, Seychelles, Slovak Republic, Solomon Islands, South Africa, Sri Lanka, St. Kitts and Nevis, St. Lucia, Suriname, Swaziland, Tonga, Trinidad and Tobago, Ukraine, Vanuatu, Vietnam.
IV. Stage of Development and Asia Versus Non-Asia Classifications

Developing Non-Asian Economies (124 economies)
Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Aruba, Azerbaijan, Bahamas, Bahrain, Barbados, Belarus, Belize, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Chile, Colombia, Comoros, Congo, Costa Rica, Côte d'Ivoire, Croatia, Cyprus, Czech Republic, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Estonia, Ethiopia, Gabon, Gambia, Georgia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, Israel, Jamaica, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyz Republic, Latvia, Lebanon, Lesotho, Liberia, Libya, Lithuania, Macedonia, Madagascar, Malawi, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Montenegro, Mozambique, Namibia, Netherlands Antilles, Nicaragua, Niger, Nigeria, Oman, Panama, Paraguay, Peru, Poland, Qatar, Romania, Russia, Rwanda, São Tomé and Príncipe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Slovak Republic, Slovenia, South Africa, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan, Suriname, Swaziland, Tajikistan, Tanzania, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Arab Emirates, Uruguay, Venezuela, Yemen, Zambia, Zimbabwe.

Developing Asian Economies (29 economies)
Bangladesh, Bhutan, Cambodia, China, Fiji, Hong Kong, India, Indonesia, Korea, Laos, Macao, Malaysia, Maldives, Federated States of Micronesia, Mongolia, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Sri Lanka, Taiwan, Thailand, Tonga, Vanuatu, Vietnam.

Developed Non-Asian Economies (20 economies)
Australia, Austria, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.

Developed Asian Economies (1 economy)
Japan.

V. Exchange Rate Regime Classification

V.1 Bretton Woods period, 1957-1972

Rigid exchange rate regimes (84 economies)
Antigua and Barbuda, Argentina, Austria, Australia, Austria, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Canada, Central African Republic, Chad, Côte d'Ivoire, Cyprus, Denmark, Dominica, Equatorial Guinea, Gabon, Gambia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, India, Ireland, Israel, Italy, Jamaica, Jordan, Kenya, Kuwait, Lesotho, Liberia, Libya, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Morocco, Myanmar, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Peru, Philippines, Portugal, Saudi Arabia, Senegal, Singapore, South Africa, Spain, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Swaziland, Sweden, Switzerland, Tanzania, Thailand, Togo, Tunisia, Uganda, United Kingdom, United States, Venezuela, Zambia.
Limited flexibility exchange rate regimes (17 economies)
Algeria, Bolivia, Colombia, Costa Rica, Ecuador, Egypt, El Salvador, Finland, France, Hungary, Iceland, Japan, Korea, Lao, Lebanon, Paraguay, Turkey.

Floating exchange rate regimes (6 economies)
Brazil, Chile, China, Congo, Dominican Republic, Indonesia.

V.2 Early Post-Bretton Woods period, 1973-1989

Rigid exchange rate regimes (44 economies)
Antigua and Barbuda, Argentina, Austria, Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Côte d’Ivoire, Dominica, Ecuador, Equatorial Guinea, Gabon, Gambia, Grenada, Guatemala, Guinea-Bissau, Guyana, Haiti, Honduras, Jamaica, Jordan, Kenya, Lesotho, Liberia, Madagascar, Mali, Mexico, Federated States of Micronesia, Nicaragua, Niger, Pakistan, Panama, Saudi Arabia, Senegal, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Swaziland, Thailand, Togo, Uruguay, Venezuela.

Limited flexibility exchange rate regimes (46 economies)
Algeria, Australia, Botswana, Brazil, Canada, Colombia, Congo, Costa Rica, Cyprus, Denmark, Dominican Republic, Egypt, El Salvador, Finland, France, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Korea, Kuwait, Lebanon, Malaysia, Malta, Mauritania, Mauritius, Morocco, Myanmar, Nepal, Netherlands, New Zealand, Norway, Paraguay, Philippines, Portugal, Singapore, Spain, Sri Lanka, Suriname, Sweden, Tunisia.

Floating exchange rate regimes (17 economies)
Bolivia, China, Germany, Ghana, Japan, Laos, Libya, Malawi, Nigeria, South Africa, Switzerland, Tanzania, Uganda, United Kingdom, United States, Zambia, Zimbabwe.

V.3 Recent years, 1990-2004

Rigid exchange rate regimes (49 economies)
Antigua and Barbuda, Argentina, Austria, Benin, Bosnia and Herzegovina, Brazil, Bulgaria, Burkina Faso, Cameroon, Central African Republic, Chad, China, Côte d’Ivoire, Cyprus, Dominica, Egypt, El Salvador, Equatorial Guinea, Estonia, Finland, France, Gabon, Greece, Grenada, Guinea-Bissau, Hong Kong, Korea, Latvia, Lebanon, Lesotho, Lithuania, Mali, Federated States of Micronesia, Moldova, Netherlands, Niger, Panama, Portugal, Saudi Arabia, Senegal, Spain, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Swaziland, Tajikistan, Thailand, Togo, Venezuela.

Limited flexibility exchange rate regimes (60 economies)
Algeria, Armenia, Azerbaijan, Bolivia, Botswana, Burundi, Canada, Chile, Colombia, Costa Rica, Croatia, Czech Republic, Denmark, Dominican Republic, Ecuador, Gambia, Guatemala, Guyana, Honduras, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Jamaica, Kazakhstan, Kuwait, Kyrgyz Republic, Lao, Liberia, Libya, Macedonia, Malaysia, Malta, Mauritania, Mauritius, Mongolia, Morocco, Myanmar, Nepal, Nicaragua, Pakistan, Paraguay, Peru, Philippines, Poland, Romania, Russia, Singapore, Slovak Republic, Slovenia, Sri Lanka, Switzerland, Tanzania, Tunisia, Turkey, Uganda, Uruguay.
Floating exchange rate regimes (20 economies)
Albania, Australia, Georgia, Germany, Ghana, Haiti, Japan, Kenya, Madagascar, Malawi, Mexico, New Zealand, Nigeria, Norway, South Africa, Sweden, United Kingdom, United States, Zambia, Zimbabwe.

B. Correlation between Structural Characteristics

|                        | Region  | Income | Indebtedness | Stage of Development |
|------------------------|---------|--------|--------------|----------------------|
| Income                 | 0.572***|        |              |                      |
| Indebtedness           | 0.410***| 0.4732***|            |                      |
| Stage of development   | 0.448***| 0.594***| n.a.         |                      |
| Asian/non-Asian        | 0.693***| 0.09   | 0.132        | 0.121                |

Notes: “***” indicates significance at the 1% level. All reported correlations are contingency coefficients except for the “income” and “indebtedness” pair for which rank correlation is reported instead because all economies in the high income group are in the “not classified” indebtedness category that is not used in the current study. No correlation coefficient of indebtedness and stage of development is reported because data are not available. The coefficients related to exchange rate regimes are not computed because most economies changed their exchange rate arrangements during the sample period.
Appendix 2 Graphs of International Reserve Ratios

The appendix contains time series plots of averages of international reserve ratios calculated according to the economy’s structural characteristics. A canonical form of the average is

$$r_{i,j,t} = \frac{\sum_{i=1}^{N_C} r_{i,j,t}}{N_C},$$

where $N_C$ is the number of economies sharing a common structural characteristic $C$, and $j$ indicates the variable used to normalize international reserves.
A2.1 International Reserve Ratios by Regions

a. International Reserves to Imports

b. International Reserves to Total Foreign Liabilities

c.1 International Reserves to Short Term External Debts

c.2 International Reserves to Short Term External Debts
d. International Reserves to Cumulative FDI Inflows

![Graph showing International Reserves to Cumulative FDI Inflows](image)

- Asia, Pacific & South Asia
- Europe & Central Asia
- Latin America & Caribbean
- Middle East & North Africa
- Sub-Saharan Africa

e. International Reserves to M2

![Graph showing International Reserves to M2](image)

- Asia, Pacific & South Asia
- Europe & Central Asia
- Latin America & Caribbean
- Middle East & North Africa
- Sub-Saharan Africa

f. International Reserves to Population

![Graph showing International Reserves to Population](image)

- Asia, Pacific & South Asia
- Europe & Central Asia
- Latin America & Caribbean
- Middle East & North Africa
- Sub-Saharan Africa

g. International Reserves to GDP

![Graph showing International Reserves to GDP](image)

- Asia, Pacific & South Asia
- Europe & Central Asia
- Latin America & Caribbean
- Middle East & North Africa
- Sub-Saharan Africa
A2.2 International Reserve Ratios: Asian versus Non-Asian Economies

a. International Reserves to Imports

b. International Reserves to Total Foreign Liabilities

c.1 International Reserves to Short Term External Debts

c.2 International Reserves to Short Term External Debts
d. International Reserves to Cumulative FDI Inflows

![Graph showing the relationship between International Reserves and Cumulative FDI Inflows over time for both non-Asia and Asia regions.]

e. International Reserves to M2

![Graph showing the relationship between International Reserves and M2 over time for both non-Asia and Asia regions.]

f. International Reserves to Population

![Graph showing the relationship between International Reserves and population over time for both non-Asia and Asia regions.]

g. International Reserves to GDP

![Graph showing the relationship between International Reserves and GDP over time for both non-Asia and Asia regions.]

A2.3 International Reserve Ratios By Income Levels

a. International Reserves to Imports

b. International Reserves to Total Foreign Liabilities

c.1 International Reserves to Short Term External Debts

c.2 International Reserves to Short Term External Debts
d. International Reserves to Cumulative FDI Inflows

![Graph showing International Reserves to Cumulative FDI Inflows with three lines for Low Income, Middle Income, and High Income categories. The years range from 1980 to 2002.]

e. International Reserves to M2

![Graph showing International Reserves to M2 with three lines for Low Income, Middle Income, and High Income categories. The years range from 1955 to 2005.]

f. International Reserves to Population

![Graph showing International Reserves to Population with three lines for Low Income, Middle Income, and High Income categories. The years range from 1980 to 2004.]

g. International Reserves to GDP

![Graph showing International Reserves to GDP with three lines for Low Income, Middle Income, and High Income categories. The years range from 1980 to 2004.]
A2.4 International Reserve Ratios by Indebtedness Levels

a. International Reserves to Imports

b. International Reserves to Total Foreign Liabilities

c.1 International Reserves to Short Term External Debts

c.2 International Reserves to Short Term External Debts
d. International Reserves to Cumulative FDI Inflows

![Graph showing International Reserves to Cumulative FDI Inflows with legends: Less Indebted, Moderately Indebted, Severely Indebted.]

-15000% -10000% -5000% 0% 5000% 10000%
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002

e. International Reserves to M2

![Graph showing International Reserves to M2 with legends: Less Indebted, Moderately Indebted, Severely Indebted.]

1958 1963 1968 1973 1978 1983 1988 1993 1998 2003

f. International Reserves to Population

![Graph showing International Reserves to Population with legends: Less Indebted, Moderately Indebted, Severely Indebted.]

US $ per head
0 100 200 300 400 500 600 700 800 900
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004

g. International Reserves to GDP

![Graph showing International Reserves to GDP with legends: Less Indebted, Moderately Indebted, Severely Indebted.]

0 5% 10% 15% 20% 25%
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004
A2.5 International Reserve Ratios by Stages of Development

a. International Reserves to Imports

b. International Reserves to Total Foreign Liabilities

c.1 International Reserves to Short Term External Debts
(for developing economies only)

c.2 International Reserves to Short Term External Debts
(for developing economies only)
d. International Reserves to Cumulative FDI Inflows

e. International Reserves to M2

f. International Reserves to Population
g. International Reserves to GDP
A2.6 International Reserve Ratios by Exchange Rate Regimes

a. International Reserves to Imports

b. International Reserves to Total Foreign Liabilities

c. International Reserves to Short Term External Debts

d. International Reserves to Cumulative FDI Inflows
e. International Reserves to M2

f. International Reserves to Population

g. International Reserves to GDP
Appendix 3  Frequency Distributions of International Reserve Ratios

The appendix contains frequency distributions of \( \{ r_{i,j} \} \) where \( N \) is the number of economies and \( j \) indicates the variable used to normalize international reserves. \( r_{i,j} \) is the time average of international reserve ratios given by

\[
r_{i,j} = \frac{\sum_{t=1}^{T} r_{i,j,t}}{T}.
\]
A3.3(II) International Reserves to Short Term External Debts

A3.4(I) International Reserves to Cumulative FDI Inflows

A3.4(II) International Reserves to Cumulative FDI Inflows

A3.5(I) International Reserves to M2
Appendix 4  Statistical Procedures

A.  Contingency Table Analysis and Contingency Coefficient

The contingency table analysis is based on the statistic defined by

\[ Q = \sum_r \sum_c \frac{(O_{rc} - E_{rc})^2}{E_{rc}}. \]

In our exercise, \( r \) is ranking (LOW and HIGH) attribute and \( c \) is an index of a given structural characteristic. Under the null hypothesis that the attributes “\( r \)” and “\( c \)” are independent, the test statistic \( Q \) has a chi-square distribution with \((R-1)(C-1)\) degrees of freedom, where \( C \) is the number of categories of the structural characteristic and \( R \) is 2, the number of rankings. For example, when the income structural characteristic is under consideration, \( c \) = low-income, middle-income and high-income, and \( C = 3 \). \( O_{rc} \) is the number of economies that have attributes “\( r \)” and “\( c \)” and \( E_{rc} \) is the corresponding expected number of economies under the null hypothesis. The expected quantity is given by \( E_{rc} = \frac{O_r O_c}{N} \), where \( O_r \) is the number of economies defined by “\( r \)” \( O_c \) is number of economies defined by “\( c \)” and \( N \) is the total number of economies under consideration.

The degree of association between the two attributes is measured by a non-parametric contingency coefficient defined as follows:

\[ \text{Contingency coefficient} = \frac{\sqrt{\chi^2}}{\sqrt{N + \chi^2}}. \]

The contingency coefficient equals zero when the two attributes are independent, and approaches one as the degree of association between them increases. The statistical significance of a contingency coefficient follows from that of the \( Q \) statistic.

B.  Rank Correlation

To assess the degree of association between the type \( j \) and type \( j^* \) international reserve ratios, we consider two ranked series \( \{ r_{i,j^*} \} \) and \( \{ r_{i,j^*} \} ; i = 1, \ldots, N \), where \( r_{i,j^*} \) is the rank of \( i \) among the \( N \) economies and \( r_{i,j^*} \) is the rank of \( i \). Specifically, we compute the Spearman rank correlation coefficient

\[ S = 1 - \sum_{i=1}^{N} \frac{(r_{i,j^*} - r_{i,j^*})^2}{N^3 - N}. \]
Under the null hypothesis of the independent of the rankings $r_{i,j,r}$ and $r_{i,j,f'}$, and for sample size, say, larger 30, the statistically significance of $S$ can be tested using the t-statistic

$$T_{N-2} = S[(N-2)/(1-S^2)]^{1/2}.$$  

The rank correlation coefficient is between 1 and -1. A rank correlation close to one indicates that the two ratios tend to give similar rankings: that is, a relatively large international reserve ratio $r_{i,j,r}$ will tend to imply a relatively large ratio $r_{i,j,f'}$. A rank correlation close to zero suggests that the ranking of an economy’s international reserve ratio $r_{i,j,r}$ bears no implication for the ranking of its other ratio $r_{i,j,f'}$. If the rank correlation is negative, then a large $r_{i,j,r}$ implies a small $r_{i,j,f'}$.

C. Augmented Dickey-Fuller Test

For a time series of international reserve ratios, $\{r_{i,j,t}\}_{t=1,\ldots,T}$, the augmented Dickey-Fuller test is based on the regression equation

$$\Delta r_{i,j,t} = \omega_t + \tau t + \delta_i r_{i,j,t-1} + \sum_{k=1}^{p-1} \varphi_k \Delta r_{i,j,t-k} + \epsilon_{i,j,t},$$

where $\Delta$ is the differencing operator. Under the unit-root null hypothesis, $\delta_i = 0$. The null hypothesis is rejected when the ADF test statistic, which is given by the usual $t$-statistic for $\delta_i = 0$ against the alternative of $\delta_i < 0$, is significant. Finite sample critical values for the test are given in Cheung and Lai (1996).
Appendix 5  The High and Low Breakdowns of International Reserve Ratios

For each type of international reserve ratios, we rank the time averages \( \{ r_{i,j} \}_{i=1, \ldots, N} \). Then we assign a LOW or HIGH label to each time average \( r_{i,j} \), depending on whether it is below or above the median of \( \{ r_{i,j} \} \). The appendix presents the proportions of economies with a LOW or HIGH label under each category of a given structural characteristic.
| I. Region categories | AR/IM** | AR/TFL*** | AR/STED*** | AR/CFDI in*** | AR/M2 | AR/POP*** | AR/GDP*** |
|---------------------|---------|-----------|------------|--------------|-------|-----------|-----------|
| 1) Asia, Pacific & South Asia | 48 | 52 | 57 | 43 | 38 | 62 | 46 | 54 | 56 | 44 | 50 | 50 | 47 | 53 |
| 2) Europe & Central Asia | 48 | 52 | 38 | 62 | 31 | 69 | 29 | 71 | 49 | 51 | 29 | 71 | 48 | 52 |
| 3) Latin America & Caribbean | 61 | 39 | 62 | 38 | 78 | 22 | 75 | 25 | 61 | 39 | 38 | 62 | 50 | 50 |
| 4) Middle East & North Africa | 12 | 88 | 19 | 81 | 47 | 53 | 18 | 82 | 41 | 59 | 29 | 71 | 6 | 94 |
| 5) Sub-Saharan Africa | 59 | 41 | 68 | 32 | 50 | 50 | 64 | 36 | 39 | 61 | 91 | 9 | 67 | 33 |

| I.a Asian Vs Non-Asian | AR/IM | AR/TFL | AR/STED | AR/CFDI in | AR/M2 | AR/POP | AR/GDP |
|------------------------|-------|--------|---------|------------|-------|--------|--------|
| 1) Asian | 50 | 50 | 50 | 50 | 53 | 47 | 49 | 49 | 51 | 49 | 51 | 51 | 49 |
| 2) Non-Asian | 48 | 52 | 48 | 52 | 38 | 62 | 42 | 58 | 53 | 47 | 54 | 46 | 43 | 57 |

| II. Income categories | AR/IM** | AR/TFL*** | AR/STED** | AR/CFDI in** | AR/M2*** | AR/POP*** | AR/GDP*** |
|-----------------------|---------|-----------|------------|--------------|----------|-----------|-----------|
| 1) Low | 61 | 39 | 72 | 28 | 39 | 61 | 59 | 41 | 36 | 64 | 98 | 2 | 68 | 32 |
| 2) Middle | 49 | 51 | 37 | 63 | 53 | 47 | 53 | 47 | 49 | 51 | 36 | 64 | 35 | 65 |
| 3) High | 31 | 69 | 43 | 57 | 79 | 21 | 24 | 76 | 74 | 26 | 0 | 100 | 52 | 48 |

| III. Indebtedness | AR/IM | AR/TFL ** | AR/STED ** | AR/CFDI in | AR/M2 | AR/POP*** | AR/GDP*** |
|------------------|-------|----------|------------|------------|-------|-----------|-----------|
| 1) Less | 51 | 49 | 74 | 26 | 54 | 46 | 63 | 37 | 47 | 53 | 83 | 17 | 72 | 28 |
| 2) Moderate | 49 | 51 | 42 | 58 | 63 | 37 | 41 | 59 | 41 | 59 | 44 | 56 | 41 | 59 |
| 3) Severe | 48 | 52 | 40 | 60 | 37 | 63 | 46 | 54 | 57 | 43 | 33 | 67 | 40 | 60 |

| IV. Stage of Development | AR/IM | AR/TFL | AR/STED | AR/CFDI in** | AR/M2** | AR/POP*** | AR/GDP** |
|--------------------------|-------|--------|---------|--------------|----------|-----------|----------|
| 1) Developing Economies | 52 | 48 | 49 | 51 | 50 | 50 | 54 | 46 | 44 | 56 | 57 | 43 | 46 | 54 |
| 2) Developed Economies | 38 | 62 | 57 | 43 | n.a. | n.a. | 24 | 76 | 90 | 10 | 0 | 100 | 76 | 24 |

Note: See the note to Table 1 and the text for definitions of the ratios. “***,” “**,” and “*” in the column headings indicate significance of the corresponding contingency coefficients reported in Table 2 in the text at, respectively, the 1%, 5%, and 10% levels.
### Table A5.2  The Observed Frequencies of High and Low International Reserve Ratios, 1957 - 1989

| Region categories | I. Region categories | AR/IM* | AR/TFL** | AR/STED | AR/CFDI in*** | AR/M2** | AR/POP*** | AR/GDP*** |
|-------------------|----------------------|--------|----------|----------|---------------|---------|-----------|-----------|
| 1) Asia, Pacific & South Asia | 42 | 58 | 45 | 55 | n.a | n.a | 42 | 58 | 50 | 50 | 52 | 48 | 56 | 44 |
| 2) Europe & Central Asia | 43 | 57 | 37 | 63 | n.a | n.a | 5 | 95 | 80 | 20 | 14 | 86 | 43 | 57 |
| 3) Latin America & Caribbean | 56 | 44 | 67 | 33 | n.a | n.a | 75 | 25 | 56 | 44 | 47 | 53 | 44 | 56 |
| 4) Middle East & North Africa | 25 | 75 | 20 | 80 | n.a | n.a | 25 | 75 | 31 | 69 | 25 | 75 | 19 | 81 |
| 5) Sub-Saharan Africa | 64 | 36 | 66 | 34 | n.a | n.a | 66 | 34 | 38 | 62 | 82 | 18 | 69 | 31 |

| I.a Asian Vs Non-Asian | AR/IM | AR/TFL** | AR/STED | AR/CFDI in*** | AR/M2** | AR/POP*** | AR/GDP*** |
|------------------------|-------|---------|---------|----------------|---------|-----------|-----------|
| 1) Asia | 52 | 48 | 53 | 47 | n.a | n.a | 53 | 47 | 51 | 49 | 49 | 51 | 50 | 50 |
| 2) Non-Asia | 42 | 58 | 39 | 61 | n.a | n.a | 38 | 62 | 46 | 54 | 56 | 44 | 52 | 48 |

| II. Income categories | AR/IM | AR/TFL** | AR/STED | AR/CFDI in*** | AR/M2** | AR/POP*** | AR/GDP*** |
|----------------------|-------|---------|---------|----------------|---------|-----------|-----------|
| 1) Low | 60 | 40 | 69 | 31 | n.a | n.a | 57 | 43 | 44 | 56 | 97 | 3 | 74 | 26 |
| 2) Middle | 49 | 51 | 49 | 51 | n.a | n.a | 59 | 41 | 47 | 53 | 43 | 57 | 41 | 59 |
| 3) High | 38 | 62 | 30 | 70 | n.a | n.a | 20 | 80 | 64 | 36 | 0 | 100 | 35 | 65 |

| III. Indebtedness | AR/IM | AR/TFL* | AR/STED | AR/CFDI in*** | AR/M2** | AR/POP*** | AR/GDP** |
|-------------------|-------|---------|---------|----------------|---------|-----------|----------|
| 1) Less | 48 | 52 | 68 | 32 | n.a | n.a | 61 | 39 | 45 | 55 | 84 | 16 | 72 | 28 |
| 2) Moderate | 48 | 52 | 39 | 61 | n.a | n.a | 45 | 55 | 52 | 48 | 42 | 58 | 45 | 55 |
| 3) Severe | 54 | 46 | 44 | 56 | n.a | n.a | 44 | 56 | 53 | 47 | 30 | 70 | 38 | 62 |

| IV. Stage of Development | AR/IM | AR/TFL* | AR/STED | AR/CFDI in*** | AR/M2*** | AR/POP*** | AR/GDP |
|--------------------------|-------|---------|---------|----------------|---------|-----------|--------|
| 1) Developing Economies | 52 | 48 | 52 | 48 | n.a | n.a | 55 | 45 | 44 | 56 | 59 | 41 | 50 | 50 |
| 2) Developed Economies | 38 | 62 | 40 | 60 | n.a | n.a | 20 | 80 | 86 | 14 | 0 | 100 | 48 | 52 |

Note: See the note to Table 1 and the text for definitions of the ratios. “***,” “**,” and “*” in the column headings indicate significance of the corresponding contingency coefficients reported in Table 2 in the text at the 1%, 5%, and 10% levels, respectively.
Table A5.3  The Observed Frequencies of High and Low International Reserve Ratios, 1990-2004

| I. Region categories                      | % low | % high | % low | % high | % low | % high | % low | % high | % low | % high | % low | % high | % low | % high |
|-------------------------------------------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|
|                                           | AR/IM** | AR/TFL*** | AR/STED*** | AR/CFDI in*** | AR/M2 | AR/POP*** | AR/GDP** |
| 1) Asia, Pacific & South Asia             | 48     | 52     | 43     | 57     | 38    | 62     | 45    | 55     | 59    | 41     | 50    | 50     | 40    | 60     |
| 2) Europe & Central Asia                  | 60     | 40     | 43     | 57     | 31    | 69     | 33    | 67     | 49    | 51     | 29    | 71     | 55    | 45     |
| 3) Latin America & Caribbean              | 55     | 45     | 57     | 43     | 78    | 22     | 81    | 19     | 61    | 39     | 34    | 66     | 47    | 53     |
| 4) Middle East & North Africa             | 12     | 88     | 13     | 87     | 47    | 53     | 18    | 82     | 53    | 47     | 29    | 71     | 18    | 82     |
| 5) Sub-Saharan Africa                     | 51     | 49     | 77     | 23     | 50    | 50     | 57    | 43     | 34    | 66     | 91    | 9      | 65    | 35     |

| I.a Asian Vs Non-Asian                    | AR/IM | AR/TFL*** | AR/STED** | AR/CFDI in*** | AR/M2 | AR/POP*** | AR/GDP* |
|                                           | AR/IM | AR/TFL*** | AR/STED** | AR/CFDI in*** | AR/M2 | AR/POP*** | AR/GDP* |
| 1) Asian                                  | 51    | 49     | 52     | 48     | 53    | 47     | 52    | 48     | 49    | 51     | 49    | 51     | 53    | 47     |
| 2) Non-Asian                              | 44    | 56     | 38     | 62     | 38    | 62     | 41    | 59     | 57    | 43     | 54    | 46     | 38    | 62     |

| II. Income categories                     | AR/IM | AR/TFL*** | AR/STED** | AR/CFDI in*** | AR/M2 | AR/POP*** | AR/GDP*** |
|                                           | AR/IM | AR/TFL*** | AR/STED** | AR/CFDI in*** | AR/M2 | AR/POP*** | AR/GDP*** |
| 1) Low                                    | 59    | 41     | 74     | 26     | 39    | 61     | 53    | 47     | 32    | 68     | 98    | 2      | 63    | 37     |
| 2) Middle                                 | 45    | 55     | 25     | 75     | 53    | 47     | 51    | 49     | 45    | 55     | 36    | 64     | 35    | 65     |
| 3) High                                   | 43    | 57     | 63     | 37     | 79    | 21     | 41    | 59     | 89    | 11     | 9     | 100    | 100   | 60     |

| III. Indebtedness                         | AR/IM | AR/TFL*** | AR/STED** | AR/CFDI in*** | AR/M2 | AR/POP*** | AR/GDP |
|                                           | AR/IM | AR/TFL*** | AR/STED** | AR/CFDI in*** | AR/M2 | AR/POP*** | AR/GDP |
| 1) Less                                   | 46    | 54     | 86     | 14     | 54    | 46     | 63    | 37     | 42    | 58     | 83    | 17     | 64    | 36     |
| 2) Moderate                               | 41    | 59     | 44     | 56     | 63    | 37     | 46    | 54     | 43    | 57     | 43    | 57     | 41    | 59     |
| 3) Severe                                 | 58    | 42     | 28     | 72     | 37    | 63     | 43    | 57     | 60    | 40     | 33    | 67     | 45    | 55     |

| IV. Stage of Development                  | AR/IM | AR/TFL*** | AR/STED** | AR/CFDI in*** | AR/M2 | AR/POP*** | AR/GDP*** |
|                                           | AR/IM | AR/TFL*** | AR/STED** | AR/CFDI in*** | AR/M2 | AR/POP*** | AR/GDP*** |
| 1) Developing Economies                  | 48    | 52     | 44     | 56     | n.a   | n.a     | 49    | 51     | 43    | 57     | 57    | 43     | 45    | 55     |
| 2) Developed Economies                   | 62    | 38     | 81     | 19     | n.a   | n.a     | 52    | 48     | 100   | 0      | 0     | 100    | 85    | 15     |

Note: See the note to Table 1 and the text for definitions of the ratios. “***,” “**,” and “*” in the column headings indicate significance of the corresponding contingency coefficients reported in Table 2 in the text at the 1%, 5%, and 10% levels, respectively.
### Table A5.4 The Observed Frequencies of High and Low International Reserve Ratios: Exchange Rate Regimes

| Period                      | I. 1957-72; Bretton Woods | II. 1973-89; post Bretton Woods | III. 1990-2001; post-Bretton Woods |
|-----------------------------|---------------------------|---------------------------------|-------------------------------------|
|                             | AR/IM* | AR/TFL* | AR/STED | AR/CFDI in* | AR/M2* | AR/POP | AR/GDP | AR/IM* | AR/TFL*** | AR/STED | AR/CFDI in* | AR/M2* | AR/POP | AR/GDP*** |
| 1) Rigid                    | AR/IM* | AR/TFL* | AR/STED | AR/CFDI in* | AR/M2* | AR/POP | AR/GDP | AR/IM* | AR/TFL*** | AR/STED | AR/CFDI in* | AR/M2* | AR/POP | AR/GDP*** |
| 2) Limited flexibility      | AR/IM* | AR/TFL* | AR/STED | AR/CFDI in* | AR/M2* | AR/POP | AR/GDP | AR/IM* | AR/TFL*** | AR/STED | AR/CFDI in* | AR/M2* | AR/POP | AR/GDP*** |
| 3) Floating                 | AR/IM* | AR/TFL* | AR/STED | AR/CFDI in* | AR/M2* | AR/POP | AR/GDP | AR/IM* | AR/TFL*** | AR/STED | AR/CFDI in* | AR/M2* | AR/POP | AR/GDP*** |

Note: See the note to Table 1 and the text for definitions of the ratios. “***,” “**,” and “*” in the column headings indicate significance of the corresponding contingency coefficients reported in Table 2 in the text at the 1%, 5%, and 10% levels, respectively.
Appendix 6  The top 10 and bottom 10 economies, 1957-1989 and 1990-2004.

In this appendix, we list the top 10 and bottom 10 economies for each of the seven international reserve ratios. The rankings are based on the averages over the 1957-1989 and 1990-2004 periods, respectively.
| Economies   | AR/IM  | Economies   | AR/TFL | Economies   | AR/CFDI_in |
|------------|--------|------------|--------|------------|------------|
| Top 10     |        |            |        |            |            |
| Saudi Arabia | 19.9941 | Portugal   | 3.3128 | Nepal      | 802.3614   |
| Malta      | 14.6229 | Saudi Arabia | 2.5829 | Hungary    | 461.6483   |
| Libya      | 14.5127 | Nepal      | 2.3759 | Bangladesh | 185.8859   |
| Uruguay    | 12.4048 | China      | 1.8225 | Bhutan     | 158.3361   |
| Switzerland | 12.3439 | Libya      | 1.8121 | Myanmar    | 142.9182   |
| Lebanon    | 11.9937 | Taiwan     | 1.689  | Kuwait     | 142.4785   |
| Portugal   | 11.2925 | Kuwait     | 1.2622 | Uruguay    | 137.9242   |
| Venezuela  | 10.4964 | Malta      | 1.0846 | Tonga      | 135.0059   |
| Cape Verde | 8.8072  | Jordan     | 0.7976 | Mongolia   | 89.9425    |
| Jordan     | 8.4126  | Mauritius  | 0.7656 | Jordan     | 44.4746    |
| Bottom 10  |        |            |        |            |            |
| Laos       | 0.2725  | Laos       | 0.002  | Cape Verde | -1390.45   |
| Liberia    | 0.3871  | Panama     | 0.0062 | Lebanon    | -151.524   |
| Bahamas    | 0.6949  | Equatorial Guinea | 0.0173 | Sudan      | -145.235   |
| Mali       | 0.7203  | Mali       | 0.0199 | Venezuela  | -20.1267   |
| Equatorial Guinea | 0.7736 | Congo     | 0.0247 | Bolivia    | -9.5636    |
| Panama     | 0.8584  | Sudan      | 0.0248 | Philippines | -7.1871   |
| Poland     | 1.1439  | Senegal    | 0.026  | Niger      | -4.1633    |
| Senegal    | 1.1652  | Mozambique | 0.0316 | Grenada    | -1.9919    |
| Haiti      | 1.1695  | Jamaica    | 0.0319 | Zambia     | -1.4845    |
| Maldives   | 1.1864  | Poland     | 0.0322 | Chile      | -1.1477    |
Table A6.1 (Continued)

| Economies      | AR/M2  | Economies       | AR/POP | Economies       | AR/GDP |
|----------------|--------|-----------------|--------|-----------------|--------|
| **Top 10**     |        |                 |        |                 |        |
| Botswana       | 1.8465 | Switzerland     | 8256.118 | Lebanon        | 1.5032 |
| Bhutan         | 1.5978 | Singapore       | 4402.968 | Malta          | 1.0492 |
| Saudi Arabia   | 1.4651 | Malta           | 3932.643 | Singapore      | 0.624  |
| Madagascar     | 1.119  | Bahrain         | 3431.53  | Botswana       | 0.5772 |
| Tonga          | 1.0797 | Kuwait          | 3317.622 | Switzerland    | 0.4308 |
| Libya          | 0.9117 | Norway          | 2590.205 | Bahrain        | 0.4002 |
| Singapore      | 0.8546 | United Arab Emirates | 2534.862 | Taiwan        | 0.3694 |
| Samoa          | 0.8152 | Qatar           | 2525.156 | Portugal       | 0.3233 |
| Solomon Islands| 0.8038 | Libya           | 2249.245 | Tonga         | 0.3183 |
| Cape Verde     | 0.7405 | Netherlands Antilles | 2223.302 | Cape Verde    | 0.3139 |
| **Bottom 10**  |        |                 |        |                 |        |
| United States  | 0.036  | Laos            | 0.7186  | Sudan           | 0.0028 |
| Japan          | 0.0377 | Sudan           | 1.0978  | Côte d’Ivoire  | 0.0036 |
| Poland         | 0.0572 | Tanzania        | 1.4796  | Laos           | 0.004  |
| Panama         | 0.0786 | Uganda          | 3.1056  | Tanzania       | 0.0054 |
| Mali           | 0.0799 | Côte d’Ivoire   | 3.2288  | Mongolia       | 0.0059 |
| Macao          | 0.0838 | Senegal         | 3.4734  | Senegal        | 0.0067 |
| Egypt          | 0.0854 | Sierra Leone    | 3.4824  | Uganda         | 0.0084 |
| Finland        | 0.0897 | Haiti           | 3.5222  | Sierra Leone   | 0.0105 |
| Sweden         | 0.09   | Benin           | 3.7593  | Haiti          | 0.0118 |
| Haiti          | 0.0903 | Equatorial Guinea | 3.9185 | Benin         | 0.0121 |

Note: No data on reserves to short term external debts are available from the 1957-1989 period. See the note to Table 1 and the text for definitions of the ratios.
| Economies | AR/IM | Economies | AR/TFL | Economies | AR/STED | Economies | AR/CFDI_in |
|-----------|-------|-----------|--------|-----------|---------|-----------|------------|
| **Top 10** |       |           |        |           |         |           |            |
| Libya     | 29.4921 | Botswana  | 2.1814 | Bhutan    | 287.941 | Kuwait    | 144.449    |
| Lebanon   | 16.9645 | Libya     | 2.1574 | Botswana  | 238.808 | Bhutan    | 58.1295    |
| Venezuela | 14.5903 | Taiwan    | 1.8148 | Cambodia  | 197.222 | Lebanon   | 39.3943    |
| Macao     | 13.482  | Kuwait    | 0.708  | Micronesia| 162.747 | Bangladesh| 17.5112    |
| Peru      | 13.1844 | United Arab Emirates | 0.6279 | China     | 74.9268 | Nepal     | 16.8282    |
| Algeria   | 12.7643 | Mauritius | 0.5982 | India     | 61.6449 | Japan     | 13.3673    |
| Egypt     | 12.6941 | Armenia  | 0.5718 | Grenada   | 56.7141 | Mongolia  | 9.2559     |
| Central African Rep | 11.8575 | Lebanon | 0.5115 | Eritrea   | 51.1339 | Tonga     | 7.6829     |
| Argentina | 11.1219 | Malta    | 0.4469 | Moldova   | 41.7143 | United Arab Emirates | 6.8218 |
| Chile     | 10.7366 | Algeria  | 0.4224 | Swaziland | 30.3089 | Botswana  | 6.0246     |
| **Bottom 10** |       |           |        |           |         |           |            |
| Liberia   | 0.0114  | Congo    | 0.0099 | Liberia Netherlands | 0.0009 | Bosnia & Herzegovina | -12.003 |
| Belarus   | 0.6801  | Sudan    | 0.0131 | Antilles  | 0.0282 | São Tomé & Príncipe | -6.9795 |
| Congo     | 0.7713  | Equatorial Guinea | 0.0152 | Bahamas  | 0.0692 | Libya     | -2.6689    |
| Bahamas   | 1.0358  | United Kingdom | 0.0155 | Congo    | 0.1038 | Suriname  | -0.1589    |
| Dominican Republic | 1.0643 | Bahrain | 0.0211 | Cameroon | 0.2185 | Gabon     | -0.0466    |
| Cameroon  | 1.2653  | Cameroon | 0.025 | Gabon St. Vincent & Grenadines | 0.3826 | Congo     | 0.0378     |
| Tajikistan | 1.3447  | Zambia   | 0.0285 | Grenadines | 0.4533 | Equatorial Guinea | 0.0381 |
| Seychelles | 1.3483 | United States | 0.0324 | Zimbabwe | 0.5562 | Angola    | 0.0869     |
| Sudan     | 1.3628  | Angola   | 0.0334 | Angola    | 0.6024 | Seychelles | 0.0877    |
| Canada    | 1.4563  | Panama   | 0.0335 | Côte d’Ivoire | 0.6063 | Papua new Guinea | 0.1052 |
Table A6.2 (Continued)

| Economies          | AR/M2  | Economies          | AR/POP | Economies          | AR/GDP |
|--------------------|--------|--------------------|--------|--------------------|--------|
| **Top 10**         |        |                    |        |                    |        |
| Botswana           | 4.1126 | Singapore          | 18041.4| Botswana           | 0.997  |
| El Salvador        | 2.6396 | Hong Kong          | 11693.7| Singapore          | 0.8668 |
| Bhutan             | 1.4832 | Switzerland        | 8899.21| Lebanon            | 0.7602 |
| Lesotho            | 1.3755 | Norway             | 5466.88| Bhutan             | 0.5272 |
| Mauritania         | 1.152  | Taiwan             | 5281.94| Malta              | 0.5196 |
| Kyrgyz Republic    | 1.1496 | Malta              | 4327.48| Hong Kong          | 0.5168 |
| Madagascar         | 1.1236 | United Arab Emirates| 3463.88| Libya              | 0.4892 |
| Armenia            | 1.1031 | Denmark            | 3456.73| Taiwan             | 0.4449 |
| Libya              | 1.0899 | Botswana           | 3378.73| Lesotho            | 0.4125 |
| Tajikistan         | 1.0441 | Kuwait             | 2979.6 | Guyana             | 0.4011 |
| **Bottom 10**      |        |                    |        |                    |        |
| Myanmar            | 0.0151 | Sudan              | 8.3281 | Cameroon           | 0.0174 |
| United States      | 0.0315 | Sierra Leone       | 9.2475 | Sudan              | 0.0185 |
| Liberia            | 0.0343 | Myanmar            | 9.5067 | United States      | 0.0195 |
| United Kingdom     | 0.0417 | Ethiopia           | 10.0433| Congo              | 0.0202 |
| Japan              | 0.0536 | Cameroon           | 11.9169| Gabon              | 0.0312 |
| Canada             | 0.0608 | Niger              | 13.0546| Belarus            | 0.0324 |
| France             | 0.0639 | Tajikistan         | 14.4081| United Kingdom     | 0.0351 |
| Germany            | 0.0716 | Bangladesh         | 15.061 | Dominican Republic | 0.0356 |
| South Africa       | 0.0769 | Madagascar         | 15.1234| Canada             | 0.0363 |
| Australia          | 0.0785 | Malawi             | 15.9946| Haiti              | 0.0396 |

Note: See the note to Table 1 and the text for definitions of the ratios.
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Figure 1: International Reserves – Regions

Figure 1.a: International Reserves – Asian versus Non-Asian Economies

Figure 1.b: International Reserves – Developed and Developing Economies in Asian and Non-Asian Regions

Figure 1.c: International Reserves – China, Japan, NICs, ASEAN4, Rest of Asia, and Rest of the World
Figure 2: International Reserves – Income Levels

Figure 3: International Reserves – Indebtedness

Figure 4: International Reserves – Developed versus Developing Economies

Figure 5: International Reserves – Exchange Rate Regimes
| International reserve ratio | Number of economies | Mean       | Median     | Standard deviation | Skewness  | Kurtosis   | Coefficient of variation |
|-----------------------------|---------------------|------------|------------|--------------------|-----------|------------|-------------------------|
| AR/IM                       | 164                 | 4.5217     | 3.8816     | 2.7176             | 1.8499    | 7.8580     | 0.6010                  |
| AR/TFL                      | 169                 | 0.2694     | 0.1532     | 0.3527             | 3.2296    | 13.7274    | 1.3093                  |
| AR/STED                     | 150                 | 13.1970    | 3.6128     | 37.2716            | 5.4886    | 34.8850    | 2.8242                  |
| AR/CFDI_in                  | 165                 | 7.2473     | 1.5751     | 50.0097            | 3.5107    | 52.0096    | 6.9004                  |
| AR/M2                       | 172                 | 0.3978     | 0.3142     | 0.3325             | 3.5489    | 24.8173    | 0.8359                  |
| AR/POP                      | 168                 | 754.8833   | 202.0336   | 1637.6537          | 4.9437    | 32.1011    | 2.1694                  |
| AR/GDP                      | 168                 | 0.1418     | 0.1125     | 0.1391             | 3.7249    | 20.3613    | 0.9805                  |

Note: The table presents the summary statistics of \( \{ r_{ij} \} \) \( i=1,\ldots,N \), where \( r_{ij} = \frac{\sum_{t=1}^{T} r_{ij,t}}{T} \), \( N \) is the number of economies and \( T \) is the sample size. The international reserve ratios are AR/IM (reserves-to-imports), AR/TFL (reserves-to-total-foreign-liabilities), AR/STED (reserves-to-short-term-external-debts), AR/CFDI_in (reserves-to-cumulative FDI-inflows), AR/M2 (reserves-to-M2), AR/POP (reserves-to-population), and AR/GDP (reserves-to-GDP). Annual data are used to construct these ratios. AR/IM is reported as the number of months of imports.
### Table 2  International Reserve Ratios and Structural Characteristics

| A. Non-Exchange Rate Regime Effects | AR/IM  | AR/TFL | AR/STED | AR/CFDI_in | AR/M2  | AR/POP | AR/GDP |
|------------------------------------|--------|--------|---------|------------|--------|--------|--------|
| 1. 1957-2004 Region                | 0.2721** | 0.3097*** | 0.3099*** | 0.3721*** | 0.1672 | 0.4553*** | 0.3207*** |
|         Asian                       | 0.0164  | 0.0203  | 0.1174  | 0.0666    | 0.0306 | 0.0319  | 0.0638  |
|         Income                      | 0.2102** | 0.2969*** | 0.2246** | 0.2513*** | 0.2661*** | 0.5946*** | 0.2791*** |
|         Indebtedness               | 0.0286  | 0.2813** | 0.2217** | 0.1680    | 0.1369 | 0.3864*** | 0.2712*** |
|         Stage of development       | 0.0909  | 0.0609  | n.a.    | 0.1968**  | 0.2890*** | 0.3536*** | 0.1942**  |
| 2. 1957-1989 Region               | 0.2443*  | 0.3221** | n.a.    | 0.4409*** | 0.2916** | 0.4316*** | 0.2992*** |
|         Asian                       | 0.1609  | 0.2798  | n.a.    | 0.3049    | 0.1544 | 0.5853  | 0.3121  |
|         Income                      | 0.0551  | 0.2428** | n.a.    | 0.1535*** | 0.0642 | 0.4183*** | 0.2794*** |
|         Indebtedness               | 0.1021  | 0.0960*  | n.a.    | 0.2437    | 0.2896 | 0.3901*** | 0.0202**  |
|         Stage of development       | 0.0776  | 0.1000  | n.a.    | 0.1160*** | 0.0382*** | 0.0564*** | 0.0188  |
| 3. 1990-2004 Region               | 0.2618** | 0.3615*** | 0.3099*** | 0.3718*** | 0.2025 | 0.4524*** | 0.2684** |
|         Asian                       | 0.0493  | 0.1012  | 0.1174  | 0.0819    | 0.0612 | 0.0319  | 0.1267*  |
|         Income                      | 0.1395  | 0.4076*** | 0.2246** | 0.0885    | 0.3815*** | 0.5946*** | 0.2579*** |
|         Indebtedness               | 0.1459  | 0.4206*** | 0.2217** | 0.1661    | 0.1741 | 0.3864*** | 0.1796  |
|         Stage of development       | 0.0909  | 0.2557*** | n.a.    | 0.0182    | 0.3494*** | 0.3536*** | 0.2606*** |

| B. Exchange Rate Regime Effects    |        |        |        |           |        |        |        |
|------------------------------------|--------|--------|--------|------------|--------|--------|--------|
| Bretton Woods 1957-1972            | 0.2406* | 0.2465* | n.a.   | 0.2498    | 0.2844** | n.a.   | n.a.   |
| Early post-B.W. 1973-1989          | 0.1646  | 0.1304  | n.a.   | 0.2673**  | 0.0829** | 0.3429*** | 0.2421** |
| Recent years 1990-2004              | 0.1988* | 0.3489*** | 0.1053 | 0.2059*   | 0.2378*  | 0.1121 | 0.2881*** |

Note: The table presents the contingency coefficients between international reserve ratios and structural characteristics. See the note to Table 1 and the text for definitions of the ratios and structural characteristics. Significance at the 1%, 5%, and 10% levels is indicated by “***,” “**,” and “*,” respectively. “n.a.” means data are not available.
Table 3  Rank Correlations Between Time Averages of International Reserve Ratios

|          | AR/IM     | AR/TFL     | AR/STED    | AR/CFDI_in | AR/M2 | AR/POP |
|----------|-----------|------------|------------|------------|-------|--------|
| A. 1957-2004 |          |            |            |            |       |        |
| AR/TFL   | 0.7234*** |            |            |            |       |        |
| AR/STED  | 0.2574*** | 0.3666***  | 0.2088**   |            |       |        |
| AR/CFDI_in | 0.3783*** | 0.4704***  | 0.3250***  | 0.0497     |       |        |
| AR/M2    | 0.3053*** | 0.3617***  | 0.3250***  | 0.0497     | -0.1229 |        |
| AR/POP   | 0.2929*** | 0.5055***  | 0.1865***  | 0.2088**   | 0.2929*** | 0.5055*** |
| AR/GDP   | 0.5147*** | 0.7524***  | 0.3274***  | 0.2304***  | 0.5214*** | 0.5030*** |
| B. 1957-1989 |          |            |            |            |       |        |
| AR/TFL   | 0.8512*** |            |            |            |       |        |
| AR/STED  | n.a.      |            |            |            |       |        |
| AR/CFDI_in | 0.2668*** | 0.4051***  | n.a.       |            |       |        |
| AR/M2    | 0.5037*** | 0.5614***  | n.a.       | 0.0411     |       |        |
| AR/POP   | 0.4276*** | 0.5815***  | n.a.       | 0.0775     | 0.1370 |        |
| AR/GDP   | 0.5959*** | 0.7775***  | n.a.       | 0.1307     | 0.5928*** | 0.7324*** |
| C. 1990-2004 |          |            |            |            |       |        |
| AR/TFL   | 0.6390*** |            |            |            |       |        |
| AR/STED  | 0.2976*** | 0.4423***  | 0.3248***  |            |       |        |
| AR/CFDI_in | 0.4743*** | 0.5765***  | 0.3248***  |            |       |        |
| AR/M2    | 0.3555*** | 0.3929***  | 0.3675***  | 0.2840***  |       |        |
| AR/POP   | 0.2359*** | 0.3714***  | 0.0004     | 0.1008     | -0.2490*** |        |
| AR/GDP   | 0.5648*** | 0.7701***  | 0.3587***  | 0.3816***  | 0.4801*** | 0.4091*** |

Note: The table presents estimates of rank correlation between international reserve ratios. See the note to Table 1 and the text for definitions of the ratios. Significance at the 1%, 5%, and 10% levels is indicated by “***,” “**,” and “*,” respectively. “n.a.” means data are not available.
| Economies   | AR/IM    | Economies   | AR/TFL   | Economies   | AR/STED | Economies   | AR/CFDI_in |
|------------|---------|------------|----------|------------|---------|------------|------------|
| Top 10     |         |            |          |            |         |            |            |
| Libya      | 17.9963 | Portugal   | 1.9588   | Bhutan     | 287.9412| Nepal      | 458.6906   |
| Saudi Arabia | 14.7749 | Libya      | 1.9354   | Botswana   | 238.8081| Hungary    | 192.892    |
| Lebanon    | 13.8578 | Taiwan     | 1.7429   | Cambodia   | 197.2221| Kuwait     | 143.2899   |
| Malta      | 12.4657 | Saudi Arabia | 1.6032   | Micronesia | 162.7468| Bangladesh | 112.222    |
| Venezuela  | 11.7758 | Nepal      | 1.49     | China      | 74.9268 | Bhutan     | 91.5317    |
| Switzerland | 11.5231 | Botswana   | 1.419    | India      | 61.6449 | Myanmar    | 82.487     |
| Uruguay    | 11.1867 | Kuwait     | 0.994    | Grenada    | 56.7141 | Uruguay    | 81.5918    |
| Macao      | 10.1359 | China      | 0.9769   | Eritrea    | 51.1339 | Tonga      | 68.9866    |
| Portugal   | 9.9665  | Malta      | 0.8334   | Moldova    | 41.7143 | Mongolia   | 27.1862    |
| Nepal      | 9.7280  | Mauritius  | 0.6938   | Swaziland  | 30.3089 | Jordan     | 25.9827    |
| Bottom 10  |         |            |          |            |         |            |            |
| Liberia    | 0.2117  | Equatorial Guinea | 0.016 | Liberia     | 0.0009 | Cape Verde | -305.7931 |
| Belarus    | 0.6801  | Panama     | 0.0179   | Netherlands Antilles | 0.0282 | Sudan      | -85.2858   |
| Bahamas    | 0.8370  | Congo      | 0.0184   | Bahamas    | 0.0692 | Lebanon    | -70.5284   |
| Congo      | 1.0656  | Sudan      | 0.0198   | Congo      | 0.1038 | Bosnia & Herzegovina | -12.0025 |
| Haiti      | 1.3157  | United Kingdom | 0.0334 | Cameroon    | 0.2185 | Venezuela  | -10.7475   |
| Tajikistan | 1.3447  | Angola     | 0.0334   | Gabon      | 0.3826 | São Tomé & Príncipe | -6.9795  |
| Equatorial Guinea | 1.3944 | Laos      | 0.0363   | St. Vincent & Grenadines | 0.4533 | Bolivia    | -5.3983    |
| Netherlands Antilles | 1.5361 | Guinea    | 0.0397   | Zimbabwe   | 0.5562 | Philippines | -3.8582   |
| Seychelles | 1.5441  | Senegal    | 0.0448   | Angola     | 0.6024 | Niger      | -2.3077    |
| Panama     | 1.5706  | Côte d'Ivoire | 0.0457 | Côte d'Ivoire | 0.6063 | Grenada    | -0.8567    |
| Economies    | AR/M2  | Economies   | AR/POP   | Economies   | AR/GDP  |
|-------------|--------|-------------|----------|-------------|---------|
| **Top 10**  |        |             |          |             |         |
| Botswana    | 3.0187 | Singapore   | 12586.0444 | Lebanon    | 1.0574  |
| Bhutan      | 1.5197 | Hong Kong   | 11693.7165 | Botswana   | 0.8291  |
| El Salvador | 1.3137 | Switzerland | 8641.9747  | Singapore  | 0.7697  |
| Kyrgyz Rep  | 1.1496 | Norway      | 4316.2100  | Malta      | 0.7499  |
| Madagascar  | 1.1206 | Malta       | 4155.8131  | Hong Kong  | 0.5168  |
| Armenia     | 1.1031 | Taiwan      | 3857.2832  | Bhutan     | 0.4493  |
| Saudi Arabia| 1.0457 | Kuwait      | 3114.8094  | Taiwan     | 0.4147  |
| Tajikistan  | 1.0441 | United Arab Emirates | 3092.2726 | Libya     | 0.3852  |
| Cambodia    | 0.9974 | Bahrain     | 2817.7479  | Switzerland| 0.3117  |
| Libya       | 0.9541 | Denmark     | 2536.6661  | Bahrain    | 0.2996  |
| **Bottom 10** |       |             |          |             |         |
| United States| 0.0346 | Sudan       | 5.4360    | Sudan      | 0.0122  |
| Japan       | 0.0427 | Sierra Leone| 6.9415    | Cameroon   | 0.0160  |
| Liberia     | 0.0745 | Myanmar     | 8.1544    | Congo      | 0.0196  |
| United Kingdom | 0.0768 | Ethiopia   | 8.2354    | United States | 0.0262 |
| France      | 0.0842 | Bangladesh  | 11.0422   | Haiti      | 0.0285  |
| Canada      | 0.0922 | Haiti       | 11.5324   | Belarus    | 0.0324  |
| Eritrea     | 0.0937 | Cameroon    | 12.0352   | Gabon      | 0.0348  |
| South Africa| 0.0944 | Madagascar  | 12.7807   | Sierra Leone| 0.0354 |
| Panama      | 0.0951 | Malawi      | 13.1565   | Dominican Republic | 0.0367 |
| Italy       | 0.0974 | Tajikistan  | 14.4081   | Canada     | 0.0369  |

Note: The rankings are based on the averages of ratios from 1957 to 2004. See the note to Table 1 and the text for definitions of the ratios. The negative reserves-to-cumulative FDI inflows ratios are due to the presence some extreme reversals of FDI inflows. A complete list of economies with a negative reserves-to-cumulative FDI inflows ratio is available upon request.
Table 5  
Rank Correlations between International Reserve Ratios: Developed Vs. Developing Economies, 1957 to 2004

|                      | A. Developed Economies | B. Developing Economies |
|----------------------|------------------------|-------------------------|
|                      | AR/IM                  | AR/TFL                  | AR/STED | AR/CFDI_in | AR/M2 | AR/POP | AR/TFL | AR/STED | AR/CFDI_in | AR/M2 | AR/POP |
| AR/IM                | 0.8383***              |                        |         |             |       |        | 0.7061***          |         |                 |       |        |
| AR/TFL               |                        | 0.8383***              |         |             |       |        | 0.1850**           | 0.3516*** | 0.3969***   | 0.3336*** | 0.5216*** |
| AR/STED              | n.a.                   | n.a.                   |         |             |       |        | 0.3103***          | 0.4056*** | 0.4339***   | 0.4056*** | 0.3389*** |
| AR/CFDI_in           | 0.6761***              | 0.6841***              | n.a.    |             |       |        | 0.5875***          | 0.4570*** | 0.3116***   | 0.1964**  | 0.3442*** |
| AR/M2                | 0.3103***              | 0.4056***              | n.a.    |             |       |        | 0.2043***          | 0.6013*** | 0.1640**    | 0.0086    | 0.2527*** |
| AR/POP               | 0.3612***              | 0.4570***              | n.a.    |             |       |        | 0.6013***          | 0.8127*** | 0.1315*     | 0.0811    | 0.5266*** |
| AR/GDP               | 0.5296***              | 0.6282***              | n.a.    |             |       |        | 0.4904***          | 0.8127*** | 0.0811      | 0.0811    | 0.6490*** |

Note: The table presents estimates of rank correlation between international reserve ratios. See the note to Table 1 and the text for definitions of the ratios. Significance at the 1%, 5%, and 10% levels is indicated by “***,” “**,” and “*,” respectively. “n.a.” means data are not available.
Table 6: Rank Correlations between International Reserve Ratios: Asian versus Non-Asian Economies, 1957 to 2004

|                  | AR/IM       | AR/TFL      | AR/STED     | AR/CFDI_in  | AR/M2       | AR/POP      |
|------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| **A. Asian**     |             |             |             |             |             |             |
| AR/TFL          | 0.7753***   |             |             |             |             |             |
| AR/STED         | 0.2728***   | 0.3259***   |             |             |             |             |
| AR/CFDI_in      | 0.4860***   | 0.2998***   | 0.4435***   |             |             |             |
| AR/M2           | -0.1388*    | 0.1090      | 0.4530***   | -0.0277     |             |             |
| AR/POP          | 0.2351***   | 0.4462***   | -0.2108***  | -0.1804**   | 0.1622**    |             |
| AR/GDP          | 0.2602***   | 0.5061***   | 0.0748      | -0.1764**   | 0.5873***   | 0.6773***   |
| **B. Non-Asian**|             |             |             |             |             |             |
| AR/TFL          | 0.7211***   |             |             |             |             |             |
| AR/STED         | 0.1955**    | 0.3488***   |             |             |             |             |
| AR/CFDI_in      | 0.3597***   | 0.5058***   | 0.1123      |             |             |             |
| AR/M2           | 0.3692***   | 0.4135***   | 0.3088***   | 0.0385      |             |             |
| AR/POP          | 0.3074***   | 0.4595***   | 0.0238      | 0.3375***   | -0.2445***  |             |
| AR/GDP          | 0.5435***   | 0.7669***   | 0.3679***   | 0.3066***   | 0.5453***   | 0.4115***   |

Note: The table presents estimates of rank correlation between international reserve ratios. See the note to Table 1 and the text for definitions of the ratios. Significance at the 1%, 5%, and 10% levels is indicated by “***,” “**,” and “*,” respectively.
### Table 7  Persistence Patterns, 1957 to 2004

|                        | AR/IM | AR/TFL | AR/STED | AR/CFDI_in | AR/M2 | AR/POP | AR/GDP |
|------------------------|-------|--------|---------|------------|-------|--------|--------|
| **A. Overall**         | 25%   | 27.90% | 12.70%  | 48.50%     | 20.30%| 9.50%  | 16.10% |
| **B. By structural characteristics** |       |        |         |            |       |        |        |
| **I. Region**          |       |        |         |            |       |        |        |
| Asia, Pacific & South Asia | 27.6% | 21.7%  | 20.7%   | 48.3%      | 15.6% | 3.3%   | 20.0%  |
| Europe & Central Asia  | 28.6% | 38.1%  | 7.7%    | 34.1%      | 19.5% | 2.4%   | 11.9%  |
| Latin America & Caribbean | 24.2% | 23.8%  | 9.4%    | 46.9%      | 18.2% | 18.8%  | 21.9%  |
| Middle East & North Africa | 29.4% | 31.3%  | 11.8%   | 58.8%      | 29.4% | 11.8%  | 23.5%  |
| Sub-Saharan Africa     | 15.4% | 19.4%  | 13.6%   | 59.5%      | 20.5% | 14.0%  | 11.6%  |
| Non-Asia               | 24.8% | 30.4%  | 10.7%   | 48.6%      | 21.8% | 10.7%  | 15.7%  |
| Asia                   | 25.9% | 14.3%  | 20.7%   | 48.1%      | 13.3% | 3.6%   | 17.9%  |
| **II. Income**         |       |        |         |            |       |        |        |
| Low income             | 20.4% | 14.0%  | 14.0%   | 47.3%      | 19.6% | 8.9%   | 12.5%  |
| Middle income          | 27.4% | 24.2%  | 14.3%   | 48.0%      | 17.9% | 10.4%  | 18.2%  |
| High income            | 28.6% | 56.7%  | 0.0%    | 51.5%      | 25.7% | 9.1%   | 18.2%  |
| **III. Indebtedness**  |       |        |         |            |       |        |        |
| Less indebted          | 27.0% | 10.7%  | 13.5%   | 57.1%      | 30.6% | 13.9%  | 13.9%  |
| Moderately indebted    | 19.5% | 25.0%  | 12.2%   | 48.8%      | 15.0% | 9.8%   | 14.6%  |
| Severely indebted      | 26.5% | 22.5%  | 14.8%   | 40.7%      | 14.3% | 7.3%   | 18.2%  |
| **IV. Stage of Development** |     |        |         |            |       |        |        |
| Developing             | 23.1% | 21.7%  | 12.7%   | 47.9%      | 19.2% | 10.2%  | 16.3%  |
| Developed              | 38.1% | 61.9%  | n.a.    | 52.4%      | 28.6% | 4.8%   | 14.3%  |

Note: The table presents the proportion of economies for which the unit root hypothesis is rejected at the 10% significance level.
Table 8  Persistence and Structural Characteristics, 1957 to 2004

|                        | AR/IM | AR/TFL | AR/STED | AR/CFDI in | AR/M2 | AR/POP | AR/GDP |
|------------------------|-------|--------|---------|------------|-------|--------|--------|
| Region                 | 0.124 | 0.171  | 0.131   | 0.192      | 0.092 | 0.214**| 0.133  |
| Asia/Non-Asia          | 0.009 | 0.129  | 0.117   | 0.003      | 0.080 | 0.090  | 0.022  |
| Income                 | 0.081 | 0.333* | 0.123   | 0.031      | 0.074 | 0.024  | 0.073  |
| Indebtedness           | 0.079 | 0.144  | 0.032   | 0.132      | 0.179 | 0.090  | 0.053  |
| Stage of Development   | 0.115 | 0.308**| n.a.    | 0.030      | 0.076 | 0.061  | 0.018  |

Note: The table presents the contingency coefficients between persistence and structural characteristics. See the note to Table 1 and the text for definitions of the ratios and structural characteristics. Significance at the 5% and 10% levels is indicated by “**” and “*” respectively. “n.a.” means data are not available.