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Capital Flows, Financial Integration,
and International Reserve Holdings:
The Recent Experience of Emerging
Markets and Advanced Economies

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Abstract

This Working Paper should not be reported as representing the views of the IMF.
The views expressed in this Working Paper are those of the author(s) and do not necessarily represent those of the IMF or IMF policy. Working Papers describe research in progress by the author(s) and are published to elicit comments and to further debate.

This paper examines the interaction between capital flows and international reserve holdings in the context of increasing financial integration. For emerging markets the sensitivity of reserves to net capital flows was negative in the 1980s, but became positive after the Asian crisis when these countries used net capital flows to build up reserves. For advanced countries, net capital flows had a negative effect on reserves, especially in recent years. Using measures of financial globalization, we also provide evidence that the sensitivity of reserves to net capital flows increased with globalization for emerging markets while it decreased for advanced countries.

JEL Classification Numbers: E50; G10

Keywords: international reserves; capital flows; financial integration; sovereign liquidity; stockpiling motive; panel data.

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I. INTRODUCTION

Global holdings of international reserves have increased rapidly in recent years. This increase has been especially dramatic in emerging markets, both in absolute terms as well as in comparison to the reserves held by advanced countries. At the end of 2005, the average reserves-to-GDP ratio reached 19 percent in emerging markets, compared to a ratio of 10 percent in the advanced countries. Emerging markets have accumulated reserves well above the levels suggested by traditional rules of thumb based on current account transactions and short-term external liabilities.[2] Also, the recent record pace of reserve accumulation in emerging markets is at odds with the prediction of a standard reserve holding model (see IMF, 2003).

With increasing financial liberalization and openness to cross-border transactions, managing a country's liquid assets to facilitate current and future international transactions—what we call "sovereign liquidity"—has become a key element in macroeconomic management. Clearly, the desired level of reserves and the availability of liquidity depend on a sovereign's access to international capital markets. This paper uses panel data from 36 emerging markets and 24 advanced economies for the 1980–2005 period to examine the interaction between capital flows, financial integration, and reserve holdings.

In recent decades, currency and/or financial crises accompanied by reversals in capital flows have become more frequent and severe (see, for example, Eichengreen and Adalet, 2005). With increased financial integration, countries are more vulnerable to contagion from within and outside their regions.[3] In response, central banks in developing countries have accumulated reserves to cushion extreme events, the bunching of external debt maturities, or other shocks that could affect the foreign exchange market and the domestic economy.

Holding large reserves is costly, but the perceived cost may be small relative to the economic and social cost of a crisis. Many of the currency and financial crises of the last ten years have been associated with the contractionary effects of currency depreciation, with substantial output losses, especially through balance sheet channels (see, for example, Choi and Cook, 2004, and Frankel, 2005). After the Asian financial crisis, emerging markets have reduced short-term external debt, and stockpiled reserves to reduce their vulnerability to a crisis (see, for example, Aizenman and Marion, 2004; McKinnon and Schnabl, 2004; Rodrik, 2006). Since a reserve holding country can always opt not to use its reserves for debt service, reserves have an insurance value specific to the country (Van Wijnbergen, 1990).

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[2] Prior to the 1990s, emerging market reserves fluctuated between three and four months of imports, in line with the traditional rule of thumb that reserves equivalent to three months of imports are sufficient to accommodate current account transactions. At the end of 2005, they stood at an average of 5.8 months of imports—Korea and China held more than 8 months and 14 months of imports, respectively. More recently, the Guidotti-Greenspan rule has been invoked: countries hold reserves to cover short-term external debt (see Jeanne and Rancière, 2006; Rodrik, 2006). Even by this metric, emerging market reserve cover has been very high: the ratio of reserves to short-term debt was greater than 3.0 for Korea and 6.5 for China in 2005. However, recent research suggests that a broader metric should be used for assessing reserve adequacy (see Lipschitz and others, 2006).

[3] See, Kaminsky and Reinhart (2000) for an examination of how trade and financial sector links influence the pattern of contagion. Forbes (2004), using cross-country firm-level data, shows that liquidity in global markets may have affected the stock returns on individual companies during the East Asian and Russian crises.

Central banks also hold reserves to back a peg or managed exchange rate system. Since countries classified as having a free or a managed float often resemble pegs, a "fear of floating" appears to be pervasive (Calvo and Reinhart, 2002; Reinhart and Rogoff, 2004a). This is especially so for countries with dollarized liabilities (Choi and Cook, 2004). To soften local currency volatility, central banks use reserves even in the absence of severe shocks.

Reserve accumulation has also taken place as a by product of a strategy to protect external competitiveness in countries dependent on exports for output growth (Dooley, Folkerts-Landau, and Garber, 2004; Eichengreen, 2004). Furthermore, in principle, holding assets in foreign currencies, whether by the central bank or directly by individuals or firms, may constitute a reasonable investment strategy—the value of foreign currency assets may be negatively correlated with that of domestic investments, providing the benefits of risk diversification.

Given frictions and information problems in international capital markets, countries facing uncertain growth prospects and volatile capital flows have a stockpiling motive in reserve management, even at the cost of increased external debt. Sovereign liquidity holdings are analogous to corporate liquidity holdings in that they help in coping with uncertain income streams and cash flows. In the face of external finance premia, the behavior of corporations suggests that the value of having liquid assets is disproportionately high for financially weak firms (Kim and others, 1998; Choi and Kim, 2001; Almeida and others, 2004). Further, reserves, if they are beyond the reach of creditors, allow a country to smooth consumption in the event of a default on external debt and loss of access to international financial markets.

With increasing financial integration, and greater exposure and dependence on international capital, sovereign liquidity management has become crucial for macroeconomic stability. The fact that more capital does not flow from rich to poor countries—the paradox of too little flow (Lucas, 1990)—might be substantially attributable to credit-market imperfections (Reinhart and Rogoff, 2004b).[4] For the high-growth emerging markets, the paucity of capital flows has been ameliorated by financial globalization. Nonetheless, one would expect emerging markets to take advantage of the wave of capital inflows to stockpile reserves, since in other times external financing may be expensive due to credit-market imperfections. With increased capital and financial account transactions, the risk of capital flow reversals that can result in huge output losses has increased the option value of holding reserves.

This paper examines the link between capital flows and the accumulation of international reserves by countries, given financial frictions and information problems. Sovereign liquidity shortages may lead to expensive borrowings, or a forced reduction in consumption and investment spending. Hence, countries perceiving a risk of binding liquidity constraints in the future have an incentive to fend off such potential financial strains by hoarding reserves today. Clearly, countries that can borrow at reasonable risk premia will need a smaller stock of reserves, and the differential in reserve holdings across countries should depend on the degree of access to international markets.

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[4] Reinhart and Rogoff (2004b) suggest that the true paradox may not be in uneven bouts of capital flows and volatile cycles, but that too much capital (specifically in the form of debt) is channeled to "debt-intolerant" serial defaulters.

To examine the effect of (net) capital flows and financial integration on reserve holdings, we estimate panel data models and take account of economy size, import share, exchange rate variability, exchange rate regimes, world interest rates, and fiscal conditions. Our analysis suggests that the sensitivity of the stock of reserves to capital flows has changed dramatically over time for emerging markets, and their reserve holding pattern has been quite different from that of advanced countries. In the 1980s, reserve holdings were negatively associated with capital flows for emerging markets, while such a negative link was less pronounced for advanced countries. This suggests that for emerging markets capital flows were used to finance current account deficits. In recent years, capital flows have had a strong positive effect on reserves for emerging markets but a negative effect for the advanced countries. This suggests that in recent years capital inflows have been used to build up reserve buffers in emerging markets. With increasing financial integration and the experience of capital account crises in the developing world, this buildup is attributable to heightened concerns about the risks of "sudden stops" (Calvo, 1998) and the loss of access to international capital markets.

The rest of the paper is organized as follows. Section II presents the determinants of international reserves and empirical model specifications. Section III provides data descriptions and summary statistics of key variables. Section IV presents the results of panel regressions. Section V concludes the paper. The appendix contains a description of the data.

II. DETERMINANTS OF INTERNATIONAL RESERVES

Recent studies have used a number of factors to explain reserve holdings. This section reviews these factors and draws implications for sovereign liquidity management in the context of increased capital flows and financial integration.

A. Buffer Stocks and the Precautionary Motive

To explain international reserve holdings, traditionally the buffer stock model has been used (see, for example, Frenkel and Jovanovic, 1981; Bahmani-Oskooee, 1985). This model says that central banks should choose a level of reserves to balance the opportunity cost of holding reserves with macroeconomic adjustment costs incurred in the absence of reserves or when they fall short. Flood and Marion (2002) find that buffer stock reserve models work about as well in the modern floating exchange rate period as they did during the Bretton Woods regime period. They observe that global reserve holdings were about 17 weeks of imports at the end of 1999, which is almost double what they were at the end of 1960, and 20 percent higher than they were at the start of the 1990s. The IMF (2003), using a standard buffer stock model based on Aizenman and Marion (2004), suggests that the rapid accumulation of reserves in emerging markets between 1997 and 2001 was broadly in line with fundamentals, but the surge in reserves in 2002 and 2003 was above the level predicted by the model.

Given informational problems and frictions in international financial markets, however, sovereign liquidity demand will depend on external finance premia and cash flows. Sovereign liquidity can be viewed as analogous to corporate liquidity. Liquid assets enable a firm to reduce the firm's dependence on costly external funding for future production activities—a precautionary or stockpiling motive. Choi and Kim (2001) suggest that firms increase liquid

assets by drawing on lines of credit when external finance becomes costly. Almeida and others (2004) show that financially constrained firms have a propensity to use cash flows to build up cash or liquid assets, while financially unconstrained firms have no systematic tendency to do so.

In light of informational problems and frictions in international financial markets, large reserve holdings by emerging markets may reflect a precautionary demand in the face of shocks and limited access to international capital markets. The lack of terms-of-trade contingent instruments in international capital markets and differences in risk aversion between creditors and emerging market debtors explain why reserves have an option value (Van Wijnbergen, 1990). Aizenman and Marion (2003) show that an increase in loss aversion or an increase in volatility of shocks boosts precautionary reserves, and Aizenman and Lee (2005) emphasize that the precautionary holding of reserves can provide self-insurance against sudden stops and capital flight. Jeanne (2007) derives how a country can determine its reserve level by trading off the cost of reserves and the risk of a capital account crisis. Ben-Bassat and Gottlieb (1992) and Caballero and Panageas (2004) discuss the use of reserves as macroeconomic stabilizers.

Scaling factors

The scaling variable measures the size of international transactions and can be represented by GDP, GDP per capita, or population size. Aizenman and Marion (2004) suggest that reserve holdings should increase with the size of international transactions and thus be positively correlated with the country's population or standard of living. In emerging markets with large populations like China and India, population may overestimate the size of these countries since a large share of the population is not directly involved in international transactions. To attenuate this problem, the logarithm of the population can be used.

Opportunity cost of holding reserves

The opportunity cost variable plays an important role in theoretical models. The standard measure of the opportunity cost in empirical studies is the differential between the country's own-interest rate and the interest rate on comparable US treasuries. Most empirical studies, however, do not find a significant negative effect for the opportunity cost (Flood and Marion, 2002; IMF, 2003; Aizenman and Marion, 2004). As Aizenman and Marion (2004) point out, the opportunity cost variable may not be properly measured since the composition of reserves is not adequately reflected, and until the early 1990s, most emerging markets did not have market determined domestic interest rates. In addition, the standard measure does not take into account the cost of acquiring international currencies for building up reserves, which importantly depends on the country-risk premium and access to international capital markets.

Volatility of international transactions

The buffer stock approach suggests that reserve holdings increase with the volatility of international transactions (Frenkel and Jovanovic, 1981; Flood and Marion, 2002; Aizenman and Marion, 2004). The volatility of international transactions is usually measured by the standard

deviation of the trend-adjusted changes in reserves over some period.[5] An alternative measure is the volatility of export receipts used by Edwards (1985) and Aizenman and Marion (2004).

B. Other Considerations

Exchange rate flexibility

Conventional wisdom holds that greater flexibility in the exchange rate should reduce the demand for reserves since central banks then do not need a large reserve stockpile to maintain a peg or to enhance the peg's credibility (Disyatat, 2001; Flood and Marion, 2002; Aizenman and Marion, 2004).[6] Also, more flexible exchange rate regimes can better accommodate shocks to the economy, and hence need smaller liquidity buffers (for example, Heller and Mohsin, 1978).

However, the need for reserves may increase with exchange rate flexibility to temper exchange rate movements if capital flows are volatile. Also, central banks, in an attempt to dampen the appreciation of their currencies, may accumulate reserves (Frankel and Dornbusch, 1995; Dooley and others, 2004).

Import share in output

The relationship between reserves and the import share in output is ambiguous (Heller and Khan, 1978). If the import share in output (the average propensity to import) is a proxy for the marginal propensity to import, and thus its inverse is an indication of the required output adjustment to produce a particular level of reserves, then the relationship would be negative since countries can use their reserves to reduce such adjustment costs. If the import share in output is taken to represent the economy's openness and vulnerability to external shocks (Edwards, 1984; Aizenman and Marion, 2004), then the relationship would be positive since the more open is a country to external shocks, the greater the need for reserves. Moreover, the use of the ratio of reserves to imports as an indicator of reserve adequacy implies that the relationship is positive. Many empirical studies on reserve holdings have used the import share in GDP to represent openness and required reserves to facilitate current account transactions.

Sovereign ratings

Countries with low ratings have limited access to international capital markets and thus may hold more reserves to better withstand adverse external shocks. Sovereign ratings summarize and supplement information about macroeconomic indicators and default history, as well as about social and political factors (Cantor and Packer, 1996). Since creditors in sovereign debt markets have limited enforcement rights (for example, few possibilities for seizing country assets), political and credit risk play an important role in the flow of capital from rich to poor countries

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[5] Such a reserve volatility measure, however, can be contaminated because it combines jumps in reserves owing to reserve restocking and sudden declines due to speculative attacks (Flood and Marion, 2002).

[6] Analyzing the effect of exchange rate regimes assumes that the regimes are correctly classified. Recently, Reinhart and Rogoff (2004a) suggest a system of reclassifying historical exchange regimes based on *de facto* exchange rate practices, which may differ substantially from the conventional *de jour* regime classification.

(Reinhart and Rogoff, 2004b). Governments generally seek credit ratings to ease their access to international capital markets and broaden their investor base since many investors prefer rated securities over unrated ones with similar credit characteristics. Kaminsky and Schmukler (2002) find that sovereign ratings affect country risk premia and stock returns for emerging markets.

Fiscal Conditions

The net effect of the fiscal stance on reserves will depend on a combination of political-economy factors and the risk of a crisis associated with fiscal vulnerabilities. Aizenman and Marion (2004) argue that political-economy considerations may affect optimal reserve levels. A greater chance of opportunistic behavior by future policymakers reduces the demand for international reserves, and may lead to higher external borrowing for increasing the current consumption of special interest groups.[7] In the same way, political corruption may also reduce optimal reserve holdings (Aizenman and Marion, 2003). Such political-economy considerations suggest a positive link between reserves and fiscal surpluses. On the other hand, fiscal problems increase the risk of a currency or banking crisis. The weaker the fiscal stance, the higher the risk of sovereign default, and thus a higher external finance premium. Hence, countries in fiscally fragile situations may hold larger reserve cushions, and this could lead to a negative link between reserves and fiscal surpluses (Reinhart and Rogoff, 2004b).

C. Capital Flows and Financial Integration

With increased financial integration and open capital accounts, the scope of international reserve management has expanded over time and includes not just moderating volatility in the exchange rate and facilitating the export and import of goods and services, but now also encompasses a wide variety of cross-border asset transactions. Due to this trend, sovereign liquidity management has gained in importance and is increasingly perceived as a key element in reducing the vulnerability to international financial shocks.

How have countries reacted to changes in the global financial environment? The traditional buffer stock model of reserves assumes that the brokerage fee or the liquidation cost of assets for restocking reserves is known and fixed. In reality, however, the cost of restocking reserves through selling assets or extending liabilities depends on the country's access to international capital markets.[8] Since such adjustment costs depend on global financial conditions, they are state-dependent: in good times countries have low country-risk premia and may raise capital easily, but in bad times countries with low creditworthiness, facing restricted access to international capital markets, find it expensive to borrow. The precautionary view (Choi and Kim, 2001; Almeida and others, 2004) suggests that countries stockpile reserves for intertemporal liquidity management when liquidity is available at low financing costs. Therefore, reserve holdings will respond to capital flows, depending on the financial environment.

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[7] For a discussion on how differences in political institutions and political stability can contribute to explaining the variance in debt policies, see Alesina and Tabellini (1990).

[8] Bar-Ilan, Marion, and Perry (2006) suggest that adjustment costs are important in explaining the time path of reserve accumulation. The cost of adjusting the stock of reserves indirectly reflects the costs of external finance.

Despite the development of financial markets and financial instruments, international markets are far from complete and subject to more than the usual frictions and information problems. And the recent experience of developing countries has heightened concern about sudden reversals in capital flows and the risk of financial crises (Calvo, 1998, 2002; Aizenman and Marion 2003; Caballero and Panageas, 2004; Edwards, 2004). Durdu and others (2007) suggest that financial integration coupled with credit market imperfections could generate endogenous sudden stops through a collateral constraint on dollarized external debt, and hence provide an explanation for a large scale buildup of reserves.

To capture changes in the financial openness of an economy, empirical studies use *de jure* financial integration measures based on policies to promote capital account liberalization or *de facto* measures based on actual capital flows.[9] Prasad and others (2003) and Lane and Milesi-Ferretti (2006) suggest *de facto* measures of financial integration.

III. DATA AND DESCRIPTIVE STATISTICS

The empirical analysis uses annual data for 36 emerging markets and 24 advanced countries for the 1980–2005 period (see Appendix A for the list of countries). Most of the data have been collected from International Financial Statistics, the World Economic Outlook, and CEIC (China Economic Information Company). The data on sovereign ratings were provided by Standard and Poor's, and exchange rate regime classifications are based on Reinhart and Rogoff (2004a).

The descriptive statistics are reported in Table A1 in the appendix. As in Aizenman and Marion (2004) and IMF (2003), international reserves are defined as gross reserves net of gold. Reserves relative to GDP over the entire period are higher for emerging markets (12.5 percent) than for advanced countries (9.6 percent). On average, the GDP per capita in advanced countries is more than five times that of emerging markets. The population size is on average greater in emerging markets, in large part due to China and India. Exchange rate variability is far higher in emerging markets. The import-GDP ratio is higher for advanced countries than for emerging markets. We measure net capital flows by the capital and financial account of the balance of payments. Emerging markets have had higher net capital flows than advanced countries by about 2.5 percent of GDP. The current account balance is on average close to zero for advanced countries but negative for emerging markets. The credit ratings are higher on average for advanced countries (22 compared to 14 for emerging markets). The range for credit ratings is much wider for emerging markets (from 2 to 23), while all the advanced countries are above investment grade (from 14 to 23). The (overall) fiscal balance is on average in deficit for emerging markets (by 2.6 percent of GDP) and advanced countries (by 4.1 percent). The M2-to-GDP ratio of advanced countries is on average higher than that of emerging markets, indicating the higher monetization of the former.

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[9] Indicators of government restrictions on capital flows may suggest that many countries in Latin America are closed to financial flows. However, on a de facto basis, these Latin American countries are quite open to global financial flows. By contrast, some countries in Africa have few formal restrictions on capital account transactions but have not experienced significant capital flows.

Figure 1. International Reserves, Net Capital Flows, and Current Accounts

A. International Reserves

B. Net Capital Flows

C. Current Accounts
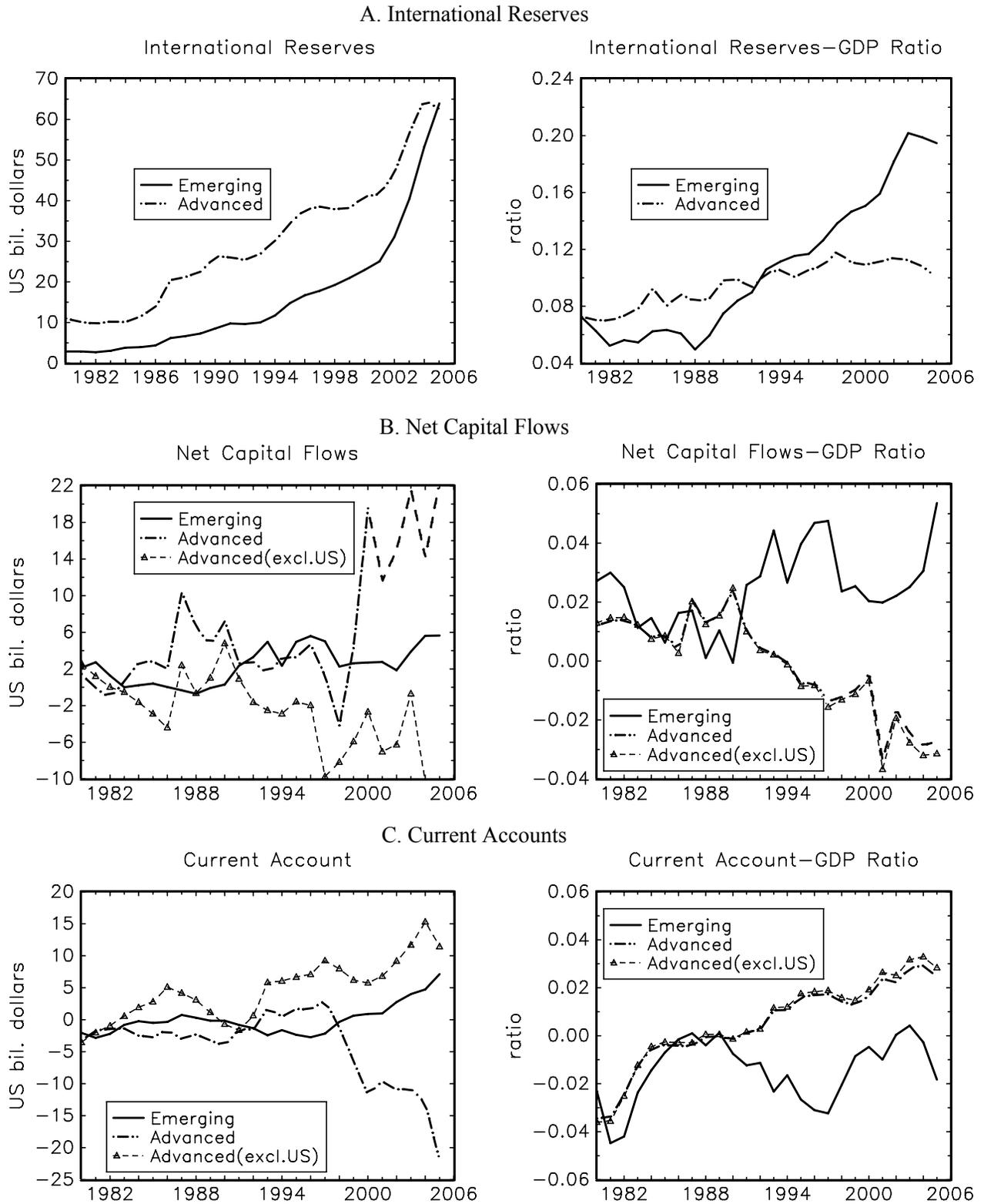
Notes: The figure depicts the cross-section averages of variables. Dotted lines with symbols in panels B and C indicate the cross-section average of variables excluding the U.S.

To show how the key variables are correlated, we report their simple correlation coefficients in Table A2. Note that some correlations differ across the two country groups. For example, the reserves-to-GDP ratio is positively correlated with sovereign ratings for emerging markets (0.42) but negatively correlated for advanced countries (–0.25), perhaps reflecting that reserves have a positive effect on the sovereign ratings for emerging markets but not for advanced countries. The correlation between openness and the net capital flow-GDP ratio is positive for emerging markets (0.34) but negative for advanced countries (–0.36).

Figure 1 (panel A) depicts the averages for the reserve level and reserves-to-GDP ratio by country group for the 1980–2005 period. In terms of the reserves-to-GDP ratio, the emerging markets as a group caught up with the advanced countries in the early 1990s. Thereafter, for the advanced countries this ratio fluctuated around 10-11 percent, while for emerging markets it rose substantially after the Asian crisis until it reached 20 percent by 2003, and then slowed down to 19% by 2005. Panel B shows the different patterns in the movement of net capital flows for the country groups. For emerging markets, as capital accounts were liberalized, net capital flows increased steadily over the 1991–96 period but fell dramatically for 1997–1998 owing to the Asian crisis (see Ghosh and others, 2002). For advanced countries, net capital flows showed a downward trend since 1991, a sharp increase after the Asian crisis, and an upsurge since 2000, which reflects the funding of the large U.S. current account deficits.

Figure 1 (panel C) also plots the cross-section averages for the current account. For emerging markets, a downward swing in the current account for 1991–96 mirrors an upward swing in net capital flows. During recent years, emerging markets have exhibited a rising trend in the current account. For advanced countries, the current account relative to GDP fluctuates around a rising trend but was on average negative until the early 1990s. The negative current account average for advanced countries since 1998 is attributable to the U.S. current account deficit: excluding the U.S. from the sample, the cross-section average has been positive.

Figure 2 shows over sub-periods the changes in the distribution of the reserves-to-GDP ratio. The figure complements the recent increasing divergence in reserve holding behavior between the two groups of countries. For emerging markets, the distribution has shifted to the right over time. In contrast, for the advanced countries if the outliers (Singapore and Hong Kong SAR) are excluded, the distribution in recent years has become more concentrated around 5 percent.

The divergence in reserve holding behavior does not seem to be attributable to the variability of (net) capital flows and current accounts although conventional theory on precautionary liquidity demand would predict a positive link between liquidity demand and the variability of cash flows. As shown in Figure 3, for emerging markets, capital flow variability fell between 1980–85, rose between 1985–90, spiked in 1991, and since 1992 has been on a gently rising trend; for advanced countries, capital flow variability was low till the mid-1990s and then increased sharply. The current account variability (on average) showed no apparent trend for emerging markets. For advanced countries, it was low till the early 1990s and since then has been on a sharp upward trend. In advanced countries, the ratio of reserves to GDP has been steady despite the rising variability in capital flows and current accounts; and in emerging markets it has risen sharply although the variability of capital flows and current accounts has not shown a conspicuous trend over the last decade.

Figure 2. Reserves-to-GDP Ratio: Changes in the Distribution
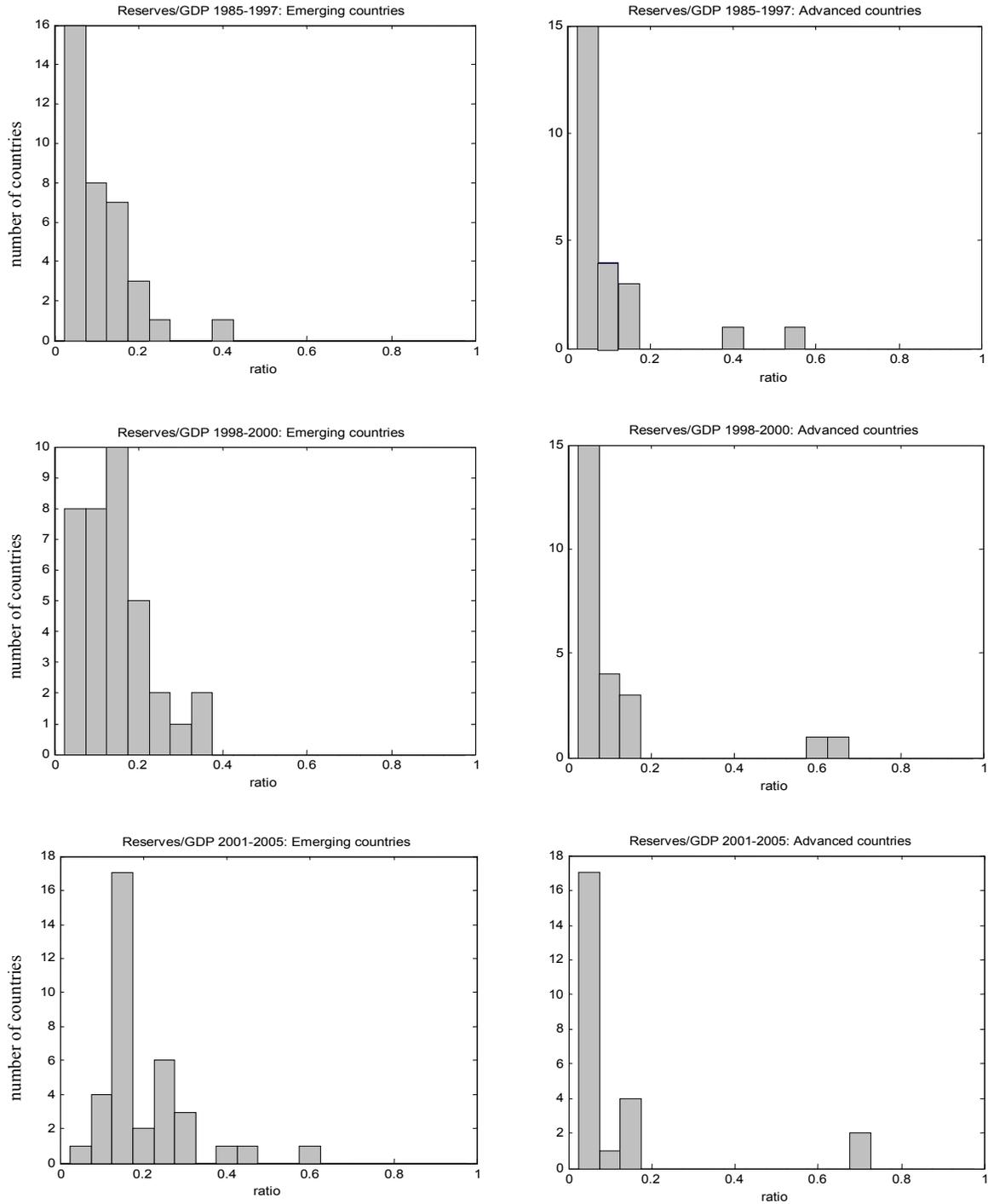
Notes: The first sample period starts from 1985 since observations for some emerging markets are not available in the first half of the 1980s. The grid size is 0.05.

Figure 3. Variability in Net Capital Flows and Current Accounts
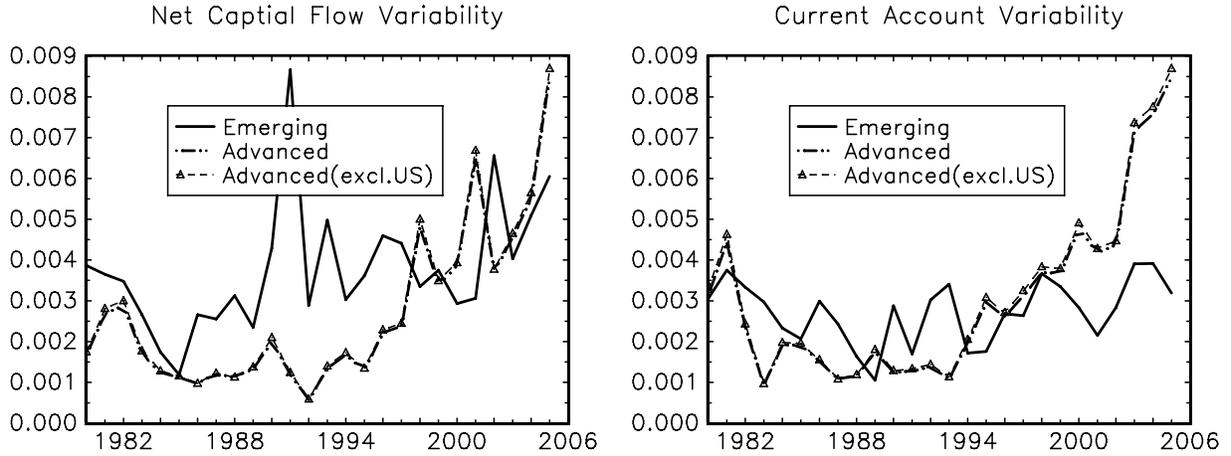
Notes: The figure depicts the cross-section average of (net capital flows/GDP)^2 in panel 1 and that of (current account/GDP)^2 in panel 2 for emerging markets (solid lines) and advanced countries (dashed lines) over time. Dotted lines with symbols indicate the cross-section average of variables excluding the U.S.

IV. EMPIRICAL RESULTS

In this section, we specify and estimate baseline regressions, and then extend the regressions to include other factors affecting reserve accumulation. Instrumental variables are used to deal with the endogeneity of regressors. Statistical inferences about coefficient estimates are based on heteroscedasticity and autocorrelation consistent standard errors.

A. Baseline regressions

Our basic regression is similar to that of Aizenman and Marion (2004), except that we normalize reserves by GDP and include sovereign ratings and net capital flows.[10] For country i at time t, the regression for the ratio of reserves to output is given by

$$\left(\frac{IR}{GDP}\right)_{i,t} = \alpha_i + \beta_S SIZE_{i,t} + \beta_\sigma \sigma_i + \beta_{IM}\left(\frac{IM}{GDP}\right)_{i,t} + \beta_{SR} SR_{i,t} + \beta_{CF}\left(\frac{CF}{GDP}\right)_{i,t} + \varepsilon_{i,t}, \qquad (1)$$

where IR/GDP is the ratio of international reserves to GDP (gross domestic product in U.S. dollars); $SIZE$ is the natural log of population, a supplementary scale factor in the model since we scale the dependent variable, reserves, by GDP; σ_i is the standard deviation of the growth rate of the nominal exchange rate for country i over the sample period; and IM/GDP, the import share in GDP. The parameter α denotes fixed-county effects, and ε is the error term.

SR is the sovereign rating assigned by Standard and Poor's. Since a higher rating implies a lower risk of default on external debt, it reduces the need for reserves, suggesting that β_{SR} is

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[10] Aizenman and Marion (2004) find the volatility of export receipts to be statistically insignificant. We exclude this variable from our regressions because the sign of its coefficient varies depending on which other variables are included in the model and is highly sensitive to normalizations.

negative.[11] *CF /GDP* is the ratio of net capital flows to GDP. If net capital flows are used mainly for financing current account deficits (stockpiling reserves), β_{CF} will be negative (positive).[12]

The net capital flow and sovereign rating variables may be correlated with the error term due to reverse causality, which may arise, for example, when countries borrow from abroad to meet a reserves target and when ample reserve holdings have a favorable impact on the assessment of sovereign rating. To deal with the endogeneity of regressors, we use instrumental variables (IV), with the lagged values of sovereign ratings and net capital flows as the instruments.[13] A first-stage regression showed that the instruments were highly correlated with the endogenous variable. In addition, the Hansen test for overidentification suggested that the regression model was correctly specified and the instruments were valid.

Table 1 summarizes the baseline regressions for the pooled sample, emerging markets, and advanced countries. For the pooled sample, when country heterogeneity is taken into account by fixed country effects, the adjusted R-squares, $\overline{R}^2$, show that the model explains about 88 percent of the variation in reserves. However, if the variation explained by the fixed country effects is excluded, $\overline{R}^2$ drops to 57 percent, suggesting that a large part of the variation in reserves is picked by country-specific heterogeneity. For the group specific regressions, the explanatory power of the model is much higher for advanced countries than for emerging markets, as indicated by their $\overline{R}^2$ (0.93 vs. 0.78). Excluding the fixed country effects, $\overline{R}^2$ in the OLS regressions drops to 0.39 for emerging markets and 0.72 for advanced countries, suggesting much larger heterogeneity in reserve holding behavior for the former group.

Reserves increase with the scale variable, decrease with exchange rate variability, and increase with the import share in GDP for both OLS and IV regressions, in accordance with Aizenman and Marion (2004). More specifically, first, the population coefficient is positive and larger for emerging markets than for advanced countries. One could argue that the need for reserves relative to output initially increases as an economy grows to a certain threshold, and then flattens out or even declines. Second, the exchange rate variability coefficient is negative, consistent with Flood and Marion's (2002) finding that countries with greater flexibility in the exchange rate hold lower reserves. The β_{σ} estimate is much smaller for emerging markets than for advanced countries, partly because exchange rate variability on average is much larger for the former than for the latter (see Table A1). Third, the import share coefficient is positive for all country groups and more significant for emerging markets than for advanced countries. In addition, the sovereign rating has a negative effect on reserves, implying that the higher is a country's creditworthiness, the less is the need for reserve holdings since it has better access to international markets. In the baseline regressions for emerging markets, the effect of sovereign ratings is not significant.

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[11] Since the data on sovereign ratings are often not available for emerging markets in the 1980s, we also estimated regressions for the 1990–2005 period. The results were very similar to those reported in the paper.

[12] If international reserves are strictly targeted, the current account balance can be fully offset by capital flows leaving reserves unchanged. In this extreme case, β_{CF} becomes zero.

[13] To account for endogeneity that may stem from high reserve holdings leading to a reduction of exchange rate variability, we also used the lagged values of exchange rate regime dummies (defined in section IV.C) as instruments for exchange rate variability. The results were qualitatively the same.

Table 1. Baseline Regressions

Independent Variables	Pooled		Emerging		Advanced	
	OLS	IV	OLS	IV	OLS	IV
SIZE	0.217***	0.251***	0.246***	0.277***	0.136***	0.056
	(5.99)	(4.65)	(5.07)	(4.30)	(3.40)	(1.20)
σ	−0.963***	−0.908***	−0.002***	−0.002***	−0.639***	−0.543***
	(−8.64)	(−8.29)	(−4.35)	(−3.41)	(−6.35)	(−5.56)
IM/GDP	0.239***	0.227***	0.344***	0.330***	0.124*	0.146**
	(5.41)	(4.60)	(6.21)	(5.10)	(1.76)	(2.21)
SR	−0.003*	−0.006**	−0.002	−0.003	−0.013***	−0.015***
	(−1.64)	(−2.44)	(−1.22)	(−1.10)	(−3.57)	(−3.56)
CF /GDP	0.058	0.095	0.171**	0.182	−0.236***	−0.489***
	(1.13)	(0.78)	(2.44)	(0.90)	(−2.86)	(−4.11)
$\bar{R}^2$	0.882 [0.573]	0.889 [0.600]	0.779 [0.391]	0.782 [0.375]	0.933 [0.716]	0.929 [0.726]
No. of observations	973	874	444	408	527	500
Hansen's test [1]		χ^2 (2)=0.537		χ^2 (2)=1.020		χ^2 (2)=3.856
		[0.764]		[0.600]		[0.145]

Notes: The international reserves-to-GDP ratio (*IR/GDP*) is regressed on the log of population (*SIZE*), exchange rate variability (σ), import share (*IM/GDP*), sovereign rating (*SR*), and net capital flows (*CF/GDP*). Regressions use Ordinary Least Squares (OLS) or Instrumental Variables (IV) and include fixed-country effects. $\bar{R}^2$ is the adjusted *R*-squares, and the figure in square brackets excludes variance explained by the fixed-country effects. The *z*-ratios in parentheses are based on standard errors robust to heteroscedasticity and autocorrelation (Bartlett kernel; bandwidth=2). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

[1] Hansen's test is an overidentification test for all instruments. Under the null hypothesis that the model is correctly specified and the instruments are valid, the test statistic is distributed as a chi-square with the degrees of freedom equal to the number of overidentifying restrictions (with *p*-values in square brackets). Instruments are the one-period lagged values of sovereign ratings and the three lags of net capital flows.

The coefficient of net capital flows is positive (but statistically insignificant in the IV regression) for emerging markets, whereas it is negative (and significant in both the OLS and IV regressions) for advanced countries. This result suggests that the stockpile motive may dominate the motive of financing current account deficits for emerging countries, but the converse would hold for advanced countries. It is statistically insignificant in the pooled regressions, possibly owing to the opposite effects of net capital flows on reserves in the two country groups. We do not report the regressions including the standard opportunity cost measure of reserves (the money market rate adjusted for the exchange rate change minus the foreign interest rate), because, as in previous studies, we did not find that it had any discernible effect on reserves.[14] However, in section D below, we do examine the effect of world interest rates on reserves.

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[14] We also used the EMBI (emerging markets bond index) and EMBI plus spreads for Latin American and non-Latin American countries for the 1992–2005 period as a proxy for the opportunity cost variable in emerging markets—the IV estimate was negative but not statistically significant.

B. Estimating the Effects of Financial Integration

In recent decades, there has not only been an increase in flows among industrial countries but also a sharp rise in the flows from industrial to developing countries. The effects of financial integration in terms of increased global capital flows, however, have been spread unevenly across developing countries (Reinhart and Rogoff, 2004b).

Following Lane and Milesi-Ferretti (2006), we consider two measures of global financial integration: one is the ratio of total foreign assets and liabilities to GDP, and the other is the sum of the stock of portfolio equity assets and liabilities and the stock of foreign direct investment (FDI) assets and liabilities to GDP. Over the 1970–2004 period, this measure gradually increased during the 1970s and 1980s but accelerated, especially in advanced countries, in the mid-1990s, suggesting 1998 as the year when there was a change in trend. Figure 4 depicts the cross-section average of the Lane and Milesi-Ferretti measures for the country groups that we use in this paper. For advanced countries, both measures show an upward trend with a sharp increase starting in 1998. For emerging markets, they show a gradual increase over the 1980s, some fluctuations with no apparent trend over the 1990s, and then a modest rise in recent years.[15] Overall, in recent years international financial transactions, relative to output, have grown much more rapidly for advanced countries than for emerging markets.

The baseline regressions do not account for the effect of financial integration on reserves. To investigate whether the effect of net capital flows has varied over subperiods, we estimate the following regression:

Figure 4. Measures of Financial Integration
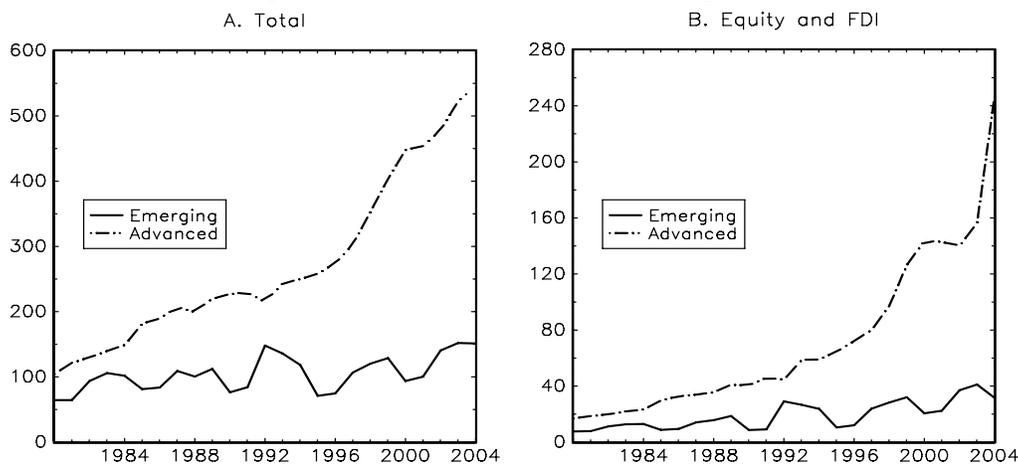
Notes: Panel A (Panel B) depicts the cross-section average of the percentage ratio of total foreign assets and liabilities (the sum of the stock of portfolio equity assets and liabilities and the stock of FDI assets and liabilities) to GDP for 1980–2004 for emerging market and advanced county groups. Luxembourg was excluded from the sample because the data were available only from 2000. (source: Lane and Milesi-Ferretti, 2006).

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[15] Prasad and others (2003) divide developing countries into two groups, according to the ratio of the gross stock of foreign assets and liabilities to GDP as in Lane and Milesi-Ferretti (2006). The more financially integrated group is included in the sample of emerging markets used in this paper, and it is these emerging markets that have received the vast majority of capital flows to the developing world.

Table 2. Regression Model 1: The Effects of Capital Flows over Three Subperiods

Independent Variables	Pooled		Emerging		Advanced	
	OLS	IV	OLS	IV	OLS	IV
SIZE	0.217***	0.239***	0.262***	0.324***	0.144***	0.071
	(6.00)	(4.75)	(5.50)	(4.54)	(3.63)	(1.43)
σ	–0.964***	–0.912***	–0.002***	–0.002***	–0.630***	–0.550***
	(–8.64)	(–8.24)	(–4.12)	(–2.83)	(–6.16)	(–5.73)
IM/GDP	0.240***	0.237***	0.291***	0.208***	0.119*	0.148**
	(5.32)	(4.72)	(4.99)	(2.86)	(1.64)	(2.20)
SR	–0.003*	–0.005**	–0.003*	–0.007**	–0.012***	–0.015***
	(–1.62)	(–2.18)	(–1.60)	(–2.35)	(–3.58)	(–3.62)
$D_{(80\text{-}90)}$*(*CF /GDP*)	0.058	0.108	–0.391**	–1.057**	–0.038	–0.296*
	(0.63)	(0.67)	(–2.02)	(–2.47)	(–0.43)	(–1.94)
$D_{(91\text{-}97)}$*(*CF /GDP*)	0.077	0.183	0.079	0.075	–0.182	–0.461**
	(1.10)	(1.11)	(0.89)	(0.30)	(–1.38)	(–2.15)
$D_{(98\text{-}05)}$*(*CF /GDP*)	0.050	0.042	0.347***	0.704**	–0.292***	–0.479***
	(0.77)	(0.35)	(4.28)	(2.39)	(–2.99)	(–4.04)
$\bar{R}^2$	0.882 [0.573]	0.887 [0.593]	0.787 [0.394]	0.778 [0.374]	0.935 [0.722]	0.932 [0.721]
No. of observations	973	892	444	407	527	490
Hansen's test [1]		$\chi^2 (3)=0.053$ [0.997]		$\chi^2 (3)=0.943$ [0.815]		$\chi^2 (3)=4.819$ [0.186]

Notes: The reserves-to-GDP ratio (*IR/GDP*) is regressed on the log of population (*SIZE*), exchange rate variability (σ), import share (*IM/GDP*), sovereign rating (*SR*), and net capital flows (*CF/GDP*) interacted with time dummies (*D*). Regressions use Ordinary Least Squares (OLS) and Instrumental Variables (IV) and include fixed-country effects. $\bar{R}^2$ is the adjusted *R*-squares, and the figure in square brackets excludes variance explained by the fixed-country effects. The *z*-ratios in parentheses are based on standard errors robust to heteroscedasticity and autocorrelation (Bartlett kernel; bandwidth=2). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
[1] Hansen's test is an overidentification test for all instruments. Under the null hypothesis that the model is correctly specified and the instruments are valid, the test statistic is distributed as a chi-square with the degrees of freedom equal to the number of overidentifying restrictions (with *p*-values in square brackets). Instruments are the one-period lagged values of sovereign ratings and the two lags of each of the net capital flow variables.

$$\left(\frac{IR}{GDP}\right)_{i,t} = \alpha_i + \beta_S SIZE_{i,t} + \beta_\sigma \sigma_i + \beta_{IM}\left(\frac{IM}{GDP}\right)_{i,t} + \beta_{SR}SR_{i,t} + \sum_{j=1}^{k}\beta_{CF,j}D_j \times \left(\frac{CF}{GDP}\right)_{i,t} + \varepsilon_{i,t}. \quad (2)$$

Table 2 shows the results of regression model 1 for different country groups. Model 1 has three time dummies interacting with the capital flow variable: $D_{(80\text{-}90)}, D_{(91\text{-}97)},$ and $D_{(98\text{-}05)}$ take on the value 1 for periods 1980–90, 1991–97 and 1998–05, respectively, and zero otherwise. The OLS and IV regressions give similar results.[16]

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[16] Two additional instruments were considered—the interest rate spread, defined as the domestic Treasury-bill rate (adjusted for exchange rate depreciation) minus LIBOR, as a proxy for the country-risk premium; and the lagged values of GDP growth. For advanced countries, when the net capital flow variable was regressed on all the above-mentioned instruments, only the lagged net capital flow variables turned out to be significant. For emerging markets, the lagged values of GDP growth were also significant and were added to the set of instruments for the group. However, the extended set of instruments did not change the results appreciably.

Table 3. Regression Model 2: The Effects of Capital Flows over Four Subperiods

Independent Variables	Pooled		Emerging		Advanced	
	OLS	IV	OLS	IV	OLS	IV
SIZE	0.220***	0.246***	0.273***	0.346***	0.143***	0.071
	(6.08)	(4.88)	(5.66)	(4.73)	(3.64)	(1.44)
σ	−0.961***	−0.913***	−0.002***	−0.001**	−0.621***	−0.548***
	(−8.58)	(−8.21)	(−4.04)	(−2.51)	(−6.10)	(−5.75)
IM/GDP	0.240***	0.239***	0.260***	0.126*	0.106	0.144**
	(5.31)	(4.75)	(4.48)	(1.61)	(1.44)	(2.15)
SR	−0.003*	−0.005**	−0.003	−0.007**	−0.012***	−0.015***
	(−1.61)	(−2.21)	(−1.53)	(−2.41)	(−3.50)	(−3.61)
$D_{(80\text{-}90)}*(CF/GDP)$	0.058	0.112	−0.391**	−1.065**	−0.037	−0.294*
	(0.63)	(0.70)	(−2.04)	(−2.46)	(−0.42)	(−1.92)
$D_{(91\text{-}97)}*(CF/GDP)$	0.073	0.195	0.062	0.032	−0.168	−0.455**
	(1.04)	(1.21)	(0.70)	(0.14)	(−1.29)	(−2.10)
$D_{(98\text{-}00)}*(CF/GDP)$	−0.087	− 0.122	0.145	0.427*	−0.180*	−0.447***
	(−1.20)	(−1.02)	(1.49)	(1.70)	(−1.76)	(−2.80)
$D_{(01\text{-}05)}*(CF/GDP)$	0.099	0.127	0.433***	0.946***	−0.342***	−0.493***
	(1.39)	(1.01)	(5.06)	(3.03)	(−2.83)	(−4.04)
$\overline{R}^2$	0.883 [0.575]	0.888 [0.595]	0.791 [0.399]	0.774 [0.386]	0.935 [0.722]	0.932 [0.722]
No. of observations	973	892	444	407	527	490
Hansen's test [1]		$\chi^2(4)=0.114$ [0.998]		$\chi^2(4)=1.463$ [0.833]		$\chi^2(4)=4.876$ [0.300]

Notes: The reserves-to-GDP ratio (*IR/GDP*) is regressed on the log of population (*SIZE*), exchange rate variability (σ), import share (*IM/GDP*), sovereign rating (*SR*), and net capital flows (*CF/GDP*) interacted with time dummies (*D*). Regressions use Ordinary Least Squares (OLS) and Instrumental Variables (IV) and include fixed-country effects. $\overline{R}^2$ is the adjusted *R*-squares, and the figure in brackets excludes variance explained by the fixed-country effects. The *z*-ratios in parentheses are based on standard errors robust to heteroscedasticity and autocorrelation (Bartlett kernel; bandwidth=2). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
[1] Hansen's test is an overidentification test for all instruments. Under the null hypothesis that the model is correctly specified and the instruments are valid, the test statistic is distributed as a chi-square with the degree of freedom equal to the number of overidentifying restrictions (with *p*-values in square brackets). Instruments are the one-period lagged values of sovereign ratings and the two lags of each of the net capital flow variables.

The time-varying effects of net capital flows on reserves were quite different across emerging markets and advanced countries, while they were insignificant for the pooled sample. For emerging markets, reserves decreased with net capital flows in the 1980s. This indicates that, before financial integration took off, net capital flows were used to finance current account deficits. In contrast, during the two subsequent periods, net capital flows either had little effect or a positive effect on reserves. During the 1991–97 period, there was a substantial net flow of capital into emerging markets, but this led to only small increases in reserves, reflecting the use of net capital flows primarily to finance domestic expenditures. In the aftermath of the Asian crisis (1998–05), however, the relatively high coefficient implies that net capital flows led to a substantial accumulation of reserves. For advanced countries, net capital flows were associated with lower reserve levels, and the effect was especially strong in the 1998–2005 period.

Table 4. Regression Model 3: Capital Flows and Financial Integration

Independent Variables	Pooled		Emerging		Advanced	
	OLS	IV	OLS	IV	OLS	IV
Panel A: Globalization measure based on total foreign assets and liabilities						
SIZE	0.218***	0.224***	0.246***	0.284***	0.103***	0.032
	(5.46)	(4.35)	(4.55)	(3.96)	(2.58)	(0.68)
σ	−0.881***	−0.835***	−0.002***	−0.002***	−0.444***	−0.310**
	(−8.22)	(−7.73)	(−6.08)	(−4.74)	(−4.23)	(−2.37)
IM/GDP	0.234***	0.221***	0.329***	0.294***	0.097	0.109**
	(4.72)	(3.84)	(5.72)	(4.27)	(1.53)	(2.06)
SR	−0.004**	−0.005**	−0.003**	−0.004*	−0.014***	−0.019***
	(−2.38)	(−2.30)	(−1.97)	(−1.57)	(−4.88)	(−5.67)
CF /GDP	0.633**	0.183	−1.159***	−1.605***	2.663***	3.468***
	(2.04)	(0.37)	(−2.89)	(−2.58)	(5.89)	(4.52)
GLOB*(CF /GDP)	−0.114*	−0.036	0.274***	0.367***	−0.496***	−0.658***
	(−1.88)	(−0.39)	(3.19)	(2.84)	(−5.83)	(−4.93)
$\bar{R}^2$	0.892 [0.646]	0.895 [0.657]	0.807 [0.449]	0.810 [0.435]	0.949 [0.816]	0.946 [0.813]
No. of observations	869	812	386	356	483	461
Hansen's test [1]		χ^2 (1)=0.551		χ^2 (1)=0.309		χ^2 (1)=0.089
		[0.458]		[0.578]		[0.766]
Panel B: Globalization measure based on the stock of equity and direct investment						
SIZE	0.215***	0.219***	0.256***	0.291***	0.099**	0.015
	(5.34)	(4.23)	(5.01)	(4.33)	(2.33)	(0.30)
σ	−0.899***	−0.847***	−0.003***	−0.002***	−0.471***	−0.292**
	(−8.15)	(−7.65)	(−6.22)	(−4.92)	(−4.58)	(−2.24)
IM/GDP	0.241***	0.230***	0.355***	0.312***	0.102	0.107*
	(4.48)	(3.83)	(5.55)	(4.27)	(1.46)	(1.89)
SR	−0.004**	−0.005**	−0.003**	−0.003	−0.014***	−0.020***
	(−2.25)	(−2.20)	(−1.75)	(−1.42)	(−4.52)	(−5.55)
CF /GDP	0.245	0.059	−0.589***	−0.825***	1.262***	2.122***
	(1.53)	(0.20)	(−3.12)	(−2.56)	(5.24)	(3.85)
GLOB*(CF /GDP)	−0.055	−0.019	0.230***	0.282***	−0.322***	−0.535***
	(−1.27)	(−0.28)	(4.19)	(2.94)	(−5.29)	(−4.54)
$\bar{R}^2$	0.892 [0.645]	0.896 [0.657]	0.815 [0.447]	0.817 [0.425]	0.945 [0.814]	0.939 [0.810]
Hansen's test [1]		χ^2 (1)=0.986		χ^2 (1)=2.038		χ^2 (1)=0.327
		[0.321]		[0.153]		[0.567]

Notes: The international reserves-to-GDP ratio (*IR/GDP*) is regressed on the log of population (*SIZE*), exchange rate variability (σ), import share (*IM/GDP*), sovereign rating (*SR*), and net capital flows (*CF/GDP*) interacted with a constant and the logarithm of the globalization measure (*GLOB*). Regressions using Ordinary Least Squares (OLS) and Instrumental Variables (IV) are performed for emerging markets, advanced countries, and the pooled sample. All regressions include fixed-country effects. $\bar{R}^2$ is the adjusted *R*-squares (accounting for the fixed-country effects), and the figure in brackets excludes variance explained by the fixed-country effects. The *z*-ratios in parentheses are based on standard errors robust to heteroscedasticity and autocorrelation (Bartlett kernel; bandwidth=2). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

[1] Hansen's test is an overidentification test of all instruments. Under the null hypothesis that the model is correctly specified and the instruments are valid, the test statistic is distributed as chi-squared with degrees of freedom equal to the number of overidentifying restrictions (with *p*-values in square brackets). Instruments are the one-period lagged values of sovereign ratings, the two lags of net capital flows, and the current globalization measure (*GLOB*) multiplied by the one-period lagged *CF/GDP* (as we treat *GLOB* as exogenous).

For emerging markets, net capital flows fell drastically during 1997–98, reversed in 2001, and increased thereafter (Figure 1). To see if the strong effect during the 1998–05 period is mainly due to net capital flows in the latter half of this period, in regression model 2 we interacted the capital flow variable with four time dummies: $D_{(80-90)}$, $D_{(91-97)}$, $D_{(98-00)}$, and $D_{(01-05)}$ took on the value 1 for 1980–90, 1991–97, 1998–2000, and 2001–05 respectively, and were zero otherwise. Table 3 summarizes the results. For emerging markets, the positive effect of net capital flows comes mainly from the 2001–05 period. For advanced countries, the negative effect of net capital flows is more significant for the 2001–05 period than other periods. The effects of other regressors are similar to those in the baseline regressions with the exception that the sovereign rating tends to be significant for emerging markets.[17]

The Lane and Milesi-Ferretti measure of financial globalization is employed in place of the time dummies interacted with the capital flow variable in regression model 3:

$$
\left(\frac{IR}{GDP}\right)_{i,t} = \alpha_i + \beta_S SIZE_{i,t} + \beta_\sigma \sigma_i + \beta_{IM}\left(\frac{IM}{GDP}\right)_{i,t} + \beta_{SR} SR_{i,t}
$$

$$
+ \beta_{CF}\left(\frac{CF}{GDP}\right)_{i,t} + \beta_{GL}\left[GLOB_{i,t} \times \left(\frac{CF}{GDP}\right)_{i,t}\right] + \varepsilon_{i,t}, \tag{3}
$$

where $GLOB_{i,t}$ denotes the logarithm of the country-specific globalization measure for country i at time t. We use two alternative country-specific globalization measures: the two-year average of the ratio of total foreign assets and liabilities to GDP; and the two-year average of the ratio of the sum of the stock of equity assets and liabilities and the stock of FDI assets and liabilities to GDP (see Table A1 for descriptive statistics). As shown in Table 4, the two alternative measures give the same qualitative results. The effect of net capital flows per se—measured by β_{CF}—is significantly negative for emerging markets but positive for advanced countries.[18] Importantly, the coefficient of net capital flows interacted with the financial globalization measure (β_{GL}) is significantly positive for emerging markets but negative for advanced countries. This finding reinforces the earlier results: the effect of net capital flows on reserve accumulation drifts up over time (from negative to positive) for emerging markets and shifts down over time for advanced countries. The effects of other variables are similar to those in regression model 2.

C. Effects of World Interest Rates and Exchange Rate Regimes

This section examines how reserves respond to world interest rates, since countries are likely to economize on reserve holdings if world interest rates are relatively high. LIBOR is included as a proxy for the world interest rate (*WIR*) in regression model 2. The opportunity cost of reserve

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[17] When Hong Kong SAR and Singapore are excluded from the advanced country group, however, the goodness of fit statistics for the group regressions fall: size and import share variables become less significant or insignificant, and the effects of net capital flows are less pronounced (see Table A3 in the appendix).

[18] The average *total* effect of net capital flows during a period can be measured by $\beta_{CF} + \beta_{GL}*GLOB^{AVE}$, where the superscript ^{AVE} denotes the period average value. In particular, for 2001–05, the total effect based on the IV estimator in panel A is 0.135 (= −1.605+0.367×4.74) and −0.427 (= 3.468−0.658×5.92) for emerging markets and advanced countries, respectively.

Table 5. Regression Model 2 with World Interest Rates

Independent Variables	Pooled		Emerging		Advanced	
	OLS	IV	OLS	IV	OLS	IV
SIZE	0.190***	0.207***	0.160***	0.207**	0.223**	0.171**
	(4.29)	(3.39)	(3.04)	(2.39)	(3.52)	(2.19)
σ	−0.969***	−0.917***	−0.001***	−0.001*	−0.605***	−0.524***
	(−8.62)	(−8.26)	(−3.39)	(−1.67)	(−5.82)	(−5.46)
IM/GDP	0.241***	0.237***	0.247***	0.106	0.092	0.236*
	(5.31)	(4.71)	(4.29)	(1.35)	(1.21)	(1.79)
SR	−0.003*	−0.005***	−0.002	−0.007**	−0.013***	−0.015***
	(−1.65)	(−2.38)	(−1.20)	(−2.22)	(−3.73)	(−3.69)
$D_{(80-90)}$*(*CF /GDP*)	0.062	0.105	−0.426**	−1.200**	−0.023	−0.313**
	(0.66)	(0.65)	(−2.00)	(−2.45)	(−0.27)	(−2.07)
$D_{(91-97)}$*(*CF /GDP*)	0.069	0.165	0.050	−0.028	−0.157	−0.424*
	(1.00)	(1.03)	(0.59)	(−0.12)	(−1.21)	−(1.95)
$D_{(98-00)}$*(*CF /GDP*)	−0.079	−0.109	0.206*	0.534**	−0.165*	−0.408***
	(−1.07)	(−0.90)	(1.90)	(1.99)	(−1.67)	(−2.67)
$D_{(01-05)}$*(*CF /GDP*)	0.094	0.116	0.330***	0.794**	−0.346***	−0.506***
	(1.33)	(0.93)	(4.12)	(2.51)	(−2.88)	(−4.17)
WIR	−0.001	−0.001	−0.007***	−0.008***	0.002**	0.003**
	(−1.51)	(−1.30)	(−4.02)	(−3.58)	(2.05)	(2.40)
$\bar{R}^2$	0.883 [0.577]	0.888 [0.598]	0.802 [0.437]	0.793 [0.424]	0.936 [0.724]	0.934 [0.725]
No. of observations	973	892	444	407	527	490
Hansen's test [1]		$\chi^2(5)=6.820$		$\chi^2(5)=2.378$		$\chi^2(4)=4.708$
		[0.234]		[0.795]		[0.319]

Notes: The reserves-to-GDP ratio (*IR/GDP*) is regressed on the log of population (*SIZE*), exchange rate variability (σ), import share (*IM/GDP*), sovereign rating (*SR*), net capital flows (*CF/GDP*) interacted with time dummies (*D*), and world interest rates (*WIR*). Regressions use Ordinary Least Squares (OLS) and Instrumental Variables (IV) and include fixed-country effects. $\bar{R}^2$ is the adjusted *R*-squares, and the figure in brackets excludes variance explained by the fixed-country effects. The *z*-ratios in parentheses are based on standard errors robust to heteroscedasticity and autocorrelation (Bartlett kernel; bandwidth=2). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

[1] Hansen's test is an overidentification test for all instruments. Under the null hypothesis that the model is correctly specified and the instruments are valid, the test statistic is distributed as a chi-square with the degrees of freedom equal to the number of overidentifying restrictions (with *p*-values in square brackets). Instruments are the one-period lagged values of sovereign ratings and the world interest rate, and two lags of each of the net capital flow variables.

holdings defined as the spread between the country's external financing cost and the return on reserves[19]—depends on the country-risk premium. The country-risk premia for emerging markets are sizable, volatile, and positively correlated with the world interest rate, whereas those for advanced countries are typically small and much less volatile. Hence, LIBOR may be a better measure of opportunity cost of reserves for emerging markets than for advanced countries.

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[19] The return on reserves can be proxied by the return on U.S. Treasuries in which the reserves are reinvested (see Rodrik, 2006).

Figure 5. Reserves-to-GDP Ratio by Exchange Rate Regime Type
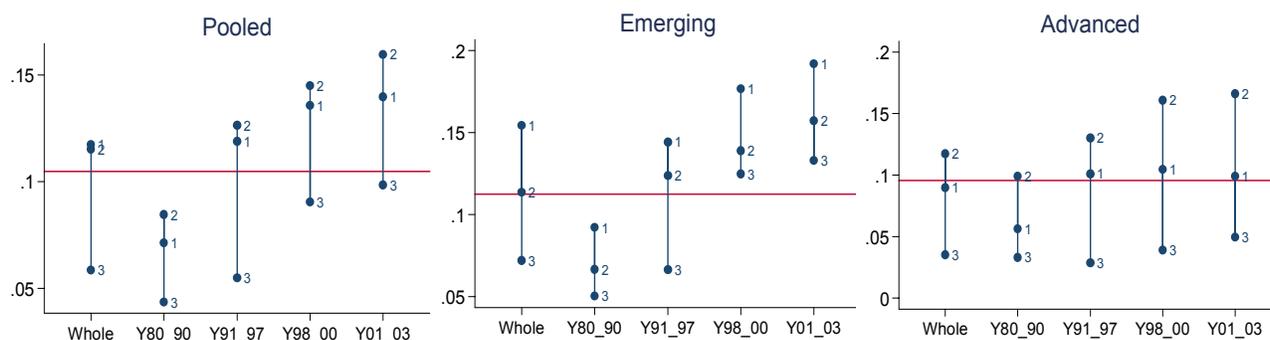
Notes: The figure depicts the group means of the reserve-to-GDP ratio by exchange rate regime type over subsample periods. The whole sample covers the 1980–2003 period with the countries dictated by the availability of the Reinhart and Rogoff (2004a) regime classification. Regimes are indexed as follows: fixed regime = 1; intermediate regime = 2; and floating regime = 3. The subsample periods are: Whole (1980–03); Y80_90 (1980–90); Y91_97 (1991–97); Y98_00 (1998–00); and Y01_03 (2001–03).

As shown in Table 5, our main results are robust to the inclusion of world interest rates (*WIR*). For emerging markets, the coefficient on *WIR* is significantly negative, suggesting that lower world interest rates in recent years may have reinforced the accumulation of reserves. For advanced economies, the coefficient on *WIR* is positive—perhaps because advanced countries have contributed to global liquidity rather than stockpiling reserves. In IV regressions, *WIR* is instrumented by its lagged value to account for endogeneity, since central banks' transactions of U.S. government securities for reserves management may affect the world interest rate.

Our regressions so far have controlled for exchange rate variability, but this has been a time-invariant country characteristic. Exchange rate variability, however, can change when a country chooses a different exchange rate regime or changes its exchange rate management: for example, a transition economy can experience a substantial change in exchange rate variability as it moves from high inflation to low inflation.

To see whether the data support the conventional wisdom that reserves decline with exchange rate flexibility, Figure 5 shows the group means of the reserve/GDP ratios under different exchange rate regimes. Based on the classification used by Reinhart and Rogoff (2004a), regimes are divided into three categories: a fixed regime (index = 1), an intermediate regime (index = 2), and a floating regime (index = 3).[20] Two observations are noteworthy. First, for emerging markets, consistent with the conventional wisdom the more flexible regimes are associated with lower reserves. For advanced countries, the floating category (index = 3) is associated with the lowest reserves-to-GDP ratio, but the intermediate regime (index = 2) has the highest ratio. This may reflect that more reserves are required for ameliorating exchange rate volatility under a closely managed float. Second, the time-varying link between reserves and regimes suggests that factors other than the exchange rate regime may have an important effect

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[20] Our index corresponds to the Reinhart-Rogoff classification as follows: index value 1 has categories from "no separate legal tender" to "de facto peg", index value 2 has categories from "pre-announced crawling peg" to "managed floating," and index value 3 has categories from "freely floating" to "freely falling." We exclude sample observations for the category: "dual market in which parallel market data is missing."

Table 6. Regression Model 2 with Exchange Rate Regimes

Independent Variables	Pooled		Emerging		Advanced	
	OLS	IV	OLS	IV	OLS	IV
SIZE	0.225***	0.219***	0.257***	0.296***	0.192***	0.128***
	(5.78)	(4.17)	(5.03)	(4.06)	(4.72)	(2.55)
IM/GDP	0.155***	0.149***	0.208***	0.056	–0.004	0.068
	(3.12)	(2.77)	(4.50)	(0.82)	(–0.05)	(0.94)
SR	–0.002	–0.003	–0.003*	–0.008***	–0.008***	–0.010***
	(–1.11)	(–1.53)	(–1.64)	(–2.65)	(–2.65)	(–2.99)
$D_{(80-90)}$*(*CF /GDP*)	0.032	–0.063	–0.337*	–1.204***	–0.048	–0.333**
	(0.43)	(–0.45)	(–1.95)	(–2.59)	(–0.60)	(–2.21)
$D_{(91-97)}$*(*CF /GDP*)	0.043	0.039	–0.007	–0.187	–0.087	–0.380*
	(0.68)	(0.28)	(–0.09)	(–0.95)	(–0.72)	(–1.82)
$D_{(98-00)}$*(*CF /GDP*)	–0.116*	–0.258**	0.092	0.333	–0.154*	–0.415**
	(–1.68)	(–2.40)	(1.00)	(1.39)	(–1.57)	(–2.50)
$D_{(01-03)}$*(*CF /GDP*)	0.056	–0.160	0.430***	0.897***	–0.448***	–0.592***
	(0.52)	(–1.16)	(4.78)	(2.74)	(–2.87)	(–4.16)
Intermediate regime dummy	0.013**	0.022**	–0.015	–0.016	0.015**	0.026***
	(2.09)	(2.61)	(–1.31)	(–0.91)	(2.18)	(2.63)
Floating regime dummy	0.018*	0.022	–0.830***	–0.045*	0.017*	0.014
	(1.87)	(1.24)	(–4.45)	(–1.56)	(1.58)	(1.01)
$\overline{R}^2$	0.895 [0.670]	0.904 [0.699]	0.797 [0.447]	0.774 [0.453]	0.939 [0.762]	0.936 [0.762]
No. of obs.	842	762	364	328	482	445
Hansen's test [1]		$\chi^2(4)$=3.120 [0.538]		$\chi^2(4)$=2.284 [0.684]		$\chi^2(4)$=6.434 [0.169]

Notes: The reserves-to-GDP ratio (*IR/GDP*) is regressed on the log of population (*SIZE*), exchange rate variability (σ), import share (*IM/GDP*), sovereign rating (*SR*), net capital flows (*CF/GDP*) interacted with time dummies, and exchange rate regime dummies. Regressions use Ordinary Least Squares (OLS) and Instrumental Variables (IV) and include fixed-country effects. $\overline{R}^2$ is the adjusted *R*-squares (accounting for the fixed-country effects), and the figure in square brackets excludes variance explained by the fixed-country effects. The *z*-ratios in parentheses are based on standard errors robust to heteroscedasticity and autocorrelation (Bartlett kernel; bandwidth=2). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The regressions are estimated for the 1980–2003 period using the Reinhart and Rogoff (2004a) regime classification.

[1] The Hansen test is a test of overidentifying restrictions. The null hypothesis is that the model is correctly specified and the instruments are valid (with *p*-values in square brackets). Under the null, the test statistic is distributed as chi-squared in the number of overidentifying restrictions. Instrumental variables are the one-period lagged values of sovereign ratings, two regime dummies, and two lags of the net capital flow variables.

on reserves. The reserves-to-GDP ratios show an upward trend under all three categories for emerging markets but only under the intermediate regime for the advanced countries.

To examine how the choice of exchange rate regime affects reserves, we include dummy variables for the intermediate and the floating regimes in place of exchange rate variability in regression model 2. The regression results in Table 6 are quite consistent with Figure 5. For emerging markets, reserve holdings tend to be lower under the floating regime than under the other two categories. In contrast, for the advanced countries and for the pooled sample, the reserves-to-GDP ratio is significantly higher under the intermediate regime than under the fixed

regime, suggesting that advanced countries tend to hold more reserves for a managed float.[21] Again, our main results are largely unaffected by the inclusion of the regime dummies.

In regression model 2, we also introduce other covariates associated with the exchange rate. The main results are similar, as shown in Table A4 of the Appendix. Additional findings are twofold. First, the negative effect of exchange rate variability on reserves declines with conditional volatility of capital flows for advanced countries.[22] Second, emerging markets accumulate reserves in the face of currency appreciation when they are running current account surpluses, whereas advanced countries reduce reserves. This finding supports the view that emerging markets have accumulated reserves to resist or delay their currency appreciation (e.g., Dooley and others, 2004).

D. Dynamic Panel Regressions for International Reserve Holdings

Dynamic panel data regressions are characterized by two sources of persistence over time: autocorrelation due to the presence of lagged dependent variables, and individual effects capturing the heterogeneity across countries. First differencing the equation removes the fixed effects and produces an equation that can be estimated by instrumental variables. We employ Arellano and Bond's (1991) Generalized Method of Moments (GMM) estimator in the presence of lagged dependent variables.

The dynamic panel model is specified as follows. Two lags of the dependent variable are included to capture the dynamics of reserve holdings. Since exchange rate variability is defined as a "fixed" characteristic over the sample period, it is just like a fixed effect. The population variable also shows little variability around a trend over time and is not suitable for a dynamic setting. Hence, variables for fixed country effects, population, import share, and exchange rate variability are dropped from the dynamic panel model. All other time-varying variables are first differenced and included as regressors in the dynamic panel model. The dynamic panel counterpart of equation (3) is represented as:

$$\Delta\left(\frac{IR}{GDP}\right)_{i,t} = \sum_{j=1}^{2}\rho_j\Delta\left(\frac{IR}{GDP}\right)_{i,t-1} + \beta_{SR}\Delta SR_{i,t} + \beta_{CF}\Delta\left(\frac{CF}{GDP}\right)_{i,t} + \beta_{GL}\Delta\left[GLOB_{i,t}\times\left(\frac{CF}{GDP}\right)_{i,t}\right] + u_{i,t}. \quad (4)$$

In these regressions, the sovereign rating (considering that reserve levels can affect the sovereign rating) and net capital flows are assumed to be endogenous variables.

Table 7 shows how financial integration may have changed the effect of capital flows on reserve accumulation.[23] The results are generally in line with those obtained in the earlier OLS and IV regressions (Table 4). They suggest that the effect of net capital flows on reserves has

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[21] Using the Reinhart-Rogoff classification with a pooled sample of 137 countries for 1980–2000, Baek and Choi (2004) find that the intermediate regime is associated with more reserves than other regimes.

[22] For advanced countries, the average *total* effect of exchange rate variability, given the average V_{CF}=0.003, is still negative (–0.544+13.174*0.003 = –0.504).

[23] The results are reported for the equity-based globalization measure. The other measure based on total assets and liabilities gave similar qualitative results.

Table 7. Dynamic Panel Regressions

Independent Variables	With Globalization Measure			With Fiscal Balance			With M2		
	Pooled	Emerging	Advanced	Pooled	Emerging	Advanced	Pooled	Emerging	Advanced
$\Delta(IR/GDP)_{-1}$	0.864***	0.778***	0.763***	0.858***	0.765***	0.775***	0.830***	0.690***	0.775***
	(11.62)	(7.85)	(15.28)	(10.55)	(6.74)	(16.79)	(11.79)	(6.10)	(16.79)
$\Delta(IR/GDP)_{-2}$	0.004	–0.075	0.100*	–0.004	–0.078	0.090	–0.014	–0.049	0.090
	(0.05)	(–1.10)	(1.66)	(–0.05)	(–1.06)	(1.50)	(–0.23)	(–0.71)	(1.50)
ΔSR	–0.005***	–0.004***	–0.005**	–0.005***	–0.003***	–0.005	–0.005***	–0.004***	–0.005
	(–4.15)	(–2.64)	(–1.94)	(–3.89)	(–2.26)	(–1.41)	(–4.36)	(–4.20)	(–1.41)
$\Delta(CF/GDP)$	0.339**	–0.101	0.739***	0.341**	–0.151	0.703***	0.317**	0.010	0.703***
	(2.17)	(–0.59)	(4.67)	(2.15)	(–0.76)	(4.14)	(2.28)	(0.08)	(4.14)
$\Delta[GLOB*(CF/GDP)]$	–0.048	0.101***	–0.149***	–0.050	0.108***	–0.142***	–0.042	0.076**	–0.142***
	(–1.36)	(2.75)	(–4.01)	(–1.43)	(2.61)	(–3.55)	(–1.29)	(2.51)	(–3.55)
$\Delta(F/GDP)$				0.003***	0.144	–0.000			
				(6.04)	(0.99)	(–0.02)			
$\Delta(M2/GDP)$							0.055***	0.128***	–0.000
							(3.05)	(5.64)	(–0.02)
Constant	0.001**	0.004***	–0.000	0.001**	0.035***	–0.000	0.000	0.002**	–0.000
	(2.16)	(3.74)	(–0.54)	(2.00)	(3.73)	(–0.06)	(0.30)	(2.38)	(–0.06)
Wald test	$\chi2(5)=615.2$	$\chi2(5)=137.8$	$\chi2(5)=444.8$	$\chi2(6)=652.0$	$\chi2(6)=145.8$	$\chi2(6)=569.6$	$\chi2(6)=774.2$	$\chi2(6)=401.4$	$\chi2(5)=569.6$
No. of observations	771	333	439	761	325	385	717	333	385
Arellano-Bond tests									
Autocov. of order 1	–4.12	–2.98	–3.30	–4.07	–2.91	–2.85	–4.03	–2.88	–2.85
	(0.000)	(0.003)	(0.001)	(0.000)	(0.004)	(0.004)	(0.000)	(0.004)	(0.004)
Autocov. of order 2	–0.54	–0.47	0.71	–0.35	–0.08	–0.01	–0.68	–0.79	–0.01
	(0.586)	(0.639)	(0.476)	(0.728)	(0.934)	(0.989)	(0.494)	(0.430)	(0.989)

Notes: The first-difference of the reserves-to-GDP ratio ($\Delta(IR/GDP)$) is regressed on two lags of the dependent variable ($\Delta(IR/GDP)_{-1}$ and $\Delta(IR/GDP)_{-2}$), and the first-difference of sovereign ratings (ΔSR), and the first-difference of net capital flows ($\Delta(CF/GDP)$) interacted with the financial integration measure. Regressions in columns 5–10 additionally include the first difference of fiscal balance or M2 ($\Delta(F/GDP)$ or $\Delta(M2/GDP)$). The globalization measure is based on the sum of the portfolio equity assets and liabilities and the stock of FDI assets and liabilities. The dynamic panel models, treating sovereign ratings, net capital flows, and fiscal balances (or M2) as endogenous variables, are estimated by the GMM method for the period 1980–2004, with the last period being dictated by the availability of the globalization measure. The z-ratios in parentheses are based on standard errors robust to heteroscedasticity. Significance at the one, five, and ten percent level is given by ***, **, and *, respectively. The statistics for the Arellano-Bond tests are based on the null hypothesis of no autocorrelation of order 1 and 2 (with p-values in parentheses).

increased with financial integration for emerging markets, whereas the converse is true for advanced economies. For the pooled sample, the effect of net capital flows on reserves decreases with financial integration, suggesting that the effect for advanced countries dominates the effect for emerging markets.

Turning to the specifics of the regression results, the coefficient on the one-period lagged dependent variable has a statistically significant coefficient of 0.7–0.8 for both country groups, indicating substantial persistence in reserve ratios. Sovereign ratings had a negative effect on reserves for all country groups, indicating that smaller reserve cushions were needed by economies with higher ratings. The Wald test statistics indicate the joint significance (at the 1 percent level) of the regressors in all regressions. The Arellano-Bond test for the null of no autocorrelation of order 1 in residuals is strongly rejected, and that for order 2 is not rejected. Thus, the Arellano-Bond serial correlation tests do not indicate misspecification.[24]

We extend the dynamic panel regressions by incorporating fiscal and financial factors. First, to see how the fiscal stance affects reserves, we include the (overall) fiscal balance to GDP ratio as an endogenous variable. Table 7 (columns 5–7) shows that the fiscal balance coefficient is statistically insignificant for both emerging markets and advanced counties. This result suggests that, within each group of countries, the positive effect of the political-economy factors largely offset the negative effect of a precautionary motive to reduce the risk of a crisis. However, when emerging markets and advanced countries are grouped together, the coefficient is significantly positive, suggesting that political-economy factors are more important than the precautionary motive in explaining differential reserve holdings across emerging markets and advanced countries. Second, to account for the financial dimension of international transactions, we use the M2-to-GDP ratio in place of the population variable, which is a crude measure for international transactions. As shown in Table 7 (columns 8–10), the M2-to-GDP ratio has a statistically significant positive effect on reserves for emerging markets but not for advanced countries. This result suggests that the level of monetization is not a determinant of reserve holdings for advanced countries which already have relatively well developed financial markets. The main results are largely unaffected by the inclusion of fiscal and financial factors.

V. CONCLUDING REMARKS

The paper has shown that, despite increasing financial integration and moves toward more flexible exchange rate arrangements, emerging markets have used capital inflows to build up considerable reserve stocks. This is in contrast to the advanced economies where reserve accumulation has been negatively correlated with net capital flows. For emerging markets, the accumulation of reserves is probably a response to the capital account crises of the last decade, during which emerging markets faced with sudden reversals in capital flows had to pay extremely high borrowing costs and/or appeal to the IMF for financial support. In recent years, it may also reflect the lower cost of acquiring capital in international markets.

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[24] The Arellano-Bond estimator assumes (by construction) first-order autocorrelation of the residuals. If the model is correctly specified, there should not be any second-order autocorrelation among the residuals.

An important issue in the context of global financial stability is how to make an assessment of comfortable reserve levels, and put the savings of emerging markets to better use without compromising their financial stability (see, for example, IMF, 2005; Mohanty and Turner, 2006). The development of domestic financial markets and regional arrangements for pooling reserves will help improve sovereign liquidity management in the face of volatile capital flows. And, as the recent crises in emerging markets fade into history, better and continued access to international financial markets will decrease the need for large stocks of reserves.

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Appendix

A. Country Group List

Emerging market group (36 countries)			Advanced country group (24 countries)		
Argentina	Brazil	Bulgaria	Australia	Austria	Belgium
Chile	China	Colombia	Canada	Denmark	Finland
Croatia	Czech Republic	Egypt	France	Germany	Greece
Estonia	Hungary	India	Hong Kong SAR	Ireland	Italy
Indonesia	Israel	Jordan	Japan	Luxembourg	Netherlands
Kazakhstan	Latvia	Lithuania	New Zealand	Norway	Portugal
Malaysia	Mexico	Pakistan	Singapore	Spain	Sweden
Peru	Philippines	Poland	Switzerland	United Kingdom	United States
Romania	Russia	Slovak Republic			
Slovenia	South Africa	South Korea			
Taiwan Province of China	Thailand	Turkey			
Ukraine	Uruguay	Venezuela			

Notes: Our country groups correspond to the groups "emerging market countries" and "industrial countries" in the IMF Research Department's *Global Data Source*. Our emerging market group is similar to the "emerging market countries" except that it includes Croatia, Egypt, Jordan, Kazakhstan, and Uruguay but excludes Hong Kong SAR and Singapore. Our advanced country group includes Hong Kong SAR and Singapore, in addition to "industrial countries." We include Hong Kong SAR and Singapore in the advanced country group primarily because their per capita income has been well above the sample mean of advanced countries for at least the last 10 years. Also, their financial globalization measures have been among the highest over the period considered.

B. Descriptive Statistics and Correlations

Table A1. Descriptive Statistics

A. Emerging countries

Variable	Units	N	Mean	Std	Min	Max
Reserves	Billion USD	798	18.0	49.0	0.045	821.5
Reserves/GDP	Ratio	783	0.125	0.104	0.002	0.726
GDP (dollars)	Billion USD	921	132.9	206.7	0.904	2,226
GDP per capita	USD	919	3,559	3,354	175.7	18,994
ln (Population)		934	3.184	1.582	0.285	7.182
Exchange rate variability		921	7.232	16.866	0.052	83.322
Import/GDP	Ratio	801	0.356	0.216	0.046	1.276
Net capital flows/GDP	Ratio	926	0.025	0.056	–0.230	0.483
Current account/GDP	Ratio	782	–0.014	0.051	–0.157	0.212
S&P rating	Number (1-23)	454	13.7	3.6	2.0	23.0
GLOB (total)		687	4.519	0.592	1.710	6.132
GLOB (equity)		679	2.664	1.132	–1.497	5.221
Fiscal balance/GDP	Ratio	751	–0.026	0.038	–0.267	0.099
M2/GDP	Ratio	789	0.526	0.342	0.090	2.121

B. Advanced countries

Variable	Units	N	Mean	Std	Min	Max
Reserves	Billion USD	610	30.2	66.0	0.0	834.3
Reserves/GDP	Ratio	607	0.096	0.138	0.002	0.747
GDP (dollars)	Billion USD	622	773.2	1,619	3.3	12,487
GDP per capita	USD	622	20,473	11,124	1,925	79,266
ln (Population)		624	2.582	1.415	–1.022	5.698
Exchange rate variability		622	0.096	0.039	0.000	0.146
Import/GDP	Ratio	624	0.453	0.385	0.071	2.159
Net capital flows/GDP	Ratio	608	–0.001	0.052	–0.281	0.156
Current account/GDP	Ratio	606	0.005	0.055	–0.192	0.290
S&P rating	Number (1-23)	534	22.0	1.8	14.0	23.0
GLOB (total)		552	5.230	0.821	3.357	7.527
GLOB (equity)		552	3.823	1.136	1.145	6.525
Fiscal balance/GDP	Ratio	620	–0.041	0.441	–0.208	0.169
M2/GDP	Ratio	531	0.727	0.391	0.000	2.658

Notes: The descriptive statistics are based on annual panel data sets that comprise 36 emerging markets and 24 advanced countries for 1980–2005. The reserves-to-GDP ratio is based on international reserves excluding gold. Population is in million persons, and all other variables except S&P rating are measured on the basis of US dollar (USD). GLOB (total) is the logarithm of the two-year average of the percentage ratio of total foreign assets and liabilities to GDP, and GLOB (equity) is that of the sum of the portfolio equity assets and liabilities and the stock of foreign direct investment assets and liabilities.

Table A2. Correlations among Variables

A. Pooled data

	Reserve/GDP	Ex_variability	Import/GDP	S&P rating	CF/GDP	WIR	Fiscal/GDP
Ex_variability	0.013						
Import/GDP	0.717	0.028					
SP	−0.150	−0.309	0.085				
CF/GDP	−0.147	0.143	−0.110	−0.208			
WIR	−0.213	−0.123	−0.147	0.280	− 0.023		
Fiscal/GDP	0.051	0.011	0.049	−0.012	0.001	−0.010	
M2/GDP	0.549	−0.195	0.446	0.290	−0.319	−0.124	0.003

B. Emerging countries

	Reserve/GDP	Ex_variability	Import/GDP	S&P rating	CF/GDP	WIR	Fiscal/GDP
Ex_variability	−0.086						
Import/GDP	0.544	0.064					
SP	0.422	−0.196	0.374				
CF/GDP	0.018	0.089	0.341	0.217			
WIR	−0.190	−0.110	−0.105	0.106	−0.072		
Fiscal/GDP	0.121	0.097	0.149	0.139	0.199	−0.042	
M2/GDP	0.713	−0.230	0.315	0.512	−0.170	−0.033	−0.097

C. Advanced countries

	Reserve/GDP	Ex_variability	Import/GDP	S&P rating	CF/GDP	WIR	Fiscal/GDP
Ex_variability	−0.291						
Import/GDP	0.815	−0.251					
SP	−0.254	−0.081	−0.126				
CF/GDP	−0.382	0.053	−0.363	−0.201			
WIR	−0.145	−0.047	−0.176	0.167	−0.787		
Fiscal/GDP	0.488	−0.200	0.494	0.026	0.170	−0.161	
M2/GDP	0.573	−0.205	0.547	−0.337	−0.283	−0.279	0.289

Notes: The pooled sample includes both emerging and advanced countries for 1980–2005. Simple correlation coefficients among variables: reserves-to-GDP ratio, exchange rate variability (Ex_ variability), import-GDP ratio, S&P rating, net capital flow (CF)-GDP ratio, world interest rate adjusted for exchange rate depreciation (WIR), fiscal balance-GDP ratio, and M2-GDP ratio.

C. Additional Regressions

Table A3. Regressions for the Advanced Countries Group Excluding Hong Kong SAR and Singapore

Independent Variables	Regression Model 2		Regression Model 3			
			Globalization (total)		Globalization (equity)	
	OLS	IV	OLS	IV	OLS	IV
SIZE	0.052**	0.016	0.047*	0.016	0.042	0.011
	(2.03)	(0.48)	(1.64)	(0.47)	(1.47)	(0.34)
σ	−0.371**	−0.343**	−0.344***	−0.309***	−0.341***	−0.305***
	(−4.10)	(−3.72)	(−4.04)	(−3.39)	(−4.00)	(−3.32)
IM/GDP	−0.032	−0.003	0.006	0.030	0.002	0.025
	(−1.01)	(−0.07)	(0.15)	(0.69)	(0.04)	(0.60)
SR	−0.017***	−0.019***	−0.016***	−0.018***	−0.016***	−0.018***
	(−5.03)	(−4.78)	(−5.08)	(−4.96)	(−5.03)	(−4.94)
$D_{(80\text{-}90)}$*(*CF /GDP*)	0.115*	−0.018				
	(1.70)	(−0.15)				
$D_{(91\text{-}97)}$*(*CF /GDP*)	0.212***	0.142				
	(3.07)	(0.97)				
$D_{(98\text{-}00)}$*(*CF /GDP*)	0.127	0.120				
	(1.60)	(0.90)				
$D_{(01\text{-}05)}$*(*CF /GDP*)	−0.013	−0.087				
	(−0.18)	(−0.96)				
CF /GDP			1.014***	0.929	0.576***	0.501
			(3.55)	(1.57)	(3.68)	(1.38)
GLOB*(*CF /GDP*)			−0.170***	−0.176*	−0.119***	−0.128*
			(−3.26)	(−1.71)	(−3.38)	(−1.65)
$\bar{R}^2$	0.745 [0.321]	0.744 [0.319]	0.761 [0.397]	0.758 [0.386]	0.761 [0.398]	0.757 [0.390]
No. of observations	494	458	452	431	452	431
Hansen's test [1]		χ^2 (4)=3.372		χ^2 (1)=1.586		χ^2 (1)=2.016
		[0.498]		[0.208]		[0.156]

Notes: The reserves-to-GDP ratio (*IR/GDP*) is regressed on the log of population (*SIZE*), exchange rate variability (σ), import share (*IM/GDP*), sovereign rating (*SR*), and net capital flows (*CF/GDP*) interacted with time dummies (*D*) or with a constant and the logarithm of the globalization measure (*GLOB*). *GLOB* is based on total foreign assets and liabilities (columns 4−5) or the sum of equity and FDI assets and liabilities (columns 5−6). Regressions use Ordinary Least Squares (OLS) and Instrumental Variables (IV) and include fixed-country effects. $\bar{R}^2$ is the adjusted *R*-squares, and the figure in brackets excludes variance explained by the fixed-country effects. The *z*-ratios in parentheses are based on standard errors robust to heteroscedasticity and autocorrelation (Bartlett kernel; bandwidth=2). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

[1] Hansen's test is an overidentification test for all instruments. Under the null hypothesis that the model is correctly specified and the instruments are valid, the test statistic is distributed as a chi-square with the degree of freedom equal to the number of overidentifying restrictions (with *p*-values in square brackets). Instruments are the one-period lagged values of sovereign ratings and the two lags of each of the net capital flow variables.

Table A4. Regressions with Conditional Factors Associated with the Exchange Rate

Independent Variables	Exchange Rate Variability Interacted with Conditional Volatility of Capital Flows			Exchange Rate Appreciation Interacted with Current Account Balance		
	Pooled	Emerging	Advanced	Pooled	Emerging	Advanced
SIZE	0.247***	0.345***	0.073	0.241***	0.317***	0.072
	(4.89)	(4.76)	(1.52)	(4.69)	(4.57)	(1.40)
σ	–0.913***	–0.001**	–0.544***	–0.891**	–0.002***	–0.559***
	(–8.20)	(–2.25)	(–5.83)	(–8.00)	(–3.14)	(–5.58)
IM/GDP	0.238***	0.126*	0.129**	0.238**	0.129*	0.138**
	(4.73)	(1.62)	(2.04)	(4.66)	(1.65)	(2.03)
SR	–0.005**	–0.007**	–0.018***	–0.005**	–0.007**	–0.015***
	(–2.15)	(–2.38)	(–4.11)	(–2.18)	(–2.38)	(–3.65)
$D_{(80\text{-}90)}$*(*CF /GDP*)	0.111	–1.062**	–0.246*	0.156	–0.977**	–0.345**
	(0.69)	(–2.46)	(–1.67)	(0.87)	(–2.36)	(–2.10)
$D_{(91\text{-}97)}$*(*CF /GDP*)	0.193	0.024	–0.409**	0.224	0.123	–0.469**
	(1.20)	(0.11)	(–2.00)	(1.35)	(0.53)	(–2.13)
$D_{(98\text{-}00)}$*(*CF /GDP*)	–0.127	0.409*	–0.345**	–0.113	0.507**	–0.419***
	(–1.06)	(1.67)	(–2.41)	(–0.94)	(2.06)	(–2.67)
$D_{(01\text{-}05)}$*(*CF /GDP*)	0.125	0.931***	–0.368***	0.159	1.063***	–0.547***
	(1.00)	(3.05)	(–3.45)	(1.17)	(2.93)	(–4.15)
σ* V_{CF}	0.041	0.024	13.174**			
	(1.12)	(1.56)	(2.10)			
$I_{(appreciation)}$*$I_{(surplus)}$				0.014**	0.052***	–0.013**
				(2.14)	(3.95)	(–2.17)
$I_{(appreciation)}$*(1– $I_{(surplus)}$)				–0.000	–0.011	0.000
				(–0.09)	(–1.12)	(0.08)
$\overline{R}^{\,2}$	0.888 [0.559]	0.776 [0.388]	0.935 [0.734]	0.889 [0.600]	0.788 [0.449]	0.933 [0.722]
No. of observations	892	407	490	892	407	490
Hansen's test [1]	χ^2(4)=0.123	χ^2(4)=1.528	χ^2(4)=5.461	χ^2(4)=0.059	χ^2(4)=1.658	χ^2(4)=4.589
	[0.998]	[0.822]	[0.243]	[1.000]	[0.798]	[0.332]

Notes: The reserves-to-GDP ratio is regressed on the regressors of model 2 and a conditional factor associated with the exchange rate. The conditional factor in columns 2–4 is exchange rate variability (σ) interacted with conditional volatility of capital flows (V_{CF}). V_{CF} is the one-period-ahead prediction of conditional variance from the estimated GARCH (1,1) model for the capital flows to GDP ratio, which allows for different means across countries. The conditional factor in columns 5–7 is an indicator function for exchange rate appreciation interacted with another indicator function for current account balance: $I_{(appreciation)}$ =1 if exchange rate growth >0, and zero otherwise; and $I_{(surplus)}$= 1 if the current account balance > 0, and zero otherwise. All regressions use Instrumental Variables (IV) and include fixed-country effects. $\overline{R}^{\,2}$ is the adjusted R-squares, and the figure in brackets excludes variance explained by the fixed-country effects. The z-ratios in parentheses are based on standard errors robust to heteroscedasticity and autocorrelation (Bartlett kernel; bandwidth=2). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

[1] Hansen's test is an overidentification test for all instruments. Under the null hypothesis that the model is correctly specified and the instruments are valid, the test statistic is distributed as a chi-square with the degree of freedom equal to the number of overidentifying restrictions (with p-values in square brackets). Instruments are the one-period lagged values of sovereign ratings and the two lags of each of the net capital flow variables.