Country Insurance
The Role of Domestic Policies

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The following conventions are used in this publication:

• In tables, a blank cell indicates "not applicable," ellipsis points (. . .) indicate "not available," and 0 or 0.0 indicates "zero" or "negligible." Minor discrepancies between sums of constituent figures and totals are due to rounding.

• An en dash (–) between years or months (for example, 2005–06 or January–June) indicates the years or months covered, including the beginning and ending years or months; a slash or virgule (/) between years or months (for example, 2005/06) indicates a fiscal or financial year, as does the abbreviation FY (for example, FY2006).

• "Billion" means a thousand million; "trillion" means a thousand billion.

• "Basis points" refer to hundredths of 1 percentage point (for example, 25 basis points are equivalent to ¼ of 1 percentage point).

As used in this publication, the term "country" does not in all cases refer to a territorial entity that is a state as understood by international law and practice. As used here, the term also covers some territorial entities that are not states but for which statistical data are maintained on a separate and independent basis.

Preface

Countries face a range of shocks that can contribute to higher volatility in aggregate output and, in extreme cases, to economic crises. The presence of such risks underlies a potential demand for mechanisms to soften the blow from adverse economic shocks. Such a protective infrastructure is referred to in this paper as "country insurance." Protective measures that countries can take themselves ("self-insurance") include sound economic policies, robust financial structures, and adequate reserve coverage. Beyond self-insurance, countries have also established regional arrangements that pool risks while, at the multilateral level, the IMF plays a central role through the temporary provision of its resources when shocks create balance of payments difficulties for a member, and through the policy advice it provides under surveillance. This Occasional Paper focuses on what countries can do on their own—that is, on the role of domestic policies—with respect to country insurance.

The paper was prepared under the direction of Jonathan D. Ostry (Deputy Director, Research Department) by a staff team led by Paolo Mauro (Chief of the Strategic Issues Division in the Research Department). The other authors were Törbjörn Becker, Olivier Jeanne, and Romain Rancière. Other contributors were Andrei Levchenko (Appendix II) and Marcos Chamon and Cheng-Hoon Lim (Box 3.2). The authors are grateful to Raghuram Rajan (Director, Research Department) for suggesting the topic and for his support and helpful suggestions throughout the project; to Martín Minnoni and Aleksandar Zaklan for excellent research assistance; and to Usha David for editorial assistance. Paul Gleason of the External Relations Department copyedited the paper and coordinated its production and publication.

The opinions expressed are solely those of the authors and do not necessarily reflect the views of the International Monetary Fund or its Executive Directors.

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I Introduction

Member countries are routinely faced with a range of shocks that can contribute to higher volatility in aggregate output and, in extreme cases, to economic crises. The presence of such risks underlies a potential demand for mechanisms to soften the blow from adverse economic shocks. Such a protective infrastructure—which may, of course, have ancillary benefits that are not related to offering protection against the impact of adverse shocks—will be referred to in this paper as "country insurance." Protective measures that countries can take themselves ("self-insurance") include sound economic policies, robust financial structures, and adequate reserve coverage. Beyond self-insurance, countries have also established regional arrangements that pool risks while, at the multilateral level, the IMF has a central role in making its resources temporarily available to ease the costs of economic adjustment when shocks create balance of payments difficulties for a member country. In addition, the IMF, through the policy advice it provides under surveillance, has a key role in helping countries improve their own crisis-proofing armor.

This paper analyzes a number of mechanisms through which countries can self-insure, with particular focus on national balance sheets—including the roles of countries' external liability structures and self-insurance through reserves accumulation. As foreshadowed in the IMF Managing Director's medium-term strategy (see IMF, 2005a), separate staff papers are expected to address collective insurance arrangements—regional reserve pooling arrangements, and global arrangements using a possible new lending instrument to provide high-access contingent financing for countries that have strong macroeconomic policies, sustainable debt, and transparent reporting, but nevertheless remain vulnerable to shocks.[1]

The nature of the shocks that countries face—and for which they may seek insurance—is worthy of examination in its own right, because having a clear notion of which shocks are relatively frequent and costly—and for which members—is an essential step toward tailoring insurance solutions appropriately. For example, if terms of trade shocks or natural disasters are important for one group of countries, but sudden stops in financial flows are important for another, then appropriate insurance arrangements for them may well differ. Information on the structure of shocks (and their costs) for different countries is key in both tailoring policy advice on country insurance matters and drawing on regional or multilateral facilities to meet the diverse needs of member countries. Likewise, decisions about the appropriate or warranted level of official reserves for a country are likely to depend on the probability of facing different disturbances and the consequences of such shocks.

Against this background, our paper begins with an analysis of the frequency and economic costs of the most important shocks faced by different groups of member countries (mainly emerging market and developing countries). Output drops are found to be associated primarily with real shocks (notably terms of trade declines) in developing countries, while financial shocks (such as sudden stops) appear to play a lead role in emerging market countries. Although wars and episodes of political turmoil are relatively infrequent over the entire sample, they are extremely costly, particularly for developing countries, when they do occur.

Following the analysis of shocks, the paper considers some of the actions that member countries can take to self-insure. The major and long-lasting damage inflicted by currency, debt, and banking crises reemphasizes the role of sound macroeconomic policies and supporting institutions as a first line of defense. Beyond this, evidence outlined in the paper shows that sound policies may facilitate the issuance of long-term, domestic currency debt, with commensurately lower rollover and foreign exchange risk, and that longer-run reforms aimed at improving broad institutional quality may also foster increases in the share of equity-like liabilities (such as foreign direct investment (FDI)) in countries' external liability structures, thereby strengthening links between external payments and countries' ability to pay.

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[1]See IMF (2004, 2005a, and 2006 and, relatedly, a variety of other external and internal proposals on the Fund's possible role in providing country insurance, including Calomiris (1998), Cordella and Levy-Yeyati (2005), Council on Foreign Relations Task Force (1999), Krueger (2006), Meltzer (2005), Ostry and Zettelmeyer (2005), and Rajan (2006).

Underutilized private sector arrangements or financial instruments may also have a role to play in providing country insurance. Relevant examples include catastrophe bonds and insurance against natural disasters for smaller, disaster-prone countries; commodity price futures or other instruments aimed at hedging against commodity price fluctuations for countries with heavily concentrated production structures; and GDP growth-indexed bonds for a broader segment of the IMF membership. As with many types of financial innovation, issuance of new types of instruments would have a greater chance of success when undertaken by larger economies, which are more likely to provide the necessary critical mass for a deep and liquid secondary market, and by countries with transparent institutions and statistics—these are especially relevant to overcoming measurement challenges posed by growth-indexed bonds.

On the asset side, the main form of self-insurance is, of course, reserve holdings—a flexible and reliable form of insurance against a wide variety of shocks. Relatively high stocks of reserves are especially desirable for emerging market countries that are exposed to sudden stops in financial flows and, more generally, for countries facing large shocks that cannot be hedged using alternative instruments. In determining a desired level of reserves, countries need to trade off the financial costs of holding reserves against the consumption-smoothing benefits of having a ready stock of reserve assets. To help guide judgments about the desirable level of self-insurance through reserves, this paper develops an analytical framework that takes into account the costs of reserve holdings, their consumption-smoothing benefits, and the role of country fundamentals in determining the likelihood of crisis.

The framework yields a number of insights about the degree to which reserve accumulation in different regions is warranted by the fundamentals captured by the model. For example, although reserve buildups observed in Asian emerging markets since the early 1990s are assessed to have been initially commensurate with these countries' insurance needs, they appear more recently to have exceeded what could be justified on the basis of plausible changes in fundamentals. Further, although Latin American emerging markets seem to have been underinsured in the early 1990s, their reserves are now assessed as providing a broadly appropriate degree of self-insurance, given the fundamentals faced by these countries.

The remainder of this paper is organized as follows. Section II examines the nature and economic costs of various types of shock across different segments of the IMF's membership. Section III analyzes the roles of sound fundamentals and liability structures, especially in relation to the external capital structures of countries and their public debt management. Section IV turns to the asset side of countries' balance sheets and develops an analytical framework to help guide judgments about the desirable level of self-insurance to be obtained through accumulation of official reserves. Section V summarizes and concludes.

II Insurance Against What? Shocks and Their Costs

In analyzing the types of events that countries may wish to insure against, this paper will focus on drops in per capita GDP as a practical and widely available proxy for the economic costs that countries incur when adverse disturbances occur.[2] This approach requires a number of simplifications, such as abstracting from distributional effects. Nevertheless, drops in per capita GDP would seem to capture many empirically relevant features of welfare declines, as well as being a highly visible measure that the public and country authorities are worried about when they consider the costs of economic crises.

Definitions

The events analyzed are defined as starting in the first year of a decline in per capita GDP and ending when per capita GDP returns to its pre-event level. Yearly losses are measured relative to pre-event GDP per capita and are cumulated over the duration of the event. (See the shaded area in Figure 2.1.)[3] Two further conditions are imposed to filter out events that might result from measurement error or temporary growth spurts: (i) the duration of the event must be at least two years; and (ii) the total output loss must be at least 5

percent of pre-event per capita GDP. If an event is completely observed within the sample period, it is called a concluded event (Figure 2.1); this seems to correspond to the notion of a temporary, though costly crisis. The analysis also, however, includes ongoing events where per capita GDP has failed to recover to pre-event levels by the end of the sample period. Many ongoing events in the sample are extremely long lasting and associated with severe output losses and prolonged growth slowdowns. (Several of these started in the 1970s and 1980s and relate to emerging and developing countries that experienced major domestic crises in the wake of civil wars, oil price increases, interest rate hikes, or adverse terms of trade developments from which they had not fully recovered by the end of the sample period.)[4] Finally, a subevent is defined as a new event starting before the end of a previous event.

Empirical Features of Output Drops

Output events are more frequent, long-lasting, and costly for emerging market and developing countries than for advanced economies (Table 2.1).[5] On average, both emerging market and developing countries have output events starting about every 16 years (or approxi-

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Note: This section was prepared by Törbjörn Becker and Paolo Mauro.

[2]The main results—including on the relative importance of various shocks—hold using drops in either income or consumption per capita as the proxy for the economic costs of shocks (Becker and Mauro, 2006). Consumption drops and output events are closely associated in most countries, though the association is somewhat weaker for countries that are highly integrated into international financial markets. Closer proxies for income (such as GNP rather than GDP) might also be used but present greater difficulties with respect to data availability; in most cases, however, the differences are small.

[3]On the one hand, a potential concern is that this approach may produce a conservative measure of the cost of output events by abstracting from trend growth during the events. On the other hand, defining the start of events and associated costs with respect to pre-event GDP might lead to an overstatement of event cost if boom-bust cycles are prevalent. Conceivably, these two biases might offset one another. As a robustness check, an alternative approach is to define the start of an event as output falling relative to a (Hodrick-Prescott-filtered) trend, and to assess the end of the event and the associated loss relative to this trend: the main results are similar.

[4]To compute the duration and output loss associated with ongoing events (for which the end date is unknown), it is assumed that the event ends in the first year after the end of the sample period. This produces a lower bound on the durations and costs associated with these events.

[5]Throughout this paper, advanced countries are defined as in the IMF's World Economic Outlook (WEO) database, except for the Republic of Korea, which for the purpose of the empirical analysis is classified as emerging, rather than advanced, to capture the experience of its 1997–98 crisis; emerging market countries are countries included in either the (stock market–based) International Finance Corporation's Major Index (2005) or JPMorgan's EMBI Global Index (2005) (which consists of countries that issue bonds on international markets), excluding countries classified as advanced by the WEO; remaining countries are classified as developing. The exact sample varies depending on data availability for each exercise. Real GDP is measured in purchasing power parity (PPP)-adjusted dollars. The end of the sample period (2001) is determined by the availability of comparable data. All results are similar using an alternative classification of countries according to their level of financial development (high, intermediate, or low). Data sources and definitions are reported in Appendix I.

Figure 2.1. A "Concluded" Output Event
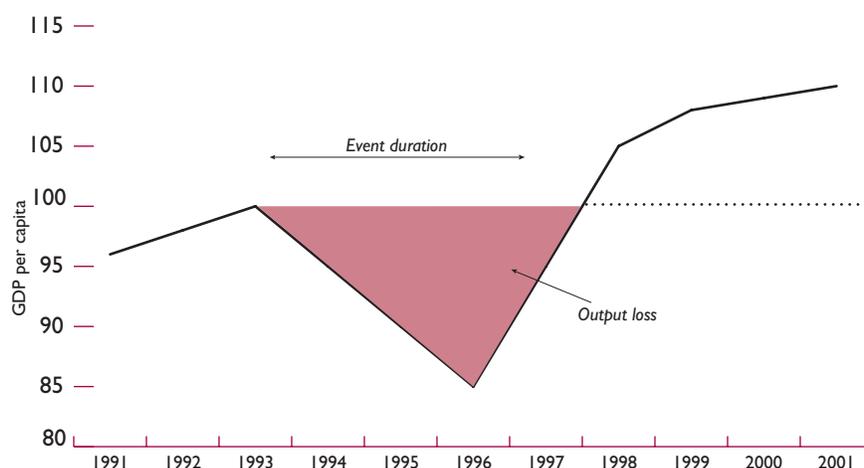
Note: The shaded area is the cumulative output loss, and the event duration in this example is four years.

mately twice during the three decades considered in the sample period); the events last for six years in emerging markets and twice as long in developing countries. The median cumulative output loss over the event (for

Table 2.1. Output Events: Frequency, Duration, and Loss, 1970–2001

	Advanced Economies	Emerging Markets	Developing Countries
(in percent of country-years)			
Sample frequency			
All	1.9	6.5	6.7
Concluded	1.5	3.0	2.3
(in years)			
Median duration			
All	4	6	12
Concluded	5	5	5
(in percent of pre-event GDP per capita)			
Median cumulative loss			
All	15	41	89
Concluded	13	15	38

Sources: Maddison (2003); and IMF staff calculations.

Notes: "All" events include concluded, ongoing, and subevents. Concluded events are fully observed within the sample period, whereas ongoing events had not ended by 2001 and the duration and loss for these events are calculated assuming that the events ended in 2002. Subevents are new events that start before the previous event has ended.

concluded events) is equivalent to 15 and 38 percentage points of GDP for emerging markets and developing countries, respectively. (To illustrate, a total cumulative output loss of 15 percentage points of GDP per capita would correspond to the hypothetical case of a country whose output per capita fell by 5 percentage points, remained stable for 3 years, and then jumped back up to its initial level.) For both emerging markets and developing countries, the frequency, duration, and especially median loss of concluded output events is significantly lower than for all events. Output losses are two to three times larger (for any type of event) in developing countries than they are in emerging markets.[6]

Taxonomy of Shocks and Their Cost

A systematic analysis of the types of shock that are associated with output drops may help countries prioritize among different forms of country insurance. The shocks analyzed here include the following:[7]

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[6]Furthermore, the relative impact on consumption is exacerbated by the degree of economic and financial development: for a given output decline, consumption falls more in developing countries than in emerging markets. This may reflect either liquidity constraints or the events' more pronounced impact on permanent income in developing countries.

[7]Volatility owing to abrupt changes in aid flows, an important issue for developing countries, is not considered; but see Bulíř and Hamann (2003) and Gelb and Eifert (2005). For data sources and definitions of shocks, see Appendix I.

Table 2.2. Frequencies and Cost of Shocks
(Based on concluded output events, 1970–2001)

	Unconditional Frequency of Shocks			Frequency of Output Event Conditional on Shocks			Cumulative Output Loss Conditional on Shocks		
	Advanced economies	Emerging markets	Developing countries	Advanced economies	Emerging markets	Developing countries	Advanced economies	Emerging markets	Developing countries
	(in percent of country-years)			*(in percent)*			*(in percent of pre-event GDP per capita)*		
Financial and macroeconomic shocks									
Currency crisis	2.6	9.1	6.5	4.8	7.6	0.7	6	56	...
Banking crisis	12.5	5.7	4.6	0.0	5.4	0.0	...	10	...
Debt crisis	0.0	3.8	1.6	...	9.3	0.0	...	56	...
Sudden stop in capital flows	5.5	11.5	15.1	3.2	9.3	1.6	7	76	10
Country-specific external shocks									
Terms of trade shock	5.7	14.3	21.4	2.2	7.3	2.9	27	14	64
Disaster	0.6	2.1	3.2	0.0	4.2	2.3	...	41	10
Sociopolitical									
War	2.1	3.2	3.1	0.0	10.8	3.7	...	8	24
Political shock	0.4	3.0	3.4	...	5.7	5.4	...	...	55
Global shocks									
Global interest rate hike	12.5	12.5	12.5	1.0	2.8	2.4	6	19	41
Oil price hike	12.5	12.5	12.5	0.0	1.4	2.1	...	...	38
End of booms									
End of lending boom	2.1	3.6	3.5	0.0	...	0.0	...	...	...
End of growth boom	0.4	1.1	1.3	...	0.0	8.8	...	...	24

Source: IMF staff calculations based on GDP data from Maddison (2003).

Notes: The dates for currency, banking, and debt crises, as well as lending booms, are based on existing studies. (See Appendix I.) Sudden stops in financial flows are defined as a 5 percentage point of GDP decline in financial flows, drawn from the IMF's International Financial Statistics database. Terms of trade shocks are defined as a 10 percent worsening in the terms of trade of goods, drawn from the IMF's World Economic Outlook (WEO) database. The dates of disasters, wars, and political shocks are from the Center for Research on the Epidemiology of Disasters (CRED) *(http://www.em-dat.net),* Correlates of War *(http://www.correlatesofwar.com),* and Marshall and Jaggers (2002), respectively. The global interest rate shock is defined as an increase in the U.S. federal funds rate by more than 150 basis points in one year. The dates of the oil shocks are from IMF (2003). The three columns report how often the various types of shock occur, how often the occurrence of a given type of shock leads to an output decline, and the median output losses for output events associated with each type of shock. Median (rather than average) output losses are used to reduce sensitivity to outliers. Missing values indicate that the frequency of output event is based on fewer than five occurrences of the relevant type of shock, or that the median loss is based on fewer than five concluded output events (associated with the given type of shock for the relevant group of countries).

- *financial and macroeconomic*—currency crises, banking crises, debt crises, and sudden stops in financial flows;[8]
- *country-specific external*—terms of trade shocks and disasters;
- *sociopolitical*—wars and political turbulence;

- *global*—large increases in international interest rates and oil prices; and
- *boom-bust cycles*—the end of lending booms and growth booms.[9]

Two simplifying assumptions bear highlighting. First, the analysis does not address the causes of shocks; in particular, it does not ask whether shocks cause declines in output rather than the other way around. (Inspection of WEO forecasts for 1990–2001, however, suggests that output events have been largely unexpected.) Second, the analysis does not seek to separate the effects of individual shocks for those events that are associated with more than one shock. (One-third of output events are associated with more than one shock; for example, various types of finan-

[8]The present study defines a sudden stop as a worsening in the financial account balance by more than 5 percentage points of GDP compared with the previous year, though the main results hold using alternative numerical thresholds. Should sudden stops be attributed to volatile supply of international flows to emerging markets, or are they caused by worsening expectations regarding a country's economic performance? Although this question cannot be answered definitively, the list of sudden stops seems to include few, if any, instances in which the stop was clearly triggered by worsening growth expectations. For the 1990s, this was confirmed by analyzing quarterly data on financial flows, identifying the first quarter when the sudden stop began, and checking that the immediately preceding *World Economic Outlook* did not forecast a slowdown in economic growth for the country in question.

[9]The end of a lending or growth boom may fail to fit the usual definition of a shock; nevertheless, this type of episode is included in the analysis to capture output declines that might be part of a boom-bust cycle.

Figure 2.2. Expected Cost of Shocks
(In percent of pre-event GDP per capita)

Notes: The expected cost of a given shock is the expected annual loss of output associated with each type of shock. It equals the unconditional probability of the shock (left panel of Table 2.2), times the probability of an output event given the shock (middle panel), times the median cost of the event when it occurs (right panel). The large differences in expected costs between the two panels of this figure, especially for developing countries, reflect costly ongoing events, including very long-lasting events.

cial crises—currency, debt, or banking crises, or sudden stops—often occur in combination.) Moreover, the frequency and nature of the shocks may result from underlying factors—including domestic policies and institutions. Nevertheless, the associations between shocks and output drops may provide a useful gauge of the relative importance of the various types of shock for different country groups, which may help countries to find strategies for mitigating output costs through country insurance.

The importance of a given type of shock may be summarized by the expected cost of the shock or, equivalently (for cases where insurance arrangements might be conceivable), the ex ante value of insurance (analogous to the value a risk-neutral homeowner would attach to fire insurance). Three inputs are needed, and

are estimated on the basis of observed frequencies in 1970–2001 (Table 2.2): (i) the probability of the shock (how often a fire starts), (ii) the conditional probability that the shock will lead to a loss in output (the likelihood the house will burn down if a fire starts), and (iii) the output cost associated with the event (the cost of rebuilding the house).[10]

Combining these three components (Table 2.2), the expected cost seems to be substantial for several types of shock (Figure 2.2).[11] For emerging markets, the largest expected cost is for financial and macroeconomic

shocks—especially sudden stops (¾ of 1 percent of GDP per capita annually based on concluded events) and currency crises. For developing countries, terms of trade shocks are the most costly (amounting to 2½ percent of per capita GDP annually when concluded and ongoing events are considered), followed by debt crises and global interest rate hikes. The expected cost refers to the impact of one type of shock (regardless of whether it occurs in combination with other shocks). Thus, for example, for emerging markets, the expected cost is 1 percentage point of GDP for currency crises and 0.8 percentage points of GDP for debt crises, but the expected cost of both shocks would be less than 1.8 percentage points of GDP, because some part of the cost is double counted when currency and debt crises occur simultaneously.

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[10]The expected cost will be substantially lower than the ex post cost of observed output events, because the relevant probabilities are much lower than one.

[11]Figure 2.2 is based on contemporaneous correlations between shocks and output events. Similar results are obtained using lagged shocks. The figure omits advanced countries, because the value of insurance for this segment appears to be very low. This may be due to a better diversified production structure or more resilient financial systems and institutions. An additional factor, however, may be

the focus on types of shock that seem to be more relevant for emerging and developing countries.

III Sound Fundamentals and Liability Structures

It is generally recognized that countries can self-insure significantly against shocks through their own policies and institutions. Beyond prudent macroeconomic policies, resilience to shocks can be fostered through measures and reforms aimed at increasing flexibility in the exchange rate regime (Mussa and others, 2000; Rogoff and others, 2004), openness in the financial account (which may help cushion consumption and investment from the impact of output shocks, though it may also bring volatilities of its own, at least in the short run—see Prasad and others, 2003), and goods and labor market flexibility. Reducing constraints on the ability of entrepreneurs to shift resources across sectors might also foster resilience by enhancing sectoral diversification, though there are, of course, trade-offs between the gains from specialization and the benefits from greater output stability.[12] This section, however, will focus on a specific aspect of sound fundamentals, namely the role of countries' external liability structures in fostering international risk sharing of the costs of adverse shocks, and the role of sound policies and institutions in promoting structures that can better meet countries' insurance needs.

External Capital Structure of Countries

The composition of a country's external liabilities (that is, the shares of foreign direct investment, portfolio equity, and external debt in its external finance) is often held to be an important determinant of the risk of crisis and the economic costs countries incur when they experience a crisis. Two types of argument are put forward to support this view.

First, the payments associated with some types of external liabilities have desirable cyclical properties. For example, with equity-like forms of finance such as portfolio equity or FDI, payments are lower when economic performance is worse. Equity finance thus makes it possible for domestic producers to share risk with foreign investors, which helps to stabilize domestic consumption and improves domestic producers' ability to undertake projects with higher risk and expected return. Indeed, it has been argued that emerging market countries should adopt a less debt-intensive structure of external finance (Rogoff, 1999).

Second, some forms of flows behave in a more desirable manner during a crisis than others. For example, liquidity crises have often been triggered by sudden stops in debt flows, rather than flows of equity-like forms of finance. More generally, foreign direct investment has traditionally been viewed as more stable than portfolio financial flows.

The analysis in this paper offers broad support for the conventional wisdom about the external capital structures of countries during sudden stops:

- An analysis of 33 sudden stop episodes using annual data over the period since 1980 suggests that FDI has played essentially no role in financial flow reversals (Figure 3.1). This result is robust to alternative thresholds for defining sudden stops and also holds using quarterly data for all emerging market countries in a specific analysis of reversals during the Russia/Long Term Capital Management (LTCM) crisis.
- Portfolio equity also seems to play a limited role in sudden stops. Portfolio debt plays a more prominent role, though it recovers relatively quickly.
- Bank lending flows and official flows experience severe drops and remain depressed for several years after sudden stops.

Although the results mentioned previously underscore a protective role of FDI and equity flows during sudden stops, the relative stability of FDI also appears to hold more generally over the entire sample (including during noncrisis times). For emerging and developing countries, Table A2.2 (in Appendix II) suggests a clear ranking in volatility measures (taking into account the size of flows) from FDI and portfolio equity flows (low), to portfolio debt and official flows (medium), to bank flows (high). Moving beyond volatility measures, and perhaps in contrast with conventional wisdom, comovement across countries does

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Note: This section was prepared by Paolo Mauro.

[12]Some benefits of real sector diversification might be achievable through the financial system—for example, by holding foreign equities or engaging in total return swaps between governments or private entities of countries with different production structures—a proposal associated with Nobel laureate Robert C. Merton.

Figure 3.1. Composition of Financial Flows Around All Sudden Stops, 1980–2004

(In percentage points of GDP)
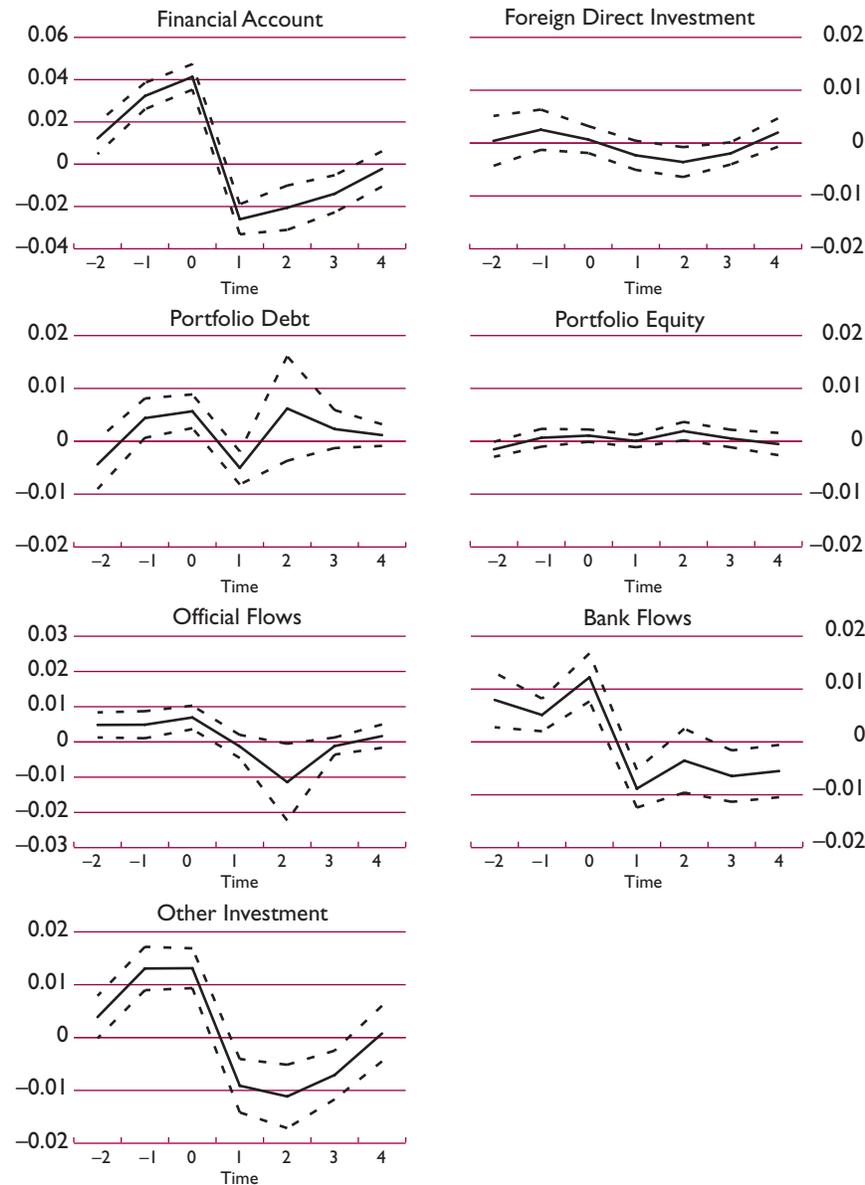
Source: IMF, Balance of Payments Statistics database.

Notes: The behavior of different types of flows is illustrated in sudden-stop time, with *t*=1 being the year the sudden stop occurred. The solid line represents the average across episodes for each type of financial flow. The dotted lines are one-standard-error bands. Sudden stops are reversals in the financial account by more than 5 percentage points of GDP. The sample is restricted to instances in which all six subcomponents of the financial account are available for at least a five-year period around the sudden-stop year. The sample consists of 33 episodes: Argentina (2001); Barbados (1992, 2002); Brazil (1983); Chile (1991); Côte d'Ivoire (1983, 1996), Croatia (1998); the Czech Republic (1996); Estonia (1998); the Republic of Korea (1997); Latvia (2000); Lithuania (1999); Mauritius (2001); Mexico (1995); Namibia (1991, 1999); Panama (2000); Peru (1998); the Philippines (1997); the Russian Federation (1998); Senegal (1982); Slovenia (1998); Swaziland (1993); Thailand (1982, 1997); Togo (1992); Turkey (1994, 2001); Ukraine (1998); and República Bolivariana de Venezuela (1980, 1989, 2002). For each type of financial flow, the entire available sample of countries and years is first regressed on a full set of country and year fixed effects to remove country-specific means and global trends from the data.

not seem to be more pronounced for portfolio flows or bank flows (often viewed as a channel of contagion) than for FDI. Differences across financial flows with respect to other features—such as persistence, procyclicality, or responsiveness to Group of Seven (G-7) growth or U.S. interest rates—are also not particularly striking. Against this background, a key issue is what factors help to explain the external liability structures observed in particular countries. Although the empirical evidence is not extensive, results based on a cross section of emerging market and developing countries suggest that equity-like liabilities (foreign direct investment and, especially, portfolio equity) as a share of total external liabilities (or GDP) are positively and significantly associated with indicators of educational attainment and, especially, institutional quality (Faria and Mauro, 2004).[13] Thus, by improving institutional quality, countries may be able to secure a beneficial impact on their national external liabil-

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[13]The Institutional Quality Index used in the estimation is the simple average of the Kaufmann, Kraay, and Mastruzzi (2003) indicators of voice and accountability; political stability and absence of violence; government effectiveness; regulatory quality; rule of law; and control of corruption. The results are robust to variations in how the index is computed. A recent firm-level analysis of corporate balance sheets in a panel of countries has also found an important effect of institutional quality on domestic financial structures, including debt-equity ratios and the ratio of short-term debt in total debt (Fan, Titman, and Twite, 2003).

ity structures, though the effect is likely to be gradual owing to the persistence of institutional quality through time (IMF, 2005b; and Johnson, Ostry, and Subramanian, 2006).

Public Debt Management and Debt Structure

In spite of the desirability of equity-like instruments, debt will undoubtedly remain an important component of the capital structures of emerging market countries. The insurance perspective suggests that—for a given cost of borrowing—debt managers should seek to induce as high a correlation as possible between debt-service costs and the borrower's ability to repay. A previous study (Borensztein and others, 2004) suggested that this objective could be pursued by (i) developing domestic debt markets so as to allow borrowers to extend maturities and to issue debt denominated in domestic currencies; and (ii) denominating international debt in the domestic currency or indexing it to real variables, such as economic growth. More specifically,

- Credibility of fiscal and monetary policies is a key prerequisite for investors' willingness to hold long-term local currency bonds. Credibility, in turn, depends on both the quality of institutions and a reputation for sound policymaking. This is reflected

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Box 3.2. Argentina's GDP-Linked Securities[1]

In Argentina's recent global debt restructuring, GDP-linked securities were included in the package of new bonds issued to creditors participating in the exchange. The warrants were intended to add value to the exchange offer by providing creditors with the potential to benefit from Argentina's future economic growth while ensuring that the additional payments could be met by available resources. In settling its exchange on June 10, 2005, Argentina issued 11 new bonds, each with a detachable GDP-linked security. For each US$1 of defaulted debt tendered and accepted in the exchange, creditors received new restructured bonds and one unit of a GDP-linked security.

This was the largest operation to date involving the issuance of financial instruments indexed to economic growth. Following the conclusion of the exchange, a forward market for trading GDP-linked securities in isolation emerged, with market participants placing a higher value on the securities, partly reflecting a more favorable forecast of medium-term growth. The forward market was thin, however. Market activity picked up considerably after the GDP-linked securities were detached and began trading independently on November 30, 2005. At that time, total market capitalization amounted to US$2.9 billion. Subsequent upward revisions to growth expectations have led prices approximately to double—to 9.3 cents per dollar of notional value in mid-April 2006—with total market capitalization reaching US$5.8 billion.

Payments on the GDP-linked securities are contingent on Argentina's economic performance. The securities will pay holders only if both the level and growth of GDP exceed a specified threshold in the relevant reference year, beginning in 2005 and ending in 2034. In addition, the sum of payments that can be received during the life of the security cannot be higher than 48 percent of its notional value. Payments will be made on December 15 of each year following the relevant reference year. The first payment, of about 0.2 percent of GDP, is expected to be made on December 15, 2006.

As the GDP-linked securities were attached to their underlying bonds at the time of the debt exchange, it was difficult to separate the valuation of each item. The value of the restructuring offer was priced by market participants in the range of 34–35 cents per dollar of principal claims. Market analysts at that time estimated the theoretical value of the GDP-linked securities to be about 4 points (cents per dollar of notional value) but recommended adopting a conservative approach and valuing the GDP-linked securities at half the estimated theoretical value. The conservative approach reflected a host of factors that are hard to quantify, including the novelty of the instrument and other possible obstacles; these are analyzed in Borensztein and others (2004).

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[1]This box was prepared by Marcos Chamon and Cheng-Hoon Lim.

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in the differences in debt structures among emerging markets. For example, the share of foreign currency–denominated or indexed debt is far higher in Latin America than in Asia, and this may reflect, at least in part, the regions' different inflation histories (Figure 3.2). Building credibility in this area can take years, but a combination of macroeconomic stabilization and institutional reforms has, in practice, helped to accelerate this process. Countries that curbed inflation and committed themselves to macroeconomic stability through reforms, such as the establishment of central bank independence or inflation-targeting regimes; adopted pension reforms that widened the domestic investor base; and used inflation-indexed bonds in the transition toward a lengthened maturity structure of the debt have seen a payoff in their debt structures.[14]

- Debt instruments with equity-like features, which provide for lower payments in the event of adverse shocks and weak economic performance, could help sovereigns to improve debt sustainability and international risk sharing. In particular, growth-indexed bonds would likely provide substantial insurance benefits to a broad range of countries, though they present a number of implementation challenges (Borensztein and Mauro, 2004; and Borensztein and others, 2004).[15]

These considerations may have underpinned a number of developments in emerging market country debt structures in recent years, including the following:

- _Greater reliance on long-term, domestic currency debt by a number of emerging market issuers._ Domestic currency bonds have become more attractive for nonresidents, owing in part to the development of local emerging market indices (IMF, 2005c, Chapter 2). In addition, a number of emerging market sovereigns have issued domestic currency debt on international markets.[16] And the share of long-term, domestic currency debt issued on domestic markets has recently increased somewhat, though with considerable variation across regions (Figure 3.3).

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[14]These results are corroborated in a new dataset on the structure of government debt in emerging market countries (Guscina and Jeanne, 2006).

[15]Chamon and Mauro (2006) provide a simple framework to price growth-indexed bonds.

[16]Examples include Uruguay in 2003 and 2004, Colombia in 2004, and Brazil in 2005. In addition, private entities have issued global bonds denominated in or indexed to the local currencies in Mexico and Brazil.

**Figure 3.2. Emerging Market Economies: Central Government
Domestic Debt Composition, 1980–2004**

(In percent of total central government domestic debt)

Asia

Latin America

■ *Short-term*   ■ *Medium-term*   ■ *Long-term*

Domestic currency fixed interest rate

Domestic currency floating interest rate

Foreign currency fixed interest rate

Foreign currency floating interest rate

Indexed fixed interest rate

Indexed floating interest rate
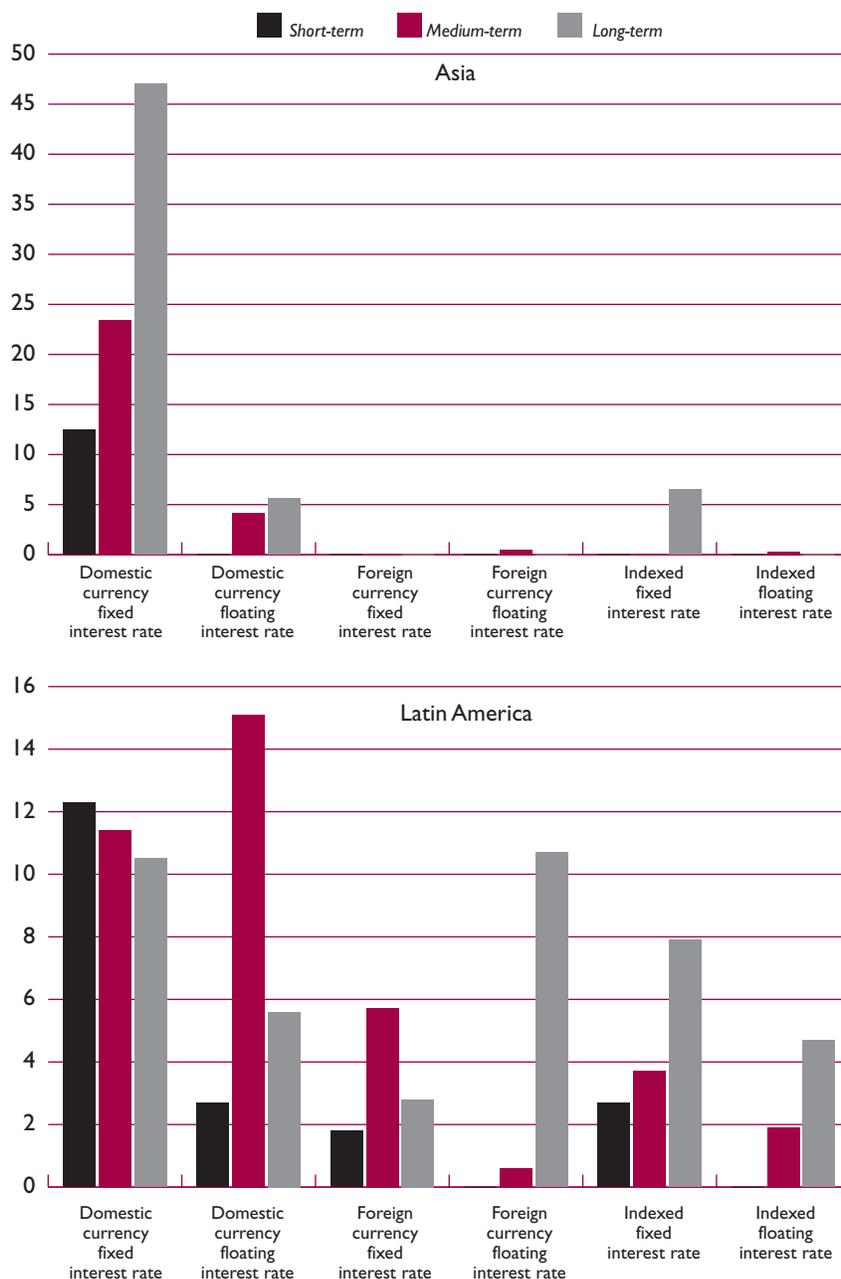
Source: Guscina and Jeanne (2006).

Notes: Short-term debt has a maturity of less than one year; medium-term debt has a maturity of between one and five years; and long-term debt has a maturity of more than five years. The data are simple averages across countries for 1980–2004. Asian economies include China, India, Indonesia, the Republic of Korea, Malaysia, the Philippines, and Thailand. Latin American economies include Argentina, Brazil, Chile, Colombia, Mexico, and República Bolivariana de Venezuela. Indexed debt involves indexation to consumer prices (or, rarely, commodity prices) and may apply to principal or coupon payments. Floating-interest-rate debt involves indexation to short-term or foreign interest rates.

Figure 3.3. Emerging Market Economies: Shares of Long-Term and Medium-Term Fixed-Rate Domestic Currency Debt, 1990–2003
(In percent of total central government domestic debt)
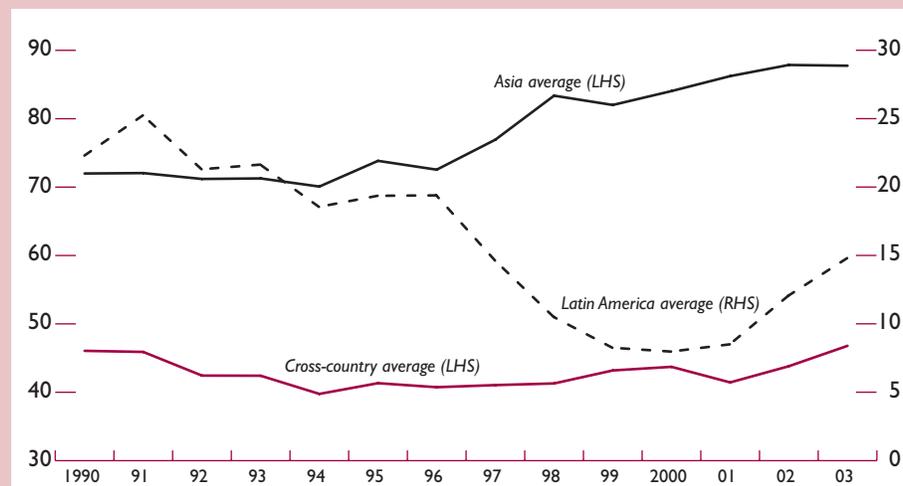
Source: Guscina and Jeanne (2006).
   Notes: The sample includes emerging economies in Latin America (Argentina, Brazil, Chile, Colombia, Mexico, and República Bolivariana de Venezuela), Asia (China, India, the Republic of Korea, Malaysia, the Philippines, and Thailand), and other regions (Israel and Turkey). The share of long-term and medium-term fixed-rate domestic currency debt is far higher in Asia (left-hand scale) than it is in Latin America (right-hand scale). LHS denotes left-hand scale, and RHS denotes right-hand scale.

- *Asian Bond Market Initiative.* The establishment of a set of Asian Bond Funds has sought to foster the development of government bond markets in the domestic currencies of a number of East Asian countries (Box 3.1). This is aimed in part at reducing countries' exposures to maturity and exchange rate risks as well as sudden stops.
- *Use of GDP warrants in Argentine debt exchange of early 2005.* This is by far the largest issue of growth-indexed instruments to date, for a total mar-

ket capitalization estimated at US$5.8 billion in mid-April 2006 (Box 3.2).

   On the whole, these developments may be viewed as representing a gradual move toward greater reliance on long-term domestic currency debt and greater use of innovative forms of financing, such as growth-indexed instruments. Although this is encouraging, countries' liability structures are unlikely to have evolved sufficiently rapidly to obviate the need for other forms of self-insurance against sudden stops and other shocks.

IV Self-Insurance Through International Reserves

On the asset side of countries' external balance sheets, international reserves constitute the main form of self-insurance against damaging crises, partly because of the speed and ease with which they can be used in a period of balance of payments pressure and partly because of their role in underpinning the credibility of the monetary and exchange regime, such as to help ward off external pressures and currency crises. Reserves are costly to hold, however, because they yield a return that is generally lower than the interest rate that the authorities must offer on their debt. The authorities must therefore strike a balance between the cost of reserves in noncrisis times and their benefits in crisis times.

Trends in Reserve Accumulation, and Benefits and Costs of Reserve Holdings

Total international reserves in the world economy have more than tripled since 1990, partly reflecting the rapid deepening in trade and financial integration (IMF, 2003; and Flood and Marion, 2002). The increase has been particularly pronounced in Asian emerging economies, whose share of global reserves increased by more than 20 percentage points between 1990 and 2005 (Figures 4.1 and 4.2).[17]

The causes of rapid reserve accumulation have been the subject of fervent debate—for example, regarding whether accumulation in Asia reflects a desire to keep exchange rate stability in the face of significant current and financial account inflows, rather than crisis-prevention efforts (Dooley, Folkerts-Landau, and Garber, 2004; Goldstein, 2004; and Genberg and others, 2005). An analytical framework to gauge the benefits and costs of international reserves would thus seem

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Note: This section was prepared by Olivier Jeanne and Romain Rancière.

[17]Considering the ratio of reserves to M2 (a measure of the country's ability to withstand a sudden shift in demand from local currency to foreign currency), Latin America displays the highest ratio, as might be expected in light of widespread de facto dollarization in several countries, but the smallest increase. Of the 34 emerging economies in the sample, 7 are defined as highly dollarized by Honohan and Shi (2002); of these, 5 are located in Latin America.

Figure 4.1. International Reserves, by Country Group, 1990–2005

Foreign Exchange Reserves
(Billion U.S. dollars)

Other emerging and developing
Emerging Asia
Advanced economies

Share of Global Reserves
(Percent of global reserves)

1990
2000
2005

Advanced economies — Emerging Asia — Other emerging and developing

Source: IMF, International Financial Statistics database.
Note: Data for 2005 refer to stocks at the end of the second quarter of 2005.

Figure 4.2. International Reserve Ratios, by Country Group, 1990–2005

······ *Advanced economies* ── *Emerging Asia* ── *Emerging Latin America* - - *Emerging others* - - *Developing*

Sources: IMF, International Financial Statistics (IFS) and World Economic Outlook (WEO) databases; and World Bank, World Development Indicators database.

Notes: Data for 2005 refer to the end of the second quarter for the stocks of reserves and M2, and to WEO projections for GDP and imports. "Emerging others" includes emerging market economies in Eastern Europe, the Middle East, and Africa. For each country group, the data refer to unweighted cross-country averages. For the developing countries, reserves as a share of M2 and reserves as a share of short-term debt are medians to avoid undue influence of outliers.

helpful for shedding light on recent developments as well as giving policy guidance. This subsection reports results based on a calibrated model for emerging market countries (Jeanne and Rancière, 2006). The model focuses on an open economy that is hit by financial flow reversals, which, in turn, lead to falls in output. The optimal level of reserves in the model equates the opportunity cost of holding foreign reserves with the marginal benefit from being able to smooth domestic consumption in the event of a sudden stop.

Benefits

From an insurance perspective, countries hold reserves to achieve a range of objectives, whose rela-

tive importance depends on several factors, such as the exchange rate regime and the degree of integration into international financial markets. Such objectives include limiting volatility in the exchange rate; providing liquidity to the foreign exchange market, thus making a floating exchange rate regime more efficient; buffering the domestic economy against shocks to the balance of payments; and providing liquidity to the domestic financial markets and the banking sector, especially if there is significant dollarization (Jeanne and Wyplosz, 2003).

With countries' increasing international financial integration, considerations regarding reserve adequacy have shifted from an emphasis on trade (traditionally associated with the "three-months-of-imports" rule)

to the financial account and balance-sheet fragilities (associated with the Greenspan-Guidotti rule, according to which reserves should cover short-term debt).[18] Indeed, if one considers a sample of 33 middle-income countries during 1980–2003, 31 out of 40 episodes in which reserves decreased by more than 10 percentage points of GDP are associated with a sudden stop, a currency crisis, or a banking crisis.[19]

Reserves have played an important role in cushioning domestic absorption (that is, consumption and investment) during financial account reversals. The typical sudden stop—which sees average net inflows of 5 percent of GDP (in the year prior to the stop) turn to net outflows of 4 percent of GDP (in the year of the stop)—is accompanied by a large drop in reserves (by 4 percentage points of GDP). This drop helps to hold the observed fall in domestic absorption to 2½ percentage points of GDP, which is much smaller than the counterfactual fall in domestic absorption (6½ percentage points of GDP) that would have been observed if reserves had been held constant during each episode.

It has also been argued that reserves help reduce the likelihood of crises, including by discouraging speculation against the domestic currency; making it easier for the public and private sectors to roll over their foreign currency debt; and instilling confidence in the domestic financial sector. Empirical evidence on these benefits is mixed, owing in part to methodological difficulties. An increase in the ratio of reserves to short-term debt has been found to be associated with a lower probability of a currency crisis or sudden stop (Bussière and Mulder, 1999; and Garcia and Soto, 2006).[20] However, the robustness of this finding has been questioned out of sample (Berg, Borensztein, and Pattillo, 2004) and because of reverse causality (Detragiache and Spilimbergo, 2001).

Costs

The cost of holding reserves is usually measured as the difference between the return on short-term foreign currency assets and the return on more profitable alternative investment opportunities. The simplicity of this approach, however, masks thorny questions regarding the appropriate definition of alternative investment opportunities, which have traditionally been interpreted as the repayment of foreign debt (Frenkel and Jovanovic, 1981; and Flood and Marion, 2002) or higher-yielding investment opportunities in the domestic business sector or public infrastructure (Ben-Bassat and Gottlieb, 1992; and Hauner, 2005).

Even following the traditional approach based on the opportunity cost of repaying long-term foreign debt, plausible arguments can be made both in favor of and against using only some subcomponents of the yield on bonds issued by an emerging market country. The full yield can be thought of as the sum of four components: (i) the short-term rate on U.S. treasury bonds, (ii) the term premium—the difference between long-term and short-term U.S. interest rates, (iii) the default premium, and (iv) the risk premium owing to a possible correlation between the tendency for defaults and the global cycle or global asset prices. Although in practice the default premium and the risk premium cannot be observed separately, they are conceptually distinct and may need to be treated differently. There is some evidence to suggest that the risk premium is small, because there is essentially no relationship between emerging market defaults and the "world market portfolio" held by international investors (Borensztein and Mauro, 2004). However, to the extent that investor classes are segmented, and investors specialize in emerging market bonds and other assets that comove strongly with them, the risk premium could be significant. Regarding the default premium, one could argue that it should be excluded on the grounds that, on average, it is a fair reflection of the probability of nonrepayment. At the same time, country authorities that have no intention of defaulting will likely include the default premium when computing the cost of holding reserves. Given the size and variation of the default premium across countries and over time, the choice of whether or not to include it has important implications for the results, as is discussed later on. The opportunity cost of holding reserves is thus estimated using two variants: (a) the U.S. term premium—that is, the difference between long and short rates excluding the default and risk premiums—which is the baseline in this paper; and (b) the full difference between emerging market yields and U.S. short-term treasury bonds.[21]

On average, the total cost of holding reserves was substantially lower in Latin America than in Asia in 2001–2005 (ranging between 0.2 and 0.4 percentage points of GDP in the former and 0.3–0.8 percentage points of GDP in the latter) using the term premium (Table 4.1). The cost was, however, relatively similar in the two regions using the term premium *plus* the spread (ranging between 1.0–1.6 percentage points of GDP in Latin America and 0.7–1.2 percentage points of GDP in Asia). This is explained by the fact that although,

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[18]The operational implications of this greater emphasis on balance-sheet considerations are further analyzed in Mulder (2000) and IMF (2000 and 2001).

[19]Banking and currency crises are drawn from Caprio and Klingebiel (2003) and Ghosh, Gulde, and Wolf (2002), respectively.

[20]A higher level of reserves has also been found to reduce the portion of exchange rate volatility that is unrelated to macroeconomic fundamentals (Hviding, Nowak, and Ricci, 2005).

[21]The analysis considers the ex ante cost of holding foreign reserves and thus, in light of the unpredictability of exchange rates, abstracts from exchange rate gains or losses, even though these can turn out, ex post, to have been substantial (Hauner, 2005).

Table 4.1. Cost of Reserves in Emerging Market Countries, 2001–2005

	2001	2002	2003	2004	2005
Reserves/GDP *(in percent)*					
Latin America	12.1	11.6	12.5	13.5	14.0
Asia	21.2	22.6	25.3	28.9	29.1
Others	17.5	20.0	21.3	21.8	21.3
Cost of reserves *(in percent of GDP)*					
based on term premium					
Latin America	0.2	0.3	0.4	0.4	0.2
Asia	0.3	0.7	0.8	0.8	0.3
Others	0.3	0.6	0.6	0.7	0.3
Cost of reserves *(in percent of GDP)*					
based on term premium + sovereign spread					
Latin America	1.0	1.6	1.4	1.4	0.8
Asia	0.9	1.1	1.2	1.2	0.7
Others	1.1	1.5	1.2	1.0	0.5

Sources: IMF, International Financial Statistics and World Economic Outlook databases; and JPMorgan.

Notes: The cost of reserves is computed as the stock of reserves times either the term premium (the differential between the yields on 10-year and 3-month U.S. treasuries) or the term premium *plus* the EMBIG spread. All regional averages are unweighted.

on average, the reserves/GDP ratio is twice as high for Asian countries as for Latin American countries, the sovereign spread is substantially higher in Latin America than in Asia. The cost of holding reserves has increased moderately for emerging market countries over the past few years, as the impact of reserve accumulation has been partly offset by a reduction in sovereign spreads.

Although the previous analysis assumes that reserves are held in liquid assets such as short-term, fixed-income instruments issued by the major advanced countries, the cost of holding reserves might be reduced by investing in longer-term, higher-yielding foreign assets (Genberg and others, 2005). For the specific case of economies experiencing large financial inflows and accumulating substantial reserve stocks, a related idea is to use these favorable external circumstances to make gradual progress toward financial account liberalization, with a portion of financial inflows being securitized through closed-end mutual funds that issue shares in domestic currency and use the proceeds to purchase foreign exchange from the central bank and then invest abroad (Prasad and Rajan, 2005). This would eliminate the fiscal costs of sterilizing inflows, give domestic investors opportunities for international diversification, stimulate the development of domestic financial markets, and allow central banks to control both the timing and quantity of outflows.

Another way of reducing the cost of self-insurance through reserves may be to hold assets that provide liquidity at the time when countries most need it, thus obviating the need to hoard large amounts of reserves in noncrisis times. For example, a commodity exporter might hold instruments whose return is inversely related to the price of its main exports; or an emerging market country could hold instruments that provide liquidity when international liquidity conditions are tight. One possibility would be for the central bank's portfolio to include instruments whose payoff is positively related to the implied volatility index on the S&P 500—the so-called VIX, which has displayed an empirical association with recent sudden-stops episodes. Such a proposal—advanced by Caballero and Panageas (2004 and 2005)—is summarized in Box 4.1.

Framework for Assessing Optimal Level of Reserves

While it has been recognized that the benefits of reserves are multifaceted, reserve adequacy has traditionally been assessed using rules of thumb based on ratios of reserves to imports or, reflecting greater international financial integration, to short-term debt. Although these provide useful guidance, they lack fully developed analytical foundations. The remainder of this section seeks to fill this gap by developing an analytical framework that may be useful for making judgments about the level of reserves that is warranted by a country's particular fundamentals. The analysis focuses on the role of reserves as self-insurance against vulnerabilities resulting from changes in the financial

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Box 4.1. State-Contingent Reserves Based on Volatility Index

Given the cost of holding reserves, a strategy that made it possible to have reserves available only when they are needed would yield considerable savings. With that goal in mind, a hedging approach for the management of international reserves based on the use of contingent securities has been proposed by Caballero and Panageas (2004 and 2005). The authors suggest that a central bank would find it optimal to invest part of its reserves in contingent securities that provide a return when a sudden stop occurs. The authors argue that such a hedging strategy can be efficiently implemented by using options on the Standard and Poor's (S&P) 500 implied Volatility Index (VIX).

The VIX is an index of near-term U.S. financial market volatility based on the prices of S&P 500 stock index options. It tends to increase when investors are more reluctant to participate in risky markets. More importantly, the authors show that spikes in the VIX are correlated with sudden stops in emerging markets. (The probability of observing a statistically significant jump in the VIX, conditional on a sudden stop, is about 70 percent.) The authors derive the optimal hedging portfolio of a central

bank using risk-free liquid assets and call options on the VIX. This portfolio increases the expected reserves during sudden stops by as much as 40 percent, compared with a portfolio invested only in risk-free assets.

An advantage of VIX derivatives for central banks is that the VIX index is correlated with sudden stops but is independent of country policies, thus limiting moral hazard and measurement issues. The current size of the VIX market is relatively small, however. (The notional value of open futures contracts is about US$1.5 billion. Options are traded over the counter.) Two potential concerns would remain even if the market were to become much larger. First, it is not clear whether the correlation observed in recent years between occurrences of sudden stops and spikes in the VIX index will persist in the years ahead. Second, investors with short positions on call options on the VIX might already be exposed to emerging markets through their holdings of other assets; in the event of a sudden stop, the central banks might then face a serious counterparty risk. Investors might be unable to honor their obligations undeer the VIX contracts, should they sustain losses on other assets as well.

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account balance and may thus be especially relevant for emerging markets facing a risk of sudden stops.[22]

The main benefit of reserves in the context of the model is that they help to smooth domestic consumption in response to decreases in financial inflows and output. Based on a calibration of the model, the warranted level of reserves can be derived as an explicit function of factors that include the probability of a sudden stop, the size of a sudden stop, the output cost of a crisis, the opportunity cost of reserves, and the authorities' risk aversion regarding crisis episodes. The probability of a sudden stop is based upon panel probit regressions that relate sudden stops to country fundamentals (including the exchange rate regime, financial openness, the level of public debt, de facto dollarization, output growth, and exchange rate overvaluation).[23]

Warranted Reserves as Function of Macroeconomic Fundamentals

The model can be used to compute the impact of a change in fundamentals (for example, a change in the debt/GDP ratio) on the warranted level of reserves.[24] A change in fundamentals will affect the probability of a sudden stop (to an extent estimated by the probit model), and the calibration will determine the implications for the optimal level of reserves. Plausible changes in fundamentals have a substantial impact on the optimal level of reserves (Table 4.2). The (comparative statics) results may be summarized as follows:

- Moving from no real exchange rate overvaluation to an overvaluation of 20 percent increases the estimated annual probability of a sudden stop by approximately 4.3 percentage points and generates an increase in the optimal level of reserves of 2.7 percentage points of GDP.
- A rise in the ratio of public debt to GDP from 40 percent to 60 percent implies an increase in the optimal reserve ratio by 1.7 percentage points of GDP.
- A large buildup of the ratio of foreign liabilities to money, calibrated on the experience of Thailand between 1990 (45 percent) and 1997 (262 percent),

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[22]For further details, see Jeanne and Rancière (2006). Other related studies include Aizenman, Lee, and Rhee, 2004; Lee, 2004; Aizenman and Lee, 2005; and Caballero and Panageas, 2005.

[23]More specifically, in the version of the model presented in Appendix III, the probability of a sudden stop is estimated for each country and each year by applying the regression coefficients to the observed country fundamentals. The size of the sudden stop and the output cost of a crisis are assumed constant (and identical across countries) and are estimated as the observed averages for the 33 countries in the sample over 1980–2003. Risk aversion is also assumed constant, across countries and over time, at a level that is well within the range of plausible estimates available from existing studies. The opportunity cost of holding reserves is the term premium and therefore varies over time but not across countries.

[24]The exercise is based on a benchmark economy characterized by the calibration parameters presented in Appendix III (Table A3.1), with the cost of holding reserves based on the term premium only. The effect of a change in each fundamental on the optimal level of reserves is analyzed by comparison with the optimal level of reserves in the benchmark economy.

Table 4.2. Changes in Fundamentals and Optimal Reserves: Simulations for Emerging Markets
(In percentage points unless otherwise noted)

Fundamentals	Sample Mean	Parameter Change *(in percent)*	Estimated Change in Sudden Stop Probability	Change in Optimal Ratio of Reserves to GDP	Change in Optimal Level of Reserves *(in months of imports)*	Change in Optimal Ratio of Reserves to Short Term
Exchange rate overvaluation	0	0 → 20	4.3	2.7	1.3	34.6
Public debt/GDP	40	40 → 60	2.2	1.7	0.8	21.8
Foreign liabilities/money	46	45 (Thailand, 1990) → 262 (Thailand, 1997)	7.0	3.7	1.8	47.4
Financial openness as (|gross inflows|)/GDP	5.5	5.5 → 10.4	5.4	3.2	1.5	41.0
Exchange rate regime	—	Floating → Fixed	5.3	3.4	1.6	43.5

Source: See Appendix I.

Notes: The initial optimal level of reserves is equivalent to 8.2 percent of GDP (about 3 months of imports, or 105 percent of short-term debt). The results are based on regression (1) in Table A3.2 (in Appendix III)—except for the exchange rate regime, which is based on regression (2). All fundamentals are averages of the first and second lags.

raises the optimal level of reserves by 3.7 percentage points of GDP.

- An increase of one standard deviation in the degree of financial openness (measured by the absolute value of gross inflows, divided by GDP) leads optimal reserves to increase by 3.2 percentage points of GDP.
- A change from a floating to a fixed exchange rate regime induces an increase in the optimal level of reserves of 3.4 percentage points of GDP.

The changes in fundamentals analyzed previously are sizable but have certainly been observed in the sample considered. Interestingly, such assumed changes in one fundamental variable lead to large changes in optimal reserves, in some cases by one-third to one-half of the initial optimal level of reserves. The next subsection considers the impact on optimal reserves of the observed combination of changes in all fundamentals simultaneously.

Trends in Optimal Reserves for Country Groups

The optimal level of reserves—based on the calibrated model—is computed for each country and year for the 33 middle-income countries used in the probit estimation over 1980–2003. To trace the implications of the model for trends in optimal reserves, results are then summed up to obtain regional averages for Latin American and Asian emerging markets.[25] For each country

and year, the probability of a sudden stop is computed on the basis of the probit estimates. The size of the sudden stop is set to its realized mean value in each region and each decade. The only unobservable parameter, risk aversion, is set equal to six—a value selected to match the actual mean level of reserves to GDP in Asia in the middle of the sample period (1991).[26] Using this approach, it is possible to compare changes over time in the optimal level of reserves, actual reserves, and the three-months-of-imports and Greenspan-Guidotti rules of thumb (Figure 4.3).

For the group of Asian emerging markets, the model suggests that reserves should have declined somewhat between the early and the late 1980s: in the aftermath of the debt crisis of the early 1980s, a slowdown in financial flows to emerging markets contributed to reducing the probability of sudden stops. Beginning in the early 1990s, the model envisages a rapid increase in optimal reserves, owing to rising international financial integration.[27] The slight decline in optimal reserves following the Asian crisis is primarily accounted for by the reduction in public debt and financial flows. Although the model is intended to be normative, it is interesting to note that it outperforms the rules of thumb in predicting the actual level of reserves for most of the period under consideration. In

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[25]The remaining emerging markets in the sample form a limited and heterogeneous group—the related average is therefore not reported.

[26]Ogaki, Ostry, and Reinhart (1996) provide estimates by region of this parameter.

[27]A further factor contributing to the increase in optimal reserves in the mid-1990s and the post-crisis decline is the buildup and subsequent unwinding of foreign currency liabilities, particularly in Thailand.

Figure 4.3.   Asia and Latin America: Reserves as Shares of GDP, 1980–2003

(In percentage points of GDP)

Sources: IMF staff calculations using data from IMF, International Financial Statistics database; and World Bank, Global Development Finance database.

Note: Total reserves *minus* gold (excludes IMF financing). See text and Jeanne and Rancière (2006).

particular, the upward trend in reserves in Asia during the 12 years prior to the Asian crisis (1985–96) is matched more closely by the model than by the alternative rules depicted in Figure 4.3.

For the Asian emerging market countries following 1997–98, however, the model suggests that the buildup in reserves may have been excessive—a finding con-sistent with previous analyses (IMF, 2003). A possible caveat is that the Asian crisis may have led to an upward revision of the size of sudden stops or of the associated output loss, though the revision would need to be very large for actual accumulation to be consistent with the increase in optimal reserves predicted by the model. For example, in order for the model to explain

the increase in the average level of reserves held by emerging Asian countries between 1997 and 2003, the expected size of either the sudden stop or the output cost would have had to more than double relative to its average level observed in the 1990s.[28] Another possible caveat is that the crisis may have led some countries to revise their views on the availability of other sources of insurance—such as financial support by the international financial institutions. A further note of caution on the result of excessive reserve accumulation is that some countries may envisage measures to increase their degree of integration in international financial markets and may thus be preparing for greater exposure to international financial flows.

In Latin America, warranted reserves appear to have been well in excess of actual reserves in the 1980s, a turbulent period for the region. Predicted reserves are lower in the early 1990s, partly on account of improved fundamentals (public debt and economic growth), but the rise over the course of the past decade seems to be in line with heightened international financial integration and increasing de facto dollarization. The close match between the model and the data for 1991–2003 is notable, considering that no individual-year level of reserves for Latin America has been used in the calibration.[29] The model might be interpreted to suggest that the current level of reserves is, on average, adequate in Latin America. It is important to recall, however, that although the model includes de facto dollarization among the determinants of the likelihood of sudden stops, it does not take into account the possibility that output losses may be greater for dollarized economies in the event of a crisis.

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[28]Increasing the risk aversion parameter from 6 to 10 (the maximum value considered in existing studies on growth and business cycles) would lead the warranted level of reserves to increase by less than 3 percentage points of GDP, much less than is needed to explain the post-crisis buildup in emerging Asia's reserves.

[29]Extensions of the model might help explain a portion of the difference in reserve holdings between Asia and Latin America: this would be the case, for example, if one were to consider the opportunity cost based on the sum of the term and the individual-country sovereign spreads, because spreads are lower in Asia than in Latin America.

V Conclusion

The stylized facts presented in this study suggest that countries are subject to a wide variety of shocks that often have major, enduring consequences for levels of aggregate output, and thus for economic well-being. Against this background, mechanisms aimed at preventing such shocks from causing excessive economic disruption have the potential to provide sizable benefits for the affected countries and the global economy as a whole. This paper has examined various types of insurance mechanisms that countries can pursue to soften the blow from adverse shocks and their relevance for different segments of the IMF's membership (Table 5.1).

Although all countries are subject to a range of financial and real shocks, the types of shock differ considerably across country groups. For developing countries, real shocks, such as changes in the terms of trade, tend to rank among the most costly, though the debt crises of the early 1980s also inflicted considerable economic damage. For emerging market countries, in contrast, greater integration in global financial markets has been associated with higher exposure to financial shocks, which are by far the most significant for this segment of the IMF's membership.

For all countries, the first line of defense against adverse shocks is the pursuit of sound policies. In light of the large costs experienced by emerging markets and developing countries as a result of past debt crises, fiscal policies should seek to improve sustainability, taking into account that sustainable debt levels seem to be lower in emerging and developing countries than in advanced countries. Appropriate debt management aimed at increasing the share of long-term, domestic currency debt in total debt would also be beneficial. Efforts to improve the structure of the liability side of national balance sheets more generally, by increasing the share of equity-like liabilities, such as FDI, would also be well rewarded. The evidence presented in this paper suggests that macroeconomic stability and supporting institutional reforms may facilitate the move toward safer liability structures.

A range of financial instruments may also have a role to play in providing country insurance. Relevant examples include catastrophe bonds and insurance against natural disasters for smaller, disaster-prone countries; commodity price futures or other instruments aimed at hedging against commodity price fluctuations for countries with heavily concentrated production structures; and GDP growth–indexed bonds for a broader segment of the IMF's membership. New instruments would have a greater chance to succeed with large issuers, which are more able to provide the critical mass necessary for a deep and liquid secondary market.

Maintaining appropriate cushions of official reserves is also clearly an essential part of countries' self-insurance toolkit. The analytical framework developed in this paper may be useful in clarifying judgments about the trade-off between the costs of holding reserves and the benefits they provide in smoothing the impact of external shocks. When applied to data for the past two and a half decades for a sample of more than thirty middle-income countries, the framework suggests that the rapid reserve accumulation observed in Asian emerging markets since the early 1990s may now have resulted in a degree of self-insurance that exceeds what can be justified on the basis of plausible changes in fundamentals. More specifically, although increased international financial integration and the related potential for financial flow reversals seem consistent with the rapid increase in reserves observed in earlier years, for the period since the late 1990s reserve accumulation seems to be excessive compared with what the model would estimate as appropriate self-insurance. For Latin America, the model suggests a substantial degree of underinsurance, at least until the early 1990s, though, on average, reserves may have reached broadly adequate levels in recent years; an open issue that might alter this judgment is that the model may not fully account for larger output losses in the presence of de facto dollarization.

Although much can be accomplished by individual countries through sound policies, risk management, and self-insurance through reserves, collective insurance arrangements are likely to continue playing a key role in cushioning countries from the impact of shocks. Collective insurance arrangements—insurance provided through regional or other pooling arrangements such as the Chiang Mai initiative, or global insurance provided through international financial institutions—hold promise because of their ability to pool risks, which makes them potentially more cost effective than self-insurance. These issues are to be taken up in separate papers.

Table 5.1. Types of Insurance and Crisis-Prevention Measures

Measure/Type of Insurance	Especially Relevant for Which Countries?	Time Frame/Difficulty
Sound macroeconomic and financial policies	*All countries*	Impact to be observed in short term.
Improving institutional quality	*All countries.* Evidence suggests this should help increase the share of equity-like liabilities (e.g., foreign direct investment (FDI) and portfolio equity) in countries' total external liabilities.	Medium term
Appropriate debt management	*Emerging market countries.* Evidence suggests sound policies (macroeconomic stability and supporting institutional reforms) may facilitate an increase in the share of long-term domestic currency debt.	Impact to be observed in short term.
Innovative financial instruments	*Emerging markets and developing countries.* Instruments with equity-like features (e.g., growth-indexed bonds) could help improve debt sustainability and international risk sharing. Larger economies are more likely to attain the requisite critical mass to ensure sufficient liquidity of the instruments. Financial instruments aimed at hedging against commodity price fluctuations may be relevant for countries with heavily concentrated production structures. For disaster-prone developing countries, disaster insurance may be appropriate.	Immediate in principle, but obstacles in practice. May require some international coordination.
Appropriate reserve holdings	*Emerging markets and developing countries.* Strong reserve positions are especially important for dollarized economies and financially integrated economies.	Impact to be observed in short term.
Collective arrangements, including high-access contingent financing instrument proposal and IMF support for regional pooling arrangements	*Emerging market countries*	To be analyzed in separate studies.

Appendix I   Data Sources and Definitions

Data on per capita GDP are purchasing power-parity-adjusted (1990 international Geary-Khamis dollars), drawn from Maddison (2003). For the purposes of the present study, the sample period is limited to 1970–2001, yielding 4,882 country-year observations. At the end of the sample period, the data cover 167 countries. The shock dates or the criteria for identifying shock dates are mainly based on existing studies. Since different studies analyze different types of shock, samples vary and, in general, do not cover the same extensive set of country-years available for the output data.

Financial and Macroeconomic Shocks

Currency crises are identified using the following three conditions (as in Frankel and Rose, 1996): (i) cumulative devaluation/depreciation of at least 25 percent over a 12-month period; (ii) devaluation/depreciation rate at least 10 percentage points greater than in the preceding 12 months; and (iii) a minimum of 3 years since the last crisis. Given the relatively large depreciation/devaluation required, the definition of a currency crisis seems geared toward emerging and developing countries; nevertheless, to ensure consistency, the same definition was applied to all countries, using the IMF's International Financial Statistics (IFS) data. The banking crisis dummy takes the value 1 if at least one of the following studies identifies the country-year as an outbreak of a banking crisis: Kaminsky and Reinhart (1999), Vila (2000), Bell and Pain (2000), Caprio and Klingebiel (2003), and Demirgüç-Kunt and Detragiache (2005). The use of several studies produces a large sample, though the definition of a banking crisis is not identical across studies. Using banking crisis dates drawn from only one study does not change the main results. The debt crisis dummy records a 1 if at least one of the following studies identifies the country-year as the beginning of a debt crisis: Detragiache and Spilimbergo (2001); Manasse and Roubini (2005); and Reinhart, Rogoff, and Savastano (2003). As was mentioned in the text, sudden stops in financial flows are defined as a worsening in the financial account balance by more than 5 percentage points of GDP.

Country-Specific External Shocks

Terms of trade shocks are defined as a 10 percent worsening in the terms of trade for goods, based on the IMF's World Economic Outlook (WEO) data. The dummy variable for disasters takes the value 1 if the number of persons injured times 0.3 *plus* the number of persons killed is greater than 0.01 percent of the country's total population; the data are drawn from the World Health Organization's Emergency Events Database (EM-DAT) and published by the Center for Research on the Epidemiology of Disasters (CRED) (available on the Web at *http://www.em-dat.net*).

Sociopolitical Shocks

Data from the Correlates of War project were used to construct a war dummy, which records a 1 in the first year of a war. Shocks to the political system are defined as a deterioration by 3 points or more in the Polity index published by the Polity IV project (see Marshall and Jaggers, 2002 for a definition of the variable). The data are drawn from *http://www.cidcm.umd.edu/inscr/polity* (Center for International Development and Conflict Management, University of Maryland; and Center for Global Policy, George Mason University).

Global Shocks

The global interest rate shock takes the value 1 when the U.S. federal funds rate increases by more than 150 basis points in one year. Oil price shocks refer to the first year of these episodes (i.e., 1973, 1978, 1989, 1999).

Boom-Bust Cycles

Lending boom dates are drawn from Gourinchas, Valdés, and Landerretche (2001, Table A1). The dummy variable takes the value 1 in the year after a lending boom ends. A growth boom is defined as a three-year period with average growth exceeding by two standard deviations the country's average growth rate estimated over the entire sample period. The dummy variable takes the value 1 in the first year after such an episode.

Appendix II   Behavior of Different Types of Financial Flow

Data Description

This appendix analyzes data on the financial account and six of its components—foreign direct investment (FDI); portfolio debt investment (PDI); portfolio equity investment (PEI); official flows (which include flows by government and monetary authorities); bank flows; and other investment—for 1970–2003. All flows are net, taken from IMF's Balance of Payments Statistics (BOPS) database, and reported in current U.S. dollars. Throughout the analysis that follows, the flows are normalized by GDP in current U.S. dollars (taken primarily from the World Bank's World Development Indicators database and supplemented with data from the IMF's World Economic Outlook database). All data were checked for quality, with outliers and unusable observations dropped. The full sample includes 153 countries (Table A2.1), though only a subset of countries have reliable data for a sufficiently long time series.

Summary Statistics

Average Net Flows

Considering the average financial account balance for each country during 1970–2003, and taking the cross-country median within each country group over the period, it is perhaps not surprising that developing countries had the largest net inflows, followed by emerging markets and then advanced countries (Table A2.2). This pattern is even more pronounced for FDI, which has not been a net source of finance for advanced countries. By contrast, emerging markets received net FDI inflows averaging about 1.3 percentage points of GDP yearly, and developing countries received inflows averaging about 2.3 percentage points. The results (not reported here for the sake of brevity) are similar when considering 1990–2003 only, suggesting that the relative importance of FDI as a source of net inflows for emerging and developing countries has not diminished

over the last decade. All the main results highlighted in this appendix hold for the subperiod 1990–2003.

Volatility

Using the standard deviation of net flows as a measure of volatility, financial flows are found to be substantially more volatile in emerging and developing countries. The cross-country median of the standard deviation of the financial account is about 2.9 percentage points of GDP for advanced countries, and about 4.5 percentage points for emerging markets and developing countries, during 1970–2003. This corroborates findings by previous studies (Broner and Rigobon, 2006; Prasad and others, 2003). The ranking by standard deviation is the same for FDI and official flows. However, PDI and PEI are, respectively, two and five times more volatile in advanced countries than in developing countries with emerging market countries somewhere in between. Comparing across flows, in advanced countries, FDI is the least volatile type of flow, with the exception of official flows. For emerging markets, in contrast, FDI is more volatile than PDI or PEI. For developing countries, official flows are the most volatile, followed closely by FDI. Comparing across flows, it is important to take into account the size of the various types of flow by using the coefficient of variation. On that basis, FDI is the most stable of all flows to emerging and developing countries, with a coefficient of variation near 1, compared with 2–3 for PDI and PEI, or 5–7 for official flows, bank flows, and other investment (see also Wei, 2001).[30]

Persistence

Regarding the persistence properties of financial flows, autoregressive coefficients were calculated on pooled data for each relevant country group, using a fixed-effects regression with the first lag on the right-

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Note: This appendix was prepared by Andrei Levchenko and Paolo Mauro.

[30]One possible problem with calculating the coefficient of variation is that average net inflows are often quite close to zero. To check robustness, two alternative measures of relative volatility were calculated. First, the coefficient of variation was calculated for gross financial inflows. Second, the standard deviation of net flows was normalized by average gross flows. The conclusions reached were virtually the same.

Table A2.1. Economies, by Group

Advanced	Emerging	Developing	
Australia	Argentina	Albania	Kuwait
Austria	Brazil	Algeria	Kyrgyz Republic
Belgium-Luxembourg	Bulgaria	Angola	Lao People's Dem. Rep.
Canada	Chile	Antigua and Barbuda	Latvia
Cyprus	China	Armenia	Lesotho
Denmark	Colombia	Aruba	Lithuania
Finland	Côte d'Ivoire	Azerbaijan	Macedonia, former Yugoslav Republic of
France	Czech Republic	Bahamas, The	Madagascar
Germany	Dominican Republic	Bahrain	Malawi
Greece	Ecuador	Bangladesh	Maldives
Hong Kong SAR	Egypt	Barbados	Mali
Iceland	El Salvador	Belarus	Malta
Ireland	Hungary	Belize	Mauritania
Israel	India	Benin	Mauritius
Italy	Indonesia	Bolivia	Moldova
Japan	Jordan	Botswana	Mongolia
Netherlands	Korea, Republic of	Burundi	Mozambique
New Zealand	Malaysia	Cambodia	Namibia
Norway	Mexico	Cameroon	Nepal
Portugal	Morocco	Cape Verde	Netherlands Antilles
Singapore	Nigeria	Central African Republic	Nicaragua
Spain	Oman	Chad	Niger
Sweden	Pakistan	Comoros	Papua New Guinea
Switzerland	Panama	Congo, Republic of	Paraguay
United Kingdom	Peru	Costa Rica	Romania
United States	Philippines	Croatia	Rwanda
	Poland	Dominica	São Tomé and Príncipe
	Russia	Estonia	Senegal
	Saudi Arabia	Fiji	Seychelles
	Slovak Republic	Gabon	Sierra Leone
	South Africa	Gambia, The	Slovenia
	Sri Lanka	Georgia	Solomon Islands
	Thailand	Ghana	Sudan
	Tunisia	Grenada	Swaziland
	Turkey	Guatemala	Syrian Arab Republic
	Ukraine	Guinea	Tanzania
	Uruguay	Guyana	Togo
	Venezuela, República Bolivariana de	Haiti	Tonga
	Zimbabwe	Honduras	Trinidad and Tobago
		Jamaica	Uganda
		Kazakhstan	Vanuatu
		Kenya	Vietnam

Notes: Advanced countries are defined as in the IMF's World Economic Outlook database, except for the Republic of Korea, which for the purpose of the empirical analysis is classified as emerging rather than advanced to capture the experience of its 1997–98 crisis; the remaining countries are considered emerging if they are included in either the (stock market-based) International Finance Corporation's Major Index (2005) or JPMorgan's EMBI Global Index (2005) (which includes countries that issue bonds on international markets); the remaining countries are classified as developing.

hand side.[31] The financial account exhibits similar autoregressive properties for emerging markets and developing countries, with the AR(1) coefficient esti-mated at around 0.5. The financial account is more persistent in advanced countries, with an autoregressive coefficient of 0.7. Interestingly, for advanced countries, the AR(1) coefficient is also quite similar across flows, ranging between 0.3 and 0.4. For emerging market countries, the most persistent type of flow is FDI, with an AR(1) coefficient of 0.5, and the least persistent is PDI, with a coefficient of virtually zero. For developing countries, FDI has an AR(1) coefficient of 0.35, with the coefficients for PDI, PEI, and other flows lying

[31]Alternatively, AR(1) regressions were estimated for each country separately. The disadvantage of the pooled approach is that it constrains the AR(1) coefficient to be the same for each country group. The advantage is that it allows for inclusion of countries for which only a short time series is available. Results were similar to those reported here.

Table A2.2. Financial Account and Its Subcomponents, 1970–2003

	Financial Account	FDI	PDI	PEI	Official Flows	Bank Flows	Other Investment
Average of capital flows							
Advanced	1.3	0.1	0.3	–0.2	0.0	0.4	0.1
Emerging	2.1	1.3	0.2	0.2	0.1	0.0	0.0
Developing	3.2	2.2	–0.1	0.0	0.9	–0.1	0.6
Volatility *(standard deviation)*							
Advanced	2.9	1.4	2.1	1.6	0.8	2.3	1.9
Emerging	4.4	1.5	1.2	0.6	1.9	1.3	2.0
Developing	4.6	2.1	0.9	0.3	2.2	1.1	1.9
Volatility *(coefficient of variation)*							
Advanced	1.3	2.2	2.3	3.3	2.7	5.0	5.6
Emerging	1.8	1.0	3.2	2.0	3.2	7.2	3.6
Developing	1.3	0.9	3.1	2.1	2.4	3.6	2.2
Persistence *(AR1 pooled)*							
Advanced	0.7	0.3	0.4	0.4	0.4	0.4	0.4
Emerging	0.5	0.5	0.0	0.4	0.4	0.1	0.5
Developing	0.5	0.4	0.5	0.4	0.5	0.2	0.4
Correlation with domestic growth							
Advanced	0.1	–0.0	–0.1	0.0	–0.0	0.2	–0.0
Emerging	0.2	0.1	–0.0	0.1	–0.0	0.2	0.2
Developing	0.2	0.2	–0.1	0.0	–0.0	0.0	0.1
Correlation with G-7 growth							
Advanced	0.0	0.0	–0.0	0.0	–0.0	0.0	–0.0
Emerging	–0.1	–0.1	–0.1	0.1	–0.0	–0.1	–0.1
Developing	0.0	0.0	0.0	0.2	0.0	–0.0	–0.0
Correlation with U.S. one-year treasury bill							
Advanced	0.2	0.1	0.1	0.1	0.0	0.0	0.2
Emerging	0.1	–0.3	–0.1	0.1	0.3	0.0	0.1
Developing	0.1	–0.2	0.0	0.2	0.2	0.0	0.0
First principal component							
Advanced	0.3	0.4	0.2	0.4	0.2	0.3	0.2
Emerging	0.2	0.4	0.3	0.3	0.3	0.2	0.2
Developing	0.3	0.3	0.4	0.4	0.3	0.2	0.2

Sources: IMF, Balance of Payments Statistics database (all financial flows) and World Economic Outlook database, and World Bank, World Development Indicators database (GDP). See the text for details.

Notes: FDI denotes foreign direct investment; PDI denoes portfolio direct investment; PEI denotes portfolio equity investment; and G-7 denotes the Group of Seven industrial countires. The data reported are medians across countries within each group. All flows are net and normalized by total GDP for each year. The coefficient of variation of a series is the standard deviation divided by the mean: it is computed for each country separately, and this table reports the median across countries. The measure of persistence is the slope coefficient in a regression of a variable on its lagged value. The first principal component is a measure of comovement across countries within each group: it is the share of total variance in a set of series that can be explained by a common component.

between 0.2 and 0.5. These estimates are close to those in Obstfeld and Taylor (2004) and Broner and Rigobon (2006), though the latter argue that total financial flows are more persistent in emerging and developing countries.

Correlations

Table A2.2 also reports correlations of financial flows with domestic GDP growth, Group of Seven (G-7) growth, and the U.S. interest rate (the one-year treasury-bill rate). Correlations between financial flows and these variables turn out to be quite low, except as noted herein. Financial flows are mildly procyclical in emerging market and developing countries. In developing countries, FDI is the financial flow most correlated with growth, though the correlation is still low at 0.2. For emerging markets, official flows and other investment are the most procyclical. A positive correlation between financial flows and growth has also been

reported by Albuquerque, Loayza, and Servén (2005). The only type of flow that exhibits significant correlation with G-7 growth is PEI for emerging markets (0.1) and developing countries (0.2). The U.S. interest rate is correlated with the inflows into advanced countries, with a coefficient of 0.2, and is virtually uncorrelated with the financial accounts of emerging and developing countries. FDI is negatively correlated with the U.S. interest rate in both emerging markets (correlation of –0.3) and developing countries (correlation of –0.16). Other studies, such as Fernandez-Arias (1996), find, using higher-frequency data for shorter time periods, that foreign interest rates do matter for financial flows. The present exercise shows that at a yearly frequency, foreign interest rates matter less, a result also found in Broner and Rigobon (2006). Different kinds of financial flow are also either uncorrelated or weakly negatively correlated with each other, a pattern that holds for all country groups—this finding is consistent with Claessens, Dooley, and Warner (1995). This may suggest that different types of flows may be substitutes rather than complements or that reclassifications are frequent.

Principal Components Analysis

The interrelationships of financial flows across regions and income groups were analyzed using principal components analysis, focusing on the share of variation explained by the first principal component for each country group or region. For total financial flows, the patterns across developed and developing countries are quite similar, with the first principal component accounting for 25–30 percent of the variation in financial flows. Comparing across flows, FDI and PEI display the largest common component for advanced countries; for emerging markets, FDI has the largest common component; for developing countries, FDI, PDI, and PEI are roughly similar in this respect. Overall, however, there are no pronounced differences across types of flows in the relative importance of the common component. Although Calvo, Leiderman, and Reinhart (1993) find that the first principal component can account for 60–80 percent of variation in financial flows, their use of monthly data for a shorter time span (four years) on a Latin American sample may explain the difference in results.

Appendix III   A Model of Optimal Reserves

This appendix presents background information on the Jeanne and Rancière (2006) model of a growing open economy where reserves are accumulated, at a cost, in order to reduce the frequency of sudden stops in financial flows and smooth their impact on domestic consumption. The simple version of the model presented in this study considers only the smoothing role of reserves. At the time of a sudden stop, the country's authorities lend reserves to domestic agents whose lines of credit have been cut off by private lenders, thereby mitigating the drop in domestic consumption. The cost of holding reserves (the difference between the return on reserves and the long-term interest rate) translates into lower domestic consumption during noncrisis times. The optimal level of reserves equates the marginal costs and benefits of holding reserves. The parameters of the benchmark calibration (Table A3.1) are based on information drawn from a panel of 33 middle-income countries during 1980–2003. Defining a sudden stop as a worsening in the financial account balance by more than 5 percent of GDP, 77 sudden stops are observed during the sample period. This yields an unconditional probability of a sudden stop of 10 percent per year. The magnitude of a sudden stop is the mean size of sudden stops in the sample (11 percentage points of GDP). The output cost of a sudden stop is set equal to 6 percent of GDP (the difference in average real GDP growth between the year of the sudden stop, on the one hand, the following year and, on the other hand, the remaining years for all countries).

The cost of holding reserves is the difference between the opportunity cost of borrowing long term and the return on reserves invested in safe, short-term liquid assets. In the benchmark calibration, this premium consists only of the term premium, set at 1.5 percent—that is, the mean difference between the yield on 10-year U.S. treasury bonds and the federal funds rate during 1987–2005. Variants of the model consider the case where the opportunity cost of holding reserves also includes the sovereign spread. The coefficient of risk aversion is allowed to vary in the 1–10 range, as is customary in existing studies on growth and business cycles. It is assumed that the authorities are benevolent and maximize the welfare of the representative domestic consumer. The risk-free

rate is set at 5 percent. The potential output growth rate is set at 3.3 percent, the mean real GDP growth rate in middle-income countries during 1980–2003 excluding sudden-stop years.

To analyze the role of the parameters in determining the optimal level of reserves, the model is repeatedly simulated by letting each key parameter vary (one at a time) over a plausible range while keeping the other parameters fixed at their baseline values as in Table A3.1. For the sake of comparison, in each plot (Figure A3.1) the optimal level of reserves is presented alongside the level of reserves predicted by the Greenspan-Guidotti rule.

When the size or probability of a sudden stop is sufficiently low, the optimal ratio of reserves is zero. (The costs of reserves exceed their benefits.) Optimal reserves rise near-linearly as the size of the sudden stop increases (beyond 2.5 percent of GDP), and non-linearly as the probability of a sudden stop increases. For some starting values of the sudden-stop probability, a relatively modest rise can imply a substantial adjustment in the optimal ratio of reserves to GDP: for example, an increase in the annual probability from 5 to 10 percent leads optimal reserves to rise from 4 to 10 percent-

Table A3.1. Calibration Parameters

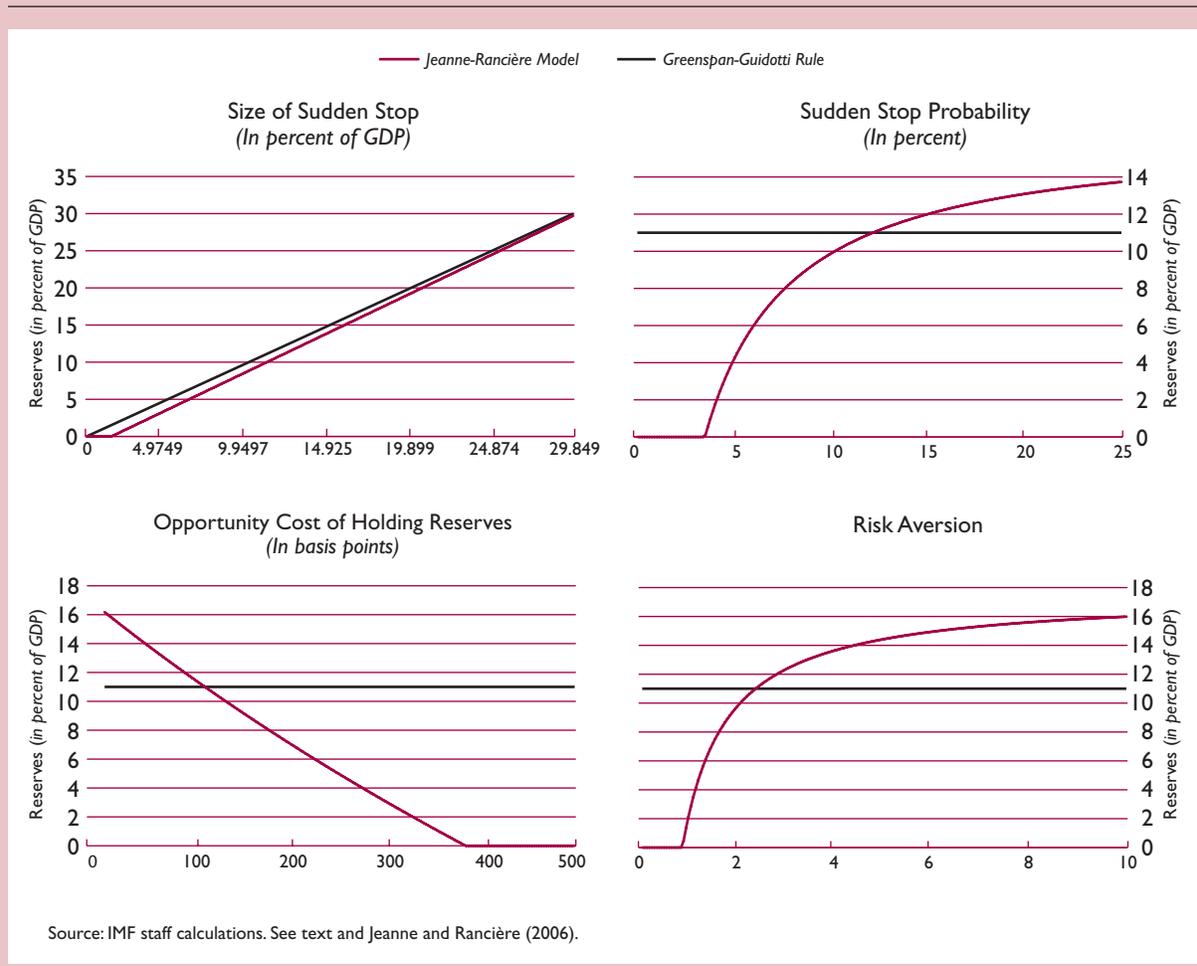| Parameters	Baseline	Range of Variation
Size of sudden stop	$\lambda = 0.11$	$[0, 0.3]$
Probability of sudden stop	$\pi = 0.10$	$[0, 0.25]$
Output loss	$\gamma = 0.06$	$[0, 0.2]$
Potential output growth	$g = 0.033$	
Term premium	$\delta = 0.015$	$[0.0025, 0.05]$
Risk-free rate	$r^* = 0.05$	
Risk aversion	$\sigma = 2$	$[1, 10]$

Sources: IMF staff calculations. The parameters were chosen based on data from the U.S. Board of Governors of the Federal Reserve System and the IMF's International Financial Statistics database.

Figure A3.1. Optimal Level of Reserves as Function of Various Factors

—— *Jeanne-Rancière Model* ——— *Greenspan-Guidotti Rule*

Size of Sudden Stop
(In percent of GDP)

Sudden Stop Probability
(In percent)

Opportunity Cost of Holding Reserves
(In basis points)

Risk Aversion

Source: IMF staff calculations. See text and Jeanne and Rancière (2006).

age points of GDP. Changes in the opportunity cost of holding reserves (regardless of whether they stem from a change in the term premium or, when included, the sovereign spread) have a substantial impact on optimal reserve levels. For example, an increase in the opportunity cost by 1.5 percentage points above its baseline value reduces the optimal reserve ratio by more than 6 percentage points of GDP. Finally, the impact of changes in the degree of risk aversion on the optimal level of reserves is major when starting from relatively low values of the coefficient, but limited when starting from higher values.

Determinants of Vulnerability to Sudden Stops

The probability of a sudden stop can be estimated as a function of a country's economic fundamen-

tals by running a probit estimation of the probability of sudden stops in a sample of 33 middle-income countries over 1980–2003. The explanatory variables are selected using a general-to-specific approach—that is, by initially considering a large set of potential explanatory variables and iteratively eliminating those that are statistically less significant to arrive at the preferred specification reported in Table A3.2. The complete set of variables considered is listed in Jeanne and Rancière (2006). All explanatory variables are averages of the first and second lags, and are thus predetermined with respect to the sudden stop. The results are robust to the inclusion of time effects and fixed effects.

The probability of a sudden stop decreases with the pre-crisis growth performance and increases with the currency's real appreciation, the ratio of public debt to GDP, openness to financial flows, and the ratio of foreign liabilities to money in the banking

Table A3.2. Probit Estimation of Probability of Sudden Stop

	(1)	(2)	(3)	(4)	(5)
Real effective exchange rate deviation from HP trend	1.52		1.52	1.85	1.78
	(3.1)***		(2.9)***	(3.4)***	(3.1)***
GDP growth	−1.25		−1.56	−1.42	−1.87
	(1.6)*		(1.7)*	(1.7)*	(1.8)*
Public debt/GDP	0.81	0.78	0.72	1.02	0.85
	(3.3)***	(3.5)***	(2.6)***	(2.4)**	(1.6)
Ratio of foreign liabilities to money in banking sector	0.23	0.20	0.22	0.22	0.20
	(3.0)***	(2.7)***	(2.8)***	(2.2)**	(1.9)*
Financial openness as (|gross inflows|)/GDP	9.11		10.04	9.82	11.15
	(5.7)***		(5.5)***	(4.9)***	(4.9)***
Dummy for fixed exchange rate regime		0.29			
		(1.8)*			
Constant	−2.31	−1.80	−2.41		
	(12.6)***	(12.9)***	(5.3)***		
Observations	707	690	707	537	537
Pseudo R^2	0.14	0.06	0.17		
Time effects	No	No	Yes	No	Yes
Fixed effects	No	No	No	Yes	Yes

Sources: IMF, International Financial Statistics database; World Bank, Global Development Finance database; and IMF staff calculations.

Note: One asterisk (*) denotes significance at 10 percent; two asterisks (**) denote significance at 5 percent; and three asterisks (***) denote significance at 1 percent. Absolute values of z statistics are in parentheses. All explanatory variables are taken as averages of first and second lags. The fixed exchange rate regime is a "fix" or "peg" in the Reinhart and Rogoff (2004) classification.

sector.[32] The last two determinants suggest that the vulnerability to sudden stops rises with the degree of international financial integration.[33] A fixed exchange rate regime is associated with a higher probability of a sudden stop, though only if financial openness and exchange rate overvaluation are omitted from the regression.

[32]The ratio of foreign liabilities of the financial sector to money in the banking sector (*International Financial Statistics (IFS)* line 26C/line 34) is a reasonable proxy for, though not a direct measure of, the extent of mismatch in the currency denomination of assets and liabilities in countries' balance sheets. It is available for almost all countries from 1970 onward.

[33]We find that trade openness does not significantly affect the probability of a sudden stop when financial openness is included as an explanatory variable.

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