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Systemic Sudden Stops: The Relevance Of Balance-Sheet Effects And Financial Integration
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ABSTRACT

Using a sample of 110 developed and developing countries for the period 1990-2004 we analyze the empirical characteristics of systemic sudden stops (3S) in capital flows --understood as large and largely unexpected capital account contractions that occur in periods of systemic turmoil -- and the relevance of balance sheet effects in the likelihood of their materialization. We conjecture that large real exchange rate (RER) fluctuations come hand in hand with 3S. A small supply of tradable goods relative to their domestic absorption -- a proxy for potential changes in the real exchange rate -- and large foreign-exchange denominated debts towards the domestic banking system, denoted Domestic Liability Dollarization, DLD, are claimed to be key determinants of the probability of 3S, conforming a balance-sheet effect that impacts on the probability of 3S in non-linear fashion. Regarding financial integration, the larger is the latter, the larger is likely to be the probability of Sudden Stop; however, beyond a critical point the relationship gets a sign reversion.

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I. Introduction

This paper is motivated by the spectacular financial crises in developing countries that took place in the last fifteen years. Our central objective is to try to isolate the role of domestic financial factors, in particular the role of foreign-exchange denominated debts and financial integration into world capital markets. The approach is eminently empirical, and it focuses on Sudden Stops episodes. These are episodes in which the economy exhibits a "large and largely unexpected" cut in capital inflows. In addition, we zero in on "systemic" Sudden Stops (3S), i.e., sudden stops that take place in conjunction with a sharp rise in aggregate interest-rate spreads.

Consequently, these are episodes for which it could be claimed that the initial trigger is *financial and external*. Thus, the procedure we use to select Sudden Stop episodes is designed to exclude crises that are idiosyncratic and can be due to factors quite disparate (like natural disasters or political turmoil) from the purely financial ones that we intend to isolate. Moreover, since our crisis definition tries to isolate episodes that are "largely unexpected," it could be argued that in these episodes market incompleteness is likely to prevail, making shocks such as large changes in relative prices difficult to handle in a context of non-contingent contracts.

The simple model discussed in Section II captures these characteristics by assuming that 3S are initially triggered by factors that are exogenous to individual economies. However, whether or not this initial shock develops into a full-fledged Sudden Stop depends also on country-specific variables. We conjecture that foreign-currency denominated debts play a central role in this respect, especially when the Sudden Stop brings about a sharp increase in the real exchange rate (RER). This is so because central banks have serious limitations as lenders of last resort in terms of foreign exchange. In the empirical implementation we focus on an even narrower concept of foreign-exchange denominated debt, namely, *Domestic Liability*

Dollarization, DLD, i.e., foreign-exchange denominated *domestic* debts towards the *domestic banking system*, as a share of GDP. The rationale behind this choice is that typically banks are at the heart of the economy's *payment system* and, thus, their bankruptcy or even temporary suspension of activities could trigger a serious supply shock. In addition, those crises are in many cases associated with major real currency depreciation. Thus, it is necessary to bring into focus factors that could provoke large increases in the real exchange rate. The framework introduced below shows that a key factor is the current account deficit *as a share of absorption of tradable goods*, which is shown to be negatively related to the ratio of tradables' output (net of transfers) to tradables' absorption (a variable that we denote by ω (see Sections II and IV for details)).[1] The smaller is ω, the larger will be the impact on tradables' absorption of a Sudden Stop (keeping international reserves constant) and, thus, the larger its impact on the real exchange rate. Thus, the model leads us to expect that the probability of a Sudden Stop will be negatively associated with ω and positively associated with DLD (given the exogenous financial trigger), bringing to the forefront the relevance of potential balance-sheet effects on the likelihood of a Sudden Stop.

The paper is organized as follows: Section II discusses a basic framework that helps to identify the variables that determine the change in the RER, which is at the heart of our empirical analysis. Section III develops an empirical definition and characterization of Sudden Stops and links this definition to the empirical literature on crises. Section IV focuses on an empirical analysis of the determinants of Sudden Stops, following a panel Probit approach, and highlights

[1] Variable ω is a measure of the economy's ability to finance domestic absorption of tradable goods. Although it could be claimed that ω is a measure of trade openness, it should be noted that it is significantly different from the standard one, i.e., the ratio of exports plus imports to GDP (see Section IV for more details).

the impact of balance-sheet effects. Section V concludes with a description of our main findings and future lines of research.

II. Basic Framework

The objective of this section is to motivate a set of key macro variables used in the empirical exploration. As noted in the Introduction, we will focus on cases in which it can be argued that the initial shock is systemic, and is associated with a sharp increase in the cost of credit, initially inducing substantial contraction in international credit and aggregate demand. Whether or not this initial credit contraction results in a full-fledged Sudden Stop depends on the effects of the initial contraction, which, in turn, depend on domestic vulnerabilities.

Consider the case in which there are two sectors, tradables and nontradables, and the following demand function for nontradables holds:

$$h = \alpha + \beta\, rer + \delta\, z, \tag{1}$$

where $h = \log H$, $z = \log Z$, $rer = \log RER$, H and Z are the demand for nontradables (or home goods) and tradables, RER is the real exchange rate (i.e., the relative price of tradables with respect to nontradables), and α, β, and δ are parameters, $\beta > 0$, $\delta > 0$.[2] Suppose for simplicity that the supply of tradables and non-tradables is inelastically given. Thus, by equation (1), if z contracts by Δz, in equilibrium we have

$$\Delta rer = -\frac{\delta}{\beta}\Delta z, \tag{2}$$

where Δ is the first-difference operator. Clearly, the larger is the proportional contraction of the demand for tradables, the larger will be the proportional increase in the real exchange rate.

[2] This equation could be derived from first principles if H and Z are identified with consumption of nontradables and tradables, the intertemporal utility function is separable, and the utility function is iso-elastic in H and Z.

Changes in *rer*, in turn, change the ratio of foreign-exchange denominated debt to GDP (assuming that those debts are not state-contingent, which is justified by looking at episodes where capital flow cuts are large and can be presumed to be largely unexpected). Thus, given a positive stock of foreign-exchange denominated debt, the larger Δrer, the larger will be the probability of financial distress. This illustrates how a systemic financial shock could create financial domestic distress, especially if the foreign-denominated debt is owed to domestic banks, as noted in the Introduction.[3]

The next step is to trace the effect of credit contraction on *z*. It should be clear from the start that such an effect will depend on preexisting debt maturity structure and central bank policy with respect to international reserves, subjects that we do not address here. Instead, the ensuing discussion suggests that a plausible proxy for the initial impact of a credit drought is the ratio of the prior-to-shock current account deficit to the absorption of tradable goods. Let the current account deficit, capital inflows, and international reserves be denoted by *CAD*, *KI*, and *R*, respectively. By definition, and abstracting from errors and omissions,

$$KI = CAD + \Delta R = Z - Y + S + \Delta R, \tag{3}$$

where *Y* is output of tradables and *S* are international factor payments, remittances abroad, etc. Let us focus on the case in which the initial or *incipient* Sudden Stop results in zero capital inflows, i.e., $KI = 0$. If *CAD* remains constant (and positive), then, by equation (3), $\Delta R < 0$, driving the economy into a balance-of-payments crisis beyond which the whole adjustment will have to fall upon *CAD*. Hence, there will come a time at which *CAD* will have to be set equal to zero. Thus, in the plausible case in which the economy initially attempts to honor its external

[3] It should be pointed out, however, that a large increase in rer is likely to generate financial difficulties even when there are no foreign-exchange denominated debts, e.g., the case of firms that depend on imported raw materials.

financial obligations (i.e., S remains largely constant), then, in the most favorable case in which Y does not contract as a result of the credit drought, we must eventually have

$$\Delta Z = - \ CAD; \tag{4}$$

thus,

$$- \Delta Z / Z = CAD / Z \, . \tag{5}$$

Approximating the relative change in Z by its first difference in logs, it follows from equations (2) and (5), that

$$\Delta rer = \frac{\delta}{\beta} \frac{CAD}{Z} . \tag{6}$$

Thus, by equation (6), the potential proportional change in the real exchange rate increases with CAD prior to the Sudden Stop, as a ratio to the absorption of tradables (Z). Given that Y is unchanged—and in some Sudden Stop episodes Y falls (it never rises)— equation (6) gives a lower bound for the required proportional increase in the real exchange rate.[4] It should be emphasized that equation (6) does not model the *actual* change in the equilibrium real exchange rate but, rather, *that part of the total change that is likely to be very difficult to prevent*. We are now ready to complete the framework that will help to rationalize Sudden Stops as defined in the empirical section.

Consider a scenario in which a shock is spread from one country to other regions, for example, because of prevailing regulations in capital market transactions (such as margin calls) that are unrelated to country fundamentals. Such a possibility is discussed in Calvo (1999),

[4] In a world of heterogeneous agents, full-fledged Sudden Stops could take place even under current account *surplus*, because there could be key sectors that exhibit a current account deficit while the rest of the economy exhibits an even larger surplus. In our sample, about 5% of Sudden Stops occur under a current account surplus the period prior to crisis. This is another reason why equation (6) is likely to underestimate the required change in *rer* of an incipient Sudden Stop.

where it is argued that a liquidity shock to informed investors due to adverse developments in one country[5] may trigger sales of assets from other countries in their portfolio in order to restore liquidity. Now add to this framework a set of uninformed investors who face a signal-extraction problem because they cannot observe whether sales of the informed are motivated by lower returns on projects or by the informed facing margin calls. In this context, uninformed investors may easily interpret the fact that informed investors stay out of the market for EM securities, or massive asset sales, as an indication of lower returns and decide to get rid of their holdings as well, even though the cause for informed investors' sales was indeed due to margin calls.[6] When this occurs, a set of countries with no ties to the country at the epicenter of the crisis could be exposed to a large and unexpected liquidity shock making their equilibrium real exchange rate rise through the mechanism discussed above. This is an example of the exogenous trigger we have been referring to above. Thus, if, as a result, the proportional change in RER is large and the economy exhibits high DLD, for example, massive bankruptcies might ensue, generating a full-fledged Sudden Stop.

The negative effect of a rise in RER can be rationalized in a variety of different ways. For example, although they do not deal with bankruptcies, models such as Izquierdo (1999) or Arellano and Mendoza (2002) help rationalize the effects of changes in the RER on output via external credit contraction, where the relevant price is that of non-tradable collateral relative to the tradable good being produced. Another scenario is given in Aghion, Bacchetta, and Banerjee (2001), a paper that is close in spirit to the present discussion because it specifically analyzes the effects of liability dollarization. The paper exploits the fact that with incomplete pass-through from exchange rates to domestic prices, currency depreciation impacts negatively on net worth

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[5] Say, a margin call due to the fall in the price of asset holdings from a particular country.

[6] This can occur when the variance of returns to investment projects in EMs is high relative to the variance of the liquidity shock to informed investors (see Calvo (1999)).

due to the increase in the debt burden of domestic firms indebted in foreign currency, thus reducing investment by constrained firms as well as output levels in future periods. The associated fall in future money demand and consequent future currency depreciation, coupled with arbitrage in the foreign exchange rate market, imply that currency depreciation must take place in the current period as well, opening the door for expectational shocks that could push an economy into a bad (low output) equilibrium.[7] [8] Therefore, given the damaging effect of real exchange rate fluctuations on balance sheets, output and repayment capacity, it can be argued that the probability of a 3S episode will be an increasing function of *CAD/Z*, and the degree of Liability Dollarization, especially Domestic Liability Dollarization , DLD, among possibly other variables.[9] This is the central conjecture that will be put to a test in the next sections.

In closing this section, it is worth pointing out that following the empirical literature on these issues we also include as an explanatory variable a measure of financial integration with the rest of the world. Interestingly, empirical results suggest that such a variable might increase the probability of Sudden Stop in the first stages of financial integration, while it might decrease the probability of Sudden Stop for highly financially integrated economies. The result is intuitively plausible given that, in the first place, to suffer from Sudden Stop economies must exhibit *some* degree of financial integration. Thus, financial integration must, in principle, increase the probability of Sudden Stop. However, for highly financially integrated economies

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[7] Sudden Stops could also be rationalized in terms of models displaying a unique equilibrium, as long as the equilibrium outcome is a discontinuous function of fundamentals. For example, Calvo (2003) shows that there could exist a critical level of government debt beyond which the economy plunges into an equilibrium that displays Sudden Stop features. Calvo (2003) is a non-monetary model, where public debt is denominated in terms of tradables. Thus, Liability Dollarization is actually assumed for the entire debt, implying that the higher the degree of Liability Dollarization (measured in this model by the public debt/output ratio), the higher the probability that a given negative shock will generate a Sudden Stop.

[8] Uniqueness could also be obtained along the lines suggested by Morris and Shin (1998). Consider the limit case in which informational noise (ε in their notation) goes to zero, and let currency devaluation after crisis be an increasing function of the degree of Liability Dollarization. In this case, the likelihood of a crisis as a result of a deterioration in *fundamentals* (θ in their notation) would be higher, the higher the degree of Liability Dollarization.

[9] For an explicit derivation of the relationship between CAD/Z and $1-\omega$, see section IV.

the latter effect could be more than offset by the existence of a better institutional framework (with better quality creditor rights), or state-contingent financial instruments which, by providing more orderly instruments for adjustment, lower the probability of Sudden Stop.

III. Sudden Stops: Definition and Characterization

Recent empirical literature has focused on alternative measures of crisis, whether currency crises (Frankel and Rose (1996),[10] Kaminsky and Reinhart (1999),[11] Edwards (2001),[12] Arteta (2003), Razin and Rubinstein (2004)[13]) or current account reversals (Milesi-Ferretti and Razin (2000), Edwards (2003)). However, to the extent that many of the recent crises were originated by credit shocks in international markets, as argued in Calvo (1999), the measure of crisis we want to consider in this case is more closely linked to large and unexpected capital account movements rather than to measures that focus on large nominal currency fluctuations or current account reversals (along these lines, Edwards (2004) makes a relevant distinction between current account reversals and capital account reversals). Besides, current account and exchange rate behavior may be more affected by endogenous policy choices than Systemic Sudden Stops, which are, by definition, triggered by large and largely exogenous aggregate interest rate spreads. Thus, Systemic Sudden Stops may imply quite different timings for the onset of a crisis compared to exchange rate crises or current account reversals.[14]

[10] Using a panel of 105 countries for the period 1970-1991, they conclude that the current account has no significance in explaining currency crises.
[11] Kaminsky and Reinhart (1999) implicitly introduce a link between current account performance and currency crises by incorporating the growth rate of imports and exports in their analysis. They select the latter as a relevant early warning indicator of currency crises based on noise-to-signal ratio properties of the series.
[12] This analysis does find that under some definitions of currency crisis, and particularly excluding African countries, current account deficits are a significant determinant of the probability of experiencing currency crises.
[13] They focus on large RER swings to define a crisis.
[14] According to our definition, for example, Argentina's Sudden Stop starts in May of 1999, whereas the currency crisis only hits in February of 2002.

One indicator of financial crisis that is akin to ours is the one advanced by Rodrik and Velasco (1999)—which, in turn, draws from Radelet and Sachs (1998). According to their definition, financial crisis takes place when there is a sharp reversal in net private foreign capital flows.[15] However, this indicator does not attempt to capture the "unexpected" component in Sudden Stops, and it does not discriminate between episodes that may be of a domestic origin from those of a systemic (and, hence, largely exogenous) origin. In contrast to this approach, as well as that of Calvo, Izquierdo and Mejia (2004), our indicator of Sudden Stop focuses on capital account reversals that coincide with sharp increases in aggregate spreads. This is done in order to pinpoint crises that are highly likely to be associated with an external trigger that is systemic in nature—i.e., Systemic Sudden Stops. It is important to notice that the 3S definition in the present paper drops the requirement in Calvo, Izquierdo and Mejia (2004) that capital account reversals coincide with a fall in output, thus reducing the potential influence of domestic factors in the definition, and helping to focus on external triggers.[16]

Rothenberg and Warnock (2006) build on Calvo, Izquierdo and Mejia (2004) to explore differences between capital account reversals originated in capital flow transactions attributable to non-residents vis-à-vis those attributable to residents, based on the finding by Cowan and De Gregorio (2005) that for the case of Chile, much of the movement in the capital account balance is due to changes in gross flows stemming from residents. For a restricted sample of countries, they find that many of the net capital flow reversals are due to transactions made by residents (although more than half of their episodes are still due to transactions made by foreigners). However, their definition of sudden stops does not require coincidence with a spike in aggregate

[15] Exceeding 5 percent of GDP.

[16] Moreover, this study expands the sample of countries from 32 to 110 given availability of new data on dollarization. Additionally, given the larger and more heterogeneous sample, controls for financial integration are introduced in estimations, with significant results reported in section IV.

EMBI spreads, and, thus may be capturing several events of a domestic nature. We do not follow this approach, not only because our definition likely excludes crises of a domestic origin, but also because of insufficient data availability on gross flows at a monthly frequency for the much larger sample of countries used in this study.[17]

Against this empirical background, and following Calvo (1998), we look for measures of a Sudden Stop that reflect *large* and *unexpected* falls in capital inflows, a central element in the characterization of this type of event. In order to make the concept of Sudden Stop operational, we first define a Sudden Stop as a phase that meets the following conditions:

- It contains at least one observation where the year-on-year fall in capital flows lies at least two standard deviations below its sample mean (this addresses the "unexpected" requirement of a Sudden Stop).[18]
- The Sudden Stop phase ends once the annual change in capital flows exceeds one standard deviation below its sample mean. This will generally introduce persistence, a common fact of Sudden Stops.
- Moreover, for the sake of symmetry, the start of a Sudden Stop phase is determined by the first time the annual change in capital flows falls one standard deviation below the mean.[19]

Notice that there is an important difference between this concept of crisis and the one used in other studies focusing on measures such as a fixed current account deficit threshold as a

[17] Besides, as it will be come evident later on, from an integrated capital market perspective, it is not crucial whether domestic or foreign investors are responsible for the cut in financing in terms of the consequences that the withdrawal of funds will pose on the real exchange rate and the associated balance-sheet effects.
[18] Both the first and second moments of the series are calculated each period using an expanding window with a minimum of 24 (months of) observations and a start date fixed at January 1990. This intends to capture a learning process or updating of the behavior of the series.
[19] As a result, a Sudden Stop phase starts with a fall in capital flows exceeding one standard deviation, followed by a fall of two standard deviations. The process lasts until the change in capital flows is bigger than minus one standard deviation.

share of GDP in that, in line with the theoretical arguments outlined in the previous section, our definition accounts for the volatility of capital flow fluctuations of each particular country at each point in time in deciding whether an event is "large and unexpected". If anything, our concept of crisis will tend to include episodes that would otherwise not qualify for crisis when using measures such as a fixed current account deficit threshold. This is so because the latter would exclude many crisis episodes in developed countries simply because their volatility is smaller.

To maximize the chances of detecting Sudden Stop episodes accurately, we work with monthly data, since lower frequency data may blur the beginning of these episodes. Assessing the right timing of these episodes is relevant because, as it will become clear later on, eventual changes in the RER that may result from potential closure of the current account deficit need to be measured *before* a Sudden Stop takes place. Given that capital account information is typically not available at this frequency, we construct a capital flow proxy by netting out the trade balance from changes in foreign reserves (both net factor income and current transfers are thus included in our measure of capital flows, but since they represent mostly interest payments on long-term debt, they should not vary so substantially as to introduce significant spurious volatility into our capital flows measure).[20] Changes in the 12-month cumulative measure of the capital flow proxy are taken on a yearly basis to avoid seasonal fluctuations.

As indicated in the introduction, our interest lies in the identification of Systemic Sudden Stops (or 3S), i.e. Sudden Stops with an exogenous trigger. For this reason, we require additionally that the detected Sudden Stop windows coincide with a period of skyrocketing

[20] See the Data Appendix for definitions and sources of these variables. All series are measured in constant 2000 US dollars.

aggregate spreads. The same methodology outlined above to detect large changes in capital flows is used for *aggregate* spreads to detect periods of capital market turmoil.[21]

In order to make the analysis as exhaustive as possible, we work with a sample of 110 countries, including 21 developed economies, and 89 developing countries for the period 1990-2004 (see the Data Appendix for details).[22] The set of countries and years in the sample is essentially restricted by availability of DLD data.

Two periods of financial turmoil for developing countries are detected in our sample, namely, the neighborhood of the Tequila crisis (1994-1995), and the neighborhood of the East Asian-Russian Crisis (1998-1999). For the case of developed countries, financial turmoil is detected for 1992, reflecting the ERM crisis. Throughout these periods, a total of 77 3S are accounted for. A list of episodes is provided in Appendix Table 1.

Our interest and the nature of our methodology to detect 3S, focusing on periods of widespread financial turmoil, bunches episodes "by construction". However, it is worth asking whether bunching takes place when only large changes in capital flows are considered—i.e., without imposing overlap with large fluctuations in *aggregate* spreads. Figure 1 displays the share of economies included in the EMBI+ index as well as other developing countries that experienced large changes in capital flows across time.[23] Bunching seems evident for EMBI+ countries, particularly around the Tequila crisis and the East Asian-Russian crisis (the two systemic events captured by large fluctuations in aggregate EMBI spreads), whereas there is no such clear bunching pattern for other developing countries, supporting the conjecture that EMs

[21] More specifically, we use J. P. Morgan's Emerging Market Bond Index (EMBI) spread over US Treasury bonds for developing countries, the Merrill Lynch Euro-area Government Index spreads for Euro-area countries (as well as Nordic countries such as Denmark, Norway, and Sweden), and G7 Government Index spreads for all remaining developed countries.

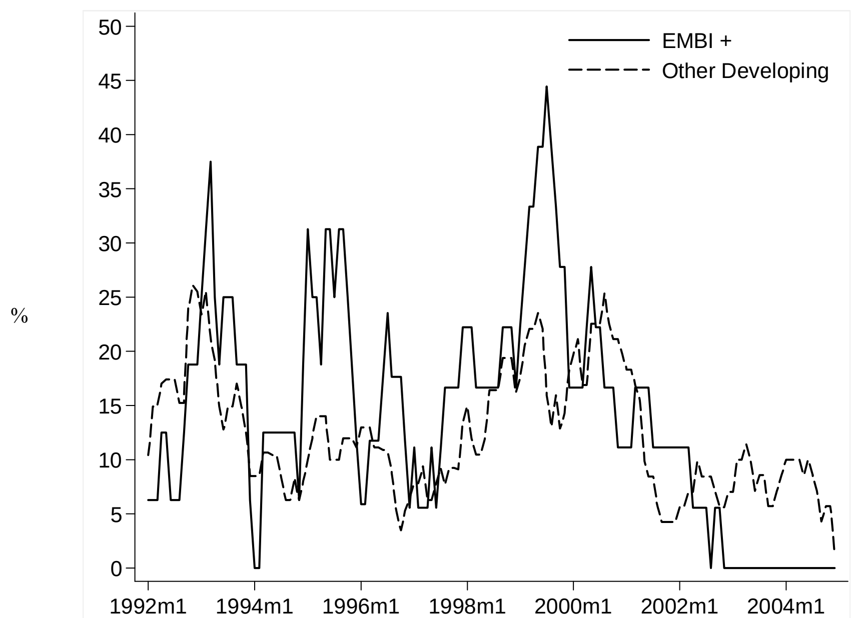
[22] The first two years of observations are lost, given that such information is used to construct initial standard deviations.

[23] The distinction between EMBI+ and other developing countries is made because their levels of financial integration differ and, thus, bunching behavior may differ.

are particularly prone to contemporaneous, systemic events (our estimations will show that financial integration may be behind these results, as the probability of a 3S increases with financial integration in the early stages of integration). Given the heterogeneous nature of EMs in terms of their fiscal stance and other macroeconomic measures, it would be hard to argue that there was a common flaw in fundamentals driving these episodes, other than the fact that they are all EMs.[24] This suggests that these episodes were not necessarily crises just waiting to happen—but rather, that they were triggered by an external event—although there may be factors that made them more prone to crisis, an issue that we raised in Section III and we will emphasize in the following section.

Figure 1

The Bunching of Sudden Stops Events:
Emerging Markets and Other Developing Countries



Note: For each group of countries, this figure displays the share of economies that experienced large changes in capital flows across time.

[24] For a detailed treatment of the Latin American episodes see Calvo, Izquierdo and Talvi (2002).

Another topic that is relevant to the hypothesis advanced in this study is whether Sudden Stop episodes have been associated with large RER depreciation—where large RER depreciation windows are defined along the same lines used to identify periods of large changes in capital flows. To this effect, we look at the share of 3S associated with large RER depreciation—i.e., the number of 3S windows that overlap with large RER depreciation windows, relative to the number of 3S events. 55 percent of 3S episodes can be linked to large RER depreciation, indicating that this large valuation element of balance sheet effects cannot be ignored.

IV. Determinants of Sudden Stops: Empirical Analysis

Having defined Sudden Stops and examined some of their empirical characteristics, we now turn to a search for Sudden Stop determinants. The framework discussed in Section III suggests balance-sheet factors that exacerbate an economy's vulnerability to Sudden Stops: The degree of domestic liability dollarization (both in the private and public sectors), as well as the sensitivity of the RER to capital flow reversals, which is related to the size of the supply of tradable goods relative to demand for tradable goods. The latter becomes clear by examining equation (6), which shows that the size of the increase in the RER depends on the percentage fall in the absorption of tradables needed to close the current account gap (CAD/Z).[25] As a matter of fact, the less leveraged the absorption of tradable goods is, the smaller will be the effect on the RER. To see this, rewrite CAD/Z as:

$$\frac{CAD}{Z}=\frac{Z-Y+S}{Z}=1-\frac{Y-S}{Z}=1-\omega\ , \tag{7}$$

where ω, defined as $\omega=\left(Y-S\right)/Z$, can be though of as the un-leveraged absorption of tradables. It is evident that the higher the supply of tradables $\left(Y\right)$, the smaller will be financing

[25] An increase means a real depreciation of the currency.

from abroad (or leverage) of the absorption of tradables. Thus, high values of 1-ω mean that a country relies less on its own financing of the absorption of tradables, and is therefore more vulnerable to RER depreciation stemming from closure of the current account gap. Notice that the denominator in (7) is the absorption of tradables, and not GDP. This points to the fact that normalization of the current account deficit by the absorption of tradables may be more suitable than normalization by GDP when analyzing vulnerability to Sudden Stops.

In order to construct a measure of 1-ω, the first component of balance-sheet effects tracking potential changes in RER, we need to obtain a value for the absorption of tradable goods (Z), which is composed of imports plus a fraction of the supply of tradable goods. We do this by proxying tradable output by the sum of agriculture plus industrial output, i.e., we exclude services from total output. Next, we obtain the fraction of tradable output consumed domestically by subtracting exports from tradable output, and adding imports to the latter in order to get a measure of Z. Having computed values for Z, and using *CAD* data, we get values for 1-ω as indicated by equation (7) (see the Data Appendix for details on definitions and sources for all the variables used in this section).

Our empirical strategy also highlights DLD, the second component of potential balance sheet effects, a phenomenon rarely considered in empirical studies of crises determination, with a few exceptions such as Arteta (2003), who explores the significance of Liability Dollarization in explaining the likelihood of a currency crisis. Interestingly, he finds no significant role for Liability Dollarization. This result is not incompatible with our findings below, given that we do not focus on currency crises, and, as stated earlier, the timing of currency crises may be quite different from that of Sudden Stops. Moreover, as it will become clear later on, our measure of dollarization is different.[26] A previous version of our study (Calvo, Izquierdo and Mejia (2004)) was the first to introduce the concept of DLD in determining the probability of a crisis. Here we conduct a much more comprehensive analysis by including a larger set of 110 countries for which DLD data is now available.[27]

For developed countries, DLD is defined as BIS reporting banks' local asset positions in foreign currency as a share of GDP. Such data is not available for EMs, so we construct a proxy by adding up dollar deposits and domestic banks' foreign borrowing as a share of GDP. This measure should be a good proxy for liability dollarization, under the assumption that banks have a tendency to match the size of their assets and liabilities for each currency denomination.[28] Data on dollar deposits comes from Levy Yeyati (2006), who, in turn, builds upon the dataset used by Honohan and Shi (2002). Data on bank foreign borrowing is obtained from IMF IFS (see the Data Appendix for a full description).

Notice that, in contrast to measures of DLD previously used in the literature—e.g., scaling dollar credit as a share of total credit, or dollar deposits as a share of total deposits (as in Arteta (2003))—we rely on liability dollarization as a share of GDP. This is particularly relevant to capture the fact that even though financial systems may not be heavily dollarized when considering the share of dollar liabilities in total liabilities, the size of the banking system may be sufficiently large that dollar liabilities as a share of GDP constitute a sizeable burden to the economy in the event of large RER depreciation. For example, a region like East Asia, where

[26] Our sample of countries is also different and much larger than that in Arteta (2003).
[27] In a related study, Cavallo and Frankel (2004), using a similar definition of Sudden Stop to that in Calvo, Izquierdo and Mejia (2004), also introduce measures of dollarization more akin to those in Arteta (2003). These alternative measures provide mixed results in terms of their contribution to the likelihood of a Sudden Stop. It is also worth mentioning that our approach focuses on the impact of dollarization on the likelihood of a Sudden Stop, rather than on the consequences of dollarization and Sudden Stops on relevant variables such as economic growth, as in Edwards (2003).
[28] Evidence on currency matching of bank assets and liabilities for EMs can be found in Inter-American Development Bank (2004).

the share of dollar liabilities in total liabilities was not large, comes at a par with Latin America, where the share of dollar liabilities is big, yet the size of the banking system is small. One problem with this measure is that ideally one would like to capture only foreign-exchange denominated loans to nontradable sectors. This would not be a major problem if the share of foreign-exchange denominated loans to non-tradables in total foreign-exchange denominated loans were about the same across countries. Preliminary evidence for a small subset of countries for which information is available suggests that there is a positive correlation between the degree of DLD and the share of dollar loans to non-tradable sectors in total dollar loans, possibly reflecting the fact that nontradable sectors are a major client of domestic banking systems.[29] Another possibility that would validate our procedure is that in the short run most goods are de facto nontradable. This has some support in recent crisis episodes in which affected countries saw export credit dry up, seriously impairing their ability to export even though large currency devaluation made exports extremely competitive (e.g., Korea and Thailand in 1997, and Brazil in 2002).

Our estimation procedure uses as a benchmark a panel Probit model that approximates the probability of falling into a full-fledged 3S episode as a function of lagged values of $1-\omega$ and DLD, controlling for a set of macroeconomic variables typically used in the literature on determinants of crises—which we describe later— and time effects using year dummies.[30] We use random effects to control for heterogeneity across panel members.[31]

[29] Based on information used in Inter-American Development Bank (2004).

[30] The use of a Probit model and the construction of a dichotomous Sudden Stop variable are due to our belief that large and unexpected capital flow reversals have non-linear effects, as they trigger substantial balance-sheet fluctuations that may lead to serious credit constraints or plain bankruptcies. An alternative, which is not explored in this paper, would be to use regime-switching models.

[31] Particular attention will be paid to estimation problems that arise from the inclusion of potentially endogenous variables within a Probit with random effects. See both the robustness section as well as the Technical Appendix for a discussion.

In order to reduce endogeneity issues, and given that many of the variables used in our estimations come at an annual frequency, we switch to lagged yearly data.[32] We are particularly interested in lagged 1-ω because it proxies for the potential change in relative prices that could occur were the country to face an incipient Sudden Stop (recall the discussion in Section III), something that would not be conveyed by contemporaneous 1-ω once the current account gap is closed and relative prices have adjusted.

A first set of regression results is presented in Appendix Table 2 (robustness checks, focusing on potential endogeneity issues between lagged 1 - ω and the latent variable behind the construction of the Sudden Stop indicator, as well as estimations that focus only on developing countries are presented later in Appendix Tables 3 through 5). They indicate that both 1 - ω and DLD are significant at the 1% level in most specifications. These results withstand the inclusion of a set of control variables typically used in the literature, including measures of financial integration such as the stock of FDI assets plus liabilities (as a share of GDP) and the stock of portfolio assets plus liabilities (as a share of GDP), terms of trade growth, the public sector balance and public external debt (all expressed as shares of GDP), the ratio of M2 to international reserves, as well as two different measures of exchange rate flexibility, and a developing country dummy (see columns 2 to 10 of Appendix Table 2).

Balance-sheet effects can be assessed by focusing on the interaction of ω and DLD, which is particularly amenable to Probit models given their non-linear nature. We find that the effects of ω on the probability of a Sudden Stop crucially depend on the degree of DLD. Low values of ω (high leverage of CAD) imply a higher probability of Sudden Stop, but this is particularly so for dollarized economies. These effects are not only statistically significant, but

[32] Except for terms-of-trade growth, a variable that enters contemporaneously in our estimations.

economically significant as well. Consider, for example, the effects of varying ω on the probability of a Sudden Stop, keeping all other variables constant at their means, except for DLD, which could be low (5th percentile in our sample), average, or high (95th percentile). This is represented in Figure 2 (panel A).[33] For small values of ω, there are substantial differences in the probability of a Sudden Stop depending on whether DLD is low or high. Take, for example, any two countries with a value of ω of 0.6 (the lowest measure of ω in our sample), and assume that the first country is highly dollarized (dotted line), whereas the second country is not (solid line). The probability of a Sudden Stop in the highly dollarized country exceeds that of the lowly dollarized country by about 17 percentage points. Now evaluate this difference for the same two countries when ω is equal to 1 (i.e., when $CAD = 0$). The difference in the probability of a Sudden Stop is now only about 5 percentage points, about 30 percent of the difference at the lower ω level. The high non-linearity described by the data implies that low ω and high dollarization can be a very dangerous cocktail, as potential balance sheet effects become highly relevant in determining the probability of a Sudden Stop. The effects of DLD on the probability of a Sudden Stop are particularly important for emerging markets. By end-1997—on the eve of the Russian crisis—61 percent of EMBI+ countries in our sample lay above the dollarization median, whereas 80 percent of developed countries lay below the dollarization median.[34]

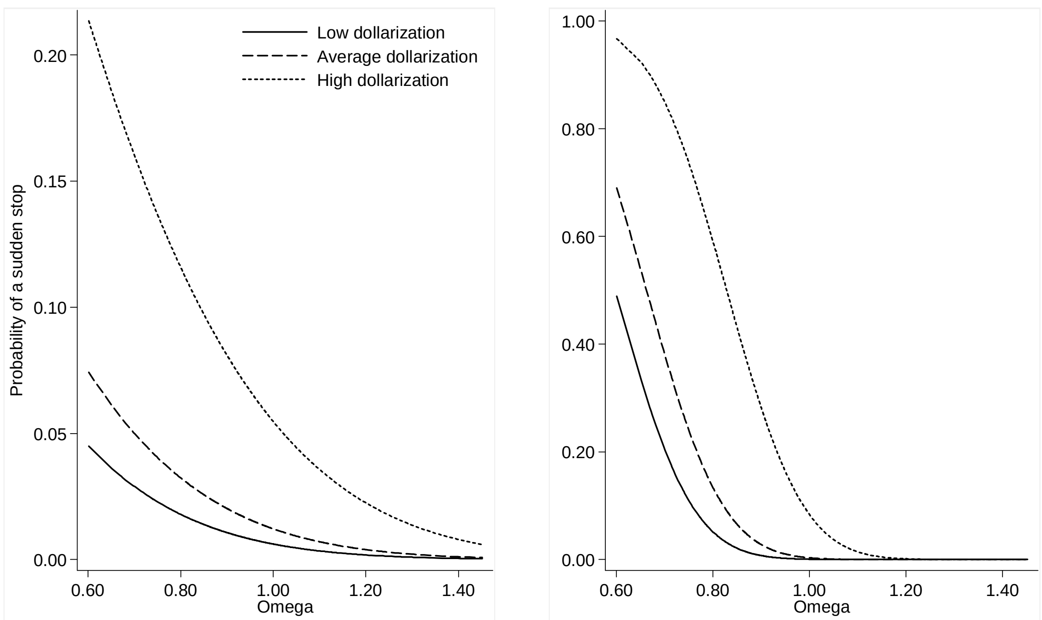
[33] For illustration purposes, we use estimations shown in column (7) of Table 2 of the Appendix to construct this figure.
[34] Other developing countries are roughly evenly split above and below the median.

Figure 2

Probability of a Sudden Stop for Different Values of ω and Domestic Liability Dollarization in the Average Country

Not controlling for the endogeneity of ω — (A)

Controlling for the endogeneity of ω — (B)



We now turn to the set of variables used as controls in our regressions. We first focus on measures of financial integration based on data constructed by Lane and Milessi-Ferretti (2006). The first measure adds the absolute value of previous period FDI asset and liability stocks as a share of GDP, while the second measure does the same for portfolio stocks. A first pass suggests that both measures are broadly significant (mostly at the five percent level, although not consistently significant across specifications), indicating that higher integration reduces the probability of a Sudden Stop (however, these results will change for lower levels of integration when considering non-linear effects, described in the next section).[35]

[35] Debt stocks are not included because they are partly captured by public external debt and bank foreign borrowing (via their participation in DLD).

The coefficient accompanying terms-of-trade growth is negative as expected but not significant at the five percent level. (Appendix Table 2, columns 5 through 10). Another variable of interest regarding Sudden Stops is the exchange rate regime. Two measures of exchange rate regime flexibility were used alternatively in the estimations presented in Appendix Table 2 (columns 7 through 10). These measures are those constructed by Levy-Yeyati and Sturzenegger (2002), who classify the flexibility of exchange rate regimes based on exchange rate volatility, exchange-rate-changes volatility, and foreign reserves volatility.[36] The first, narrower measure, classifies regimes into floating regimes, intermediate regimes, and fixed regimes, while the second measure extends this classification to 5 categories. This first pass suggests that both measures of exchange rate flexibility turn out not to be significant (although, as reported later, results are significant when focusing only on the developing country group and correcting for potential endogeneity issues). This finding may initially seem somewhat puzzling, but it can be explained by the fact that the loss of access to international credit is a real phenomenon with real effects such as output contraction, which in principle does not rely on the behavior of nominal variables. Indeed, the framework presented in Section II does not rely on any particular nominal setup to explain the change in relative prices following a Sudden Stop, which would materialize under both flexible and fixed exchange rate regimes. As a matter of fact, models that provide a full-fledged version of the effects of Sudden Stops on output such as Izquierdo (1999), Arellano and Mendoza (2002), and Calvo (2003) are concerned with real effects that are independent of nominal arrangements. Of course, this does not rule out very different short-term dynamics, which are likely to be dependent on nominal arrangements, as was evidenced by the very dissimilar behavior of several emerging economies after the Sudden Stop triggered by the Russian crisis of 1998. Even though most countries hit by Sudden Stops eventually experienced

[36] Given the way the index was originally constructed, a higher value indicates less exchange rate flexibility.

substantial real currency depreciation and output loss, the dynamics were very different for countries like Colombia, for example, which quickly depreciated its currency and withstood the real shock sooner, and Argentina, which took much longer to correct the resulting RER misalignment.[37]

At a first glance, other macroeconomic variables that we added for control, including government balance as a share of GDP, and public sector external debt as a share of GDP (to capture effects in the same vein as our DLD variable) do not turn out to be significant across specifications (at least when not controlling for potential endogeneity of ω; we address this issue later on (see page 24)), although their coefficients show the expected signs. This is broadly consistent with other empirical work on the determinants of crises that do not find a strong relationship between these variables and the probability of crisis. The fact that ω as well as domestic DLD remain significant, while public external debt measures do not, suggests that valuation effects, coupled with the materialization of contingent liabilities resulting from public sector bailouts of private sector debts against the financial system may be key in explaining the likelihood of a Sudden Stop.[38]

A measure of the potential money and quasi-money liabilities that could run against international reserves, captured by the M2 to reserves ratio, was also added to the control group; again, although the coefficient accompanying this variable is positive, it is not statistically significant at the 10 percent level.

Finally, another vulnerability measure that has been associated with financial crises is the ratio of short-term debt to international reserves. Rodrik and Velasco (1999) use two versions of

[37] See Calvo, Izquierdo and Talvi (2002) for a more detailed discussion.
[38] An example backing this assertion is the case of Korea, where public sector debt represented only 10 percent of GDP prior to its 1997 Sudden Stop, before quadrupling once the financial sector bailout was added to the fiscal burden.

this variable as a determinant of financial crises for a group of emerging markets—separating short-term debt to foreign banks from other foreign short-term debt—and find these variables to be significant in explaining the probability of a financial crisis. In a separate exercise, we use the same (but updated) data source employed in their study (the International Institute of Finance's (IIF) database, comprising 31 emerging markets, substantially shrinking the sample size) to evaluate the impact of alternative measures of the short-term-debt-to-reserves ratio on the probability of a Systemic Sudden Stop. For this relatively small subset of countries (compared to our sample of 110 countries used in other estimations), and controlling for balance-sheet effects, we do not find consistent evidence of either measure of short-term-debt-to-reserves-ratios being significant as a determinant of Systemic Sudden Stops.[39] This evidence is more in line with Frankel and Rose (1996), who find that short-term debt does not have an incidence on currency crises, and Eichengreen and Rose (1998), who actually find that short-term debt may decrease the probability of banking crises.

Robustness Checks

Addressing Endogeneity. Preliminary results indicate that a key driver of the balance-sheet effects affecting the probability of a Sudden Stop is the potential change in relative prices captured by $1 - \omega$. Yet it is quite likely that this particular variable could be endogenous with the latent variable behind Sudden Stops (capital flows) given their tight linkages through adjustments in the balance of payments, as well as unobserved and persistent characteristics common to both variables. Such would be the case of variables proxying credibility or political factors. To tackle this potential endogeneity problem, we carried out a Rivers-Vuong test to the

[39] In part, this result may be due to the lack of control groups (i.e., other developing and developed countries for which IIF does not report data). Results are available upon request.

estimations previously presented in Appendix Table 2.[40] Based on the results of this test (see Appendix Table 3), we cannot reject the presence of endogeneity since the residuals obtained in the first stage of this method are significant in Probit estimations.[41] A second element to consider is that this correction for endogeneity is done in the presence of random effects. Therefore, in order to assess the significance of all variables included in the estimations in the presence of endogeneity and random effects, we need to construct appropriate measures of the standard deviation of their coefficient estimators, as standard test statistics may no longer be valid (see the Statistical Appendix for a discussion). In order to do this, we rely on a non-parametric hierarchical two-step bootstrap methodology. Random effects introduce an intra-group correlation structure among observations. This is accounted for by first randomly sampling countries with replacements, and, in a second stage, randomly sampling without replacement within the countries sampled in the first stage. According to Davison and Hinkley (1997), this procedure closely mimics the intra-group correlation structure of the data mentioned above (see the Technical Appendix for a detailed explanation). Confidence intervals are computed using the percentile method at the 1, 5 and 10 percent significance levels, based on 500 replications.

Including residuals of the first-stage regression in Probit estimations to control for endogeneity and using bootstrapped confidence intervals, we confirm that both $1\text{-}\omega$ and domestic liability dollarization remain significant, this time at the 1 percent level in every specification.

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[40] Probit models can be reduced to latent variable models. For this particular case where endogeneity in $1\text{-}\omega$ is suspected, a system of two equations can be defined, one representing the latent variable behind the Sudden Stop variable (which is assumed to be a linear function of all variables in the Probit, including $1\text{-}\omega$), the other representing $1\text{-}\omega$, which is considered to be a linear function of all other variables included in the Probit estimation, as well as a lag in $1\text{-}\omega$. Residuals from this second regression are included in the Probit regression to determine their significance. If the latter are significant, endogeneity cannot be rejected. For further details, see Rivers and Vuong (1988), or Wooldridge (2002).

[41] Following the Rivers-Vuong approach, in the first stage we used all the other explanatory variables in the Probit equation and the second lag of ω as instruments of the potentially endogenous variable (ω_{t-1}).

Results are reported in Appendix Table 3. It is worth considering that, in particular, the coefficient accompanying 1-ω increases substantially compared to results shown in Appendix Table 2, indicating that the relevance of 1-ω increases once controlling for endogeneity.[42] This can be seen graphically by replicating panel (A) of Figure 2 with the new estimates, to show that for any given value of 1-ω, the probability of a Sudden Stop increases compared to previous estimates that do not control for endogeneity (see panel B of Figure 2). Also, the non-linearity of balance-sheet effects prevails.

After controlling for endogeneity and using bootstrapped confidence intervals, the public sector balance becomes significant at the five percent level in all specifications. Some specifications show significance in terms of trade growth, although not consistently across all specifications.

Working with the developing country sample. In order to explore whether differences in potential balance-sheet effects remain a key explanatory variable within the developing-country group, and that they are not just capturing differences between developing and developed countries (despite the inclusion of a developing country dummy), we repeat our estimations, this time excluding developed countries. Results (already controlling for endogeneity and using bootstrapped confidence intervals) are shown in Appendix Table 4. Interestingly, we confirm the same results reached with the full dataset. Both 1 - ω and DLD remain significant at the 1% level. Public balance is significant at the 1 percent level across most specifications and terms of trade growth is significant at the 5 percent level in columns (4) and (5). This last result is consistent with the case made by Caballero and Panageas (2003) that in countries where commodities are relevant, a fall in commodity prices may be accompanied by a Sudden Stop,

[42] None of the previous point estimates of the coefficient accompanying 1-ω in Appendix Table 2 fall within the confidence interval shown in Appendix Table 3.

thus amplifying the original shock. But perhaps the key element to highlight here is that, for the group of developing countries, the exchange rate regime is significant across different definitions (3-way and 5-way classification) in some specifications, in the sense that fixed exchange rate regimes are associated with a higher probability of a Sudden Stop.

Non-linearities in Portfolio Integration. An interesting result of having split the sample to include developing countries only is that portfolio integration changes sign and is significant at the 1 or 5 percent level in most specifications (see Appendix Table 4), indicating that the probability of a Sudden Stop *increases* with portfolio integration for this particular group. This stands in stark contrast to results stemming from estimations including developed countries, for which the probability of a Sudden Stop *decreases* with financial integration. Bordo (2007) suggests that so-called "financial revolutions" leading to *financial stability* depend on a set of "deep institutional factors" that countries can grow up to based on a learning process derived from experiencing financial crises. This would imply that while countries are integrating, they may be prone to financial crises, from which they can learn, so as to advance in their integration process until they become financially stable and therefore devoid of episodes such as Sudden Stops.[43]

Our findings regarding the switching sign of portfolio integration and the view stated above led us to explore the issue of non-linearities in financial integration. To this effect, we included a quadratic term of our portfolio integration measure in our estimations for the full sample including both developing and developed countries (see Appendix Table 5).[44] The coefficient accompanying this quadratic term is negative and significant at the 1 percent level

[43] Recently, Ranciere et. al. (2006) show that while developing countries may be exposed to crises, there are still long-term benefits stemming from financial liberalization. Their empirical findings show that financial liberalization fosters economic growth at the cost of a higher propensity to crises. Overall, they find a positive net effect of financial liberalization on growth.

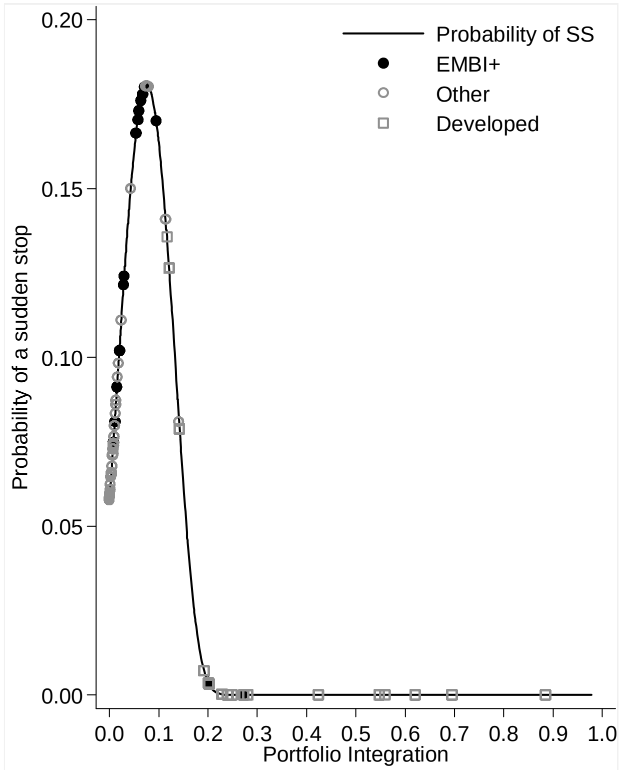
[44] These estimations already control for endogeneity in $1-\omega$ and use bootstrapped confidence intervals.

accross specifications, while the linear term of portfolio integration is positive and significant at the 1 percent level. The inclusion of a quadratic term does not affect the significance at the 1 percent level of 1-ω or DLD across specifications, while the coefficient accompanying FDI integration is negative and now significant in almost all specifications. The public sector balance remains significant at the five percent level.

Figure 3 depicts the relevance of non-linearities in portfolio integration with respect to the probability of a Sudden Stop. Using estimations shown in column (4) of Appendix Table 5 (and keeping all other variables at their sample means), results suggest that countries with portfolio integration below 7.6 percent of GDP face an increasing probability of a Sudden Stop while, beyond this threshold, the probability of a Sudden Stop decreases with portfolio integration. Of particular interest is the placement of developed, EMBI+, and other developing countries along this figure. Notice that while most developed countries lie to the very right, and other developing countries mostly lie to the left, emerging markets that are part of the EMBI+ index are concentrated in the region where the probability of a Sudden Stop is the highest. This is the group of countries that despite the benefits of financial integration may be facing the challenge of developing deep institutions that will ensure financial stability and reduce the probability of financial crises. An interesting result of this analysis is that it provides a rationale for a classification of emerging markets in accordance with their particular positioning in terms of integration and the likelihood of experiencing a Sudden Stop (a complete list of countries used in estimations and their position in terms of integration is provided in Table 6).

Figure 3

Probability of a Sudden Stop for Different Values of Portfolio Integration



Note: The probability of a sudden stop is based on the estimation shown in column (4) of Appendix Table 5, with all other variables affecting the probability of a Sudden Stop evaluated at their sample means.

V. Conclusions

Focusing on the characteristics and determinants of large capital flow reversals of a systemic nature (suggestive of shocks to the supply of international funds) for a large set of developing and developed countries, we obtained a few key empirical findings that open up several areas of research:

- Systemic Sudden Stops tend to come hand in hand with large RER fluctuations, a key ingredient for balance-sheet effects.
- Sudden Stops seem to come in bunches, grouping together countries that are different in many respects, such as fiscal stance, monetary and exchange rate arrangements. This

particular type of bunching suggests that when analyzing Sudden Stops, careful consideration should be given to financial vulnerabilities to external shocks.

- A small supply of tradable goods (relative to the absorption of tradable goods), a proxy for large potential changes in the RER, and Domestic Liability Dollarization, are key determinants of the probability of a Sudden Stop.
- Both the supply of tradable goods as well as the currency structure of Balance Sheets are in many respects the result of *domestic* policies. Countries may be tested by foreign creditors, but vulnerability to Sudden Stops is enhanced by domestic factors, such as tariff and competitiveness policies affecting the supply of tradable goods, and badly managed fiscal and monetary policies that result in Domestic Liability Dollarization.
- The effect of balance-sheet factors on the probability of a Sudden Stop could be highly non-linear. In particular, high leverage of tradables' absorption and high Domestic Liability Dollarization could be a dangerous cocktail.
- The probability of a Sudden Stop initially increases with financial integration—departing from low levels of financial integration—but eventually decreases, and is virtually nil at high levels of integration. Emerging markets largely stand in a gray area in-between developed and other developing countries, where the probability of a Sudden Stop is the highest, suggesting that financial integration can be risky when not accompanied by the development of institutions that will support the use more sophisticated and credible financial instruments.

Although our work has established the empirical relevance of balance-sheet effects on the likelihood of Sudden Stops, it does not cover two other topics that represent important extensions of the present line of research, namely, the consequences of Sudden Stops and balance sheet effects on economic growth, particularly in dollarized economies, as well as the role that international reserves could have in lowering the probability of Sudden Stops, by ameliorating the impact of balance-sheet effects .[45] [46] We leave these topics for future research.

[45] Relevant work in this direction has recently been conducted by Edwards (2003), Ranciere, Tornell and Westermann (2006), but balance-sheet effects still need to be incorporated into this line of research.

[46] Preliminary work by Calvo, Izquierdo and Loo-Kung (forthcoming) suggests that DLD net of foreign reserves as a share of GDP also works as a significant determinant of the probability of a Systemic Sudden Stop. This result could be used to compute an optimal level of international reserves that balances the costs of holding reserves against the benefit of lowering the probability of Sudden Stop.

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Appendix Table 1
List of Systemic Sudden Stop Episodes

Country	Begins	Ends	Country	Begins	Ends
Developing countries			*Developing countries (continued)*		
Angola	1999m12	2001m3	Malawi	1997m12	1998m2
Argentina	1995m1	1995m12	Malaysia	1994m12	1995m9
Argentina	1999m5	1999m11	Mexico	1994m3	1995m11
Armenia	1997m12	1998m1	Moldova	1998m6	1999m8
Armenia	1998m9	2000m2	Mozambique	1995m3	1996m5
Azerbaijan	1997m9	1998m3	Nepal	1998m5	1999m7
Azerbaijan	1999m11	2001m4	Oman	1999m11	2001m4
Barbados	1999m1	1999m3	Pakistan	1995m9	1996m2
Belarus	1999m2	2000m1	Pakistan	1998m5	1999m1
Belize	1994m10	1995m9	Paraguay	1999m9	2001m5
Bolivia	1999m12	2000m10	Peru	1997m7	1998m2
Brazil	1995m1	1995m6	Peru	1999m2	1999m11
Brazil	1998m9	1999m8	Philippines	1995m5	1995m11
Bulgaria	1995m12	1996m10	Philippines	1997m5	1999m7
Cape Verde	1993m9	1994m7	Poland	1999m3	2000m5
Cape Verde	1997m3	1998m1	Sierra Leone	1998m1	1998m11
Chile	1995m10	1996m8	Slovak Republic	1997m7	1998m4
Chile	1998m6	1999m6	Slovak Republic	1999m5	1999m9
Colombia	1997m12	2000m7	Slovenia	1998m6	1999m6
Costa Rica	1998m8	2000m8	Sri Lanka	1995m1	1996m8
Croatia	1998m9	1999m11	St. Kitts and Nevis	1993m7	1994m6
Dominican Republic	1994m3	1995m5	St. Vincent and the Grenadines	1995m2	1995m9
Ecuador	1995m5	1996m11	St. Vincent and the Grenadines	1999m3	1999m9
Ecuador	1999m7	2000m10	Suriname	1993m1	1994m5
El Salvador	1999m2	1999m10	Thailand	1996m12	1998m7
Estonia	1998m10	2000m2	Tonga	1998m4	1998m9
Guinea-Bissau	1999m1	1999m6	Turkey	1994m3	1995m1
Honduras	1995m10	1996m9	Turkey	1998m10	1999m9
Hong Kong, China	1998m7	1999m7	Uruguay	1999m3	1999m4
Indonesia	1997m12	1998m11	Uruguay	1999m12	2000m2
Indonesia	1999m12	2000m11	Yemen, Rep.	1994m6	1996m3
Jordan	1994m12	1995m5	Zimbabwe	1992m8	1994m10
Jordan	1998m10	1999m6	Zimbabwe	1997m6	1998m6
Korea, Rep.	1997m8	1998m11	Zimbabwe	1999m9	2001m5
Lao PDR	1997m7	1998m9	*Developed countries*		
Latvia	1999m4	1999m9	Austria	1992m2	1992m2
Lithuania	1999m5	2000m5	France	1992m1	1992m9
			Greece	1992m11	1993m7
			Portugal	1992m10	1993m9
			Spain	1992m4	1993m8
			Sweden	1992m1	1992m3

Appendix Table 2

Panel PROBIT

All Countries – Dependent Variable: Systemic Sudden Stop

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$1-\omega_{t-1}$	1.583	1.339	2.986	2.828	2.249	2.793	2.022	2.010	1.957	1.656
	(0.489)***	(0.495)***	(0.679)***	(0.683)***	(0.709)***	(0.658)***	(0.711)***	(0.709)***	(0.718)***	(0.771)**
DLD $_{t-1}$	1.005	0.769	2.109	2.168	2.611	1.571	1.977	1.957	2.063	2.203
	(0.419)**	(0.421)*	(0.726)***	(0.736)***	(0.812)***	(0.631)**	(0.786)**	(0.784)**	(0.808)**	(0.825)***
Developing Dummy		0.859	0.482	0.075	-0.218	0.184	0.132	0.120	0.274	0.249
		(0.315)***	(0.343)	(0.424)	(0.454)	(0.366)	(0.451)	(0.448)	(0.474)	(0.548)
FDI Integration $_{t-1}$			-1.803	-1.359	-0.671	-1.223	-0.840	-0.833	-0.806	-0.923
			(0.530)***	(0.527)***	(0.581)	(0.463)***	(0.578)	(0.576)	(0.587)	(0.608)
Portfolio Integration $_{t-1}$				-3.022	-5.018	-2.531	-4.460	-4.462	-4.953	-4.269
				(1.872)	(2.167)**	(1.667)	(2.150)**	(2.142)**	(2.220)**	(2.299)*
TOT Growth $_t$					-0.752	-0.233	-0.585	-0.575	-0.542	-0.354
					(0.745)	(0.707)	(0.767)	(0.767)	(0.777)	(0.807)
Public Balance/GDP $_{t-1}$						-0.006	-0.004	-0.004	-0.003	-0.003
						(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
Ex. Regime 3 $_{t-1}$							0.151			
							(0.116)			
Ex. Regime 5 $_{t-1}$								0.092	0.098	0.097
								(0.074)	(0.075)	(0.077)
M2 over Reserves $_{t-1}$									0.014	0.014
									(0.011)	(0.012)
Public External Debt/ GDP $_{t-1}$										0.000
										(0.000)
Constant	-2.432	-3.060	-2.077	-1.776	-2.318	-1.486	-2.579	-2.587	-2.871	-2.863
	(0.197)***	(0.339)***	(0.359)***	(0.437)***	(0.472)***	(0.373)***	(0.546)***	(0.555)***	(0.611)***	(0.669)***
Observations	1081	1081	927	921	903	849	796	796	795	661
Number of Countries	110	110	94	94	90	84	83	83	83	72
McFadden adj R2	0.138	0.146	0.176	0.187	0.207	0.120	0.216	0.216	0.215	0.196
% correctly predicted (PCP)	0.884	0.884	0.894	0.893	0.889	0.876	0.883	0.887	0.889	0.870
Adjusted PCP	-0.025	-0.025	0.125	0.116	0.065	0.000	0.079	0.109	0.129	0.122

Standard errors in parentheses. All regressions include time dummies and random effects.

* significant at 10%, ** significant at 5%, *** significant at 1%.

Appendix Table 3

Panel PROBIT – Rivers & Voung Approach

All Countries – Dependent Variable: Systemic Sudden Stop

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Residuals $_{t}$	-3.485***	-3.344***	-7.839***	-7.776***	-8.812***	-7.321***	-7.795***	-7.748***	-7.597***	-12.172***
	[-8.34,-1.97]	[-8.20,-1.85]	[-15.55,-5.49]	[-17.41,-5.59]	[-21.35,-6.11]	[-16.12,-5.17]	[-19.81,-3.82]	[-19.82,-5.58]	[-21.38,-4.81]	[-40.69,-5.32]
l-ω $_{t-1}$	3.490***	3.224***	8.895***	8.920***	9.443***	8.250***	8.012***	7.969***	7.781***	12.127***
	[2.61,9.47]	[2.39,9.03]	[6.97,18.94]	[7.66,24.40]	[7.63,25.34]	[6.26,20.04]	[5.93,26.58]	[5.89,26.21]	[6.42,28.31]	[8.75,47.90]
DLD $_{t-1}$	1.983***	1.755***	4.119***	3.900***	4.164***	3.227***	4.100***	4.062***	4.082***	2.324***
	[1.06,4.92]	[0.12,4.83]	[3.29,8.68]	[2.70,8.92]	[3.01,9.89]	[2.17,8.22]	[3.33,11.93]	[3.14,11.55]	[3.32,13.03]	[1.29,8.07]
Developing Dummy		0.757**	0.03	-0.379	-0.01	0.172	-0.055	-0.073	0.099	-0.185
		[0.13,2.25]	[-0.64,0.99]	[-1.48,0.92]	[-1.06,1.21]	[-0.65,1.43]	[-1.37,1.61]	[-1.33,1.63]	[-1.27,1.71]	[-1.67,1.54]
FDI Integration $_{t-1}$			-2.675***	-2.129***	-0.969**	-1.660***	-1.958***	-1.920***	-1.806***	-2.665***
			[-6.45,-2.23]	[-5.86,-1.45]	[-3.71,-0.18]	[-4.69,-0.74]	[-8.51,-0.37]	[-8.47,-1.18]	[-9.36,-0.62]	[-8.94,-1.85]
Portfolio Integration $_{t-1}$				-3.112	-2.672	-1.249	-2.683	-2.694	-2.413	-0.47
				[-8.92,0.28]	[-9.72,0.58]	[-5.06,2.21]	[-10.61,1.76]	[-11.06,1.79]	[-10.80,1.85]	[-7.17,4.81]
TOT Growth $_{t}$					-1.363*	-1.296*	-0.903	-0.898	-0.914	-0.734
					[-4.58,-0.14]	[-3.78,-0.15]	[-3.79,0.81]	[-3.54,0.76]	[-3.90,0.73]	[-3.58,0.94]
Public Balance/GDP $_{t-1}$						-0.065**	-0.093**	-0.093***	-0.091**	-0.100***
						[-0.19,-0.03]	[-0.47,-0.03]	[-3.91,-0.02]	[-0.36,-0.02]	[-1.40,-0.02]
Ex. Regime 3 $_{t-1}$							0.182			
							[-0.02,0.60]			
Ex. Regime 5 $_{t-1}$								0.093	0.092	0.081
								[-0.04,0.36]	[-0.05,0.33]	[-0.06,0.33]
M2 over Reserves $_{t-1}$									0.005	-0.007
									[-0.03,0.03]	[-0.06,0.02]
Public External Debt/ GDP $_{t-1}$										0.000
										[-0.00,0.00]
Constant	-2.610***	-3.169***	-2.108***	-1.847***	-3.135***	-2.083***	-3.090***	-3.029***	-3.266***	-2.7294***
	[-4.24,-2.75]	[-6.0, -3.28]	[-4.29,-1.83]	[-4.39, -1.27]	[-6.25, -2.87]	[-4.53, -1.58]	[-8.46,-2.64]	[-16.96,-2.67]	[-9.62, -2.85]	[-17.04, -1.87]
Observations	1071	1071	919	913	897	843	792	792	791	658
Number of Countries	110	110	94	94	90	84	83	83	83	72
McFadden adj R2	0.144	0.15	0.229	0.232	0.261	0.182	0.286	0.285	0.280	0.273
% correctly predicted (PCP)	0.873	0.875	0.887	0.885	0.893	0.875	0.896	0.895	0.900	0.881
Adjusted PCP	-0.115	-0.098	0.071	0.063	0.103	0.000	0.188	0.178	0.218	0.204

All regressions include time dummies and random effects.

- significant at 10%, ** significant at 5%, *** significant at 1%, using bootstrapped confidence intervals constructed by the percentile method, shown in brackets.

Appendix Table 4
Panel PROBIT – Rivers & Voung Approach
Developing Countries – Dependent Variable: Systemic Sudden Stop

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Residuals $_t$	-4.327***	-8.898***	-9.718***	-10.674***	-10.035***	-9.082***	-9.008***	-8.820***	-13.806***
	[-10.85,-1.34]	[-24.07,-5.86]	[-32.82,-5.99]	[-33.07,-6.82]	[-33.11,-6.05]	[-30.03,-5.61]	[-29.75,-5.06]	[-28.88,-5.66]	[-50.70,-7.35]
l-ω $_{t-1}$	3.681***	9.037***	9.865***	10.876***	9.978***	8.893***	8.823***	8.625***	13.259***
	[2.13,10.59]	[6.01,31.34]	[7.51,37.21]	[8.71,39.70]	[7.43,41.68]	[7.35,34.11]	[6.61,33.12]	[6.09,31.45]	[10.38,58.06]
DLD $_{t-1}$	2.387***	4.138***	3.587***	3.720***	3.578***	3.771***	3.728***	3.715***	2.477***
	[1.12,7.16]	[3.02,11.16]	[2.60,12.33]	[2.74,11.96]	[2.54,12.61]	[3.16,14.24]	[3.11,13.38]	[3.02,12.31]	[1.29,11.11]
FDI Integration $_{t-1}$		0.229	-0.732**	-0.459	-1.170**	-1.196**	-1.153**	-1.145**	-1.314**
		[-1.24,1.15]	[-3.24,-0.02]	[-2.85,0.36]	[-5.87,-0.15]	[-6.99,-0.32]	[-6.55,-0.02]	[-5.85,-0.26]	[-6.13,-0.07]
Portfolio Integration $_{t-1}$			7.914***	8.202***	8.274***	6.895***	6.706**	6.505**	3.827
			[0.91,28.89]	[0.53,36.30]	[0.98,31.00]	[0.38,32.01]	[2.75,22.64]	[2.17,22.58]	[-0.44,14.19]
TOT Growth $_t$				-1.924**	-2.015**	-1.504	-1.493	-1.454	-1.519*
				[-6.32,-0.52]	[-6.58,-0.11]	[-4.72,0.02]	[-5.00,0.02]	[-4.86,0.11]	[-5.18,-0.17]
Public Balance/GDP $_{t-1}$					-0.103**	-0.099***	-0.098***	-0.097***	-0.096***
					[-0.45,-0.03]	[-5.26,-0.02]	[-7.46,-0.01]	[-4.39,-0.02]	[-6.30,-0.01]
Ex. Regime 3 $_{t-1}$						0.249**			
						[0.04,1.00]			
Ex. Regime 5 $_{t-1}$							0.133*	0.129	0.068
							[0.03,0.53]	[-0.01,0.54]	[-0.10,0.40]
M2 over Reserves $_{t-1}$								0.01	0.013
								[-0.03,0.06]	[-0.02,0.07]
Public External Debt/ GDP $_{t-1}$									0.000
									[-0.00,0.00]
Constant	-3.685***	-4.162***	-4.043***	-4.307***	-4.051***	-4.465***	-4.416***	-4.420***	-4.137***
	[-6.93,-3.77]	[-13.10,-4.16]	[-10.11,-4.04]	[-10.69, -4.21]	[-12.26,-3.95]	[-13.76, -4.65]	[-17.67, -4.41]	[-12.98, -4.26]	[-14.15, -3.93]
Observations	833	681	675	660	606	566	566	565	540
Number of Countries	89	73	73	70	64	63	63	63	60
Mcfadden R2	0.225	0.306	0.304	0.304	0.315	0.310	0.309	0.305	0.299
% correctly predicted (PCP)	0.845	0.858	0.858	0.862	0.863	0.862	0.862	0.869	0.867
Adjusted PCP	-0.085	0.093	0.103	0.108	0.170	0.196	0.196	0.237	0.242

All regressions include time dummies and random effects.
* significant at 10%, ** significant at 5%, *** significant at 1%, using bootstrapped confidence intervals constructed by the percentile method, shown in brackets.

Appendix Table 5

Panel PROBIT – Rivers & Voung Approach – Non-linear Portfolio Integration
All Countries – Dependent Variable: Systemic Sudden Stop

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Residuals $_{t}$	-8.462***	-9.253***	-8.624***	-7.865***	-7.628***	-7.920***	-12.376***
	[-19.29,-5.20]	[-19.64,-6.16]	[-24.96,-5.73]	[-22.08,-5.02]	[-19.07,-4.94]	[-30.02,-4.63]	[-39.99,-7.07]
l-ω $_{t-1}$	9.418***	10.069***	8.719***	8.159***	7.915***	8.104***	12.166***
	[7.16,23.11]	[8.77,25.05]	[6.76,32.24]	[6.42,23.84]	[6.41,22.22]	[6.45,38.68]	[9.19,46.31]
DLD $_{t-1}$	3.275***	3.390***	3.847***	3.613***	3.364***	3.742***	1.934***
	[2.66,8.29]	[2.55,8.58]	[3.07,12.93]	[2.90,11.36]	[2.65,8.31]	[2.74,13.72]	[0.97,6.87]
Developing Dummy	0.074	-0.014	-0.026	-0.063	0.193	-0.117	-0.178
	[-0.71,1.56]	[-0.86,1.68]	[-1.05,1.19]	[-1.06,1.49]	[-0.48,1.67]	[-1.22,1.30]	[-1.48,9.04]
FDI Integration $_{t-1}$	-1.118***	-0.881**	-0.472	-1.743***	-1.369***	-1.337***	-2.046***
	[-5.98,-0.40]	[-3.69,-0.20]	[-3.40,0.26]	[-8.78,-1.02]	[-7.80,-0.20]	[-8.67,-0.09]	[-12.03,-0.95]
Portfolio Integration $_{t-1}$	19.795***	19.255***	21.041***	17.352***	17.256***	17.477***	19.979***
	[11.31,57.80]	[11.06,63.73]	[9.84,76.56]	[3.54,66.24]	[8.52,60.49]	[2.29,67.24]	[3.09,74.52]
(Portfolio Integration $_{t-1}$)^2	-131.847***	-129.510***	-146.245***	-114.123***	-106.417***	-122.164***	-114.179***
	[-383.44,-69.52]	[-392.86,-73.46]	[-486.64,-86.21]	[-453.30,-47.81]	[-319.77,-61.04]	[-477.44,-46.08]	[-515.38,-31.34]
TOT Growth $_{t}$		-1.016	-1.741*	-0.688	-0.468	-0.811	-0.614
		[-3.67,0.18]	[-4.66,-0.40]	[-3.30,0.98]	[-3.28,0.98]	[-3.70,0.83]	[-3.47,1.40]
Public Balance/GDP $_{t-1}$			-0.091**	-0.095**	-0.076**	-0.092***	-0.098***
			[-0.36,-0.02]	[-0.39,-0.02]	[-1.80,-0.02]	[-5.21,-0.02]	[-3.82,-0.02]
Ex. Regime 3 $_{t-1}$				0.125			
				[-0.08,0.48]			
Ex. Regime 5 $_{t-1}$					0.045	0.077	0.067
					[-0.08,0.23]	[-0.06,0.36]	[-0.09,0.29]
M2 over Reserves $_{t-1}$						0.007	-0.002
						[-0.02,0.04]	[-0.05,0.03]
Public External Debt/ GDP $_{t-1}$							0.000
							[-0.00,0.00]
Constant	-2.813***	-2.847***	-3.973***	-3.153***	-2.954***	-3.484***	-3.229***
	[-6.11, -2.61]	[-6.92, -2.64]	[-15.71, -3.87]	[-10.21, -2.98]	[-6.50, -2.67]	[-10.74, -3.23]	[-16.45, -2.75]
Observations	913	897	843	792	792	791	658
Number of Countries	94	90	84	83	83	83	72
McFadden adjR2	0.275	0.269	0.320	0.300	0.275	0.307	0.295
% correctly predicted (PCP)	0.900	0.899	0.897	0.896	0.896	0.899	0.884
Adjusted PCP	0.188	0.150	0.171	0.188	0.188	0.208	0.224

All regressions include time dummies and random effects.
* significant at 10%, ** significant at 5%, *** significant at 1%, using bootstrapped confidence intervals constructed by the percentile method, shown in brackets.

Appendix Table 6

Countries in which Portfolio Integration Affects Positively the Probability of Sudden Stop		Countries in which Portfolio Integration Affects Negatively the Probability of Sudden Stop	
Country	Portfolio Integration	Country	Portfolio Integration
Azerbaijan	0.0%	Czech Republic	8.0%
Bolivia	0.0%	Mexico	9.5%
Cyprus	0.0%	Thailand	11.4%
Ethiopia	0.0%	Greece	11.6%
Kyrgyz Republic	0.0%	Japan	12.1%
Mozambique	0.0%	Chile	14.1%
Sudan	0.0%	Austria	14.2%
Zimbabwe	0.0%	Italy	19.2%
Haiti	0.0%	Malaysia	20.1%
Zambia	0.0%	New Zealand	20.1%
Nigeria*	0.0%	Spain	20.2%
Yemen, Rep.	0.0%	Portugal	22.8%
Uganda	0.0%	Norway	22.9%
Kuwait	0.1%	Germany	23.9%
Ecuador*	0.1%	United States	24.0%
Jamaica	0.1%	Denmark	24.9%
Paraguay	0.1%	South Africa	26.8%
Angola	0.1%	France	27.2%
Belarus	0.1%	Australia	28.1%
Lao PDR	0.1%	Canada	42.4%
Armenia	0.2%	Sweden	54.8%
Georgia	0.2%	Belgium	55.9%
Kenya	0.3%	Finland	62.1%
El Salvador	0.4%	United Kingdom	69.5%
Trinidad and Tobago	0.4%	Netherlands	88.5%
Romania	0.4%	Hong Kong, China	133.7%
Malawi	0.5%	Switzerland	149.7%
Uruguay	0.6%		
Costa Rica	0.6%		
Dominican Republic	0.7%		
Moldova	0.7%		
Lithuania	0.8%		
Sri Lanka	0.8%		
Bulgaria*	0.8%		
Oman	0.9%		
Jordan	1.0%		
Ukraine*	1.1%		
Kazakhstan	1.2%		
Slovenia	1.3%		
Latvia	1.4%		
Colombia*	1.5%		
Pakistan	1.7%		
Mauritius	1.8%		
Poland*	2.0%		
Croatia	2.4%		
Egypt, Arab Rep.*	2.9%		
Turkey*	3.0%		
Indonesia	4.3%		
Peru*	5.4%		
Venezuela, RB*	5.7%		
Korea, Rep.*	6.0%		
Brazil*	6.4%		
Argentina*	6.7%		
Philippines*	7.2%		
Hungary	7.4%		
Estonia	7.6%		

* Countries tracked by JP Morgan's EMBI+.

Note: Countries in which portfolio integration affects positively (negatively) the probability of sudden stop are those whose average portfolio integration is below (above) 7.6%. This cutoff value was calculated as the level of portfolio integration that maximizes the probability of sudden stop: $-\alpha/2\beta$; where α is the estimated coefficient of the linear term of portfolio integration and β is the estimated coefficient of the quadratic term of portfolio integration. This cutoff value was calculated using equation 4 of Appendix Table 5. The list shows the average of portfolio integration for observations that were included in the estimation of equation 4. If instead averages were computed for all available data of portfolio integration from 1990 to 2004, Czech Republic would move to the group of countries in which portfolio integration affects positively the probability of a Sudden Stop. In addition, Iceland, Israel, Bahrain, Libya, United Arab Emirates, Ireland and Luxemburg would be listed in the group in which portfolio integration affects negatively the probability of a Sudden Stop. The rest of countries in Lane and Millesi-Ferreti's (2006) dataset not mentioned in this note or in the table would be listed in the group in which portfolio integration affects positively the probability of a Sudden Stop.

Data Appendix

Our sample of 110 countries is divided into 21 developed economies and 89 developing economies. Our choice of developed countries is dictated by OECD membership, and it includes Australia, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and USA. The list of developing countries includes: Angola, Antigua and Barbuda, Argentina, Armenia, Azerbaijan, Bangladesh, Barbados, Belarus, Belize, Bolivia, Brazil, Bulgaria, Cape Verde, Chile, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Dominica, Dominican Republic, Ecuador, Egypt Arab Rep., El Salvador, Estonia, Ethiopia, Fiji, Georgia, Ghana, Grenada, Guatemala, Guinea-Bissau, Haiti, Honduras, Hong Kong (China), Hungary, Indonesia, Jamaica, Jordan, Kazakhstan, Kenya, Korea Rep., Kuwait, Kyrgyz Republic, Lao PDR, Latvia, Lithuania, Malawi, Malaysia, Maldives, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Nepal, Nicaragua, Nigeria, Oman, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Romania, Rwanda, Sierra Leone, Slovak Republic, Slovenia, South Africa, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan, Suriname, Thailand, Tonga, Trinidad and Tobago, Turkey, Uganda, Ukraine, Uruguay, Venezuela RB, Yemen Rep., Zambia and Zimbabwe. Data are collected on an annual basis unless otherwise stated. Data spans from 1992 to 2004.

Variable	Definitions and Sources
Capital Flows Proxy	A monthly proxy is obtained by netting out changes in international reserves from the trade balance. Based on this proxy, 12-month cumulative annual flows are constructed for each month Annual differences of the latter are then used to measure capital account changes. All figures are expressed in 2000 US dollars. Source: IMF IFS.
Aggregate Sovereign Bond Spread Index	EMBI for EMs (source: J.P. Morgan), Euro-area government bond spread index for Euro-area countries (source: Merrill Lynch), G7 government bond spread index for all remaining developed countries (source: Merrill Lynch).
Systemic Sudden Stop (3S) Dummy	We define a 3S dummy as a capital-flow window that overlaps at any point in time with an aggregate-spread window. A capital-flow window contains a large fall in the capital flows proxy exceeding two standard deviations from its mean (that starts when the fall in the capital flows proxy exceeds one standard deviation, and ends when it is smaller than one standard deviation). Capital-flow windows less than 6 months apart were considered as part of the same event. Aggregate-spread windows contain those years in which a spike in the corresponding bond spread index exceeds two standard deviations from its mean (it starts when I the spread exceeds one standard deviation, and ends when it is smaller than one standard deviation). All calculations were performed at a monthly frequency and then transformed to annual frequency for Probit estimation.
Absorption of tradable goods (Z)	Imports plus tradable output domestically consumed, proxied by the sum of agricultural and industrial output minus exports. More specifically, we construct the share of tradable output in

	total output as the ratio of agriculture plus industrial output to total GDP at constant prices. Next, we multiply this share by total dollar GDP to obtain the dollar value of tradable output. We do this in order to avoid excessive fluctuations in output composition due to valuation effects that are present in sectoral data at current prices. Source: World Bank, World Development Indicators.
CAD	Current account deficit. Source: IMF's World Economic Outlook (WEO) database.
Domestic Liability Dollarization (DLD)	For developed economies: BIS reporting banks' local asset positions in foreign currency as a share of GDP (since data for Australia and New Zealand is not available from this source, we used data from their respective Central Banks). For developing economies: dollar deposits obtained from Levy-Yeyati (2006) (based on Honohan and Shi (2002)) plus bank foreign borrowing (IMFIFS banking institutions line 26c) as a share of GDP.
FDI Integration	FDI Liabilities plus FDI Assets over GDP. Source: Lane and Millesi-Ferreti (2006)
Portfolio Integration	Portfolio Liabilities plus Portfolio Assets over GDP. Source: Lane and Millesi-Ferreti (2006)
External Public Debt	Data on external public debt were obtained from IMF IFS (for some developing countries, data was obtained from World Bank's Global Development Finance database (GDF).
TOT growth	Annual rate of change of terms of trade on goods and services. Source: IMF's WEO (April 2006).
Ex. Regime 3	3-way exchange regime classification: 1 = float; 2 = intermediate (dirty, dirty/crawling peg); 3 = fix. Source: Levy-Yeyati and Sturzenegger (2002)
Ex. Regime 5	5-way exchange regime classification: 1 = inconclusive; 2 = float; 3 = dirty; 4 = dirty/crawling peg; 5 = fix. Source: Levy-Yeyati and Sturzenegger (2002)
GDP	Gross domestic product. Source: IMF's WEO database.
M2	Money plus quasi-money. Source IMF IFS.
Public Balance	General government balance to GDP ratio. Source: IMF's WEO database.
Large RER depreciation dummy	Dummy variable that takes the value of 1 when a large rise on RER (vis-à-vis US dollar) occurs and 0, otherwise. We define a rise in the RER (i.e., real depreciation of the currency) to be large when it exceeds two standard deviations above the sample mean prevailing before the rise.
Reserves	International Reserves. Source: IMF IFS
Short-term debt to foreign banks and other short-term debt due to foreigners	Source: International Institute of Finance Database. Short-term debt to foreign banks (series D353). Other short-term debt was obtained by subtracting series D353 from series D204 (total short-term debt).

Technical Appendix

Inference with Random-Effects Probits under Endogeneity

Walter Sosa Escudero[47]

This note is concerned with estimation and inference in a random effects Probit specification allowing for possibly endogenous explanatory variables. The standard random effects Probit model with exogenous explanatory variables is:

$$y_{it}^{*} = x_{it}' \beta + \mu_i + \varepsilon_{it}, \; i=1,2, \ldots, n; \; t=1,2, \ldots, T$$

where x_{it} is a k vector of exogenous explanatory variables, β is a k vector of coefficients, μ_i is IN($0, \sigma_{\mu}^{2}$), and ε_{it} is IN(0, σ_{ε}^{2}). The observed binary random variable y_{it} is related to the model through:

$$y_{it} = 1[\, y_{it}^{*} > 0]$$

Maximum likelihood estimation (MLE) of this model is extensively studied in Heckman (1981) and reviewed in Hsiao (2003). The likelihood function for this problem is given by:

$$L = \prod_{i=1}^{N} \int_{-\infty}^{+\infty} \prod_{t=1}^{T} \Phi \left\{ \left[\left(x_{it}' \beta / \sigma_{\varepsilon} \right) + \tilde{\mu}_i \left(\frac{\rho}{1-\rho} \right)^{1/2} \right] \left[2 y_{it} - 1 \right] \right\} f\left(\tilde{\mu}_i\right) d\tilde{\mu}_i$$

where $\rho \equiv \sigma_{\mu}^{2} / \sigma_{\varepsilon}^{2}$. The evaluation of the integral in the previous expression is not trivial and it is usually carried out through Hermite integration or simulation.

Guilkey and Murphy (1993) conducted an extensive Monte Carlo experiment to study the small sample behavior of alternative estimation strategies of the random effects Probit model. The most important results that are relevant for this study are summarized below:

1. Standard probit and MLE of the random effects Probit provide consistent estimation of β.
2. The standard Probit estimator of the standard errors of the estimators is markedly downward biased, leading to incorrect inferences, in the sense of suggesting significant coefficients when in fact they are not.
3. The random effects MLE based estimator provides more accurate estimators of the standard errors but the gain in performance is relatively mild when compared to that of the standard Probit.

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4. For small individual observations (N around 25), the numerical accuracy problems involved in the evaluation of the integral shown above severely affect the performance of the procedure, invalidating the use of standard asymptotic approximations.

The possibility of allowing for endogenous explanatory variables has been studied in the context of the standard Probit model:

$$y_j^* = z_j\gamma + x_j'\beta + u_j, \qquad j=1,2,\ldots,J$$

where u_j is $IN(0,\ \sigma_u^2)$, and x_j, β and y_j^* are defined as in the previous model, and z_j is a possibly endogenous explanatory variable. Rivers and Vuong (1988) provided a simple estimation strategy for the case where:

$$z_j = \tilde{x}_j'\delta + v_j$$

and $(u_j,\ v_j)$ have a bivariate normal distribution independent of $\tilde{x}_j$. $\tilde{x}_j$ is a vector of exogenous explanatory variables in the reduced-form model for z_j, which in this context is endogenous if and only if u_j and v_j are correlated. Rivers and Vuong (1988) propose a consistent estimation[48] based on a two-step approach:

- *Step 1:* Run the OLS regression of z_j on $\tilde{x}_j$ and save residuals $\hat{v}_j$.

- *Step 2:* Run a standard Probit regression of y_j on x_j, z_j and $\hat{v}_j$.

Details of the procedure can be checked in the original reference and in Wooldridge (2002). The main intuition behind the result comes from the fact that under bivariate normality of u and v, we can write $u_j = \theta v_j + \eta_j$ where η_j is independent of $\tilde{x}_j$ and v_j. Then, replacing in the definition of y_j^*:

$$y_j^* = z_j\gamma + x_j'\beta + \theta v_j + \eta_j$$

If v_j were observable, consistent estimation could proceed by a standard Probit regression of y_j on z_j, x_j and v_j, since, by construction, all explanatory variables are exogenous with respect to η_j. The first stage of the Rivers-Vuong procedure replaces v_j by a consistent estimate obtained from OLS regression in a first stage.

The performance of the Rivers and Vuong (1998) procedure in the context of the random effects specification has not been explored, and though it deserves a more detailed exploration

[48] It is important to remark that, as it is usual in binary choice index models, not all the parameters are identified, hence appropriate normalizations must be adopted. See Rivers and Vuong (1998) for details on this subject.

than the one offered here, some insights can be discussed. A simple extension in the panel context, as described in the first equation of this appendix, is to allow for endogenous explanatory variables by allowing for correlation between the observation specific error term of the index model (ε_{it}) and the error term of the reduced form of the possibly endogenous explanatory variable (v_{it}). In this context, the index model can be written as:

$$y_{it}^{*} = z_{it}\gamma + x_{it}'\beta + \theta v_{it} + \mu_i + \eta_{it}$$

and, again, if v_{it} were observable, the model should be unaltered albeit for some redefinition of relevant parameters. In this case, the Rivers-Vuong procedure is replacing an exogenous explanatory variable (v_{it}) with a consistent estimate obtained from a first stage regression.

An important problem is how to perform reliable inference with the proposed method. As discussed previously, Guilkey and Murphy (1993) suggest that the numerical accuracy problem related to the evaluation of the likelihood function of the random effects Probit makes asymptotic approximations very unreliable. A natural possibility is to consider a bootstrap approach. The nature of such procedure in this context is complicated due to the fact that, by construction, observations are not independent due to the presence of a random effect. In this note we follow Davidson and Hinkley (1997) and use a non-parametric hierarchical two-step bootstrap strategy, where in a first stage, individuals are randomly sampled with replacements, and, in a second stage, observations are randomly sampled without replacement within the individuals sampled in the first stage. According to Davison and Hinkley (1997, pp. 100-102), this procedure closely mimics the intra-group correlation structure of the data, due to the presence of the individual random effect.

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