

External Liabilities and Crisis Risk

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Abstract

Using an up-to-date sample of advanced and emerging economies and a broader set of controls than previous studies, we examine the impact of the level and composition of net external liabilities on external crisis risk. We find a strong effect on of net external liabilities on the probability of an external crisis, reflecting primarily the impact of the net debt position. These results are robust to the inclusion of additional controls, such as the current account balance and the extent of real appreciation. We also find that holdings of foreign exchange reserves reduce the likelihood of crisis even after controlling for net external liabilities, and that public debt and fiscal deficits do not have an extra effect on crisis risk once the above-mentioned controls are included.

¹ Comments welcome. The opinions expressed here are those of the authors' along and do not necessarily reflect those of the IMF, its executive board, or its management.

I. INTRODUCTION

Large current account imbalances over the past decade have given rise to sizeable cross-country differences in net foreign asset (NFA) positions. Among advanced economies, the range of such differences at end-2010 spanned from a staggering -673 percent of GDP in Iceland to 308 percent of GDP in Hong Kong S.A.R. Even excluding these extremes, the gap between the mean NFA/GDP ratio for net debtors vs. net creditor countries stood at -50 percent and +56 percent, respectively by end-2010, compared with -28 percent vs. +38 percent in 1990 and -16 percent vs. +36 percent in 1980. It is thus plain that the last few years have witnessed unprecedented imbalances of net external exposures *pari passu* with the rapid built-up of gross assets and liabilities (Lane and Milesi-Ferretti, 2008).

Standard models of sovereign debt have long focused on the ratio of external debt liabilities to GDP as a key gauge of default risk (Sachs and Cohen, 1985). While not all debt crises of the past have been associated with high ratios of external debt to GDP (see Rogoff and Reinhart, 2009), the role of high net external liabilities in triggering crises has re-emerged with a vengeance in the wake of recent developments in eurozone: three of the four countries at the epicenter of the ongoing eurozone debt crisis (Greece, Ireland, and Portugal) had NFA/GDP ratios between -70 percent in Ireland and -95 percent in Portugal at the onset of the crisis in end-2008, which then rapidly evolved into even large exposures approaching 100 percent or more of their GDPs by end-2011. This has been a matter of concern for policy makers not only because of the immediate welfare costs of high country spreads and potential spillovers neighboring economies, but also because of overwhelming evidence that debt crises usually have protracted negative effects on economic growth (see, e.g., Panizza and Prebitero, 2011 and references therein).

Against this background, the aim of this paper is to identify “tipping points” in countries’ external liabilities—defined as a threshold beyond which the likelihood of an external crisis sharply increases—and relate such thresholds to key macroeconomic fundamentals. An important dividend of such an exercise is the establishment of levels of NFA which are seemingly sustainable and thus potentially targetable, a key ingredient for assessments of current account sustainability and real exchange rate stability.

Relative to the existing literature on the topic, our exercise has two main novelties. Regarding the previous literature on the determinants of external debt crises and early warning crisis indicators (Kaminsky and Reinhart, 1999; Berg and Pattillo, 1999), the main novelty is the examination of compositional effects of net foreign liability exposures (in terms of its breakdown between gross debt, portfolio equity, foreign direct investment, as well as foreign exchange reserves) on crisis risk, using an extended version of the Lane and Milesi-Ferretti (2007) dataset, spanning the 1970-2010 period.

This paper also relates to recent work on external debt sustainability by Kraay and Nehru (2006), Pistelli, Selaive, and Valdés (2008), Gourinchas and Obstfeld (2010). As in Gourinchas and Obstfeld (2010), an important distinction between our study and others is the focus on countries with non-trivial levels of integration with international capital markets (advanced economies and emerging markets). Moreover, and unlike all the above studies including Gourinchas and Obstfeld (2010), we focus on a more circumscribed definition of crises which excludes domestic banking and fiscal crises; as our main interest is on the sustainability of foreign liability exposures, we focus on major external crisis episodes defined as either as an outright external default or the disbursement of a large multilateral financial support package. We do, however, examine the robustness of our results to a broader definition of external crises which includes major exchange rate re-alignments and output collapses.

Last but not least, a key novelty of our paper is the use of a broader set of controls. In particular, we control for host of fundamentals which are deemed to affect current account “norms” and sustainable NFA positions in the long term. To this end, we build a large database encompassing a variety of demographics, institutional, fiscal, as well as other policy and structural variables spanning a long (40-year) and broad (50 country) panel. Having such a large inventory of possible explanatory variables at hand, allows us to perform extensive robustness tests that were lacking in previous studies.

The paper is organized as follows. Section 2 presents the evolution of cross-country means of the variables of interest within an eight-year window centered on the crisis outbreak. This yields *prima facie* evidence on thresholds and what variables seem important to explain them. The econometric analysis in Section 3 tests the individual and joint significance of these variables as well as other controls in a probit model. Section IV concludes.

II. STYLIZED FACTS

As discussed above, our sample co IMF support is considered “large” when loans are at least twice as large as the respective country's quota in the IMF, when all net disbursements are computed from program's inception to end. The definition of outright default comes from various Standard & Poor reports compiled in Borensztein and Panizza (2008), sources widely used in the sovereign debt literature. The resulting sample of events by country/year is reported in Appendix. In doing so, we deliberately leave aside a myriad of smaller crises and countries where borrowing is mainly official and/or on a concessional basis rather than market driven. There are three main advantages of doing so. One is that the causal mechanisms developed in the theoretical literature on country borrowing require some reasonable degree of country integration with international capital markets, so we can draw on that literature to derive clear-cut testable implications and choice of co-variates. Second, we circumvent data limitations (including data unreliability) that are typically more prevalent in poorer countries and could potentially undermine confidence in the results. Last but not

least, focusing on major crises stacks the deck against finding a trivially lower threshold to foreign liability exposure and be subject to the criticism that our results have normative implications in favor of throwing sand in the wheels of international capital markets.

This section presents the evolution of cross-country means of the variables of interest within an eight-year window centered on the crisis outbreak, delimited by the respective upper and lower quartiles around the respective mean. In doing so, we also break down crisis events into two groups: one comprising the events over the past couple of years (largely but not exclusively the European debt crises) and the other comprising over 1970-2006 (largely confined to emerging markets). One advantage of separating the two periods is to check the robustness of the main stylized facts to period breakdowns. The other advantage is that pre-2007 events allow us to study both pre-crisis and post-crisis dynamics; this is not possible for the 2008-10 events since our sample ends in 2010.

Figure 1a plots the average dynamics of net foreign assets (scaled by GDP) prior and after the crisis ($t=0$). It shows that external crises are typically characterized by a gradual deterioration in the run up to their outbreak and the more so in the two-year window before the event. This is observed for both pre-2007 and post-2007 crises. As the upper and lower quartile indicates, the deterioration is more dramatic for countries starting-off from a higher net foreign liability (NFL) position.²

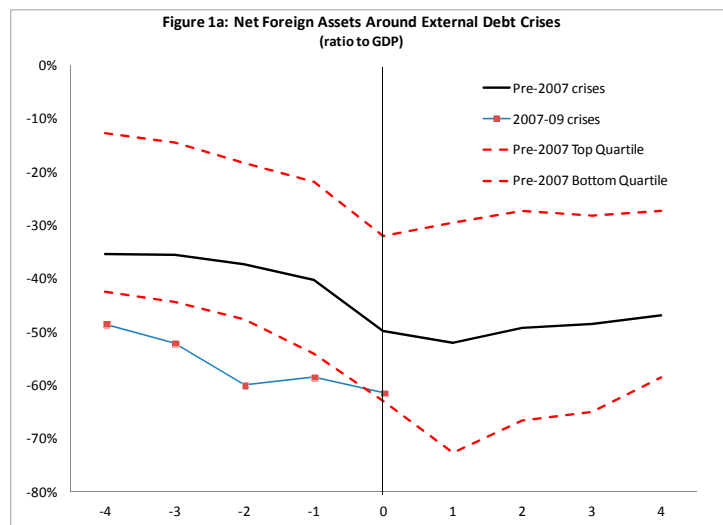


Figure 1a also highlights that recent crises have been triggered at higher NFL levels: while the cross-country mean points to a tipping point threshold between 40% and 50%, recent crises point to a threshold around 60% (average NFL between $t-1$ and t). This is not surprising for at least two reasons. One is that trade openness and greater international financial integration tend to increase the cost of debt crises or outright default (see, e.g. Rose, 2006), thus reducing country risk and thus allowing greater leverage at lower spreads than in the past. Second, as noted above, recent crises have also hit more advanced countries, most of them deemed free from “debt intolerance” and hence having greater market access to begin with. Be that as it may, averaging between the two groups of countries/events, the data

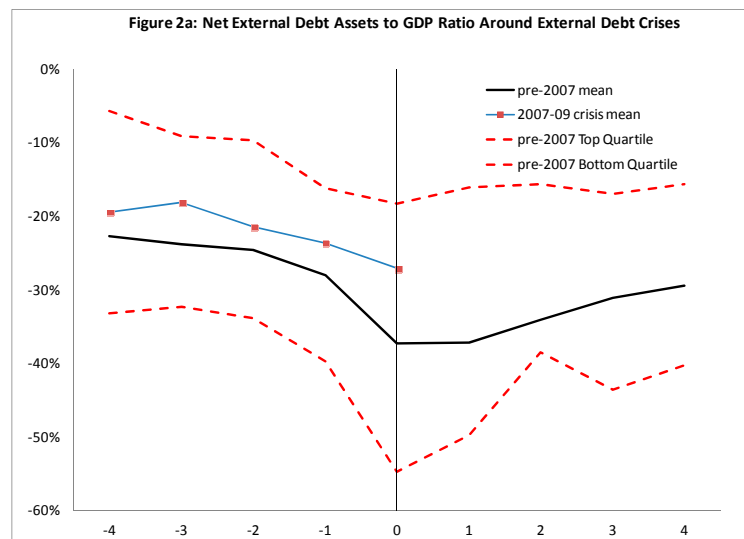
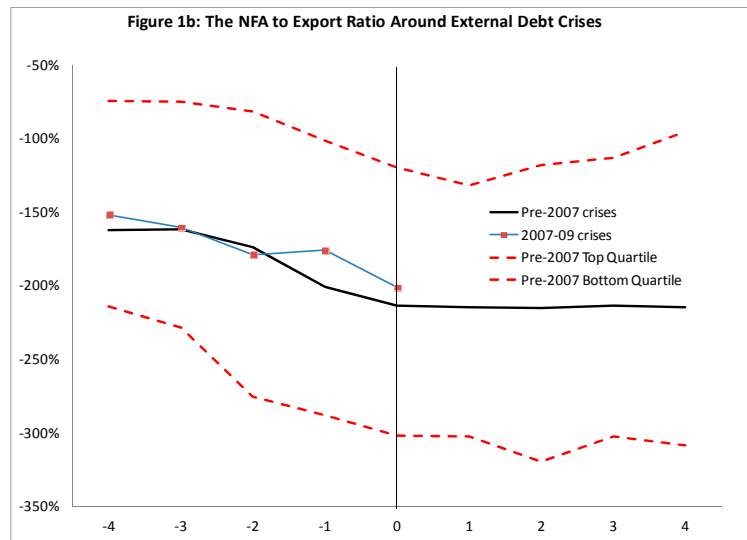
² The chart excludes Iceland, an extreme observation with a reported net foreign liability position of over 600 percent of GDP at end-2009. Including it would further strengthen the relation between NFL and crises.

is suggestive of a NFL crisis threshold in the range of 50% to 60% of GDP. The Figure also shows that some deleveraging takes place in the aftermath of the crisis.

While scaling NFL positions to GDP is standard and convenient metric, many theoretical models of debt and external crises emphasize the mismatch between NFL positions and trade openness or exports. This is because openness tends to raise the cost of default and because the ratio of exports to GDP is a rough gauge of a country's capacity to generate foreign exchange revenues to repay their external liabilities, all else constant (see, e.g. Cline, 1985 for an early comprehensive discussion). This suggests exports of goods and services as a suitable scaling variable for NFL. Such a metric is plotted in Figure 1b. A notable feature of the latter compared to Figure 1a is that the large differences in NFL positions between pre- and post-2007 crises vanish: both recent and past crises are now suggestive of a tipping point around 200% of exports of goods and services. This is equivalent to an average NFL/GDP threshold of 60% once X/GDP averages 30-35%.

Given the well-known fact that external financial crises are almost invariably associated with countries' difficulties in paying their debt and also in light of some evidence that the debt/equity composition of foreign liabilities tend to display quite distinct patterns across countries and over time (Mauro et al. 2007), Figures 2 and 3 disaggregate NFL into their debt and equity components.

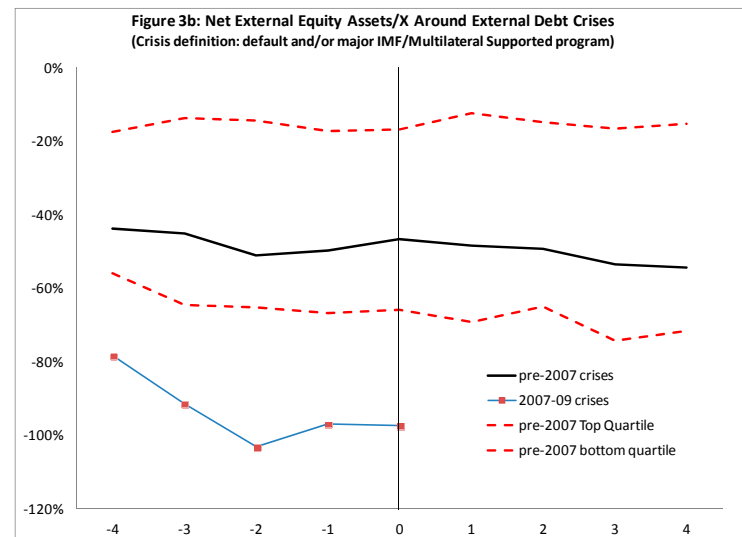
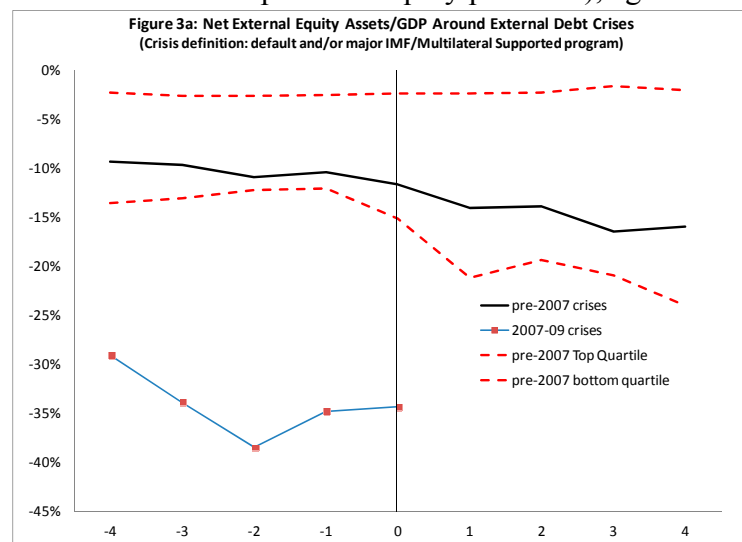
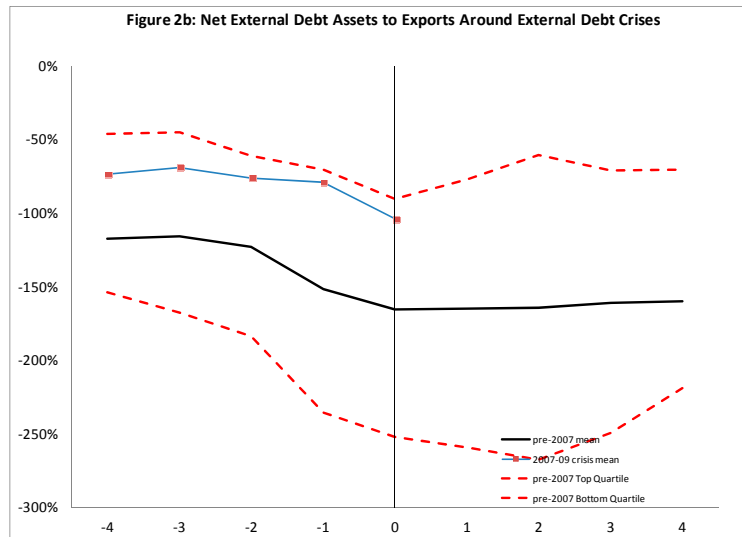
Specifically, Figure 2a shows net debt assets scaled by GDP. Net debt assets are defined as the sum of foreign exchange reserves and other public and private external assets in debt instruments (securities, loans, deposits etc) minus total external debt liabilities. Most of the pre-2007 crises occurred in EMS in years when debt instruments accounted for a large share



of NFL: hence the dynamics of net debt tracks closely that of NFL. Net debt dynamics were similar for the more recent crisis episodes, although the debt level was more modest. When net debt is scaled by exports (Figure 2b), it is even less negative in the most recent crisis, reflecting higher trade openness.

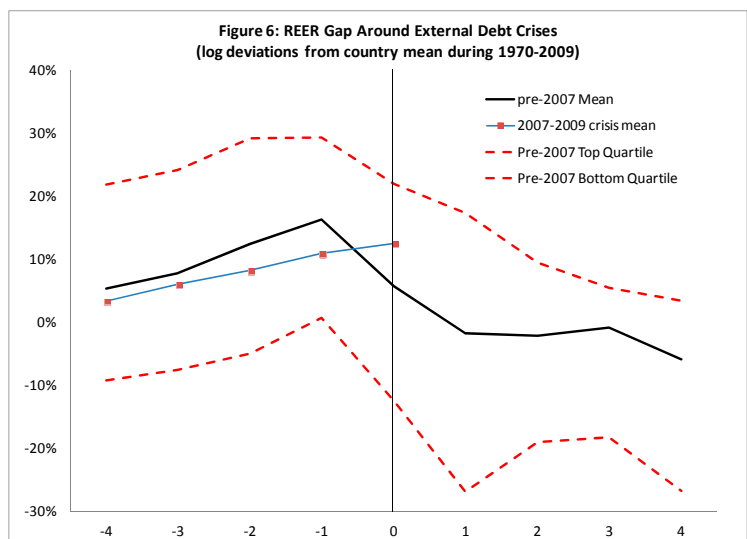
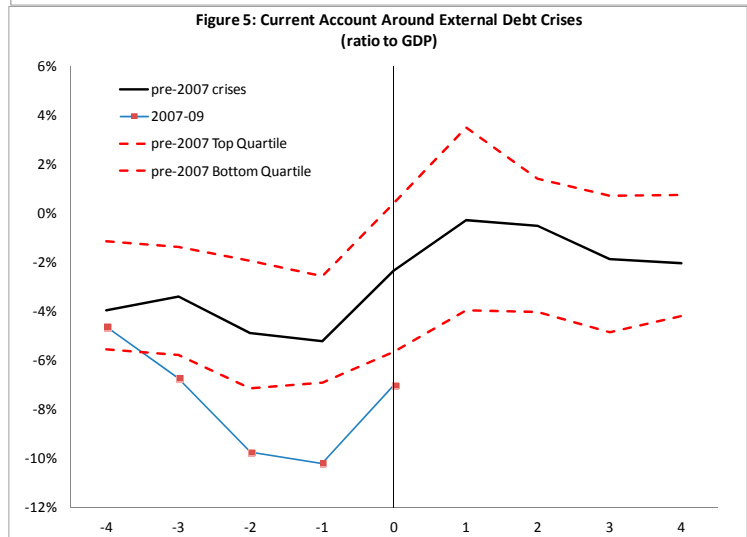
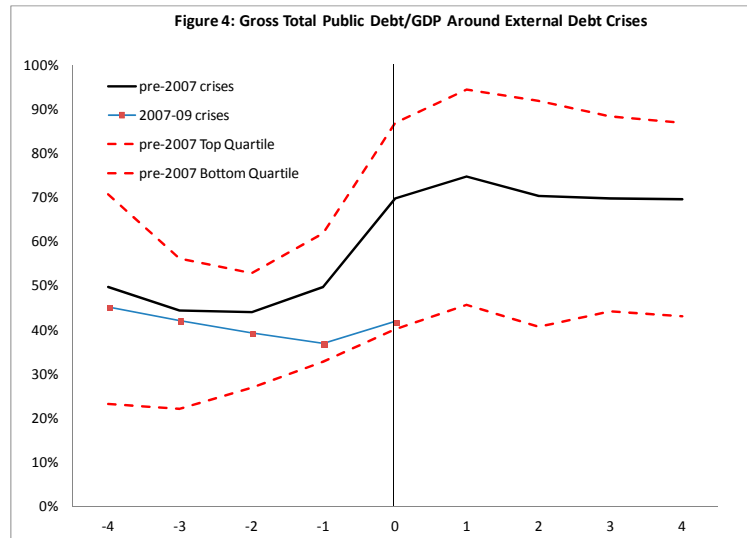
Figures 3a and 3b depict net equity positions (defined as the sum of net FDI and net portfolio equity positions), again scaled by GDP and exports, respectively. The pre-2007 crisis means confirm the received wisdom that net equity flows have a distinct dynamics than debt flows, being generally more stable. However, post-2007 crises took place in countries with much bigger net equity exposure.

Figure 4 zooms in on the main traditional driver of the rise of external debt liabilities in the run-up to external crises—namely, the rise in general government debt (foreign plus domestic). The deterioration of public sector debt positions has been a common feature of recent and past crises and the respective pre-crisis thresholds are similar—around 50% of GDP. Interestingly, there is no post-crises deleveraging: public sector debt 4 years after the crisis outbreak was in fact higher than in the year preceding the crisis.



It may be conjectured that what matters for the identification of tipping points is not only the level of liabilities, but also the speed at which they accumulate. We therefore examine the path of the current account balance around crisis events. All crisis events in our sample have been accompanied by sizeable and widening current account deficits. The mean threshold for the current account as per the pre-2007 experiences was 5% (Figure 5), in line with threshold found in earlier studies (Milesi-Ferretti and Razin, 2000). However, for recent crises the threshold shifted to close to 10%. The reason for the difference seems to be the presence of advanced countries with greater market access in the 2007-2009 crisis sample.

Large and growing current account deficits can also be associated with real exchange rate appreciations, and those appreciations could reflect “misalignments” that will trigger an eventual and economically painful reversal, as in models of unhedged balance sheet positions (see, e.g. Calvo, 1998). It is therefore important to look at the typical pattern of real effective exchange rates (REERs) in the run-up to the crises. This is shown in Figure 6. Both the pre-2007 and post-2007 crises have been associated with REER appreciations in the range of around 10-15% (measured relative to each country’s mean REER during the whole 1970-



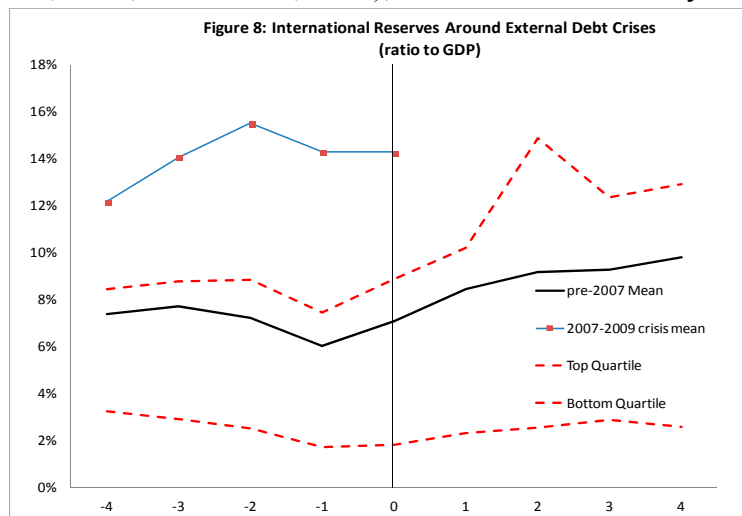
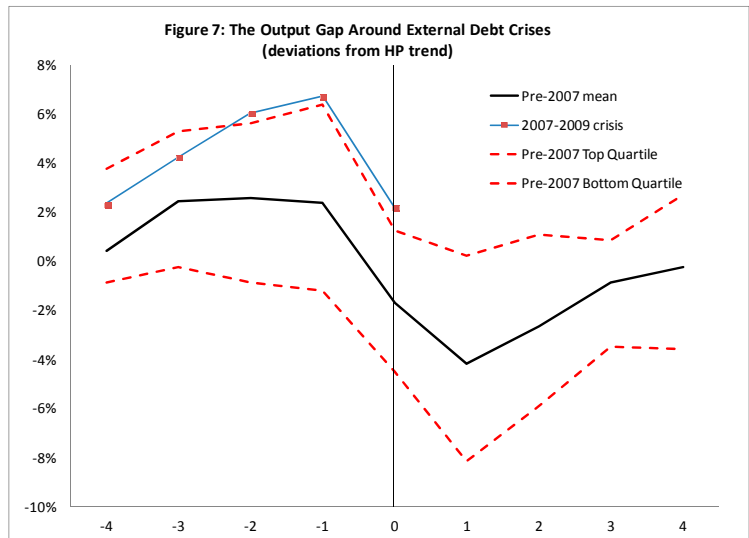
2009 sample, normalized to zero).³ While this range may not appear to be as large as required to have very disruptive balance sheet effects, deep crises (bottom quartile in the figure) have been associated with large REER adjustments—nearly 30% from peak to trough. This suggests an important role of international relative prices—a result buttressed by probit regressions in section 3.

Sizeable deviations from output growth relative to trend are also important features of external debt crises. This can be seen from the mean output gaps in Figure 7. These deviations have been particularly large in the run-up to recent crises, where output drops have been

particularly dramatic. Figure 7 also indicates that such drops are quite persistent. While some studies have focus on V-shape growth recoveries in the aftermath of defaults or systemic sudden stops (Levy-Yeyati and Panizza, 2011; Calvo et al., 2005), this is not buttressed by a large cross-country sample of crisis events. The broad cross-country evidence above seems more consistent with a model of slow output reversion to trend, where “debt traps” are typically associated with highly persistent output gaps (Catão, Fostel, and Kapur, 2009).

The last indicator we look at is the stock of official foreign exchange reserves. While there is

contention that international reserves should optimally zero when subjective time discount rates are sufficiently high relative to the risk-free at which the reserves are invested at (Alfaro and Kanuczuk, 2009), the common wisdom in policy circles is that reserve accumulation helps reduce the probability of sudden stops (Calvo et al., 2009). Figure 8 shows, however, that debt crises do take place even when reserves are not trivially low. There is some



³ Excluding Pakistan, the real appreciation for the post-2007 crises is close to 20%.

evidence of a decline in reserves in the run-up to pre-2007 debt crises, but not for recent crises. We return to examining the role of reserves around crises in the probit analysis below.

III. PROBIT ANALYSIS

We now turn to an examination of whether NFL positions and their composition matter in determining crisis probabilities in a broad multivariate context, and whether the effect is non-linear. That is to say, we test whether the response of the probability of a crisis is itself significantly increasing in NFL, and this effect is robust to the inclusion of other controls. In this connection, we also look at two important policy-related questions. The first is whether crises occurring in 2008-10 have been different in terms of the role of net external liability variables. The second is how the econometric model fares in terms of predictive power over the recent crises.

A. CRISIS DETERMINANTS

Table 1 displays the results with the binary crisis indicator as the dependent variable. Because crises have a dynamic of their own once countries get into them, we drop the subsequent crisis years from the sample. So, the observations entering all probit regressions are those preceding the crises when there is a “normal” state of affairs (crisis=0) and those of the year where the crisis outbreak took place (crisis=1). All explanatory variables are lagged one year so as to mitigate endogeneity issues. The first specification shows a simple bivariate relationship between crisis probability and NFA to GDP levels. This is clearly significant and with the right sign: higher NFA reduce crisis risk. The estimated coefficient indicates that the marginal effect of a 10% increase in NFL is to increase the probability of a crisis by 0.6%.

Specification (2) disaggregates NFA into net debt and net equity positions—again all scaled by GDP. Both are statistically significant (at 1%) and with a negative sign. No less importantly, the coefficient on the debt variable is much larger in absolute terms than the coefficient on the equity variable. Consistent with the event analysis above and also with received wisdom of past studies, this suggests that debt is of more importance than equity positions in explaining crises—after all, these are by definition debt crises.

The subsequent specifications introduce several controls discussed in section 2: the level of foreign exchange reserves scaled by GDP, the average current account balance in the two years preceding the crisis, also scaled by GDP, the log deviation of current REER from its 5-year moving average, as well output volatility (measured as the standard deviation of the output gap over a 10-year rolling window)⁴, the level of GDP per capita (in US\$ and

⁴ We have also used a 20-year rolling window and the results were basically identical. In fact, for some specifications, the attendant t-ratio on the latter was higher. The downside is that the 20-year window require a

(continued)

expressed as a ratio to US per capita GDP).⁵ We also experimented with the growth rates of trend real GDP (as per the HP filter) and the composition of absorption (the ratios of aggregate consumption to investment as well as the ratio of consumption to GDP). These were not significant and so were dropped from the regressions, with the respective results available from the authors upon request.

In addition to these country specific controls, we also allowed for the role of global factors in explaining the likelihood of an external crisis. These factors are world output (measured as deviations from an HP trend), the US yield gap (10 year Treasury bond rate minus the 3 month Treasury Bill rate) and the yield differential between U.S. corporate bonds rated BAA and AAA—a proxy for the tightness of global financial conditions and investors' risk aversion. Of these, the corporate spread was the only variable to be statistically significant, and is hence included in our baseline regressions.⁶

Specification (3) shows that once these new controls are introduced, net debt remains highly significant but net equity no longer so—in fact, the coefficient changes sign. This suggests that once we control for other variables that help explain countries' foreign liability exposure (like the current account balance, the real exchange rate, and income volatility), the net equity position has no significant effect on crisis risk.⁷

Regarding the role of the various non-NFA controls, column (3) of Table 3 shows that the probability of a crisis declines when pre-crisis foreign exchange reserves are higher. Because the net debt position includes the level of reserves, the negative coefficient on foreign exchange rate reserves implies an effect over and above its effects through a stronger net external position. The respective coefficient indicates that marginal effect of an increase in

longer time series stretching into the early 1950s which is unavailable or less reliable for some EM countries in the sample.

⁵ We have also tried to measure misalignments with log deviations from the mean (as plotted in Figure 6) and the results were very similar. Yet, to avoid the criticism that the overall period mean is endogenous to crises, we use deviations from the (backward-looking) 5-year moving average in the regression.

⁶ The US yield gap was significant at close to 10% and with the right sign on its own but its importance was dwarfed by the corporate spread. This is not surprising given the non-trivial correlation between the two variables.

⁷ One possibility is that the foreign direct investment (FDI) and portfolio equity components of equity positions offset each other – given that previous work has found that higher FDI tends to lower crisis risk controlling for other factors. In other words, it may be that net portfolio equity liabilities add to crisis risk while FDI reduces it. For the whole 1970-2010 sample we find evidence that this is the case (with FDI liabilities significant at 10% and of the opposite sign as debt liabilities). However, for recent (post-2006) crisis episodes we find that a more negative net FDI position is significantly associated with a higher probability of crisis. This is an issue we will investigate further in the next draft.

the reserve/GDP of 10% is to reduce the crisis probability by 0.3%.⁸ One rationale for this effect is that foreign exchange reserves are a tool under the direct control of a policy maker unlike, say, private sector deposits overseas. As a result, it can provide a more effective offset to external liabilities than private sector assets held overseas.

We also find that the 2-year moving average of current account balance prior to the crisis year is highly significant and with the right sign.⁹ This is consistent with preceding studies which have found that current account deficits are a significant predictor of external crises using a variety of definitions of the latter (Milesi-Ferretti and Razin, 2000; Pistelli, Selaive, and Valdés, 2008). The same goes with the coefficient on real exchange rate appreciation pre-crisis: its positive sign indicates that more appreciated real effective exchange rates (REER) are associated with a higher probability of a crisis, consistent with many models of external debt and currency crises, as discussed above. In line with theoretical priors, we also find that historical volatility increases the risk of an external crisis. We also find that external crises are less likely in countries with higher income per capita (relative to the U.S.). This variable can proxy for a variety of channels: for example, over our sample countries with higher GDP per capita typically have stronger property rights, more stable politics, and—with the notable exception of the recent crisis—better-functioning financial markets.¹⁰ This variable is quantitatively very important in explaining the probability of a crisis, also reflecting the much more modest incidence of crisis episodes among advanced economies in our sample. Finally, higher U.S. corporate spreads are associated with higher crisis risk, as one might expect.

In column (4) of Table 1, we control for total public debt (domestic and foreign) scaled by GDP. One might expect that, with the dramatic shift in the composition of public indebtedness in emerging markets over the past 20 years, fiscal imbalances can exacerbate crisis risk not just through countries' net external positions but also via large domestic debt. However, the rather negligible z-statistics on the public debt variable (0.08/0.34) suggest that higher public debt does not add to crisis risk beyond its (indirect) effects on net foreign debt

⁸ Note, however, that this is an effect at the mean. Due to the non-linearity embodied in the probit specification, this effect can be higher or lower depending on the level of reserves itself as well as other variables. Estimates of this marginal effect in crisis outbreak years are presented in Table 3 and show that the attendant marginal effect can far exceed the average marginal effect, sometimes by as much as tenfold.

⁹ All the non-NFA explanatory variables added in specification (4) were included one at a time and all contribute to statistical significance separately. Those separate results are not presented to save on space.

¹⁰ We also tried political variables from the polity database but these were all statistically insignificant and sometimes with the wrong sign, once all the other above controls were in place.

and other key controls such as current account balances and the REER.¹¹ Notice, in fact, that the coefficient on net external debt essentially does not move with the introduction of this variable (and also despite of the loss of some observations due to gaps in the public debt series for some countries); it remains highly significant, corroborating the robustness of the above inferences.

Column (5) presents results for a different specification of the probit model, in which all stock variables (net debt; net equity; and reserves) are scaled by exports rather than GDP. Results are very similar in that the coefficient on net debt remains highly significant while equity positions are not (in fact the point estimate now turns slightly negative), with other controls remaining significant as before. Also, the overall fit of the model is very similar.

B. RECENT CRISES VS. PREVIOUS CRISES

We test as to whether the importance of debt and equity positions changed in the more recent (2008-2010) crises. This is done in columns (6) and (7) by replicating the specification of columns (3) and (5), but now with the coefficients on net equity and net debt interacted with a dummy variable (“D07-10”) that takes on the value of one during those years and zero otherwise. This is an important test for structural break, in light of evidence on differences in external portfolio composition during the recent crisis episodes highlighted in our previous section. The results show that the net debt position remains statistically significant and does **not** become less important: in the specification scaled by GDP, the point estimate for the dummied D07-10 coefficient is negative at -0.56 (though not statistically significant at conventional levels), whereas in the specification scaled by exports (column 7), the coefficient of 0.23 is statistically significant at 10%. In contrast, the dummied coefficient on the equity position suggests that, if anything, equity liabilities have had a less benign role in 2008-2010 crises than previously (0.76 - 0.95). Yet overall net external equity positions appear to have less of a clear cut impact on crisis risk, compared to net external debt.

C. ROBUSTNESS TO AN ALTERNATIVE CRISIS DEFINITION

In columns (7) to (10) of Table 1 we conduct the same empirical analysis using an alternative, more extensive crisis definition (labeled “crisis 2”). Specifically, we combine the previous indicator (default and/or “large” multilateral support) with an indicator that considers crises any real exchange rate depreciation in excess to 15% in any single year or 20% in two consecutive years, coupled with negative real GDP growth and/or a drop in the output gap by more than one-standard deviation over the 1970-2009 period for each

¹¹ The appropriate control for this regression is the net financial position of the government. However, measures of government financial assets are often unavailable on a systematic basis, especially for emerging markets. This measurement problem can also contribute to the lack of significance of the public debt variable.

country.¹² In this broader definition, the number of crisis events rises from 63 to 81, with considerable overlap between the two crisis sets.

The main thrust of the results with this alternative definition is that the net external debt position continues to be a strong predictor of external crises and of a broadly similar magnitude. Likewise, pre-crisis current account balance, real exchange rate deviations from trend, and GDP per capita continue to be highly significant crisis predictors.

The main differences between the new and previous crisis definitions lie in net foreign equity and foreign exchange reserves. Equity positions now turn to be statistically significant at 5% and with the opposite sign as the debt variable. This suggests that higher net equity liabilities tend to lower crisis probabilities. However, this result does not hold if we scale equity by exports (column 10). Moreover, if we disaggregate equity between FDI and portfolio equity, none of the two coefficients is significant at 5%, though the coefficient on net FDI assets is negative (i.e., the opposite sign as net debt assets) and statistically significant at 10%. These results are not reported but available from the authors upon request. Our broad reading of this evidence is that, once again, equity positions have a much weaker and less clear-cut impact (depending on specific crisis situations and the breakdown between FDI and portfolio equity) on crisis risk than the net external debt position.

A second difference with the new crisis definition is that reserves are no longer significant when scaled by GDP. This diminished role of reserves in the broader definition of crisis may not seem surprising since it includes large exchange rate depreciation events which struck advanced countries with large ex-ante foreign exchange rate reserves (like the various ERM crises of the early 1990s). By also including a greater number of recent episodes in which the exchange rate floated more freely in the run up to the crisis (which in this case can simply take the form of a contraction in output rather than a debt default), the role of variations in reserves in the run up the crisis is minimized once such a broad definition of crisis is adopted. Note, however, that when reserves are scaled by exports (column 10), the previous result that reserves matter over and above its role of netting gross liability positions continues to hold.

D. PREDICTIVE POWER

Table 2 provides the respective goodness of fit statistics of the final specification for our preferred crisis definition (crisis 1), as of column (6) of Table 1. At the 20% threshold, the model correctly predicts 95.5% of observations and a third of the crises. At a 10% level (which is closer to the unconditional ratio of crisis events to observations, which is

¹² Country by country estimates of the output gap were computed as in Figure 7, i.e., as deviations of an HP trend with the smoothing factor lambda set to 100.

63/1925=3.2%), the model correctly predicts 91% of observations and 36 out of the 63 of the crises.

More importantly, wrong signals, in the type-2 error sense, are often observations around external crises. This can be seen from Table 3 which list all the hits and misses of the model. These “almost correct” hits include many of the early 1980s defaults (e.g. the model predicts a crisis in Argentina in 1981 and the default came in 1982), Moldova in 2000 and 2001 (the default took place in 2002), and most strikingly, Greece and Portugal in 2008 and 2009-- those crises became full blown in 2010. On the negative side, the probit model does not do well in capturing the Asian crisis of 1997-98 (only Indonesia gets a two-digit probability of crisis in 1998). This reflects in particular the relatively low net debt liabilities in countries like Korea, Malaysia and Thailand around that time (see Appendix Table 1 for a list of values of the controls including in the probit models in the year preceding the crisis).

Table 3 also provides marginal effects of increases in debt to exports and in reserves to GDP around crisis outbreaks. A 10 percentage point increase in the debt/GDP ratio for an average country increases the probability of crisis by 4 percentage points—a far from trivial figure. By the same token, the marginal effect of reserves as liquidity/insurance on crisis probabilities around these events also appears to be very strong: a one percentage point higher rate of reserves to GDP can lower crisis probability by close to 1 percentage point on average.

Finally, Table 4 provides a more stringent test on predictive power. We estimate the model through 2007 and asks the model to predict 2008, 2009, and 2010. The table shows that out of 18 crisis or crisis-like events, it has only 4 bad misses (where the probability of default is well below 10%). Conversely, it rightly predicts above either 15% or 20%, the crises in both Greece and Portugal, and also picks up the critical situation in Spain in 2010 as well as much of the Baltics.

IV. CONCLUDING REMARKS

The results in this paper suggest that once countries’ net foreign liabilities rise above 40% of GDP and are mostly comprised by debt liabilities, the risk of crisis accelerates with further net liability exposure. There is also evidence that this threshold may have shifted upward—to something in the 50 to 60% range—in recent years. Judged by probit estimation results, this seems to reflect greater trade openness (which previous studies have shown to increase the cost of defaults). The effect of net equity positions on crisis risk is overall less clear-cut: once we control for the pace of net foreign borrowing and real appreciation, we find no robust link between the net equity position and crisis risk. However, partly due to large shifts in the composition of portfolio equity vs. FDI across countries and over time, the attendant

coefficient is estimated much less precisely than the debt coefficient; in particular, its statistical significance varies widely across specifications and crisis definitions.

Our results also qualify excessive emphasis on fiscal theories of the crisis—beyond what is justified by their impact on net external liability positions and other key aggregates like the real exchange rate and the current account. Finally, there is evidence of the important role of reserve accumulation in mitigating crisis risk. In particular the above estimates indicate that reserve holdings seem to have a significant on reducing crisis probabilities over and above their effects on net debt positions. This finding provides some justification for the view in policy circles that the benefits of holding foreign exchange reserves in terms of liquidity and “insurance” against crises offset the opportunity cost in a context of low global interest rates. Further, these effects rise in importance around crisis outbreaks.

Table 1. Probit Estimates of the Determinants of External Crises
 Estimation period: 1970-2010; robust standard errors in parenthesis

VARIABLES	(1) crisis 1	(2) crisis 1	(3) crisis 1	(4) crisis 1	(5) crisis 1	(6) crisis 1	(7) crisis 1	(8) crisis2	(9) crisis2	(10) crisis2
NFA / GDP	-1.02*** (0.19)									
Net debt / GDP		-1.45*** (0.25)	-1.33*** (0.30)	-1.46*** (0.33)		-1.04*** (0.30)		-1.03*** (0.25)	-0.94*** (0.27)	
Net equity / GDP		-0.54** (0.27)	0.41 (0.43)	0.29 (0.42)		0.77 (0.48)		0.836** (0.38)	0.99** (0.43)	
FX reserves / GDP			-2.43** (0.99)	-2.37** (1.03)		-2.97** (1.24)		-0.16 (1.02)	-0.61 (1.30)	
Current account/GDP			-5.31*** (1.69)	-4.942*** (1.78)	-4.076*** (1.15)	-4.38*** (1.65)	-4.60*** (1.48)	-4.26** (1.45)	-4.59*** (1.69)	-2.71** (1.27)
Real exchange rate gap			1.96*** (0.46)	2.19*** (0.48)	2.01*** (0.51)	1.88*** (0.47)	1.87*** (0.50)	1.83*** (0.50)	1.75*** (0.49)	2.04*** (0.51)
Output volatility			4.63* (2.86)	4.96 (3.01)	4.84** (2.78)	5.46* (2.63)	5.86** (2.81)	2.67 (2.29)	2.91 (2.04)	4.01** (1.79)
GDP per capita			-0.79*** (0.00)	-0.80*** (0.00)	-0.67*** (0.00)	-0.85*** (0.00)	-0.85*** (0.00)	-0.50*** (0.00)	-0.52*** (0.00)	-0.46*** (0.00)
US corporate spread			0.397*** (0.14)	0.469*** (0.14)	0.38*** (0.14)	0.352** (0.14)	0.37*** (0.14)	0.38*** (0.10)	0.336*** (0.11)	0.317*** (0.10)
Public debt/GDP				-0.084 (0.37)						
Net debt / exports					-0.32*** (0.08)		-0.304*** (0.08)			-0.29*** (0.06)
Net equity / exports					-0.11 (0.16)		-0.069 (0.17)			0.073 (0.14)
FX reserves / exports					-0.68* (0.36)		-0.70* (0.38)			-0.682** (0.30)
Net debt/GDP 2007-10						-0.56 (0.40)			-0.61 (0.41)	
Net equity/GDP 2007-10						-0.95 (0.60)			0.23 (0.64)	
Net debt/exports 2007-10							-0.23* (0.11)			-0.124 (0.1)
Net equity/exports 2007-10							-0.10 (0.17)			-0.096 (0.17)
Observations	1935	1935	1925	1813	1925	1925	1896	1896	1896	1896
Pseudo R-squared	0.07	0.08	0.25	0.26	0.25	0.27	0.26	0.19	0.20	0.20

*** p<0.01, ** p<0.05, * p<0.1

Table 2. Probit Estimates: Goodness of Fit

```
. lstat, cutoff(0.20)
```

```
Probit model for crisis
```

Classified	True		Total
	D	~D	
+	21	44	65
-	42	1818	1860
Total	63	1862	1925

```
Classified + if predicted Pr(D) >= .2  
True D defined as crisis != 0
```

Sensitivity	Pr(+ D)	33.33%
Specificity	Pr(- ~D)	97.64%
Positive predictive value	Pr(D +)	32.31%
Negative predictive value	Pr(~D -)	97.74%
False + rate for true ~D	Pr(+ ~D)	2.36%
False - rate for true D	Pr(- D)	66.67%
False + rate for classified +	Pr(~D +)	67.69%
False - rate for classified -	Pr(D -)	2.26%
Correctly classified		95.53%

```
. lstat, cutoff(0.10)
```

```
Probit model for crisis
```

Classified	True		Total
	D	~D	
+	36	151	187
-	27	1711	1738
Total	63	1862	1925

```
Classified + if predicted Pr(D) >= .1  
True D defined as crisis != 0
```

Sensitivity	Pr(+ D)	57.14%
Specificity	Pr(- ~D)	91.89%
Positive predictive value	Pr(D +)	19.25%
Negative predictive value	Pr(~D -)	98.45%
False + rate for true ~D	Pr(+ ~D)	8.11%
False - rate for true D	Pr(- D)	42.86%
False + rate for classified +	Pr(~D +)	80.75%
False - rate for classified -	Pr(D -)	1.55%
Correctly classified		90.75%

Table 3. In-sample Fit: Hits, Misses and Marginal Effect

Country	year	crisis	Prob.	Mg. Effect of Net Ext. Debt	Mg. Effect of Reserves	Country	year	crisis	Prob.	Mg. Effect of Net Ext. Debt	Mg. Effect of Reserves
Argentina	1981	0	28%	-0.44	-1.01	Mexico	1982	1	24%	-0.40	-0.92
Argentina	1982	1	23%	-0.39	-0.89	Mexico	1995	1	7%	-0.18	-0.41
Argentina	1995	1	8%	-0.19	-0.43	Moldova	2000	0	26%	-0.42	-0.96
Argentina	2001	1	2%	-0.06	-0.13	Moldova	2001	0	21%	-0.37	-0.85
Brazil	1983	1	26%	-0.42	-0.97	Moldova	2002	1	20%	-0.37	-0.84
Brazil	1999	1	5%	-0.13	-0.30	Moldova	2009	0	42%	-0.51	-1.16
Brazil	2001	1	1%	-0.04	-0.10	Moldova	2010	0	37%	-0.49	-1.12
Bulgaria	2009	0	35%	-0.48	-1.10	Morocco	1978	0	24%	-0.40	-0.92
Bulgaria	2010	0	22%	-0.39	-0.89	Morocco	1979	0	21%	-0.37	-0.85
Chile	1972	1	5%	-0.14	-0.33	Morocco	1980	0	23%	-0.39	-0.90
Chile	1981	0	24%	-0.40	-0.91	Morocco	1981	1	30%	-0.45	-1.03
Chile	1982	0	44%	-0.51	-1.17	Pakistan	1976	0	21%	-0.37	-0.85
Chile	1983	1	52%	-0.52	-1.18	Pakistan	1977	0	21%	-0.38	-0.86
Costa Rica	1981	1	27%	-0.43	-0.98	Pakistan	1978	0	22%	-0.38	-0.87
Dominican Rep.	1982	1	18%	-0.34	-0.79	Pakistan	1981	1	17%	-0.33	-0.75
Dominican Rep.	2003	1	6%	-0.16	-0.36	Pakistan	1998	1	10%	-0.22	-0.51
Dominican Rep.	2009	1	18%	-0.34	-0.77	Pakistan	2008	1	10%	-0.22	-0.51
Ecuador	1981	0	23%	-0.39	-0.89	Panama	1982	0	21%	-0.37	-0.86
Ecuador	1982	0	36%	-0.48	-1.11	Panama	1983	1	23%	-0.40	-0.91
Ecuador	1983	1	42%	-0.51	-1.16	Peru	1976	0	23%	-0.40	-0.91
Ecuador	1996	0	20%	-0.36	-0.84	Peru	1979	1	4%	-0.11	-0.26
Ecuador	1999	1	16%	-0.31	-0.71	Peru	1982	1	19%	-0.36	-0.82
Ecuador	2008	1	3%	-0.09	-0.20	Peru	1993	0	43%	-0.51	-1.17
Egypt	1982	0	28%	-0.44	-1.01	Peru	1994	0	28%	-0.44	-1.01
Egypt	1983	0	54%	-0.51	-1.18	Philippines	1976	1	8%	-0.19	-0.44
Egypt	1984	1	51%	-0.52	-1.18	Philippines	1979	1	6%	-0.15	-0.34
Estonia	2009	0	25%	-0.41	-0.93	Philippines	1981	1	20%	-0.37	-0.84
Greece	2009	0	26%	-0.42	-0.96	Philippines	1983	1	49%	-0.52	-1.18
Greece	2010	1	37%	-0.49	-1.12	Portugal	1977	1	10%	-0.23	-0.53
Hungary	2008	1	12%	-0.26	-0.59	Portugal	1983	0	33%	-0.47	-1.08
Iceland	1976	1	3%	-0.08	-0.18	Portugal	2008	0	22%	-0.38	-0.87
India	1984	1	11%	-0.24	-0.56	Portugal	2009	0	34%	-0.47	-1.08
Indonesia	1976	0	31%	-0.46	-1.04	Portugal	2010	1	48%	-0.52	-1.18
Indonesia	1977	0	31%	-0.46	-1.05	Romania	2009	1	27%	-0.43	-0.99
Indonesia	1983	0	21%	-0.37	-0.85	Russia	1998	1	25%	-0.41	-0.94
Indonesia	1998	1	11%	-0.24	-0.54	Serbia	2009	1	38%	-0.49	-1.13
Indonesia	2003	1	13%	-0.27	-0.62	South Africa	1985	1	9%	-0.20	-0.47
Italy	1975	1	0%	-0.01	-0.03	Spain	2010	0	23%	-0.39	-0.90
Jordan	1989	1	9%	-0.21	-0.47	Thailand	1981	1	17%	-0.32	-0.74
Jordan	1994	0	25%	-0.41	-0.94	Thailand	1997	1	6%	-0.15	-0.35
Jordan	1997	1	11%	-0.24	-0.55	Turkey	1976	1	8%	-0.19	-0.43
Jordan	2002	1	0%	-0.01	-0.02	Turkey	1978	1	10%	-0.23	-0.53
Korea	1975	1	7%	-0.18	-0.41	Turkey	2000	1	6%	-0.16	-0.36
Korea	1980	1	10%	-0.22	-0.51	Turkey	2008	1	12%	-0.26	-0.60
Korea	1997	1	1%	-0.02	-0.05	Ukraine	1998	1	38%	-0.49	-1.13
Latvia	2008	1	32%	-0.47	-1.07	Ukraine	2008	1	4%	-0.10	-0.23
Lithuania	2009	0	23%	-0.39	-0.90	Uruguay	1982	0	25%	-0.41	-0.95
Lithuania	2010	0	20%	-0.36	-0.83	Uruguay	1983	1	34%	-0.47	-1.08
Malaysia	1998	1	1%	-0.04	-0.09	Uruguay	2002	1	1%	-0.02	-0.05
						Venezuela	1983	1	12%	-0.26	-0.60

Table 4. Model's Predictive Power Over 2008-10 Crises

Country	Year	Crisis	Estimated Probability
Dominican Republic	2009	1	9%
Ecuador	2008	1	1%
Estonia	2009	0	11%
Greece	2009	0	17%
Greece	2010	1	25%
Hungary	2008	1	3%
Latvia	2008	1	12%
Lithuania	2009	0	13%
Lithuania	2010	0	11%
Moldova	2009	0	22%
Moldova	2010	0	18%
Pakistan	2008	1	5%
Portugal	2009	0	17%
Portugal	2010	1	23%
Romania	2009	1	14%
Serbia	2009	1	20%
Spain	2010	0	13%
Ukraine	2008	1	2%

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