

# Linking Bank Crises and Sovereign Defaults: Evidence from Emerging Markets

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## Abstract

We analyze the mechanisms through which bank and sovereign distress feed into each other, using a large sample of emerging market economies over three decades. After defining “twin crises” as events where bank crises and sovereign defaults combine, and further distinguishing between those bank crises that end up in sovereign defaults and vice-versa, we study what differentiates “single” and “twin” events. Using an event analysis methodology, we document systematic differences between “single” and “twin” crises across various dimensions. We show that many of the regularities often associated with either “bank” or “debt” crises are present in twin events only. We further show that “twin” crises themselves are heterogeneous events: the proper time sequence of crises that compose “twin” episodes is important for understanding these events. Guided by these facts, we use discrete-variable econometric techniques to assess the main channels of distress transmission between crises. We find that balance sheet interconnections, credit dynamics, financial openness and economic growth are important drivers of twin crises. Our results inform the flourishing theoretical literature on the mechanisms surrounding feedback loops of sovereign and bank stress.

**Keywords:** Banking Crises, Sovereign Defaults, Feedback Loops, Balance Sheets

**JEL codes:** E44, F34, G01, H63

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# Linking Bank Crises and Sovereign Defaults: Evidence from Emerging Markets<sup>1</sup>

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We analyze the mechanisms through which bank and sovereign distress feed into each other, using a large sample of emerging market economies over three decades. After defining “twin crises” as events where bank crises and sovereign defaults combine, and further distinguishing between those bank crises that end up in sovereign defaults and vice-versa, we study what differentiates “single” and “twin” events. Using an event analysis methodology, we document systematic differences between “single” and “twin” crises across various dimensions. We show that many of the regularities often associated with either “bank” or “debt” crises are present in twin events only. We further show that “twin” crises themselves are heterogeneous events: taking into account the proper time sequence of crises that compose “twin” episodes is important for understanding their transmission channels and economic consequences. Guided by these facts, we use discrete-variable econometric techniques to assess the main channels of distress transmission between crises. Balance sheet interconnections, credit dynamics, fiscal and recapitalization policies, financial openness, and economic growth, are all important drivers of twin crises. These findings inform the flourishing theoretical literature on the mechanisms surrounding feedback loops of sovereign and bank stress.

*KEYWORDS: Bank Crises, Sovereign Defaults, Feedback Loops, Balance Sheets.*

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## 1. Introduction

Decades of fast-growing balance sheets and falling capital ratios have led to larger and more frequent public interventions after financial crises (Alessandri and Haldane, 2009). In turn, these interventions have strained sovereigns and, at times, threatened their debt sustainability (Reinhart and Rogoff, 2011). Still, distress has often transmitted in the opposite direction with acute fiscal problems triggering financial crises (Caprio and Honohan, 2008). This perverse feedback loop of fiscal and financial distress has been at the core of the recent crises in advanced economies, and has triggered a new strand of theoretical and empirical literature in an effort to understand its mechanisms.<sup>4</sup>

In turn, and despite the fact that intertwined sovereign and bank crises are not new to emerging markets, the literature looking at how these two types of crises combine is scarce for this set of countries.<sup>5</sup> Only a few papers address the two-way nature of this relationship for emerging countries, but they do not formally study the channels through which feedback loops materialize. Thus, Borenzstein and Panizza (2009) find that the probability of a bank crisis conditional on a default is higher than the unconditional one, while the probability of default conditional on a bank crisis is just slightly higher than the unconditional one. Reinhart and Rogoff (2011) obtain the opposite result: bank crises are significant predictors of sovereign crises, but not the other way around.<sup>6</sup>

Our paper contributes to this literature by using regression-based event analyses and discrete-variable econometric models to study the channels through which sovereign and bank crises intertwine. Using a large sample of emerging markets over three decades, we study the dynamics of a set of variables describing the balance sheet linkages between banks and sovereigns, banking sector characteristics, fiscal and monetary policies, and the macroeconomic and external environment. New to the literature, we differentiate between four types of events: “single” bank crises i.e. bank crises that are not followed by sovereign defaults; “single” sovereign debt crises i.e. sovereign defaults not followed by a bank crisis; “twin bank-debt” crises, which start with a bank crisis, followed by a sovereign one; and “twin debt-bank” crises, where a sovereign crisis is followed by a bank crisis.

We find that there are systematic differences between “twin” and “single” crisis events across many of the variables we study, and, in particular, for those variables describing the interplay between the balance sheets of domestic banks and of the central bank and government, the level and dynamics of financial intermediation, fiscal and recapitalization policies, financial openness, real growth dynamics and inflation. Another finding of our study is that twin and single events involving bank crises differ vastly in terms of their costs to the sovereign, as well as in terms of output losses and the burden of non-performing loans.

Moreover, by separating “single” and “twin” events, we show that a number of empirical facts the literature tends to associate with either “bank” or “debt” crises are to be found in “twin” events only. We also find that, in contrast to what the “twin crises” literature seems to implicitly assume, considering the sequence of crises within “twin” episodes is important for

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<sup>4</sup> See Mody and Sandri (2012), Acharya et al. (2014), Alter and Beyer (2013), Moody’s (2014), Popov and Van Horen (2013), Ongena et al. (2016), or Jorda et al. (2016) for recent empirical contributions. Relatedly, the theoretical literature is moving beyond modelling the macroeconomic effects of sovereign defaults (Mendoza and Yue, 2012 or Arellano, 2009) into explaining the role of financial dynamics (Malucci, 2015) and banks’ balance sheets (Sosa-Padilla (2012) or Engler & Gobbe-Sttefen (2016).

<sup>5</sup> The “twin crises” literature has mainly focused on the link between bank and balance-of-payments crises (Kaminsky and Reinhart, 1999).

<sup>6</sup> According to Reinhart and Rogoff (2011) (i) bank crises often lead sovereign crises, (ii) external debt surges ahead of bank crises, (iii) public debt increases ahead of sovereign crises, and (iv) short-term debt increases before debt and bank crises.

understanding their transmission channels and economic consequences. We uncover contrasting dynamics in the behavior of banking sector leverage, public finances and financial openness, which would have otherwise gone unnoticed. In addition to those differences, we also find remarkable similarities across “twin” types. Both types of “twin” events are accompanied by deeper recessions, high inflation, boom-bust credit dynamics, exchange rate pressures and feature stronger balance sheet connections between the banks and the sovereigns.

Our regression-based event analyses are very useful to understand the dynamics around the times of the crises. However, as they are univariate regressions, they can “only” examine dynamics indicator by indicator. But crises are about multiple vulnerabilities. For that reason, we also assess the importance of the factors mentioned above in the transmission of stress using multinomial and bivariate models. The results confirm that the balance sheet interconnections between banks and their sovereigns, economic growth, the credit cycle, and the degree of financial openness all help explain the onset of twin crises events.

The next section discusses the main feedback channels between bank and sovereign risk, as identified in the literature. Section 3 introduces the definitions of crises and describes the data. Section 4 presents the econometric event analysis and discusses the main results of the paper. Section 5 discusses results obtained from two alternative multivariate approaches. Section 6 derives implications of our findings for the literature. Section 7 concludes.

## **2. How does distress transmit? An overview of the literature**

Bank crises may put strains on governments through both direct and indirect channels. The former refers to the fiscal costs that the sovereign incurs to bail out the banking sector. The latter goes through the impact of crises on the broader economy and market sentiment. Similarly, when considering the transmission channels of a fiscal crisis to the financial sector, the effect of a default on the broader economy can be traced through the domestic financial system, in addition to the direct balance-sheet linkages. Below, we briefly discuss the main channels through which sovereign and bank crises intertwine as identified in the literature.

### **Balance sheet channels**

According to Candelon and Palm (2010), bank rescue operations may impair the sustainability of public finances.<sup>7</sup> These operations can include central bank liquidity provisioning, public recapitalization or the execution or materialization of public guarantees and contingent liabilities.<sup>8</sup> According to Gray and Jobst (2013) and Gray et al. (2013), contingent liabilities can have a strong impact on fiscal risk. Acharya et al. (2014) show that if the sovereign becomes overburdened, the value of public guarantees falls, aggravating the feedback loop from the financial sector into the sovereign.

In turn, when considering the transmission of a fiscal crisis to the banking system, Noyer (2010) argues that if assets need to be written off or rescheduled, banks are the first in line to take a hit. This way, banks’ sovereign exposures might lead to large capital losses, threatening their solvency. Brutti (2009), Acharya and Rajan (2013) and Gennaioli et al. (2014) show that the sovereign’s incentive to repay its debt is driven by the risk of triggering a bank crisis. In fact,

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<sup>7</sup> Rosas (2006) finds public bank bailouts more likely in open, rich economies or if turmoil was due to regulatory issues. Instead, electoral limits and central bank independence favor bank closure.

<sup>8</sup> The fiscal costs of bank crises are well documented - see Laeven and Valencia (2012b), Feenstra and Taylor (2012), Reinhart and Rogoff (2011) or Arellano and Kocherlakota (2014).

according to Livshits and Schoors (2009), the government has incentives to not adjust prudential regulation when public debt becomes risky. While this keeps borrowing costs low, a sovereign default may trigger a bank crisis. IMF (2002) shows that banks do not hold capital against sovereign risk, as prudential regulation considers government bonds risk-free.<sup>9</sup>

In fact, a growing literature looks at the drivers of increased sovereign holdings by resident banks during the euro area crisis. According to Drechsler et al. (2016), capital regulation and the ECB's collateral policy give preferential treatment to euro-area government bonds, providing incentives for banks to load up on such bonds, setting the stage for the appearance of perverse feedback loops. According to Darraq-Pariès et al. (2014), the positive connection between fiscal and bank risk is due to the banks' reliance on sovereign securities for hedging liquidity shocks. In an influential paper, Acharya and Steffen (2015) argue that purchasing bonds from a stressed sovereign implied a carry-trade gain and that banks profited from it. They further argue that this was likely driven by moral hazard, in the case of non-resident banks, and by moral suasion in the case of domestic banks (see also Battistini et al., 2014).<sup>10</sup>

### **Macroeconomic channels**

Regarding the transmission of bank crises into the sovereign realm, Reinhart and Rogoff (2008) note that, after a bank crisis, the deterioration of the sovereign's fiscal position is likely to occur due to a combination of lower revenues and higher expenditures (assistance to troubled banks and outlays associated with the economic downturn). In the same vein, Candelon and Palm (2010) argue the economic downturn accompanying bank crises increases the deficit and drives up public debt. Honohan (2008) argues that, beyond the direct cost of bank rescues, a critical factor explaining the subsequent fiscal distress is the collapse in tax revenues due to the deep economic contraction created by the bank crisis.<sup>11</sup> Reinhart and Rogoff (2009) provide evidence of a strong negative impact of financial turmoil on asset prices, employment and output. Also, Baldacci and Gupta (2009) show that using fiscal policy to solve a bank crisis leads to sharp rises in debt and deficit even in a favorable external environment.<sup>12</sup> Goldstein (2003) argues that distress can transmit to the sovereign even if debt levels are low - in fact, over half of the default episodes surveyed by Reinhart and Reinhart (2009) took place against debt levels below 60% of GDP.<sup>13</sup>

Laeven and Valencia (2013) focus on the ability of bank rescues to minimize the credit crunch created by a bank crisis. They show that firms dependent on external financing benefit significantly from bank rescues. Similarly, Kollmann et al. (2012) find that recent bank rescues helped improve macroeconomic performance. Still, while they show that bank rescue operations lead to increased investment, they find that sovereign debt purchases by domestic banks crowd out private investment, in line with the evidence in Gennaioli et al (20014b) and Popov and Van Horen (2013).

As regards twin debt and bank crises, Reinhart and Rogoff (2008) show that defaults go hand in hand with inflation, currency devaluations and bank crises.<sup>14</sup> According to these authors, the

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<sup>9</sup> The authorities often react to debt problems by coercing local banks to hold sovereign debt (in non-market terms), aggravating the situation in an event of default (Díaz- Cassou et al., 2008).

<sup>10</sup> The moral suasion argument has been found to have had a significant effect in a number of recent papers. De Marco and Macchiavelli (2016) present an identification strategy based on political factors, while Ongena et al. (2016) use refinancing needs.

<sup>11</sup> The effects are specific to each episode, but estimated fiscal costs of the median systemic banking crisis stand at 15.5% of GDP, with public debt increasing by around 30% of GDP.

<sup>12</sup> They further argue that the composition of fiscal stimulus affects the length of crises. There is a trade-off between boosting aggregate demand (short-run) and productivity growth (long-run).

<sup>13</sup> As noted by Goldstein (2003), debt-to-GDP fails to take into account contingent liabilities.

<sup>14</sup> De Paoli et al. (2009) find that two thirds of sovereign defaults overlap bank crises, and half with both bank and currency crises.

ensuing fiscal contraction may lead to reduced economic activity, further damaging the financial system.<sup>15</sup> Moreover, the economic downturn may be reinforced by a credit crunch, as banks reduce lending due to capital losses and the increase in uncertainty that comes with the default. Popov and Van Horen (2013), Broner et al. (2014) and Gennaioli et al. (2014b) support the view that large sovereign exposures can limit banks' ability to extend loans to the private sector, triggering a credit crunch. These papers document a stronger reallocation away from domestic lending in the euro area periphery during the recent crisis.<sup>16</sup>

### **External sector channels**

Bank crises may ignite a currency crash, making the sovereign unable to repay foreign currency debt (Reinhart and Rogoff, 2011, De Paoli et al., 2009). This is more likely to happen if the central bank uses reserves to finance bailouts, or the government uses monetization to overcome the crisis (Jacome, 2015).

In addition, bank crises can lead to a drop in external financing. Cavallo and Izquierdo (2009) show that in emerging markets, capital flows may collapse for months or years after bank crises, potentially triggering a solvency crisis.<sup>17</sup> Conversely, Reinhart and Rogoff (2008) find that bank crises are often preceded by strong capital inflows ("bonanzas"). Focusing on advanced economies, Van Rixtel and Gasperini (2013) argue that banks' borrowing constraints in foreign currency affect the creditworthiness of sovereigns. All these can be worsened by too much foreign debt and too much short-term debt (Obstfeld, 2011).<sup>18</sup>

Turning to the transmission of sovereign stress, Gennaioli et al. (2014b) show that sovereign defaults tend to trigger capital outflows and foreign credit crunches. In their view, strong financial institutions amplify the costs of default, disciplining the government. Also Broner et al. (2013), Gennaioli et al. (2014a) and Das et al. (2009) show that corporate borrowers and banks may face a sudden stop in financing after a sovereign default. By generating a sudden stop in foreign capital, sovereign defaults can curtail access by residents to domestic credit (Cesa-Bianchi et al., 2017). A similar effect is described in Reinhart and Rogoff (2011) - sovereign rating downgrades can lead to sudden stops and higher borrowing costs.

### **3. Data: events and variables**

Our sample contains 104 emerging market economies<sup>19</sup> and covers three decades, from 1975 to 2007. As discussed in the introduction, one of our goals is to complement the recent literature on bank-government nexus in advanced economies with a set of stylized facts on the links between bank crises and sovereign defaults in emerging markets. We therefore collect data on a large group of emerging market economies, including low-income ones. To keep the sample reasonably homogenous, we decide not to include advanced countries, given the very different nature of financial systems and of the links between banks and sovereigns in these countries,

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<sup>15</sup> Also Angeloni and Wolff (2012) assess the impact of sovereign exposures on banks' performance during the euro area crisis.

<sup>16</sup> These papers present a nuanced view of the effects of bond purchases by local banks. Other papers in the literature (see Andritzky (2012) or Asonuma et al. (2014)), show that these purchases can stabilize sovereign bond markets.

<sup>17</sup> They find that the probability of a banking crisis conditional on a capital flow bonanza is higher than the unconditional probability in 61% of the countries they cover (for the period 1960-2007).

<sup>18</sup> Obstfeld (2011) argues that "gross liabilities, especially those short-term, are what matters".

<sup>19</sup> See Appendix 1 for the full list of countries in the sample.

especially during most of the period we study. Secondly, we also exclude from our analysis all bank and sovereign episodes linked to the recent global financial crisis.

### 3.1. Definition and incidence of events

To identify and date sovereign debt crises, we rely on two sources of information: Standard & Poor's – S&P (2007) and Reinhart and Trebesch (2016). S&P defines sovereign defaults as situations where: (i) the government does not meet scheduled debt service on the due date or (ii) creditors are offered either a rescheduling (bank debt) or a debt exchange (bond debt) on less favorable terms than the original issue.<sup>20</sup> However, the S&P dataset contains defaults on private external debt only and in countries that are rated by the agency (i.e. typically, more developed emerging markets).

We complement the S&P dataset with the Reinhart and Trebesch (2016) comprehensive dataset on sovereign defaults on external debt. This dataset helps identify defaults in those emerging markets that are not rated by S&P, as well as defaults on official external debt. The latter are defined as episodes of “significant and persistent arrears to official creditors”, which occur when arrears to official creditors (including to the IMF and World Bank) exceed 1% of GDP for three consecutive years or more.<sup>21</sup> Including defaults on official external debt is important, given that many EMEs in our sample had very little private external debt to default on during most of the period we study.

With regard to bank crises, we use the “systemic” events defined by Laeven and Valencia (2012b) as situations in which a country's financial sector experiences a large number of defaults, and firms and financial institutions face great difficulties repaying contracts on time (this definition excludes minor bank crisis events, involving only isolated banks).

We define “twin crises” as pairs of bank and sovereign debt crises that take place at intervals of less than three years one from each other. Crises of the same type that occur less than three years apart are considered to belong to the same event. Accordingly, we isolate the following episodes: (a) “single bank crises”, as banking crises not followed by a sovereign default in the following three years; (b) “single sovereign debt crises”, as sovereign defaults not followed by a systemic bank crisis in the following three years; (c) “twin bank-debt” crises, as events which start with a bank crisis, followed by a sovereign one within three years; and (d) “twin debt-bank” crises, as events where a sovereign crisis is followed by a bank one within three years.<sup>22</sup>

The three-year window between the two crises that compose a twin event is chosen following the approach in Reinhart and Trebesch (2016) and Forni et al. (2016). The challenges to date crises and identify “twin” ones have led to time windows of various lengths being used in the literature, ranging from one year (e.g. see Laeven and Valencia, 2012) to four years (e.g. Kaminsky and Reinhart, 1999). Defining twin events by using a smaller window leads to marginal changes in our classification of events and results, as the majority of crises in a twin event occur at intervals of zero, one or two years (see Table 2 and 3 in Appendix 1 which show the years in which individual crises within a twin event occur).

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<sup>20</sup> While there are situations in which defaults may either take the form of high inflation episodes or be averted through an IMF intervention, we take a stricter view in this paper and focus on explicit defaults only.

<sup>21</sup> We do not consider Paris club restructurings as default events, given that they often come much later than the actual sovereign default and some of them are negotiated as part of the Heavily Indebted Poor Country (HICP) Initiative.

<sup>22</sup> There are twin events where both components (banking and debt crises) start the same year. In this case, we use IMF Article IV reports, financial press and country monographs to understand the sequence of events within a twin episode.

With these definitions, we obtain 100 sovereign debt crises and 81 bank crises. Of these, 34 are twin events – that is, one third of bank crises and 42% of sovereign defaults are part of twin events. Further differentiating twin episodes according to the sequence of crises that compose them delivers 18 “twin bank-debt” crises and 16 “twin debt-bank”. Tables 1-3 in Appendix 1 provide the full list of single and twin events.

### 3.2. Variables: definitions and sources

In light of the literature on transmission channels between bank and sovereign distress, we focus on the behavior around crises of four categories of variables describing: balance sheet interconnections between banks and the public sector, banking sector characteristics, the state of public finances, and the overall economy. Our aim is to understand whether there are systematic differences in the dynamics of these variables around different crisis types. Table 4 in Appendix 1 lists all variables used in the analysis, along with their definitions and sources. All data are of annual frequency.

We use the aggregate balance sheet of domestic depository institutions in each country (as reported in the IMF’s International Financial Statistics database - IFS) to construct two key variables that describe the interdependence between banks and the public sector: (a) bank’s holdings of sovereign debt, measured by banks’ claims on central government scaled by banking sector’s domestic assets<sup>23</sup>; and (b) central bank liquidity support, measured by credit provided by the central bank to the banking sector (scaled by banking sector’s domestic assets). Unfortunately, there is no comprehensive cross-country time-series information on two other important indicators of sovereign and banking sector interdependence: recapitalization expenditures and provision of guarantees. Still, we are able to provide a number of static indicators on the fiscal costs of different types of crises by mapping our definition of events to Laeven and Valencia’s (2012b) dataset, which contains information on bank resolution policies and outcomes.

The aggregate balance sheet of domestic banks is also used to study the behavior of assets and lending around crisis episodes. Our measure of bank assets includes domestic assets only (scaled by GDP), due to the limited quality and availability of data on foreign assets for many countries in our sample<sup>24</sup>. Lending is measured by credit extended to the private sector credit (scaled by GDP), whereas deposits are measured relative to banking sector assets.

The fiscal variables used in the analysis include budget deficit, expense and public debt. Data on budget deficits and expense come mainly from the Economist Intelligence Unit (EIU), which is the most complete cross-country database on government revenues and expenses. However, given that this dataset starts in 1980 and has a number of gaps, we collect data from alternative sources: IFS, Mitchell’s (2007) series on “International Historical Statistics”, the World Economic Outlook database, and Article IV reports. Data on public debt come from the World Bank’s World Development Indicators (WDI).

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<sup>23</sup> Arguably, a more complete measure of the banking sector’s exposure to the sovereign would also include claims on local government and public companies, which are important indicators of direct and contingent public liabilities. However, we choose to use banks’ claims on central government only due to data availability - data on claims on local/regional government and public companies are noisy and have poor coverage across many countries in our sample. We nevertheless use a measure of “total claims on government” (central + local + public companies) in a limited sample and obtain very similar results to the baseline ones.

<sup>24</sup> In a previous version of the paper (available as the *Bank of Spain Working Paper no.1414/2014*), we limit our sample to more developed emerging markets and use a measure of “total bank assets” instead, with very similar results.

The impact of the different types of crises on the economy is captured by the behavior of the real growth rate, inflation (change in CPI index), real exchange rate (real effective exchange rate index) and the share of short-term debt in total external debt. Finally, to measure the economy's (and sovereign's) access to external finance, we use gross capital inflows (as a share of GDP), as well as the Chinn-Ito index of capital account openness, which measures the extent of openness in capital account transactions/the extent and intensity of capital controls (Chinn and Ito, 2006).

#### 4. Bank Crises and Sovereign Defaults: An Event Analysis

We are interested in what differentiates “single” bank crises from those that bring down the sovereign and, similarly, what differentiates “single” sovereign defaults from those that eventually lead to bank crises. To this end, we study the behavior of our variables around different types of crisis using an event analysis methodology, as in Gourinchas and Obstfeld (2012) and Broner et al (2013). Specifically, we estimate how the conditional expectation of each variable depends on the temporal distance to each type of event, given the proximity of other crises, and relative to a “tranquil times” baseline.

Consider a variable of interest  $Z_{it}$ , where subscripts  $i$  and  $t$  refer to the country and the period, respectively. We use a panel specification with fixed effects, as follows:

$$Z_{it} = \alpha_i + \sum_{e=\{B,D,BD,DB\}} \sum_{p=-3}^{p=3} \beta_{ep} \cdot D_{ei(t+p)} + \varepsilon_{it}$$

In the equation above,  $D_{ei(t+p)}$  denotes a dummy variable equal to 1 when country  $i$  is  $p$  periods away from a type  $e$  crisis in period  $t$ . The index  $e$  denotes, respectively, sovereign debt crises ( $D$ ), systemic bank crises ( $B$ ), twin debt-bank crises ( $DB$ ) and twin bank-debt crises ( $BD$ ). The event window is set to seven years – that is, three years before and after the start of the crisis. The initial year of twin events is given by the year in which the first of the two crises begins e.g. the year when the bank crisis starts in  $BD$  and the year in which the sovereign defaults in  $DB$ . The regression includes country fixed effects,  $\alpha_i$  and, in some specifications, country-specific trends. The error term  $\varepsilon_{it}$  captures all the remaining variation. As our sample is highly heterogeneous, we minimize the effect of the most extreme observations by normalizing each series using country-specific standard deviations.

The coefficients  $\beta_{ep}$  measure the conditional effect of a type  $e$  crisis on variable  $Z$  over the event window, relative to a common non-crisis baseline. The “tranquil times” baseline provides a common reference level against which the impact of our different types of crisis can be estimated and compared. It also allows us to plot our estimated coefficients and thus obtain dynamics that can be directly comparable. Given that we work with normalized data, we follow Broner et al. (2013) and recover the economic significance of our coefficients by multiplying them with the median one standard deviation of the non-standardized value of the dependent variable across countries with the same type of crises.

#### 4.1. What are the facts?

This section presents the main stylized facts obtained from the event analysis described above. Our goal is to understand what differentiates single bank crises from those that are part of twin bank-debt events, and single sovereign defaults from those that are part of twin debt-bank crises. We also study whether there are systematic differences between the two types of twin events, depending on the timing of the two crises within an event.

To this aim, we contrast the behavior of variables around different types of crisis with help of charts 1-26 in Appendix 3, which plot the economic significance of the estimated  $\beta_{ep}$  coefficients, together with 90% confidence bands. We consider a window of three years around the start of the crisis, which is marked by year  $T$ . Appendix 4 contains the regression results. Though many of the point estimates are sizable in magnitude, some are either borderline or not significant, as standard errors are large due the small number of twin crises in the sample.

*What differentiates single bank crises from twin bank-debt crises?*

Figures 1 and 2 show that bank crises that end up in sovereign defaults ( $BD$  events) occur at the end of larger asset and credit booms compared to single bank crises ( $B$  events). Pre- and post-crisis dynamics in lending are roughly similar, and credit to the private sector stands significantly above “tranquil” levels in the run-up to both bank crises. However, this level of excess credit is much larger in  $BD$  than in  $B$  events. At the peak, credit to the private sector is more than 8% of GDP above “normal” levels in  $BD$ . This is more than two times larger than in  $B$  events. Both episodes present similar boom-and-bust patterns in domestic lending. This pattern has been well documented in the literature, though mainly in the context of twin bank and currency crises (see Bordo and Meissner, 2016).

The differences in the levels and dynamics of bank assets are even larger. Peak bank assets in  $BD$  events stand at 10% of GDP above tranquil levels, almost five times more than in  $B$  events. Figure 1 shows the striking divergence in dynamics once the bank crisis hits. A steep and sustained decline in bank assets following  $B$  events contrasts with a slow process of downsizing in  $BD$ , which gets under way only during the second year of the crisis. Three years after the start of the  $BD$  crisis, the size of the banking sector remains larger than both pre-crisis and tranquil levels.

These findings suggest that in  $BD$  episodes, distressed banks are likely to need larger public support, potentially putting more strain on the sovereign. At the same time, as shown by Gennaioli et al (2014a), a bank collapse would have a more damaging effect on the economy, giving the government incentives to intervene.

To obtain insights into the balance sheet interlinkages between the sovereign and the banking sector, we look at the amount of both public debt and central bank liquidity support on banks’ balance sheet. Figure 3 shows that neither  $B$  nor  $BD$  bank crises are preceded by exceptionally high levels of public debt on banks’ balance sheets. Nevertheless, there is a fast accumulation of banks’ claims on the sovereign ahead of  $BD$  events. With the banking crisis under way, holdings of public debt increase in both events, going significantly above tranquil levels by the end of the crisis window. We note that the credit boom prior to  $B$  events is not accompanied by a similar increase in banks’ holdings of public debt, while this is the case in  $BD$ . In fact, as the bank crisis in  $BD$  events draws near, there is a shift from credit to the private sector to credit to

government.<sup>25</sup> There are also significant differences in the liquidity support provided by the central bank to the banking sector (Figure 4). In *B*, this support is larger than “tranquil” levels ahead of the crisis, peaks at *T*, and starts falling at the same time that holdings of public debt start to increase. In contrast, central bank support is absent ahead of *BD* events, jumps during *T*, and remains significantly above “tranquil” levels during the following two years. In fact, *BD* is the only category of events where central bank support is not present prior to the start of the crisis.

Thus, in *B* episodes the central bank provides significant support to banks ahead of the crisis and removes it quickly in the aftermath, when banks’ holdings of public debt start rising. In contrast, public debt accumulates rapidly on banks’ balance sheets ahead of *BD* events, while support from the central bank arrives only once the banking crisis hits. In the aftermath, both central bank credit and holdings of public debt reach levels that are significantly above “tranquil” ones. These divergent dynamics reflect differences in the size and type of the initial shock, specific banking sector features, or differences in the policies chosen to solve the crisis.

As mentioned in section 3, no consistent panel dataset on public recapitalization costs is available. Nevertheless, insights into the fiscal costs of the various types of bank crises can be obtained by mapping our events into Laeven and Valencia’s (2012b) dataset on policy responses to bank crises. We obtain several static indicators of the cost and severity of these events. As shown in Table 5 of Appendix 2, the difference between *B* and *BD* episodes is not in the burden of non-performing loans, but in the fiscal costs of solving them. Fiscal costs with respect to GDP during *BD* crises are double those of *B* crises, and the difference is even larger when these costs are measured with respect to financial sector’s assets.

Figures 5 -7 show that budget balance positions are no different from tranquil times ahead of bank crises in either *B* or *BD* events. Moreover, public debt is significantly lower than tranquil levels ahead of *BD*, and similar to normal ahead of *B* events. In both events however, budget balances gradually drop to levels significantly below “normal” as the crisis approaches, and dynamics start to diverge after *T*. There is a sharp deterioration in budget balances during the first year of the bank crisis in *BD*, while deficits do not worsen further in the aftermath of *B* events. Even more striking is the fast and steady accumulation of public debt in *BD*, which starts during the first year of the bank crisis and reaches almost 20% of GDP above tranquil levels after three years. In fact, Table 5 in Appendix 2 shows that *BD* is the only type of crisis which entailed a positive public debt accumulation throughout the event window. This contrasts with flat debt ratios around *B* episodes.

Taken together these dynamics could indicate that the policy response in *BD* helps keeping the banking sector afloat, postponing deleveraging until the crisis engulfs the sovereign (Acharya et al., 2014). Relatedly, the very different debt and deficit dynamics, combined with the different magnitudes of the fiscal costs of crises reported above, suggest that the management of bank crises in *BD* events has a more damaging effect on the solvency of the sovereign.

As discussed in section 2, bank crises can affect the sovereign through indirect channels as well, in particular via their impact on the economic activity and financial flows. Indeed, figures 8 and 9 show that bank crises in *BD* events have a more damaging effect on growth and inflation (as also confirmed by the comparison of output costs in Table 5 of Appendix 2). In these events,

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<sup>25</sup> The increase in banks’ holdings of public debt can be due to banks’ own decisions on risk taking or retrenching from the private sector (Broner et al., 2014), or to banks being incentivized or forced to sustain the government (Ongena et al. 2016).

growth decelerates drastically and inflation increases sharply once the bank crisis hits. Growth rates remain well below and inflation well above tranquil levels in the aftermath of banking crises in *BD*.<sup>26</sup> In contrast, growth and inflation dynamics are more muted around *B* events. While growth is already below “tranquil” levels ahead of *B*, it does not worsen in the aftermath of the crisis. Instead, recovery is swift, with growth rates at normal levels by the second year of the crisis. Similarly, inflation rates are higher than in “tranquil” times ahead of *B*, but moderate to normal levels immediately after the crisis.

Figures 10-13 provide two key additional differences between *B* and *BD* events. The latter are accompanied by stronger exchange rate pressures and tend to occur during periods of capital account liberalization and large capital inflows. Bank crises in *BD* are those that are accompanied by the largest currency depreciation among our crises.<sup>27</sup> These dynamics stand in sharp contrast to those around *B* events, where the real exchange rate stays mostly flat and similar to tranquil levels. Figures 11 and 12 show that in the wake of bank crises in *BD*, there is a sudden stop in capital inflows (they fall by over 4% of GDP in three years) and a sharp reversal in capital account openness. In contrast, capital inflows are similar to tranquil levels around *B* events, and experience a less marked decline after *T*. Therefore, these figures show that the boom-bust pattern in capital flows is a feature of *BD* crises, but not of single bank crises. Closely related, figure 13 looks at the dynamics of short-term debt in total foreign debt around the two events. Reinhart and Rogoff (2011) note that this ratio increases dramatically ahead of crises, attributing it to the large loss of confidence from foreign investors. Figure 13 shows that this is the case during *BD* events only.

To sum up, bank crises that bring down the sovereign differ systematically from single ones. *BD* crises involve a larger build-up of bank assets and credit. While boom-bust dynamics in credit are similar in both events, the steep and sustained decline in bank assets in *B* contrasts with the slow process of downsizing in *BD*. At the same time, there is a larger accumulation of public debt on banks’ balance sheets around these episodes, while central bank liquidity support is late to arrive. These patterns suggest that in *BD* crises, governments put up more resources in an attempt to manage bank crises, which threaten their solvency. This is confirmed by comparing recapitalization costs between the two types of bank crises, as well as the dynamics of public finances around the two events. Although both bank crises occur against similar low levels of budget balances and public debt, this apparently sound fiscal position deteriorates sharply once the bank crisis is under way in *BD*, as deficits worsen and debt shoots up. We also find that the aftermath of bank crises in *BD* is characterized by lower growth and higher inflation. Finally, we find that financial openness has a key role to play in shaping the transmission between bank and sovereign stress. *BD* crises are accompanied by a boom-bust pattern in capital flows, occur at times of capital account liberalization, and are accompanied by strong exchange rate pressures.

#### *What differentiates single defaults from twin debt-bank crises?*

We now turn to characteristics that distinguish single sovereign defaults (*D* events) from those that are followed by bank crises (*DB* events).

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<sup>26</sup> It may be puzzling that growth rates are not higher than in tranquil times ahead of bank crises that feature a credit boom. Still, our findings fit into an empirical literature which does not converge on a clear pattern for output growth ahead of crises, as discussed by Bordo and Meissner (2016)’s meta-analysis of the literature on “financial and fiscal crises”.

<sup>27</sup> This, in turn, may add pressure on the sovereign, given that in emerging markets, debt is in a large part denominated in foreign currency.

Defaults that end up in bank crises occur against a substantial accumulation of government debt on banks' balance sheets. As shown in Figure 14, and in line with Gennaioli et al (2014a), *DB* crises take place against banks that are significantly more exposed to the government. Moreover, the accumulation of sovereign liabilities occurs at an explosive pace ahead of *DB* (indeed, the fastest pace among our four types of crisis). Once the sovereign defaults, there is a sharp and immediate drop in banks' claims on government, most likely because of debt write-offs. These developments stand in contrast with the more muted dynamics around *D* events and suggest that banking sectors in *DB* take a larger direct loss on their balance sheets following the sovereign default.

Figures 15 turn to the differences between *D* and *DB* crises in terms of liquidity support provided by the central bank to the domestic banking sector. While pre-crisis levels are significantly above "tranquil" times in both events, post-default dynamics are clearly different. Liquidity support is flat throughout *D* events, whereas it increases dramatically with the sovereign default in *DB*. Liquidity injections from the central bank reach more than 10% of bank assets above normal one year after the default in *DB*, and remain persistently large in the aftermath. The fact that the amount of central bank support provided around the two sovereign defaults is significantly larger than non-crisis levels is an indication that banking sector tensions accompany both events, including single ones. It is also likely that these tensions are addressed to a good extent by direct liquidity injections from the central bank, given the constrained fiscal space available to the sovereign after the default. Figure 15 shows that this is particularly the case in *DB* events, where such support is well in excess of central bank support in any other type of crisis. As we will discuss below, a more constrained sovereign and more damaged bank balance sheets are behind these very large differences between *DB* events and the rest.

Figures 16 and 17 provide evidence of the larger damage inflicted by *DB* events to banks' balance sheets (as also revealed by the high share of non-performing loans at the peak of these events, as reported in Table 5). These episodes are preceded by significant increases in bank assets and private sector credit, though lending stalls already two years prior to the default. The aftermath of defaults in *DB* sees a sharp and substantial fall in bank assets and credit to the economy. In contrast, these are hardly affected by single defaults, as indicated by the flat dynamics around *D* episodes. In fact, there is an incipient tendency for assets, and especially for credit, to pick up soon after the single defaults. This is consistent with theories noting that resources in the domestic economy are freed up after a default (see Aguiar et al (2009) and Arslanalp and Henry (2005)). We show that this is more likely to happen when defaults are not followed by bank crises.

Figures 18 and 19 show that ahead of both defaults, governments run budget balances that are around 2% of GDP worse than in tranquil times, on the account of public spending that is significantly larger than normal. A fiscal correction follows defaults in both events. This adjustment is sharper in *DB*, and is driven by a stronger cut in public expense (in fact, *DB* events feature four consecutive years of deficit corrections, which is the largest streak among our four types of crises). Secondly, both defaults occur against levels of public debt that are quite similar to normal three years ahead of the events (Figure 20). However, the difference between the two gets larger in the run-up to the default, due to the faster rate of debt accumulation in *DB*. Following the default, public debt is reduced significantly more rapidly in

*DB* than in *D* (see also Table 5 of Appendix 2, which shows that the largest debt reduction is to be found in the wake of defaults in *DB* events).

While our data do not allow us to tell which of the two defaults is more sizable on average, this differentiated behavior of public finances points to larger and more sustained reductions in debt and deficits in the aftermath of defaults in *DB*. In turn, this indicates a more constrained sovereign in the latter events, and therefore a more limited fiscal space available to sustain the banking sector. The static indicators in Table 5 of Appendix 2 confirm that, indeed, fiscal costs of those bank crises that follow sovereign defaults are the smallest.

Figure 21 shows that both *D* and *DB* events occur in recessionary environments. Growth rates are significantly below normal well ahead of both defaults, and worsen further as the debt crisis draws near. However, defaults that are part of *DB* episodes have a larger immediate negative impact on growth. Average growth rates in these events drop to 8% below tranquil levels during *T*, which is more than double than in single defaults. In the aftermath of defaults, growth rates remain depressed in *D* events, whereas they recover much faster in *DB* ones (albeit from extremely low levels). Table 5 shows that, indeed, *DB* is the group of events with the largest cumulated output loss. Figure 22 shows that high inflation rates accompany both defaults, a pattern well documented in the literature (see e.g. Reinhart and Rogoff, 2008). The *DB* events are a group apart, as they feature extremely high inflation rates.<sup>28</sup> Inflation falls drastically in the aftermath of both defaults.

Following our findings on the importance of financial openness in distinguishing between *B* and *BD* events, figures 24-26 show, once again, striking differences in this respect at the time of the two default types. Both capital inflows and the Chinn-Ito index of capital account openness stand at significantly low levels around defaults that are part of *DB* crises. This is not the case during single defaults, as in that case capital flows are similar to normal levels before the event, and decline only modestly in its aftermath. These findings suggest that sovereign stress is more likely to transmit to the banking sector in times of financial repression (see also Reinhart (2012) and Reinhart and Sbrancia (2015)). It is during these times that governments with limited access to capital markets can only borrow from captive domestic banks. In these circumstances, a sovereign default has a devastating effect on domestic banks. Finally, figure 26 shows that, in contrast to single defaults, the share of short-term debt in total foreign debt keeps increasing at a sustained pace in *DB* events, even after the sovereign defaults.

To sum up, sovereign defaults in *DB* events entail, on average, stronger corrections of debt and deficit levels, as well as larger public expense cuts. This limits the public resources available to support the financial sector, as confirmed by the very low recapitalization costs that characterize these episodes and the recourse to unusually large direct liquidity injections from the central bank. At the same time however, in the run-up to these episodes, domestic banks accumulate larger stocks of sovereign liabilities, leaving them significantly more exposed to the government. Part of this accumulation may have roots in the inability of the sovereign to tap foreign markets, as *DB* crises are accompanied by subdued capital flows and occur at times of low financial openness. Once the sovereign defaults, banks take a direct hit from debt write-offs. Moreover, the damage to their balance sheets is composed by a protracted recessionary

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<sup>28</sup> Indeed, the *DB* group contains a substantial number of hyperinflations. Five out of the 16 *DB* crises are hyperinflations (identified as such by Hanke and Krus, 2013). This implies that 31% of *DB* episodes are hyperinflations, which contrasts to 5% in *BD* crises (i.e. only 1 case out of 18 events), 10% in *B* events (i.e. 8 cases out of 81 events) and 2% in *D* events (i.e. 2 cases out of 100 events). These figures suggest that hyperinflations are an empirical regularity for the *DB* group, which differentiates it from the other types of crisis.

environment and very high inflation rates. In such circumstances, a full-fledged bank crisis is imminent.

#### **4.2. How different are the twins? Timing matters.**

In their classic analysis of single and twin bank-currency crises, Kaminsky and Reinhart (1999) ponder that their results “point to common causes, and whether the currency or banking problems surface first is a matter of circumstance”. We can readily translate this argument to our own analysis: it is highly likely that a common shock brings down both the banking sector and the sovereign, and our categorization of twin crises based on the chronology of events is arguably crude. Nevertheless, we do find that the behavior of many important variables is systematically different ahead of the two types of twin crisis, and that different features of the economy play different roles in shaping the transmission of stress from one sector to the other. Specifically, we highlight several marked differences between the two twin episodes, related to the behavior of banking sector leverage, public finances and financial openness.

Firstly, we find that *BD* events tend to occur at times when the banking sector experiences assets and credit booms that are much larger than in *DB* (in fact, the buildup in assets and lending around *BD* episodes is largest than in any other type of crisis). Secondly, *DB* events take place after several years of worse than normal budget balances, and larger than normal levels of government spending and public debt. This stands in contrast to *BD* episodes, where ex-ante levels of budget balances and public debt are similar to non-crisis times, or even stronger. Relatedly, we find that fiscal costs of banking crises are vastly different if these crises are preceded or, conversely, followed by sovereign defaults. Table 5 in Appendix 2 shows that fiscal costs of resolving bank crises in *BD* events are more than three times larger than fiscal costs in *DB* events, which present the smallest costs among all bank crises types.

Finally, our results point to the existence of important differences among twin events associated with external factors. We find that *BD* crises occur in times of financial liberalization and capital flow bonanzas, while *DB* crises occur in times of low access to international capital markets and low degree of financial openness.

On the other hand, our results confirm the existence of features characterizing both types of twin crises, which put them apart from single events.<sup>29</sup> Chief among them is the fact that twin crises have a more damaging effect on economic growth and inflation than single events. Twin events are also the ones more likely to be accompanied by strong exchange rate pressures. Finally, in contrast to single events, twin crises are more likely to happen against fast-growing accumulation of sovereign liabilities on banks’ balance sheets.

### **5. Understanding the drivers of twin events**

So far, our analysis has been directed at understanding the dynamics around each of the four types of crisis. In this section, we go a step further and examine what determines that a country has a single or a twin crisis, as well as what country characteristics increase the probability that a bank crisis turns into a twin bank-debt crisis or that a debt crisis turns into a twin debt-bank crisis.

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<sup>29</sup> As discussed in previous sections, these features have been well studied in the literature.

To answer these questions, we present below two alternative multivariate approaches: a multinomial logit and a bivariate ordered probit.<sup>30</sup> The models are designed to help us understand what factors could be significant in determining whether a crisis remains “single” or evolves into twin event. Guided by our previous findings, the models include both levels and first differences of the following variables: real growth, government debt and deficit (as a share of GDP), financial intermediation (bank domestic assets to GDP), balance sheet connections (banks’ exposure to the sovereign and central bank liquidity provisioning), capital flows, and financial openness.

### Multinomial Logit

The multinomial logit model (Greene, 2012) allows studying situations where there are a number of categorical outcomes which can be observed. This makes the method a useful approach for the modelling of our question of interest. The model is derived and estimated using Newton–Raphson maximum likelihood, as follows. Suppose that there are  $k$  categorical outcomes and—without loss of generality—let the base outcome be 1. The probability that the response for the  $j$ -th observation is equal to the  $i$ -th outcome is

$$p_{ij} = \Pr(y_j = i) = \begin{cases} \frac{1}{1 + \sum_{m=2}^k \exp(\mathbf{x}_j \beta_m)}, & \text{if } i = 1 \\ \frac{\exp(\mathbf{x}_j \beta_i)}{1 + \sum_{m=2}^k \exp(\mathbf{x}_j \beta_m)}, & \text{if } i > 1 \end{cases}$$

Where  $j$  is the row vector of observed values of the independent variables for the  $j$ -th observation and  $\beta_m$  is the coefficient vector for outcome  $m$ . In our specification  $x_j$  includes lagged levels and changes of real growth, debt and deficit (as percentage of GDP), bank assets (as percentage of GDP), banks’ exposure to the sovereign and central bank liquidity (both as percentage of banks’ assets), capital inflows and financial openness. Using the above, the log pseudo-likelihood is:

$$\ln L = \sum_j w_j \sum_{i=1}^k I_i(y_j) \ln p_{ik}$$

where  $I_i(y_j) = \begin{cases} 1, & \text{if } y_j = i \\ 0, & \text{otherwise} \end{cases}$ , and  $w_j$  is an optional weight.

Table 26 presents the results. We observe that better and improving growth dynamics are the best recipe against a twin crisis. There is a relatively striking absence of an effect of growth dynamics on the occurrence of single bank crises. Regarding balance sheet interconnections, while we do not observe a significant effect of the banks’ exposure to the sovereign on the occurrence of twin crises, we find a very significant effect coming from the provision of central bank liquidity. We observe that the larger the provision of such funding, the more likely that a country will face a twin bank-debt crisis. Similar to what we observe in the event analyses, we find a significant role for financial intermediation dynamics in stress transmission. According to our findings, large and growing banking systems play a dichotomous role. Countries with such banking sectors are more likely to suffer twin bank-debt crises, but also less likely to experience

<sup>30</sup> We also performed an experiment using a panel logit model (available upon request). As the results are similar to the ones presented here, we have not included them in the paper for the sake of brevity.

the transmission of sovereign distress. Finally, the results from the multinomial logit give remarkable importance to the role played by financial openness. According to our coefficients, countries that are financially more open prior to a crisis are less likely to suffer single crises and debt-bank twin events. We find, however, that for the full sample, financial liberalization increases the likelihood of suffering bank-debt crises. As shown by the coefficient associated with the change in financial openness, the effects of liberalization appear to be remarkably strong when countries are opening up. In periods of increasing liberalization, countries are more likely to suffer both simple bank crises and twin bank-debt crises.

### Bivariate Probit

One way in which an estimation of the joint probability distribution of two categorical variables can be achieved is by modelling a bivariate (ordered) probit.<sup>31</sup> Similar to univariate models, bivariate models can be derived from a latent variable model. Assume that the likelihood of bank crises and sovereign defaults are respectively denoted by two latent variables  $y_{1i}^*$  and  $y_{2i}^*$ , which are determined by:

$$\begin{aligned} y_{1i}^* &= x_{1i}'\beta_1 + \varepsilon_{1i} \\ y_{2i}^* &= x_{2i}'\beta_2 + \gamma y_{1i}^* + \varepsilon_{2i} \end{aligned}$$

where  $\beta_1$  and  $\beta_2$  are vectors of unknown parameters,  $\gamma$  is an unknown scalar,  $\varepsilon_1$  and  $\varepsilon_2$  are error terms, and subscript  $i$  denotes an individual observation.<sup>32</sup> We include in  $x_{2i}'$  and  $x_{1i}'$  the same set of control variables in lagged levels that we included in the multinomial logit. In addition, we include the product of the first differences of these controls with the crisis dummies. This interaction is designed to tell us whether the underlying factors are more or less relevant following a crisis. Notice that, to obtain consistent estimates of  $\beta_2$ , at least one element of  $x_1$  should not be present in  $x_2$ . In our case this variable is the banking sector exposure to the sovereign.<sup>33</sup>

Table 27 displays the results, which reinforce the importance of economic growth for the emergence of twin crises. Growth appears to significantly affect the spillover of bank stress to sovereign default. We also find a significant role of public debt dynamics in the transmission of sovereign stress. During sovereign defaults, debt increases are associated with bank crises. Complementing the evidence obtained before regarding balance sheet interconnectedness, we also document an important role for the banks' exposure to the sovereign. We find that the larger the exposure, the more likely is that a country faces a bank crisis following a sovereign default. Lastly, we again find a significant role for financial openness: more financially open countries are more likely to suffer bank crises, especially after sovereign defaults.

## 6. Implications for the literature

The stylized facts in this paper have important implications for the flourishing theoretical literature modeling the joint dynamics of sovereign defaults and bank crises. Our multi-faceted evidence allows us to evaluate the capacity of various modeling environments to combine underlying conditions and shocks generating the emergence of feedback loops between bank and sovereign risk. Similarly, the results regarding the boom-bust pattern and funding problems

<sup>31</sup> Using this methodology Adams (2006) studies whether R&D spillovers affect the allocation of resources to research.

<sup>32</sup> The explanatory variables in the model satisfy:  $E(x_{1i}\varepsilon_{1i}) = 0$  and  $E(x_{2i}\varepsilon_{2i}) = 0$ .

<sup>33</sup> We cannot use nonlinearity as a source of identification as it is done, for instance, in the Heckman model, because if the exclusion restriction fails, the linear system is unidentified.

within the banking system, provides support for theories such as Fahri and Tirole's (2018) model of the doom loop.

Our findings have implications for the Dynamic Stochastic General Equilibrium literature interested in designing models capable of replicating the implications of debt defaults. Our results show that, although growth collapses and capital flights are integral part of twin crises, theories relying exclusively on productivity and/or external shocks (like Arellano, 2009 or Mendoza and Yue, 2012) are less suited to capture the effect of a default. According to our findings, it is only when defaults combine with bank crises that GDP collapses in the way this literature is trying to replicate. Importantly, these growth slumps come hand in hand with credit crunches, increases in the size of central banks' balance sheets and tightening of balance sheet relations between banks and sovereigns. To the extent that these features are not an integral part of the modelling strategy, models will have a very hard time replicating the dynamics of economic activity.

On that account, theories acknowledging the role of balance sheet inter-connectedness and the role of the central bank in accommodating stress (Engler & Gobbe-Sttefen, 2016; Malucci, 2015) can provide more accurate analyses of twin crisis events. Closely related, we show that defaults happen against situations in which growth has remained subdued for a number of years. This provides support to the idea that the output costs of sovereign defaults are felt well in advance of their occurrence (see also Forni et al. 2016). In fact, we show that the contemporaneous costs of default depend critically on whether this is accompanied by a systemic bank crisis or not.

A main finding of our study is that twin and single events involving bank crises differ in the fiscal costs of solving them. We document that fiscal costs of twin bank-debt crises are larger than those of single bank crises and even more so than those during twin debt-bank events. This evidence also provides support to several recent theories according to which, in the presence of large banking systems, governments have more incentives to avoid defaults, as their effects on the economy would be amplified through the impact on banks' balance sheets (see Gennaioli et al. (2014), Acharya and Rajan (2013), Farhi and Tirole (2018)).

The results also vindicate theories arguing that monetary and fiscal coordination, and the ensuing central bank balance sheet expansion, are an integral part of crisis resolution strategies (Corsetti and Dedola, 2016). According to our findings, during the spread of sovereign crises to the banking sector, the shift from providing credit to the private sector to providing financing to the public sector is an empirical regularity. This result provides support for modeling strategies along the lines of Broner et al. (2014).

Our results could also inform the literature interested in credit cycles and the occurrence of crises. We show that boom-bust credit dynamics accompany both types of twin crises. This complements and extends the findings in Jorda et al. (2016), by showing that when credit booms go bust, the consequences are likely to not just stop at a banking crisis, but may also spill over to the sovereign.

Finally, our findings complement the literature on capital account liberalization and financial crises (e.g. Diaz-Alejandro, 1985), as we show that only bank crises that are part of twin bank-debt events fit the description in the literature. Indeed, it is these crises that are accompanied by a boom-bust pattern in capital flows, occur at times of capital account liberalization, and are accompanied by strong exchange rate pressures. Relatedly, our results also inform the literature concerned with financial repression (see Reinhart (2012) and Reinhart and Sbrancia (2015)), as

they suggest that sovereign stress is more likely to transmit to the banking sector in times of financial repression.

## 7. Conclusions

In light of the virulence and long-lasting effects of the various bank and sovereign debt crises hitting the world economy since 2007, understanding the channels through which sovereign and bank risks feed into each other is of utmost importance. In this paper, we contribute to these ongoing efforts by studying past episodes of bank and sovereign distress in emerging markets, making the distinction between “single” episodes and those in which bank and sovereign debt crises combine (“twin” crises).

Our contribution is three-fold. Firstly, we find that there are systematic differences between “single” crises and “twin” ones, across several dimensions, including the balance sheet interconnection between the banks and the sovereign, banking sector characteristics, the state of public finances, the macroeconomic environment and financial openness. Secondly, contrary to what is customary in most of the literature, we show that considering the sequence of crises within “twin” events is important for understanding their transmission channels and economic consequences. Finally, by using different econometric techniques, we show that the balance sheet interconnection between banks and their sovereign, economic growth, credit dynamics and the extent of financial openness all help explain the onset of twin crises events.

By providing a detailed understanding of the economic dynamics and stylized facts around different crisis episodes, our results can help in building better early warning indicators and inform the development of theoretical models where these issues can be formally studied.

## REFERENCES

- Acharya, V., Drechsler, I. and Schnabl, P. (2014), “A Pyrrhic Victory: Bank Bailouts and Sovereign Credit Risk”, *Journal of Finance*, vol. 69 (6), pp. 2689-2739.
- Acharya V., and R. Rajan (2013), "Sovereign Debt, Government Myopia and the Financial Sector", *Review of Financial Studies*, Volume 26, Issue 6, Pages 1526-1560
- Aguiar, M., M. Amador, and G. Gopinath, (2009), “Investment cycles and sovereign debt overhang,” *Review of Economic Studies* 76(1), pp. 1-31.
- Alessandri, P. and Haldane, A. (2009), “Banking on the State”, mimeo, *Bank of England*.
- Alter, A. and Beyer, A. (2013), “The Dynamics of Spillover Effects during the European Sovereign Debt Turmoil”, *Journal of Banking & Finance*, vol. 42, p. 134-153.
- Andritzky, J.R. (2012), “Government Bonds and Their Investors: What Are the Facts and Do They Matter?”, *IMF Working Paper no. 12/158*.
- Angeloni, C. and Wolff, W. (2012), “Are banks affected by their holdings of government debt?”, *Bruegel Working Paper no. 2012/07*.
- Arellano, C. and Kocherlakota, N.R. (2014), “Internal Debt Crises and Sovereign Defaults”, *Journal of Monetary Economics*, vol. 68(S), pp. 68-80.

- Arslanalp, S. and P.B. Henry (2005), “Is Debt Relief Efficient?”, *Journal of Finance*, 60(2), pp.1017–1051.
- Baldacci, E. and Gupta, S. (2009), “Fiscal Expansions: What Works”, *Finance & Development*, Vol. 46 (4), pp. 35-37.
- Battistini, N., M. Pagano and S. Simonelli (2014), “Systemic risk, sovereign yields and bank exposure in the euro crisis”, *Economic Policy*, April: 203-251.
- Borensztein, E and U. Panizza (2009), “The Costs of Sovereign Default”, *IMF Staff Papers*, vol. 56 (4), pp.683-741
- Bordo, M. and C. Meissner (2016), “Fiscal and Financial Crises”, *NBER Working Paper 22059*.
- Broner, F., Didier, T., Erce A. and Schmukler, S. (2013), “Gross Capital Flows: Dynamics and Crises”, *Journal of Monetary Economics*, Vol. 60(1), pp. 113–133.
- Broner, F., Erce, A., Martin, A., and Ventura, J. (2014), “Sovereign Debt Markets in Turbulent Times: Creditor Discrimination and Crowding Out”, *Journal of Monetary Economics*, Vol. 61 (C), pp. 114-142.
- Brutti, F. (2010), “Legal enforcement, public supply of liquidity and sovereign risk”, *Institute for Empirical Research in Economics, University of Zurich Working Paper no. 464*.
- Candelon, B. and Palm, F.C. (2010), “Banking and Debt Crises in Europe. The Dangerous Liaisons?”, *De Economist*, vol. 158(1), pp. 81-99..
- Caprio, G. Jr. and Honohan, P. (2008), “Banking Crises”, *Institute for International Integration Studies Discussion Paper no. 242*.
- Cavallo, E. and Izquierdo, A. (2009), “Dealing with an International Credit Crunch: Policy Responses to Sudden Stops in Latin America”, Inter-American Development Bank, *mimeo*.
- Cesa-Bianchi, A, Ferrero, A., and A. Rebucci (2017), “International Credit Cycles”, *NBER Working Paper No. 23841*.
- Chinn, M. D. and H. Ito (2006), "What Matters for Financial Development? Capital Controls, Institutions, and Interactions," *Journal of Development Economics*, Vol. 81(1), pp. 163-192.
- Corsetti, G., and Dedola, L. (2016), “The Mystery of the Printing Press: Self-fulfilling Debt Crises and Monetary Sovereignty”, *CEPR Discussion Paper no. 9358*.
- Darracq-Pariès, M., Maurin, L and Moccero, D. (2014), “Financial Conditions Index and Credit Supply Shocks for the Euro Area”, *ECB Working Paper no. 1644*.
- Das, U., Papaioannou, M., and Trebesch, C. (2009), “Sovereign Default Risk and Private Sector Access to Capital in Emerging Markets”, in: Primo Braga, C. A. and Dömeland, D. (Eds): “*Debt Relief and Beyond: Lessons Learned and Challenges Ahead*”, World Bank.
- De Marco, F. and Macchiavelli, M, (2016), “The Political Origin of Home Bias: The Case of Europe”, Federal Reserve Board, *Finance & Economics Discussion papers 060-2016*.
- De Paoli, B., Hoggarth, G. and Saporta, V. (2009), “Output costs of sovereign crises: some empirical estimates”, *Bank of England Working Paper no. 362*.
- Diaz-Alejandro, C. (1985), “Good-bye financial repression, hello financial crash”, *Journal of Development Economics*, Vol. 19(1-2), pp. 1-24.

- Diaz-Cassou, J., Erce, A. and Vazquez, J. (2008), “Recent episodes of sovereign debt restructuring: A case-study approach”, *Bank of Spain Occasional Document no. 0804*.
- Drechsler, I., Drechsler, T., Marques-Ibanez, D., and Schnabl, P. (2016), “Who Borrows from the Lender of Last Resort?”, *Journal of Finance*, vol. 71 (5), p. 1933-1974.
- Engler, P., and C. Grobde-Steffen (2016), “Sovereign Risk, interbank freezes and aggregate fluctuations”, *European Economic Review*, vol. 87, p. 34-61.
- Farhi, E., and J. Tirole (2018), “Deadly Embrace: Sovereign and Financial Balance Sheets Doom Loops”, *Review of Economic Studies*, forthcoming.
- Feenstra, R.C and Taylor, A.M. (2012), “International Economics”, 2nd edition, Worth Publishers.
- Forni, L., Palomba, G., Pereira, J., and C. Richmond (2016), “Sovereign Debt Restructuring and Growth”, *IMF Working Paper 16/147*.
- Gennaioli, N., Martin, A. and Rossi, S. (2014a), “Sovereign Default, Domestic Banks and Financial Institutions”, *Journal of Finance*, Vol. 69(2), pp.819-866.
- Gennaioli, N., Martin, A. and Rossi, S. (2014b), “Banks, Government Bonds and Default: What do the Data Say?”, *IMF Working Paper No. 14/120*.
- Goldstein, M. (2003), “Debt Sustainability, Brazil and the IMF”, *Peterson Institute Working Paper no. WP03-1*.
- Gourinchas, P.O. and M. Obstfeld (2012), “Stories of the Twentieth Century for the Twenty-First”, *American Economic Journal: Macroeconomics*, Vol. 4(1), pp. 226-65.
- Gray, D. and Jobst, A. (2013), “Systemic Contingent Claims Analysis – Estimating Market-Implied Systemic Risk”, *IMF Working Paper no.13/54*.
- Gray, D., Gross, M., Paredes, J., and Sydow, M. (2013), “Modelling Banking, Sovereign and Macro Risk in a CCA Global VAR”, *IMF Working Paper no. 13/218*.
- Hanke, S.H., and N. Krus, “World Hyperinflations”, in Parker, R. and R. Whaples (eds), “The Handbook of Major events in Economic History”, London: Routledge Publishing.
- Honohan, P. (2008), “Risk Management and the Costs of the Banking Crisis”, *National Institute Economic Review*, vol. 206 (1), pp.15-24.
- Jordà, Ò., M. Schularick and A. Taylor (2016), “Sovereigns versus Banks: credit, crises and consequences”, *Journal of the European Economic Association*, 14, pp. 45–79.
- IMF (2002), “Sovereign Debt Restructurings and the Domestic Economy Experience in Four Recent Cases”, *Policy Development and Review Department*.
- Kaminsky, G., and C. Reinhart (1999), “The Twin Crises: The Causes of Banking and Balance-of-Payments Problems”, *American Economic Review*, vol. 89(3), pp. 473-500.
- Kollmann, R., Roeger, W., and in’t Veld, J. (2012), “Fiscal Policy in a Financial Crisis: Standard Policy vs. Bank Rescue Measures”, *American Economic Review*, Vol. 102(3), pp. 77-81.
- Laeven, L. and Valencia, F. (2012a), “The Use of Blanket Guarantees in Banking Crises”, *Journal of International Money and Finance*, Vol. 31(5), pp. 1220–1248.

- Laeven, L., and Valencia, F. (2012b), “Systemic Banking Crises Database: An Update”, *IMF Working Paper no. 12/163*.
- Laeven, L. and Valencia, F. (2013), “The Real Effects of Financial Sector Interventions During Crises”, *Journal of Money, Credit and Banking*, Vol. 45(1), pp. 147-177.
- Livshits, I. and Schoors, K. (2009), “Sovereign Default and Banking”, *BEROC Working Paper Series no. 005*
- Malucci, E. (2015), “Domestic Debt and Sovereign Defaults”, *International Finance Discussion Papers no. 1153*, Board of Governors.
- Mendoza, E., and V. Yue (2012), “A General Equilibrium Model of Sovereign Default and Business Cycles”, *Quarterly Journal of Economics* no. 127, pp. 889–946.
- Meissner, C.M. and Bordo, M.D. (2007), “Financial Crises, 1880-1913: The Role of Foreign Currency Debt”, in Edwards, S., G. Esquivel and G. Márquez (eds.), *The Decline of Latin American Economies: Growth, Institutions, and Crises*, University of Chicago Press.
- Mitchell and Brian R., (2007), “*International Historical Statistics: 1750 – 2005*”, Palgrave MacMillan, London.
- Mody, A., and Sandri, D. (2012), “The Eurozone Crisis: How Banks Came to be Joined at the Hip”, *Economic Policy*, vol. 27( 70), pp. 199-230.
- Moody’s (2014), “European Sovereign Debt and Banking Crises: Contagion, Spillovers and Causality”, *Moody’s Investors Service, Credit policy*.
- Noyer, C. (2010), “Sovereign crisis, risk contagion and the response of the central bank”, mimeo.
- Ongena, S., Popov, A. and N. Van Horen (2016), "The invisible hand of the government: "moral suasion" during the European sovereign debt crisis," *CEPR Discussion Papers 11153*.
- Obstfeld , M. (2011), "Financial flows, financial crises, and global imbalances", *Journal of International Money and Finance* 31, pp. 469–480
- Popov, A., and Van Horen, N. (2013), “The impact of sovereign debt exposure on bank lending: Evidence from the European debt crisis”, *DNB Working Paper no. 382*.
- Reinhart, C.M. and C. Trebesch (2016), “Sovereign debt relief and its aftermath”, *Journal of the European Economic Association*, 14, pp. 215–251.
- Reinhart, C.M. and M.B. Sbrancia (2015), “The Liquidation of Government Debt”, *Economic Policy*, Vol. 30(82), pp.291-333.
- Reinhart, C.M. (2012), “The Return of Financial Repression”, *CEPR Discussion Paper no. 8947*.
- Reinhart, C.M. and Reinhart, V. (2009), “Fiscal stimulus for debt intolerant countries?”, *MPRA Paper no.16937*.
- Reinhart, C.M. and Rogoff, K.S. (2013), “Banking Crises: An Equal Opportunity Menace”, *Journal of Banking & Finance*, vol. 37 (11), p. 4557-4573.
- Reinhart, C.M and Rogoff, K.S. (2008), “This Time is Different: A Panoramic View of Eight Centuries of Financial Crises”, *NBER Working Paper no.13882*.

Reinhart, C.M. and Rogoff, K. S. (2009), “The Aftermath of Financial Crises”, *American Economic Review*, Vol. 99(2), pp. 466-72.

Reinhart, C.M. and Rogoff, K.S. (2011), “From Financial Crash to Debt Crisis”, *American Economic Review*, Vol. 101(5), pp. 1676-1706.

Rosas, G. (2006), “Bagehot or Bailout? An Analysis of Government Responses to Banking Crises”, *American Journal of Political Science* Vol. 50(1), pp. 175-191.

Standard and Poor’s (2006), “*Sovereign Defaults At 26-Year Low, To Show Little Change In 2007*”, *mimeo*.

Van Rixtel, A., and Gasperini, G. (2013), “Financial Crises and bank funding: recent experience in the euro area”, *BIS Working Paper no. 40*.

**APPENDIX 1: COUNTRIES, CRISES AND VARIABLES**

**Sample:** Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Azerbaijan, Bahrain, Barbados, Belarus, Belize, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Cabo Verde, Cameroon, Chile, Hong Kong, Macao, China, Colombia, Congo, Costa Rica, Cote d'Ivoire, Croatia, Czech Republic, Djibouti, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Estonia, Fiji, Gabon, Georgia, Grenada, Guatemala, Guyana, Honduras, Hungary, India, Indonesia, Iran, Israel, Jamaica, Jordan, Kazakhstan, Korea, Kuwait, Kyrgyz Republic, Latvia, Lebanon, Lesotho, Libya, Lithuania, FYR Macedonia, Malaysia, Maldives, Mauritius, Mexico, Moldova, Mongolia, Morocco, Namibia, Nicaragua, Oman, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Qatar, Romania, Russian Federation, Saudi Arabia, Senegal, Serbia, Seychelles, Singapore, Slovak Republic, Slovenia, Solomon Islands, South Africa, Sri Lanka, Sudan, Suriname, Swaziland, Syrian Arab Republic, Thailand, Tonga, Trinidad and Tobago, Tunisia, Turkey, Ukraine, United Arab Emirates, Uruguay, Venezuela, Yemen, Zimbabwe.

**Table 1. “Single” crisis events**

<b>Debt crisis</b>		<b>Bank crisis</b>	
Angola	1976	Argentina	1995
Angola	1985	Belarus	1995
Antigua and Barbuda	1996	Bolivia	1994
Belize	2006	Bosnia-Herzegovina	1992
Bhutan	1991	Brazil	1994
Bolivia	1980	Bulgaria	1996
Brazil	1983	Cabo Verde	1993
Bulgaria	1990	Cameroon	1995
Cabo Verde	1981	Chile	1976
Cameroon	2004	China	1998
Congo	1983	Colombia	1982
Costa Rica	1981	Colombia	1998
Cote d'Ivoire	1983	Congo	1992
Cote d'Ivoire	2000	Costa Rica	1994
Croatia	1992	Croatia	1998
Dominican Republic	1975	Czech Republic	1996
Dominican Republic	1982	El Salvador	1989
El Salvador	1981	Equatorial Guinea	1983
Gabon	1986	Estonia	1992
Gabon	1999	Guyana	1993
Grenada	1984	Hungary	1991
Grenada	2004	India	1993
Guatemala	1986	Israel	1977
Guyana	1979	Jamaica	1996
Honduras	1981	Korea	1997

Indonesia	2002	Kuwait	1982
Iran	1978	Kyrgyz Republic	1995
Jamaica	1978	Latvia	1995
Jamaica	1987	Lebanon	1990
Kuwait	1990	Lithuania	1995
Kyrgyz Republic	2005	Malaysia	1997
Moldova	1998	Mexico	1994
Moldova	2002	Nicaragua	1990
Mongolia	1997	Paraguay	1995
Nicaragua	1979	Philippines	1997
Panama	1983	Poland	1992
Paraguay	1986	Romania	1990
Paraguay	2003	Slovak Republic	1998
Peru	1976	Slovenia	1992
Poland	1981	Sri Lanka	1989
Romania	1981	Swaziland	1995
Romania	1986	Thailand	1983
Russian Federation	1991	Thailand	1997
Senegal	1981	Tunisia	1991
Serbia	1992	Turkey	2000
Seychelles	2000	Yemen	1996
Solomon Islands	1996	Zimbabwe	1995
South Africa	1985		
South Africa	1989		
South Africa	1993		
Sri Lanka	1979		
Sudan	1979		
Sudan	1991		
Suriname	2001		
Syria	1986		
Tonga	2002		
Trinidad-Tobago	1988		
Tunisia	1979		
Turkey	1978		
Uruguay	1987		
Venezuela	1983		
Venezuela	1990		
Venezuela	1998		
Venezuela	2004		
Yemen	1985		
Zimbabwe	2000		

Source: Bank crises dates are from Laeven and Valencia (2012b); Sovereign defaults dates are from Standard and Poor's (2007) and Reinhart and Trebesch (2016).

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**Table 2. Twin crises: Bank-to-Debt**

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<b>Country</b>	<b>Bank crisis</b>	<b>Debt crisis</b>
Algeria	1990	1991
Argentina	1980	1982
Chile	1981	1983
Djibouti	1991	1992
Dominican Republic	2003	2005
Ecuador	1982	1982
Ecuador	1998	1999
Egypt	1980	1986
Georgia	1991	1994
Indonesia	1997	1998
Mexico	1981	1982
Morocco	1980	1983
Nicaragua	2000	2003
Philippines	1983	1983
Senegal	1988	1990
Uruguay	1981	1983
Uruguay	2002	2003
Venezuela	1994	1995

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Source: Bank crises dates are from Laeven and Valencia (2012b); Sovereign defaults dates are from Standard and Poor's (2007) and Reinhart and Trebesch (2016).

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**Table 3. Twin crises: Debt-to-Bank**

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<b>Country</b>	<b>Debt crisis</b>	<b>Bank crisis</b>
Albania	1991	1994
Argentina	1989	1989
Argentina	2001	2001
Armenia	1994	1994
Azerbaijan	1994	1995
Bolivia	1986	1986
Brazil	1990	1990
Cameroon	1985	1987
Costa Rica	1986	1987
Jordan	1989	1989
Macedonia	1992	1993
Panama	1987	1988
Peru	1983	1983
Turkey	1982	1982
Russian Federation	1998	1998
Ukraine	1998	1998

---

Source: Bank crises dates are from Laeven and Valencia (2012b); Sovereign defaults dates are from Standard and Poor's (2007) and Reinhart and Trebesch (2016).

**Table 4. Variables: definitions and sources**

<b>Variable</b>	<b>Definition</b>	<b>Source</b>
<b>“Balance sheet” variables</b>		
Banking sector’s claims on government/domestic assets	Claims on central government (line 22a)/domestic assets	International Financial Statistics
Liquidity support/domestic assets	Credit from Monetary Authorities (line 26g)/domestic assets	International Financial Statistics
<b>Banking sector variables</b>		
Credit to the private sector /GDP	Claims to the private sector (line 22d)/GDP level	International Financial Statistics
Domestic bank assets/GDP	Sum of all items on the asset side, foreign assets excluded (line 20+line 20c +line 20+line 22)/GDP	International Financial Statistics
<b>Fiscal variables</b>		
Budget balance (% GDP)	(Government revenues – government expense)/GDP level	EIU, IFS, WEO, Mitchell (2007), Art.IV reports.
Budget expense (%GDP)	General government total expense/GDP level	EIU, IFS, WEO, Mitchell (2007), Art.IV reports.
Government debt (%GDP)	General government debt/GDP level	World Development Indicators
<b>Macroeconomic and external sector variables</b>		
Real GDP growth	Annual change of real GDP	World Development Indicators
Inflation rate	Annual change of the Consumer Price Index	World Development Indicators
Capital inflows/GDP	(“Foreign direct investment liabilities“, “Portfolio investment liabilities” and “Other investment liabilities”)/GDP	International Financial Statistics
ST debt/Total external debt	Ratio of short-term external debt/total external debt	World Development Indicators
Real effective exchange rate	Real effective exchange rate index (2010=100)	World Development Indicators
Chinn-Ito index	Financial Openness Index, standardized between zero and one	Chinn and Ito (2006)

**APPENDIX 2: Fiscal and output costs of banking crises**

**Table 5. Fiscal and output costs of banking crises**

<b>Crisis type</b>	<b>Fiscal Costs<sup>1</sup> (% of GDP)</b>	<b>Fiscal costs (% of financial sector assets)</b>	<b>Increase in public debt<sup>2</sup> (%GDP)</b>	<b>Output Loss<sup>3</sup> (%GDP)</b>	<b>Peak NPLs<sup>4</sup></b>
B crises	13,08	28,78	-3,11	26,26	26,94
BD crises	27,12	71,66	28,40	34,79	27,59
DB crises	8,12	18,97	-8,92	48,52	42,66
<b>Total average</b>	<b>15,37</b>	<b>36,96</b>	<b>3,10</b>	<b>32,38</b>	<b>29,42</b>

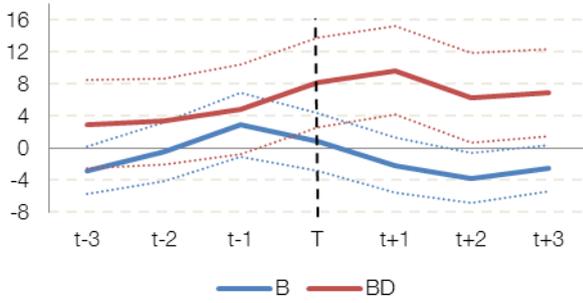
Sources: Laeven and Valencia (2012b) and authors' calculations.

- (1) Fiscal costs are defined as the component of gross fiscal outlays related to the restructuring of the financial sector. They include fiscal costs associated with bank recapitalizations but exclude asset purchases and direct liquidity assistance from the treasury.
- (2) The increase in public debt is measured over [T-1, T+3].
- (3) Output losses are computed as the cumulative sum of the differences between actual and trend real GDP over the period [T, T+3], expressed as a percentage of trend real GDP.
- (4) Non-performing loans (% total loans).

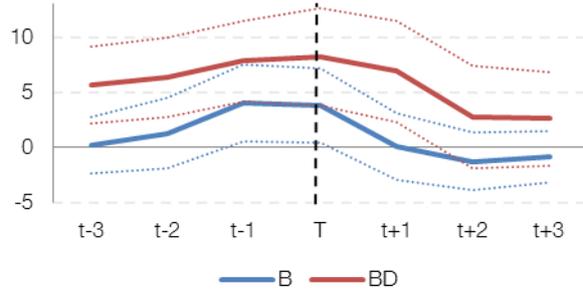
## APPENDIX 3: FIGURES

### 1. Bank (B) vs Bank-to-debt (BD) crises

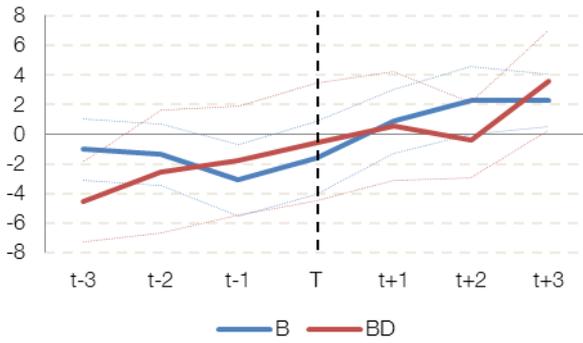
**Figure 1. Domestic assets (% GDP)**



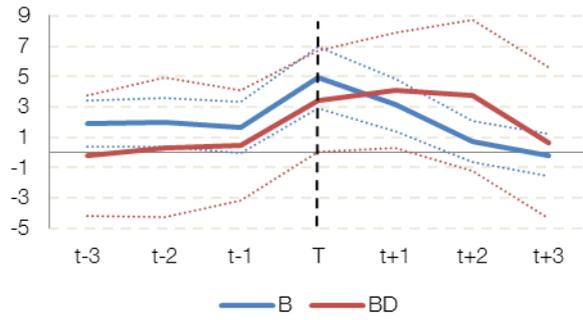
**Figure 2. Credit to private sector (% GDP)**



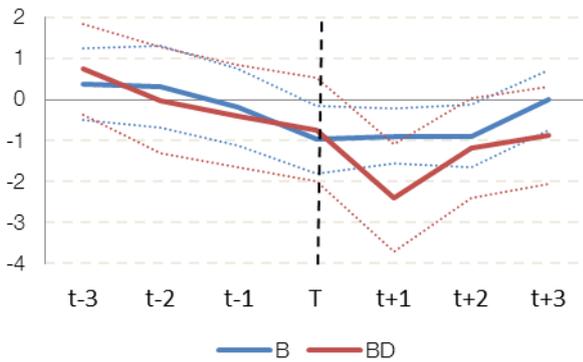
**Figure 3. Claims on government (% dom. assets)**



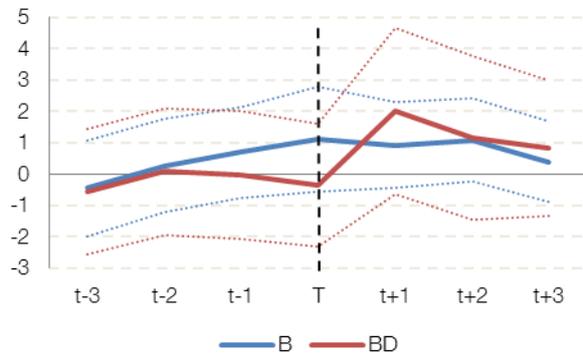
**Figure 4. Credit from the Central Bank (% dom. assets)**



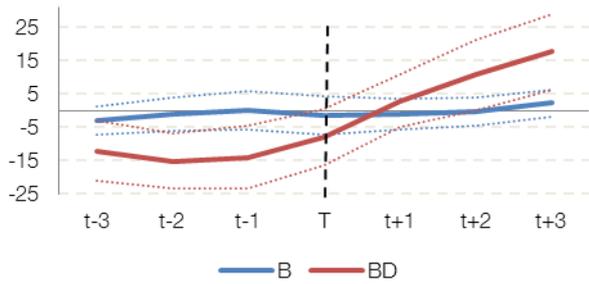
**Figure 5. Budget balance (% GDP)**



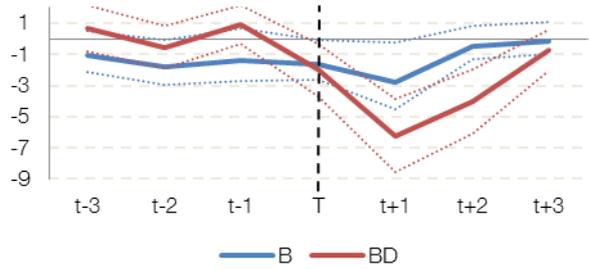
**Figure 6. Budget expenditures (% GDP)**



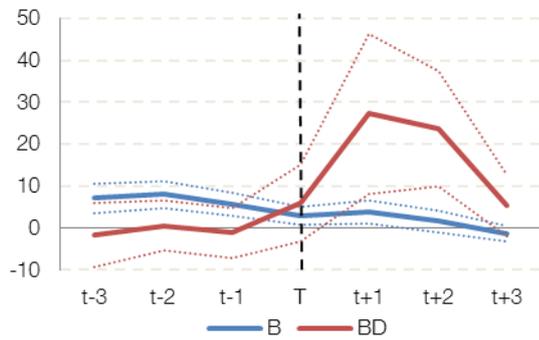
**Figure 7. Public debt (%GDP)**



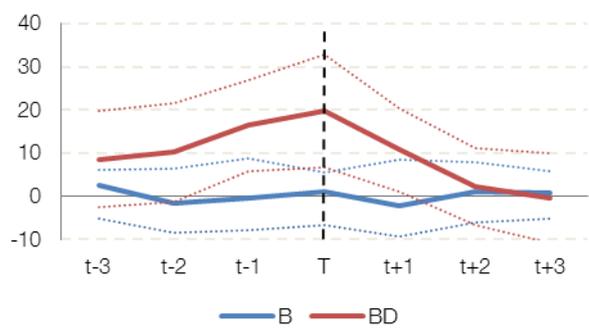
**Figure 8. Real GDP growth(%)**



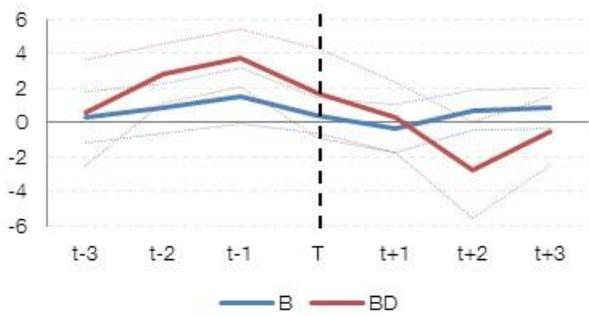
**Figure 9. Inflation rate (%)**



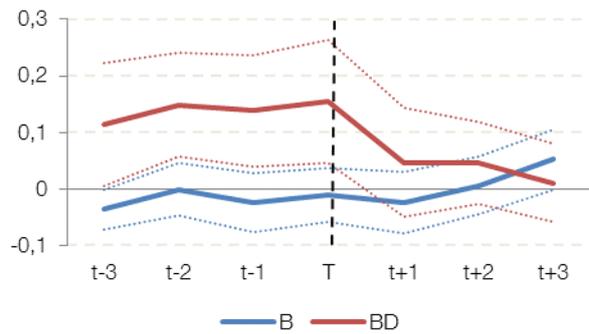
**Figure 10. Real effective exchange rate**



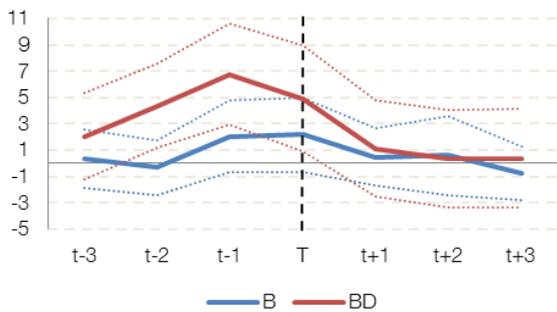
**Figure 11. Total capital inflows**



**Figure 12. The Chin-Ito Financial liberalization index**



**Figure 13. Short-term debt in total foreign debt (%)**



# 1. Debt (D) vs Debt-to-bank (DB) crises

Figure 14. Claims on government (% dom. assets)

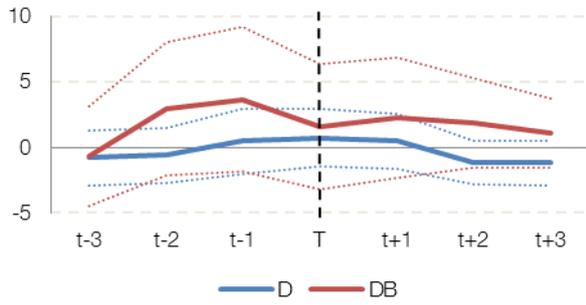


Figure 15. Credit from the Central Bank (% dom. assets)

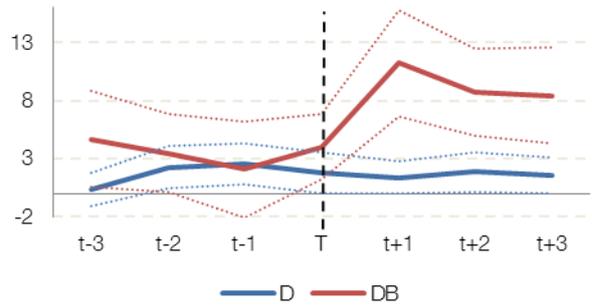


Figure 16. Domestic assets (% GDP)

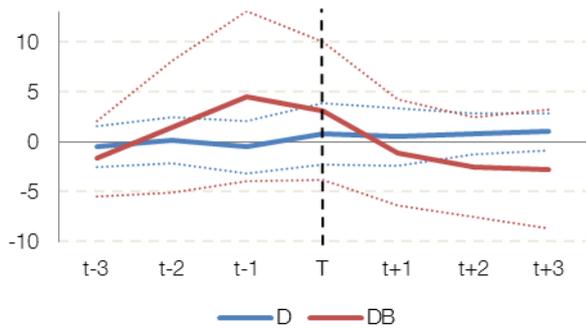


Figure 17. Credit to private sector (% GDP)

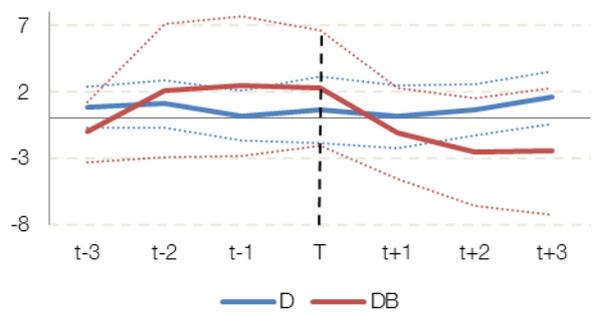


Figure 18. Budget balance (% GDP)

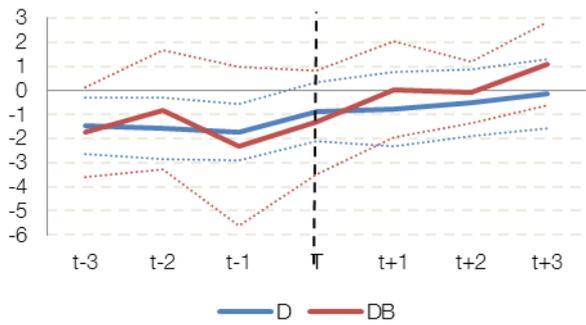
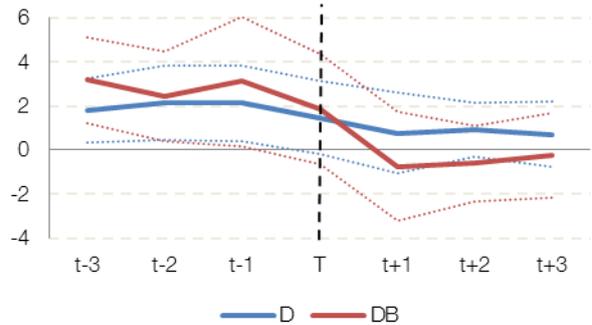
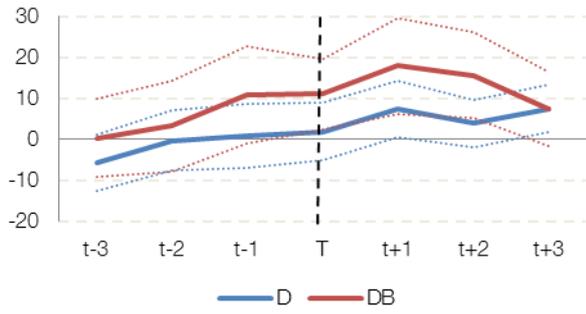


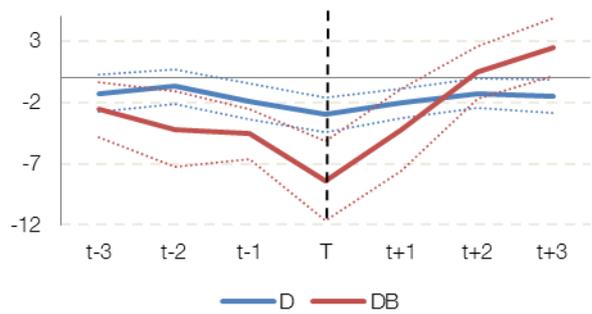
Figure 19. Budget expenditures (% GDP)



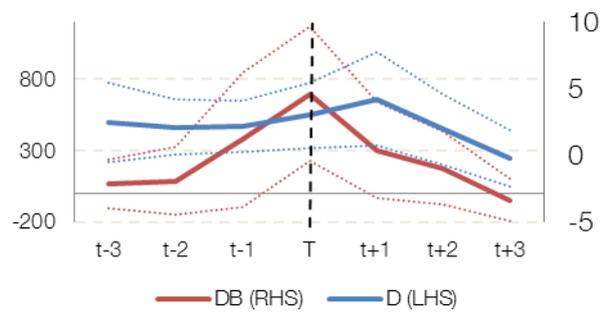
**Figure 20. Public debt (%GDP)**



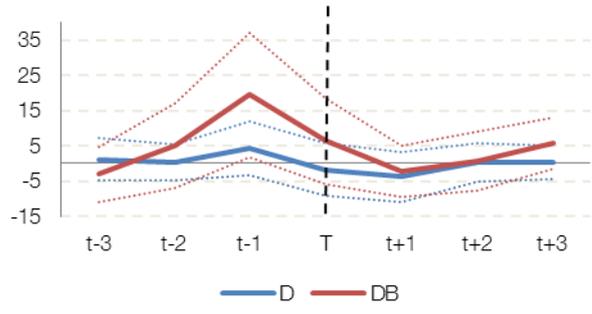
**Figure 21. Real GDP growth(%)**



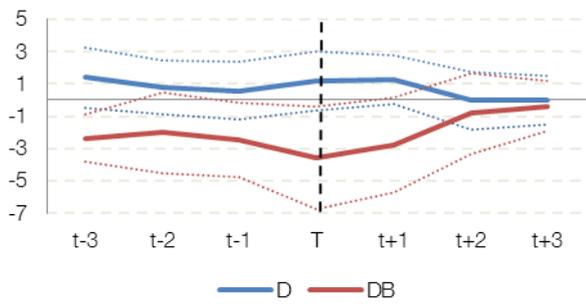
**Figure 22. Inflation rate (%)**



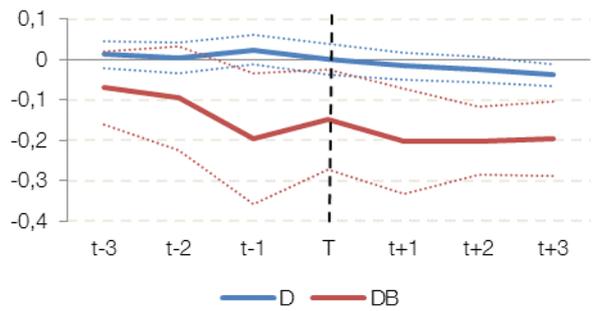
**Figure 23. Real effective exchange rate**



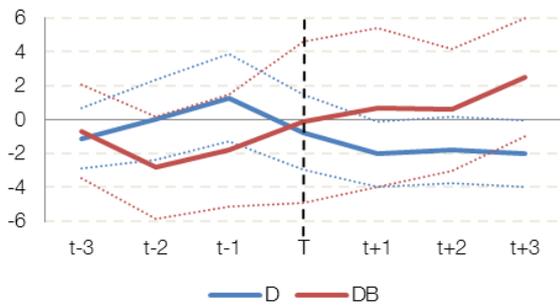
**Figure 24. Total inflows (%GDP)**



**Figure 25. The Chin-Ito Financial liberalization index**



**Figure 26. Short-term debt in total foreign debt (%)**



## APPENDIX 4: ECONOMETRIC RESULTS – EVENT ANALYSES

**Table 6. Credit from the Central Bank (% domestic assets)**

	<u>D crises</u>	<u>DB crises</u>	<u>B crises</u>	<u>BD crises</u>
<b>Year t-3</b>	0.072 [0.163]	0.536* [0.285]	0.372** [0.176]	-0.024 [0.257]
<b>Year t-2</b>	0.431*** [0.209]	0.398* [0.231]	0.386** [0.194]	0.036 [0.301]
<b>Year t-1</b>	0.490** [0.201]	0.241 [0.287]	0.319 [0.201]	0.0052 [0.235]
<b>Year Event</b>	0.340* [0.199]	0.462*** [0.192]	0.962*** [0.238]	0.363* [0.217]
<b>Year t+1</b>	0.264 [0.164]	1.276*** [0.316]	0.611*** [0.203]	0.439* [0.245]
<b>Year t+2</b>	0.352* [0.199]	0.996*** [0.262]	0.141 [0.163]	0.401 [0.323]
<b>Year t+3</b>	0.301* [0.176]	0.963*** [0.288]	-0.033 [0.164]	0.070 [0.325]
<b>Observations</b>	1807	1807	1807	1807
<b>R-squared</b>	0.06	0.06	0.06	0.06
<b>No. of Countries</b>	88	88	88	88
<b>No. of Events</b>	41	12	37	16
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Country trends</b>				

**Table 7. Claims on Government (% domestic assets)**

	<u>D crises</u>	<u>DB crises</u>	<u>B crises</u>	<u>BD crises</u>
<b>Year t-3</b>	-0.103 [0.170]	-0.091 [0.308]	-0.136 [0.167]	-0.648*** [0.234]
<b>Year t-2</b>	-0.081 [0.167]	0.393 [0.408]	-0.183 [0.168]	-0.357 [0.355]
<b>Year t-1</b>	0.062 [0.201]	0.484 [0.445]	-0.409** [0.195]	-0.254 [0.316]
<b>Year Event</b>	0.094 [0.178]	0.213 [0.386]	-0.214 [0.196]	-0.075 [0.344]
<b>Year t+1</b>	0.062 [0.170]	0.298 [0.370]	0.118 [0.174]	0.079 [0.315]
<b>Year t+2</b>	-0.149 [0.134]	0.245 [0.277]	0.299 [0.184]	-0.055 [0.219]
<b>Year t+3</b>	-0.159 [0.141]	0.141 [0.211]	0.303** [0.140]	0.513* [0.288]
<b>Observations</b>	2238	2238	2238	2238
<b>R-squared</b>	0.42	0.42	0.42	0.42
<b>No. of Countries</b>	104	104	104	104
<b>No. of Events</b>	49	13	40	16
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Country trends</b>	Yes	Yes	Yes	Yes

The table reports the coefficients obtained from a fixed-effects panel regression of the variable in the title on a seven-year window around crisis events, controlling for country fixed effects. Crisis events are split into independent debt crises; independent bank crises; twin debt-bank crises; and twin bank-debt crises. The variable is first normalized by dividing by the standard deviation at the country level. The sample period is 1975 to 2007. Standard errors, clustered at the country-level, are reported in brackets. \*, \*\*, and \*\*\* mean significant at 10%, 5%, and 1% respectively

The table reports the coefficients obtained from a fixed-effects panel regression of the variable in the title on a seven-year window around crisis events, controlling for country fixed effects. Crisis events are split into independent debt crises; independent bank crises; twin debt-bank crises; and twin bank-debt crises. The variable is first normalized by dividing by the standard deviation at the country level. The sample period is 1975 to 2007. Standard errors, clustered at the country-level, are reported in brackets. \*, \*\*, and \*\*\* mean significant at 10%, 5%, and 1% respectively

**Table 8. Domestic assets (% GDP)**

	D crises	DB crises	B crises	BD crises
<b>Year t-3</b>	-0.050 [0.183]	-0.152 [0.207]	-0.231 [0.147]	0.242 [0.274]
<b>Year t-2</b>	0.017 [0.155]	0.131 [0.360]	-0.038 [0.183]	0.270 [0.265]
<b>Year t-1</b>	-0.060 [0.179]	0.406 [0.464]	0.243 [0.201]	0.389 [0.276]
<b>Year Event</b>	0.084 [0.205]	0.281 [0.376]	0.065 [0.179]	0.663** [0.277]
<b>Year t+1</b>	0.057 [0.192]	-0.100 [0.289]	-0.177 [0.175]	0.784*** [0.273]
<b>Year t+2</b>	0.085 [0.139]	-0.227 [0.270]	-0.311** [0.154]	0.505* [0.268]
<b>Year t+3</b>	0.112 [0.126]	-0.246 [0.322]	-0.210 [0.146]	0.563** [0.268]
<b>Observations</b>	2254	2254	2254	2254
<b>R-squared</b>	0.45	0.45	0.45	0.45
<b>No. of Countries</b>	104	104	104	104
<b>No. of Events</b>	49	13	41	16
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Country trends</b>	Yes	Yes	Yes	Yes

The table reports the coefficients obtained from a fixed-effects panel regression of the variable in the title on a seven-year window around crisis events, controlling for country fixed effects. Crisis events are split into independent debt crises; independent bank crises; twin debt-bank crises; and twin bank-debt crises. The variable is first normalized by dividing by the standard deviation at the country level. The sample period is 1975 to 2007. Standard errors, clustered at the country-level, are reported in brackets. \*, \*\*, and \*\*\* mean significant at 10%, 5%, and 1% respectively

**Table 9. Credit to the private sector (% GDP)**

	D crises	DB crises	B crises	BD crises
<b>Year t-3</b>	0.098 [0.107]	-0.117 [0.156]	0.019 [0.150]	0.559** [0.210]
<b>Year t-2</b>	0.128 [0.125]	0.243 [0.352]	0.126 [0.187]	0.631*** [0.216]
<b>Year t-1</b>	0.025 [0.132]	0.281 [0.368]	0.388* [0.204]	0.777*** [0.221]
<b>Year Event</b>	0.072 [0.174]	0.263 [0.304]	0.370* [0.198]	0.812*** [0.267]
<b>Year t+1</b>	0.017 [0.165]	-0.127 [0.241]	0.014 [0.177]	0.685** [0.275]
<b>Year t+2</b>	0.074 [0.133]	0.289 [0.284]	-0.119 [0.151]	0.274 [0.281]
<b>Year t+3</b>	0.181 [0.138]	-0.284 [0.332]	-0.077 [0.135]	0.257 [0.252]
<b>Observations</b>	2350	2350	2350	2350
<b>R-squared</b>	0.46	0.46	0.46	0.46
<b>No. of Countries</b>	104	104	104	104
<b>No. of Events</b>	53	14	44	17
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Country trends</b>	Yes	Yes	Yes	Yes

The table reports the coefficients obtained from a fixed-effects panel regression of the variable in the title on a seven-year window around crisis events, controlling for country fixed effects. Crisis events are split into independent debt crises; independent bank crises; twin debt-bank crises; and twin bank-debt crises. The variable is first normalized by dividing by the standard deviation at the country level. The sample period is 1975 to 2007. Standard errors, clustered at the country-level, are reported in brackets. \*, \*\*, and \*\*\* mean significant at 10%, 5%, and 1% respectively

**Table 10. Budget Expenditures (% GDP)**

	D crises	DB crises	B crises	BD crises
<b>Year t-3</b>	0.372** [0.180]	0.776*** [0.289]	-0.098 [0.198]	-0.146 [0.322]
<b>Year t-2</b>	0.446** [0.210]	0.597* [0.303]	0.056 [0.194]	0.022 [0.325]
<b>Year t-1</b>	0.436** [0.214]	0.759* [0.434]	0.147 [0.190]	-0.012 [0.328]
<b>Year Event</b>	0.301 [0.205]	0.451 [0.373]	0.237 [0.217]	-0.091 [0.315]
<b>Year t+1</b>	0.157 [0.227]	-0.179 [0.336]	0.199 [0.180]	0.535 [0.425]
<b>Year t+2</b>	0.192 [0.150]	-0.147 [0.252]	0.234 [0.173]	0.307 [0.418]
<b>Year t+3</b>	0.148 [0.185]	-0.057 [0.287]	0.084 [0.168]	0.218 [0.346]
<b>Observations</b>	1921	1921	1921	1921
<b>R-squared</b>	0.03	0.03	0.03	0.03
<b>No. of Countries</b>	95	95	95	95
<b>No. of Events</b>	42	13	40	14
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Country trends</b>	No	No	No	No

**Table 11. Budget Balance (% GDP)**

	D crises	DB crises	B crises	BD crises
<b>Year t-3</b>	-0.395** [0.190]	-0.426 [0.276]	0.127 [0.182]	0.306 [0.281]
<b>Year t-2</b>	-0.422** [0.205]	-0.198 [0.366]	0.109 [0.206]	-0.006 [0.329]
<b>Year t-1</b>	-0.465** [0.191]	-0.565 [0.489]	-0.061 [0.196]	-0.167 [0.312]
<b>Year Event</b>	-0.237 [0.198]	-0.321 [0.318]	-0.333* [0.171]	-0.304 [0.318]
<b>Year t+1</b>	-0.212 [0.251]	0.011 [0.298]	-0.307** [0.140]	-0.994*** [0.330]
<b>Year t+2</b>	-0.136 [0.224]	-0.021 [0.192]	-0.309* [0.159]	-0.493 [0.306]
<b>Year t+3</b>	-0.040 [0.234]	0.268 [0.255]	-0.004 [0.152]	-0.363 [0.299]
<b>Observations</b>	1921	1921	1921	1921
<b>R-squared</b>	0.03	0.03	0.03	0.03
<b>No. of Countries</b>	95	95	95	95
<b>No. of Events</b>	42	13	40	14
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Country trends</b>	No	No	No	No

The table reports the coefficients obtained from a fixed-effects panel regression of the variable in the title on a seven-year window around crisis events, controlling for country fixed effects. Crisis events are split into independent debt crises; independent bank crises; twin debt-bank crises; and twin bank-debt crises. The variable is first normalized by dividing by the standard deviation at the country level. The sample period is 1975 to 2007. Standard errors, clustered at the country-level, are reported in brackets. \*, \*\*, and \*\*\* mean significant at 10%, 5%, and 1% respectively

The table reports the coefficients obtained from a fixed-effects panel regression of the variable in the title on a seven-year window around crisis events, controlling for country fixed effects. Crisis events are split into independent debt crises; independent bank crises; twin debt-bank crises; and twin bank-debt crises. The variable is first normalized by dividing by the standard deviation at the country level. The sample period is 1975 to 2007. Standard errors, clustered at the country-level, are reported in brackets. \*, \*\*, and \*\*\* mean significant at 10%, 5%, and 1% respectively

**Table 12. Public Debt (% GDP)**

	<b>D crises</b>	<b>DB crises</b>	<b>B crises</b>	<b>BD crises</b>
<b>Year t-3</b>	-0.270 [0.201]	0.022 [0.340]	-0.196 [0.179]	-0.486** [0.221]
<b>Year t-2</b>	-0.014 [0.212]	0.192 [0.396]	-0.059 [0.209]	-0.607*** [0.199]
<b>Year t-1</b>	0.041 [0.228]	0.639 [0.425]	0.004 [0.238]	-0.563** [0.230]
<b>Year Event</b>	0.093 [0.203]	0.651** [0.307]	-0.103 [0.240]	-0.317 [0.208]
<b>Year t+1</b>	0.352* [0.195]	1.055** [0.415]	-0.057 [0.191]	0.122 [0.193]
<b>Year t+2</b>	0.184 [0.166]	0.922** [0.371]	-0.005 [0.176]	0.433 [0.261]
<b>Year t+3</b>	0.359** [0.164]	0.438 [0.324]	0.156 [0.171]	0.712*** [0.279]
<b>Observations</b>	2138	2138	2138	2138
<b>R-squared</b>	0.04	0.04	0.04	0.04
<b>No. of Countries</b>	99	99	99	99
<b>No. of Events</b>	47	12	41	14
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Country trends</b>	No	No	No	No

**Table 13. Real GDP growth (%)**

	<b>D crises</b>	<b>DB crises</b>	<b>B crises</b>	<b>BD crises</b>
<b>Year t-3</b>	-0.246 [0.188]	-0.404* [0.209]	-0.261* [0.154]	0.168 [0.234]
<b>Year t-2</b>	-0.141 [0.168]	-0.651** [0.290]	-0.427** [0.166]	-0.140 [0.217]
<b>Year t-1</b>	-0.389*** [0.176]	-0.712*** [0.192]	-0.328* [0.195]	0.239 [0.199]
<b>Year Event</b>	-0.595*** [0.173]	-1.310*** [0.307]	-0.380** [0.147]	-0.521** [0.264]
<b>Year t+1</b>	-0.406** [0.145]	-0.658** [0.320]	-0.671*** [0.248]	-1.618*** [0.370]
<b>Year t+2</b>	-0.249* [0.147]	0.071 [0.201]	-0.116 [0.124]	-1.039*** [0.325]
<b>Year t+3</b>	-0.294* [0.168]	0.395* [0.222]	-0.032 [0.119]	-0.191 [0.210]
<b>Observations</b>	2336	2336	2336	2336
<b>R-squared</b>	0.07	0.07	0.07	0.07
<b>No. of Countries</b>	100	100	100	100
<b>No. of Events</b>	55	16	40	18
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Country trends</b>	No	No	No	No

The table reports the coefficients obtained from a fixed-effects panel regression of the variable in the title on a seven-year window around crisis events, controlling for country fixed effects. Crisis events are split into independent debt crises; independent bank crises; twin debt-bank crises; and twin bank-debt crises. The variable is first normalized by dividing by the standard deviation at the country level. The sample period is 1975 to 2007. Standard errors, clustered at the country-level, are reported in brackets. \*, \*\*, and \*\*\* mean significant at 10%, 5%, and 1% respectively

The table reports the coefficients obtained from a fixed-effects panel regression of the variable in the title on a seven-year window around crisis events, controlling for country fixed effects. Crisis events are split into independent debt crises; independent bank crises; twin debt-bank crises; and twin bank-debt crises. The variable is first normalized by dividing by the standard deviation at the country level. The sample period is 1975 to 2007. Standard errors, clustered at the country-level, are reported in brackets. \*, \*\*, and \*\*\* mean significant at 10%, 5%, and 1% respectively

**Table 14. Inflation rate (%)**

	<b>D crises</b>	<b>DB crises</b>	<b>B crises</b>	<b>BD crises</b>
<b>Year t-3</b>	0.258 [0.185]	0.119 [0.184]	0.767*** [0.28]	-0.075 [0.212]
<b>Year t-2</b>	0.218* [0.130]	0.153 [0.254]	0.857*** [0.215]	0.024 [0.165]
<b>Year t-1</b>	0.224* [0.121]	0.664 [0.505]	0.612*** [0.181]	-0.054 [0.165]
<b>Year Event</b>	0.309** [0.154]	1.223** [0.503]	0.323** [0.143]	0.264 [0.249]
<b>Year t+1</b>	0.434* [0.219]	0.534 [0.359]	0.416** [0.186]	1.225** [0.524]
<b>Year t+2</b>	0.203 [0.165]	0.313 [0.274]	0.167 [0.166]	1.064** [0.377]
<b>Year t+3</b>	-0.025 [0.132]	-0.078* [0.155]	-0.143 [0.122]	0.243 [0.201]
<b>Observations</b>	2258	2258	2258	2258
<b>R-squared</b>	0.06	0.06	0.06	0.06
<b>No. of Countries</b>	100	100	100	100
<b>No. of Events</b>	51	14	40	15
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Country trends</b>	No	No	No	No

**Table 15. Total inflows (% GDP)**

	<b>D crises</b>	<b>DB crises</b>	<b>B crises</b>	<b>BD crises</b>
<b>Year t-3</b>	0,267 [0,217]	-0,532 [0,179]	0,073 [0,230]	0,117 [0,423]
<b>Year t-2</b>	0,155 [0,196]	-0,453 [0,303]	0,205 [0,220]	0,568 [0,240]
<b>Year t-1</b>	0,111 [0,206]	-0,556 [0,277]	0,384 [0,241]	0,754 [0,230]
<b>Year Event</b>	0,228 [0,215]	-0,807 [0,383]	0,096 [0,158]	0,345 [0,356]
<b>Year t+1</b>	0,236 [0,175]	-0,633 [0,355]	-0,085 [0,207]	0,055 [0,281]
<b>Year t+2</b>	-0,007 [0,210]	-0,187 [0,306]	0,174 [0,179]	-0,554 [0,382]
<b>Year t+3</b>	-0,001 [0,179]	-0,081 [0,191]	0,202 [0,175]	-0,1 [0,274]
<b>Observations</b>	1,864	1,864	1,864	1,864
<b>R-squared</b>	0,19	0,19	0,19	0,19
<b>No. of Countries</b>	91	91	91	91
<b>No. of Events</b>	42	12	34	17
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Country trends</b>	No	No	No	No

The table reports the coefficients obtained from a fixed-effects panel regression of the variable in the title on a seven-year window around crisis events, controlling for country fixed effects. Crisis events are split into independent debt crises; independent bank crises; twin debt-bank crises; and twin bank-debt crises. The variable is first normalized by dividing by the standard deviation at the country level. The sample period is 1975 to 2007. Standard errors, clustered at the country-level, are reported in brackets. \*, \*\*, and \*\*\* mean significant at 10%, 5%, and 1% respectively

The table reports the coefficients obtained from a fixed-effects panel regression of the variable in the title on a seven-year window around crisis events, controlling for country fixed effects. Crisis events are split into independent debt crises; independent bank crises; twin debt-bank crises; and twin bank-debt crises. The variable is first normalized by dividing by the standard deviation at the country level. The sample period is 1975 to 2007. Standard errors, clustered at the country-level, are reported in brackets. \*, \*\*, and \*\*\* mean significant at 10%, 5%, and 1% respectively.

**Table 16. Short-term debt in total foreign debt (%)**

	D crises	DB crises	B crises	BD crises
<b>Year t-3</b>	0.067 [0.165]	-0.084 [0.214]	-0.003 [0.172]	0.283 [0.243]
<b>Year t-2</b>	0.173 [0.198]	-0.195 [0.266]	-0.051 [0.173]	0.555** [0.236]
<b>Year t-1</b>	0.159 [0.195]	-0.069 [0.365]	0.182 [0.206]	0.950*** [0.314]
<b>Year Event</b>	-0.093 [0.185]	-0.035 [0.333]	0.161 [0.204]	0.582 [0.352]
<b>Year t+1</b>	-0.326** [0.140]	0.086 [0.355]	-0.016 [0.164]	0.157 [0.331]
<b>Year t+2</b>	-0.370*** [0.132]	0.220 [0.277]	-0.002 [0.211]	-0.119 [0.354]
<b>Year t+3</b>	-0.309** [0.154]	0.438* [0.252]	-0.133 [0.146]	-0.380* [0.214]
<b>Observations</b>	1602	1602	1602	1602
<b>R-squared</b>	0.03	0.03	0.03	0.03
<b>No. of Countries</b>	65	65	65	65
<b>No. of Events</b>	48	12	40	15
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Country trends</b>	No	No	No	No

**Table 17. Real effective exchange rate (index, 2000=100)**

	D crises	DB crises	B crises	BD crises
<b>Year t-3</b>	0.067 [0.165]	-0.084 [0.214]	-0.003 [0.172]	0.283 [0.243]
<b>Year t-2</b>	0.173 [0.198]	-0.195 [0.266]	-0.051 [0.173]	0.555** [0.236]
<b>Year t-1</b>	0.159 [0.195]	-0.069 [0.365]	0.182 [0.206]	0.950*** [0.314]
<b>Year Event</b>	-0.093 [0.185]	-0.035 [0.333]	0.161 [0.204]	0.582 [0.352]
<b>Year t+1</b>	-0.326** [0.140]	0.086 [0.355]	-0.016 [0.164]	0.157 [0.331]
<b>Year t+2</b>	-0.370*** [0.132]	0.220 [0.277]	-0.002 [0.211]	-0.119 [0.354]
<b>Year t+3</b>	-0.309** [0.154]	0.438* [0.252]	-0.133 [0.146]	-0.380* [0.214]
<b>Observations</b>	1602	1602	1602	1602
<b>R-squared</b>	0.03	0.03	0.03	0.03
<b>No. of Countries</b>	65	65	65	65
<b>No. of Events</b>	48	12	40	15
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Country trends</b>	No	No	No	No

The table reports the coefficients obtained from a fixed-effects panel regression of the variable in the title on a seven-year window around crisis events, controlling for country fixed effects. Crisis events are split into independent debt crises; independent bank crises; twin debt-bank crises; and twin bank-debt crises. The variable is first normalized by dividing by the standard deviation at the country level. The sample period is 1975 to 2007. Standard errors, clustered at the country-level, are reported in brackets. \*, \*\*, and \*\*\* mean significant at 10%, 5%, and 1% respectively.

The table reports the coefficients obtained from a fixed-effects panel regression of the variable in the title on a seven-year window around crisis events, controlling for country fixed effects. Crisis events are split into independent debt crises; independent bank crises; twin debt-bank crises; and twin bank-debt crises. The variable is first normalized by dividing by the standard deviation at the country level. The sample period is 1975 to 2007. Standard errors, clustered at the country-level, are reported in brackets. \*, \*\*, and \*\*\* mean significant at 10%, 5%, and 1% respectively.

**Table 18. The Chinn-Ito index (%)**

	<b>D crises</b>	<b>DB crises</b>	<b>B crises</b>	<b>BD crises</b>
<b>Year t-3</b>	0.067 [0.165]	-0.084 [0.214]	-0.003 [0.172]	0.283 [0.243]
<b>Year t-2</b>	0.173 [0.198]	-0.195 [0.266]	-0.051 [0.173]	0.555** [0.236]
<b>Year t-1</b>	0.159 [0.195]	-0.069 [0.365]	0.182 [0.206]	0.950*** [0.314]
<b>Year Event</b>	-0.093 [0.185]	-0.035 [0.333]	0.161 [0.204]	0.582 [0.352]
<b>Year t+1</b>	-0.326** [0.140]	0.086 [0.355]	-0.016 [0.164]	0.157 [0.331]
<b>Year t+2</b>	-0.370*** [0.132]	0.220 [0.277]	-0.002 [0.211]	-0.119 [0.354]
<b>Year t+3</b>	-0.309** [0.154]	0.438* [0.252]	-0.133 [0.146]	-0.380* [0.214]
<b>Observations</b>	1602	1602	1602	1602
<b>R-squared</b>	0.03	0.03	0.03	0.03
<b>No. of Countries</b>	65	65	65	65
<b>No. of Events</b>	48	12	40	15
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Country trends</b>	No	No	No	No

The table reports the coefficients obtained from a fixed-effects panel regression of the variable in the title on a seven-year window around crisis events, controlling for country fixed effects. Crisis events are split into independent debt crises; independent bank crises; twin debt-bank crises; and twin bank-debt crises. The variable is first normalized by dividing by the standard deviation at the country level. The sample period is 1975 to 2007. Standard errors, clustered at the country-level, are reported in brackets. \*, \*\*, and \*\*\* mean significant at 10%, 5%, and 1% respectively.





## APPENDIX 5: ECONOMETRIC RESULTS (II): MULTIVARIATE APPROACHES

**Table 19. Multinomial Logit Regressions**

VARIABLES	Bank		Debt		Bank-Debt		Debt-Bank	
	Full Sample	EMEs Only	Full Sample	EMEs Only	Full Sample	EMEs Only	Full Sample	EMEs Only
Δ GDP Growth (annual %)	-0.027 (0.035)	-0.041 (0.041)	-0.074 (0.057)	-0.069 (0.070)	-0.118*** (0.038)	-0.128*** (0.037)	-0.091 (0.063)	-0.157*** (0.052)
Δ Bank Exposure to the Government (% of banks' domestic assets)	4.620 (3.655)	7.048 (4.798)	-0.429 (4.194)	-3.491 (3.657)	-0.575 (4.996)	2.747 (6.410)	-0.578 (5.813)	-4.607 (6.741)
Δ Central bank liquidity provision (% of banks' assets)	11.464** (5.535)	15.218*** (5.301)	-0.780 (4.580)	0.229 (6.810)	21.440*** (6.764)	16.400** (6.840)	3.643 (6.314)	7.105 (9.280)
Δ General Government Balance (% of GDP)	-0.012 (0.045)	-0.013 (0.066)	0.056 (0.039)	0.080* (0.045)	-0.073 (0.064)	-0.079 (0.067)	-0.029 (0.086)	0.003 (0.087)
Δ Gross Public Debt (% of GDP)	-0.006 (0.018)	-0.035*** (0.013)	0.013 (0.008)	0.013 (0.015)	0.001 (0.017)	0.001 (0.026)	0.016 (0.021)	0.013 (0.022)
Δ Capital Inflows (% of GDP)	-0.007 (0.021)	-0.029 (0.029)	0.058* (0.032)	0.055 (0.042)	-0.049 (0.051)	-0.070 (0.052)	-0.089 (0.060)	-0.083 (0.071)
Δ Banks' Domestic Assets (% of GDP)	1.672 (4.348)	3.920 (4.129)	-2.768* (1.433)	-2.642 (1.899)	3.987* (2.278)	3.945* (2.135)	-13.367*** (3.462)	-12.969*** (3.235)
Δ Capital Account Openness <sup>†</sup>	3.529*** (1.115)	2.843** (1.121)	-3.541** (1.606)	-3.315* (1.744)	4.548 (3.127)	4.833* (2.806)	-6.187 (4.321)	-7.260 (4.955)
Lagged GDP Growth (annual %)	-0.022 (0.046)	-0.050 (0.048)	-0.113*** (0.043)	-0.162*** (0.040)	-0.034 (0.045)	-0.057 (0.041)	-0.115 (0.077)	-0.207*** (0.067)
Lagged Bank Exposure to the Government	-0.354 (1.639)	-0.040 (1.810)	0.958 (1.343)	0.603 (1.830)	-4.262 (6.365)	-2.772 (6.457)	2.501 (2.064)	2.620 (2.032)
Lagged Central bank liquidity provision	0.697 (2.096)	2.714 (2.355)	1.112 (1.962)	1.782 (2.602)	3.293 (2.045)	5.315** (2.083)	6.333*** (1.723)	5.725** (2.465)
Lagged General Government Balance (% of GDP)	0.005 (0.036)	-0.016 (0.034)	0.015 (0.023)	0.020 (0.032)	0.010 (0.056)	0.022 (0.067)	0.066 (0.064)	0.043 (0.054)
Lagged Gross Public Debt (% of GDP)	0.001 (0.003)	-0.002 (0.003)	0.001 (0.002)	0.001 (0.004)	-0.002 (0.007)	-0.012 (0.010)	-0.012 (0.012)	0.001 (0.011)
Lagged Capital Inflows (% of GDP)	0.030 (0.033)	0.036 (0.035)	0.050* (0.030)	0.050 (0.038)	0.055 (0.034)	0.045 (0.044)	0.033 (0.036)	0.021 (0.033)
Lagged Banks' Domestic Assets (% of GDP)	1.252*** (0.435)	1.362*** (0.424)	-1.671** (0.849)	-1.465 (1.076)	-1.382 (0.916)	-1.301 (0.948)	-5.479*** (2.060)	-6.812** (2.660)
Lagged Capital Account Openness <sup>†</sup>	-1.510** (0.623)	-1.593** (0.679)	-1.151* (0.642)	-1.604** (0.780)	1.658* (0.931)	0.931 (0.813)	-1.890** (0.934)	-3.122*** (1.022)
Constant	-4.387*** (0.496)	-4.477*** (0.553)	-2.841*** (0.516)	-2.684*** (0.608)	-5.625*** (0.995)	-4.885*** (0.783)	-3.257*** (1.159)	-3.057*** (1.097)
Observations	1,537	1,343	1,537	1,343	1,537	1,343	1,537	1,343

Dependent categorical variable is crisis type, whose level is denoted in the column header. <sup>†</sup>Normalized Chinn-Ito Index. Robust standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table 20. Bivariate Ordered Probit Regressions**

VARIABLES	Debt equation		Bank equation	
	Full Sample	EMEs Only	Full Sample	EMEs Only
Lagged GDP Growth (annual %)	-0.047*** (0.008)	-0.030*** (0.009)	-0.008 (0.008)	-0.007 (0.009)
Lagged Central Bank Liquidity Provision	0.831 (0.521)	0.822 (0.596)		
Lagged Bank Exposure to the Government			0.234 (0.244)	0.861*** (0.271)
Lagged General Government Balance (% of GDP)	0.038*** (0.008)	0.042*** (0.009)	0.027*** (0.007)	0.028*** (0.008)
Lagged Gross Public Debt (% of GDP)	0.011*** (0.001)	0.017*** (0.001)	0.002** (0.001)	-0.001 (0.001)
Lagged Capital Inflows (% of GDP)	-0.016** (0.007)	-0.015** (0.007)	-0.006 (0.006)	0.000 (0.007)
Lagged Banks' Domestic Assets (% of GDP)	-0.913*** (0.120)	-1.271*** (0.141)	0.544*** (0.111)	0.689*** (0.122)
Lagged Capital Account Openness <sup>†</sup>	0.085 (0.111)	0.028 (0.118)	0.672*** (0.105)	0.557*** (0.111)
$\Delta$ GDP Growth (annual %) * Bank Crisis	-0.038*** (0.010)	-0.023* (0.012)		
$\Delta$ Central Bank Liquidity Provision * Bank Crisis	1.559 (1.322)	-0.392 (1.893)		
$\Delta$ Banks' Domestic Assets * Bank Crisis	-0.892* (0.503)	-0.899 (0.553)		
$\Delta$ General Government Balance * Bank Crisis	-0.002 (0.016)	0.024 (0.018)		
$\Delta$ Gross Public Debt * Bank Crisis	0.001 (0.004)	0.008 (0.006)		
$\Delta$ Capital Inflows * Bank Crisis	0.008 (0.009)	-0.010 (0.012)		
$\Delta$ Capital Account Openness <sup>†</sup> * Bank Crisis	0.264 (0.434)	0.252 (0.452)		
$\Delta$ GDP Growth (annual %) * Debt Crisis			-0.011 (0.010)	-0.011 (0.010)
$\Delta$ Bank Exposure to the Government * Debt Crisis			1.610* (0.969)	2.013** (1.065)
$\Delta$ Banks' Domestic Assets * Debt Crisis			-0.062 (0.536)	0.496 (0.547)
$\Delta$ General Government Balance * Debt Crisis			0.006 (0.012)	0.009 (0.014)
$\Delta$ Gross Public Debt * Debt Crisis			-0.004 (0.003)	-0.009** (0.004)
$\Delta$ Capital Inflows * Debt Crisis			0.002 (0.007)	0.003 (0.009)
$\Delta$ Capital Account Openness <sup>†</sup> * Debt Crisis			1.256*** (0.400)	1.233*** (0.419)
Arc-hyperbolic tangent of $\rho$	-14.20*** (0.201)	-20.14*** (0.312)	-14.20*** (0.201)	-20.14*** (0.312)
Cut-off Point	-0.384*** (0.099)	-0.274** (0.108)	0.457*** (0.089)	0.490*** (0.094)
Observations	1,537	1,343	1,537	1,343

Dependent variable and sample listed in column header. <sup>†</sup>Normalized Chinn-Ito Index. Robust standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

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