THREE SISTERS: THE INTERLINKAGE BETWEEN SOVEREIGN DEBT, CURRENCY, AND BANKING CRISES

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ABSTRACT

The interlinkage between sovereign debt defaults, currency crises, and banking crises is rarely explored in financial crisis literature. This study attempts to dive into this unexplored area by applying panel data binary choice model to a sample of 20 emerging economies observed monthly between 1985 and 2007. The roles of prior banking and currency crises in predicting debt crises, as well as the role of sovereign defaults in predicting future currency and banking crises are explored. Also, the likelihood of the joint occurrence of these three crises is tested using multivariate probit estimation technique. The evidence of this study suggests that there are contemporaneous and lagged relationships between banking and debt crises, that banking crises usually precede debt crises. Additionally, in countries with high short-term indebtedness the occurrence of a banking crisis provides information on the likelihood of a future debt crisis. Although there is no evidence supporting any direct relationship between currency and debt crises, countries experiencing both currency crises and misaligned exchange rates are more likely to default on their future sovereign obligations.

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1. INTRODUCTION

Sovereign debt defaults have always been a part of the history of emerging countries. As for the empirical literature of financial crises, analyzing the determinants of these defaults is quite popular. However, if one looks at the previous incidences of debt defaults in emerging countries, it is not uncommon to notice that they are coupled with either banking or currency crises, and in some cases all three crises occur close to each other in time. Yet empirical studies pay little attention to analyzing the triple crises which have a tendency to occur in emerging economies especially[3]. Looking back at history, especially in the last three decades there are various examples of currency, banking and debt crises occurring at close intervals in Latin American and Asian countries. Some examples include the Tequila crisis in Mexico in 1994, the Russian financial crisis in 1998, the Asian financial crisis of 1997-98, and the Argentinian economic crisis of 2001-02. There are cases where default is the result or the cause of crises in the exchange rate market and financial sectors. In others, growing tensions in the economic and political system trigger three crises at the same time. Yet the aftermaths are similar: long periods of recession leading to huge losses in economic well-being.

Grounded in these interesting yet rarely explored experiences in emerging economies, this study provides empirical evidence on sovereign debt crises and their links with currency and banking crises. The sample covers 20 emerging countries observed monthly between the years 1985 and 2007. The findings fill important gaps in the empirical literature about financial crises in emerging economies. Firstly, we reveal the determinants of sovereign debt defaults on a monthly basis, relying not only on economic indicators but also on the quality of the institutions and the political structure of countries. Secondly, we discover the empirical links between sovereign debt, currency and banking crises. In this sense, monthly analysis gives the benefit of investigating the time structure of these three crises and to determine whether they occur jointly because of common factors or whether there is contagion that make one crisis occur after the onset of another crisis.

[3] Recently, there is a growing literature following the Eurozone crisis focusing on the advanced countries such as Babecký *et al.* (2012), Candelon and Palm (2010), and Reinhart and Rogoff (2013). However, these studies mainly focus on the relationship between banking and debt crises.

The first part of the empirical analysis looks at the impact of institutional, political and macroeconomic indicators, and the onset of currency and banking crises on the probability of sovereign default. The hypotheses are that not only institutional and economic factors, but also the onset of banking and currency crises provide information about the likelihood of sovereign defaults. Additionally, currency crises might indirectly increase the likelihood of sovereign defaults through overvalued real exchange rates since the overvaluation corrected by depreciation might lead to worsening of the government finances and accelerate a debt crisis (Jahjah and Montiel, 2003). An initial banking crisis is hypothesized to increase future debt crisis probability if the losses of the banking sector become a burden for the government[4]. These indirect effects on the likelihood of sovereign defaults are investigated by including the interaction of lagged currency crises with misaligned exchange rates, and the interaction of prior banking crises with short-term external debt. By doing so, the study tries to examine the theoretical linkages from currency to debt crises when the economy has overvalued real exchange rates; and from banking to debt crises if the country has a high ratio of short-term foreign debt to foreign exchange reserves.

An initial sovereign debt default might also lead to a crisis in the banking sector or a depreciation of the domestic currency. The second part of the empirical analysis deals with this reverse relationship by including lagged sovereign debt default as one of the determinants of currency and banking crises. This part also addresses the simultaneous occurrence of the three crises by estimating three equation systems in order to discover the contemporaneous correlation between these crises types. We apply a multivariate probit approach to determine if currency, debt and banking crises occur jointly and are led by common unobservable factors.

The study finds evidence that both economic indicators and institutional indicators help in predicting sovereign debt defaults. Specifically, a high public debt to GDP ratio, an increase in international interest rates, an appreciated real exchange rate, slowing growth rate of GDP, inflation, a high ratio of short-term external debt to reserves, as well as an instable political, economic and financial situation contribute to the likelihood of sovereign debt defaults in our sample of emerging countries.

[4] Velasco (1987), Arellano and Kocherlakota (2008).

As for the relationship between currency, banking and debt crises, our findings suggest that the prior onset of banking crisis is highly correlated with debt crisis. Banking crises significantly contribute to sovereign defaults within the next twelve-month period. There is also evidence on the joint occurrence of banking and debt crises. The onset of a banking crisis significantly increases the contemporaneous debt default, and vice versa. Additionally prior currency and banking crises have significant indirect effects on the probability of sovereign default that currency crises through misaligned exchange rates, and banking crises through high short-term foreign debt contribute to the likelihood of future sovereign defaults. On the other hand, there is no evidence on the direct relationship between currency and debt crises.

The rest of the study is structured as follows: Section 2 presents the literature on sovereign debt defaults and on the possible links between sovereign debt, banking and currency crises; the methodology and data of the study are presented in Section 3, followed by the results of the pooled probit estimations of the determinants of sovereign default in Section 4; Section 5 offers evidence on the predictive power of lagged defaults on the probability of currency and banking crises, and joint estimation of currency, banking and debt crises equations; lastly the conclusion is presented in Section 6.

2. LITERATURE REVIEW

2.1 Causes of Debt Crises

Theoretical studies regarding sovereign risk and sovereign default consist of two broad categories. The first category looks at the cost-benefit analyses by governments in deciding to continue servicing their debt. In these cases government chooses to default if the benefit of the default exceeds its costs, such as reputation loss or negative output effects. Pioneered by the classical paper of Eaton and Gersovitz (1981)[5], this category focuses on the debtors' willingness to pay. Therefore, the default decision is not the result of the inability of governments to service their obligations and for that reason they do not occur during recessions. However, empirical literature shows that defaults are actually taking place during recessions though this is not supported by these

[5] Later works developing this theory are Eaton *et al.* (1986), Bulow and Rogoff (1989), and Grossman and Van Huyck (1988) amongst others.

models[6]. Later modifications in the model by various authors correct this counter cyclicality of the model to allow for a default taking place during bad times[7]. The second major category focuses on the inability of governments to commit to their future policies. These models lead to multiple equilibria that, in one of the equilibria, the insolvency or illiquidity of the government results in its defaulting in its obligations. In the other equilibrium, the crisis does not occur and the government manages to roll over its obligations. Some of the leading theoretical works on these self-fulfilling defaults include Calvo (1988); Alesina *et al*. (1990); Detragiache (1996); and Cole and Kehoe (2000).

Political stability and its role in risk of default appear as another strand in the literature. The theoretical intuition by Citron and Nickelsburg (1987) on political stability and its connection with debt crisis is later explored by others such as Amador (2003), and Cuadra and Sapriza (2008). They build their models in order to show how political uncertainty can influence the incentive of the government to repay its debt. The main finding of these studies is that with the increase in the stability of the political system, the risk of the government failing to service its debt decreases.

Generally, empirical studies seeking the causes of sovereign debt crises use discrete choice models with the occurrence of sovereign default as the dependent variable and various macroeconomic variables, and debt and liquidity measures as independent variables. However, there is no single definition for sovereign debt crisis in the empirical literature and it changes depending on the availability of information and the specific effects investigated in each study.

According to Detragiache and Spilimbergo (2001), a country suffers a debt crisis if its government engages in a restructuring agreement or if the accumulation of arrears exceeds five percent of the total commercial debt. By analyzing a sample of 69 developing countries for the years between 1971 and 1998 using probit model estimations they find that short-term debt, debt service, and foreign exchange reserves – the three measures of liquidity – play a role in explaining debt crises.

[6] Panizza *et al.* (2009).
[7] Such as Aguiar and Gopinath (2006), Rochet (2006), and Arellano (2008). The reader can refer to Levy-Yeyati and Panizza (2011) for further discussion and examples.

Manasse *et al.* (2003) ask which fundamentals in an economy are in imbalance prior to a sovereign debt crisis. They define a debt crisis following Standard and Poor's default criteria, in addition to high amounts of IMF financing. Using a dataset consisting of yearly observations for 47 developing countries (having market access) between 1970 and 2002, they estimate the probability of debt crisis by applying logit and binary recursive tree techniques. The authors control for the internal and external macroeconomic environment causing debt crises. Most of the debt crisis periods are predicted correctly by the model. Mainly high levels of foreign debt, short-term indebtedness, slowdown in the growth rate of GDP, current account deficit, lower openness to international trade, a tight interest rate policy on the part of the G7 countries, high levels and volatility of inflation, election years, and a high ratio of public debt to GDP precede the debt crises for the economies in the sample. Manasse and Roubini (2009) confirm these results applying classification and regression tree methodology and they distinguish three major default risks; insolvency, illiquidity and macro-exchange (resulting from low growth and fixed exchange rates) risks. Their model has higher predictive power both in and out-of-sample compared to other early warning signal models.

Levy-Yeyati and Panizza (2011) look at the correlation between the GDP growth rate and the probability of default by using quarterly data for 24 default episodes in developing countries between 1982 and 2003. They find that output contractions are followed by default episodes rather than the other way around. The results confirm the findings of a similar work by Tomz and Wright (2007) which uses a larger data set for default episodes between 1820 and 2004. The results indicate that defaults tend to occur in "bad times" rather than "good times", which gives information on the default incentive of the debtor country[8].

Cottarelli *et al.* (2010) conduct a comparison of the vulnerabilities of advanced economies recently suffering from sovereign debt problems with emerging economies defaulting on their debts. They conclude that interest payments and the differential of real interest rate and real GDP growth are problems for emerging economies, whereas for advanced economies the main problem for debt sustainability is the primary deficit.

[8] More discussion and extensive review of sovereign default literature can be found in Das *et al.* (2012).

There exist a number of empirical studies focusing on political riskiness and its effect on default probability. The initial empirical work on political uncertainty in predicting default probability is conducted by Citron and Nickelsburg (1987). They take into account economic and political factors in predicting the debt crisis by estimating a logit model for five countries for the years 1960 to 1983. Their finding suggests that political riskiness plays a major role in increasing the sovereign default probability. Balkan (1992) uses a probit model for 33 developing countries for the years between 1970 and 1984 in testing the effect of political instability and the level of democracy, among other indicators, on the probability of sovereign debt rescheduling. He finds a negative relationship between the democracy level of a country and rescheduling probability, and a positive relationship between political instability and the probability of debt rescheduling. These results suggest that higher democracy and political stability decrease the probability of debt rescheduling. On the other hand, De Haan *et al.* (1997) look at the predictive power of political instability, as well as economic factors, on the sovereign debt rescheduling probability for a wide country range (65 countries are included in their sample), including a large number of political indicators for the period between 1984 and 1993. They fail to discover any expected influence of political factors on the probability of debt crisis. The authors suggest that the political situation is already reflected in macroeconomic indicators. Enderlein *et al.* (2012), however, construct a government coerciveness index instead of a binary crisis variable for debt crises in 31 developing countries between 1980 and 2007; they find that political indicators are much more significant in explaining default probability than economic and financial indicators. Some other studies look at types of government as an influence on debt servicing incentives; for instance, Kohlscheen (2007) finds that presidential democracies have a higher likelihood of defaulting on their external debt obligations than parliamentary democracies for the years between 1976 and 2000, and Saiegh (2009) finds that coalition governments tend to default less than unified governments.

2.2 Links: Sovereign Debt, Currency and Banking Crises

Unlike the ample empirical literature on the links between currency and banking crises, studies analyzing the connection of debt crisis with currency or banking crises are scarce. Debt, currency and banking crises might happen simultaneously since there might be common fundamentals resulting in a triple crisis. On the other hand, these crises can be contagious through worsening of macroeconomic environment and hence triggering each other. In this section, the links established

in the academic literature between banking crises and sovereign defaults as well as between currency crashes and debt crises are explored.

2.2.1 Theoretical Links: Sovereign Debt and Currency Crises

Some studies focus on the link from currency to sovereign debt crises. Among them, one of the well-known links is the "original sin" argument: a devaluation may lead to sovereign default if most of the debt is denominated in foreign currency, and this has been a common problem for emerging economies[9]. Another link is through the overvalued real exchange rate that is one of the leading indicators of currency crises. Jahjah and Montiel (2003) show in a multiple equilibria model that initial overvaluation of the real exchange rate increases the default risk in a conventional fixed exchange rate regime if the government chooses to depreciate the domestic currency. Increasing domestic interest rates in defending the currency during speculative attacks might also increase the risk of default. It raises the future price of debt, since government has to increase the risk premiums. Additionally, the resulting high interest rates after a currency crisis increase the risk of private debt default and decrease the tax revenue of the government, and hence lead to a rise in the probability of sovereign default[10]. A fall in the credit ratings of the country following devaluation might also lead to a debt crisis, since it makes it harder for governments to find external finance[11]. Finally, the rise in international interest rates can trigger currency and debt crises. Governments might get into difficulty in servicing their increased debt burden because of higher interest payments. The refusal of foreign creditors to roll over the debt, and the resulting capital flight, might lead to both currency and debt crises[12].

An initial default on sovereign obligations might also lead to a currency crisis. Following a sovereign default, foreign creditors might refuse to lend to the domestic economy since the economy is perceived to be in a recession and they might pull their capital out of the economy, thereby increasing the probability of devaluation. The resulting decrease in domestic demand due to the debt crisis might induce central banks to implement expansionary monetary policies in order to avoid recession. As second generation crisis models predict, the policy makers' intention to give

[9] Eichengreen and Hausmann (1999, 2005), and Jeanne (2005).
[10] Dreher *et al.* (2006).
[11] Reinhart (2002).
[12] Dreher *et al.* (2006).

up the exchange rate peg can be self-fulfilling and lead to a speculative attack on the domestic currency[13].

2.2.2 Theoretical Links: Sovereign Debt and Banking Crises

A crisis in the banking sector might lead to a sovereign debt crisis. Velasco (1987) discusses how the high indebtedness of the financial sector turns into massive government liabilities once the government acts as a guarantor of the financial sector's liabilities. Arellano and Kocherlakota (2008), in their model, show that bank insolvencies (or, more generally, internal defaults) might lead to sovereign defaults through the pressure they put on the government's fiscal budget. These crises are unavoidable consequences of the informational problems of private sector borrowing. The decrease in domestic demand due to the banking crisis might also indirectly lead to a risk of default as a result of the expansionary fiscal policies applied to boost the demand.

A sovereign default might also lead to a banking crisis if the domestic financial sector holds a large amount of sovereign debt on their balance sheets. Modeled by Gennaioli *et al.* (2014), this link from sovereign default to banking crisis is stronger in countries having a developed financial sector[14]. On the other hand, Reinhart and Rogoff (2011) argue that for a default to trigger a banking crisis, the domestic financial sector need not be directly exposed to government debt. If the resulting fall in nation-wide credit ratings were to influence the international borrowing of domestic banks, this "sudden stop" might cause a banking crisis immediately on top of the debt crisis.

2.2.3 Empirical Studies: Sovereign Debt, Currency and Banking Crises

Some empirical works explore the link between currency, banking and debt crises. Most of these studies focus on the dual relationships either between banking and debt crises or between currency and debt crises.

[13] Obstfeld (1994).
[14] A similar model is developed by Bolton and Jeanne (2011) for the financially integrated advanced economies with fiscal disunity.

Reinhart (2002) analyzes, amongst other things, the interaction between currency and debt crises and finds that in emerging economies, currency crises help in predicting debt crises in 84 percent of the cases but the reverse is not true. For developed economies the study fails to find any relation between currency and debt crises. She finds that following a currency crisis, the sovereign credit ratings are downgraded and these ratings can work as a link from currency crises to sovereign defaults. Herz and Tong (2008), with the help of bivariate probit estimations, look at the contemporaneous debt and currency crises in a two equation system. Their sample includes 108 developing economies having yearly observations from 1975 to 2005. They find that currency and debt crises occur simultaneously, caused by common unobserved fundamentals. However, they fail to find causality running from lagged currency to debt crises and they only find a weak connection from lagged debt crises to currency crises.

Reinhart and Rogoff (2011) conduct a historical analysis dating back to the 1800s to analyze the relationship between banking and debt crises, applying multinomial logit estimations on banking and debt crises equations. The main finding of the study is that previous and contemporaneous banking crises help predict the occurrence of debt crises. However, lagged debt crises are not significant indicators of banking crises. Borensztein and Panizza (2009) investigate the link from sovereign defaults to banking crises with a sample of 149 countries between the years 1975 and 2000. The results suggest that sovereign defaults fail to predict credit crunches. Gennaioli *et al*. (2014) look at the linkage between the domestic financial sector and government defaults for 46 emerging markets and developing countries between 1980 and 2005. They find that in countries where the banking sector is more exposed to government debt, a credit crunch is more likely to follow a default. They also find that banking crises increase the likelihood of future sovereign defaults.

Several empirical studies focus on the analyses of triple crises. Bordo and Meissner (2005) compare the 1880-1913 period to 1972-1997 in searching for the correlations between currency, banking and debt crises, focusing on the role of foreign currency debt in predicting these crises. The authors use currency and banking crises as indicators in explaining sovereign debt crisis and find evidence that a currency crisis experienced in the current or previous period increases the probability of a debt crisis both for the 1880-1913 and 1972-1997 samples. However, lagged and

contemporaneous banking crises are not significantly associated with debt crises. As a recent attempt to explore the early warning indicators of the three types of crises, Babecký *et al*. (2012) apply panel vector autoregression techniques on quarterly data for 40 developed countries between 1970 and 2010. They find that banking crises lead to debt crises (as well to currency crises), but the opposite is not true. Although they do not find a significant link from currency to debt crises, there is evidence that debt crises lead to currency crises. Nevertheless, because of the rareness of incidences of debt crises in the developed countries, these results should be interpreted with caution.

As presented in this section, theoretical studies indicate clear correspondences between banking and debt crises, and between currency and debt crises. Nevertheless, non-comprehensive empirical literature lags behind in providing information regarding the triple crises. The following sections provide our attempt to fill this gap in the empirical financial crisis literature, applying monthly data on an emerging economy sample linking sovereign debt, currency and banking crises.

3. METHODOLOGY AND DATA

3.1 Starting Dates of Sovereign Debt, Currency and Banking Crises

Almost all empirical studies investigating financial crises rely on annual data since establishing the exact month of the onset of sovereign debt and banking crises is not easy. Annual dating of crises lowers concern about precision in dating the onset of crises and gives the benefit of including a high number of countries in the sample. However, it leads to a significant loss of information regarding the leads and lags of particular crises types, especially in the analysis of the relation between multiple crises types. Therefore, acknowledging the limitations of monthly crisis dating, in this study, we use the monthly starting dates of financial crises.

Information about the months in which the sovereign debt crises started is taken from Artera and Hale (2008). They define the start of the sovereign debt crisis as the date when the renegotiation of the sovereign debt is first mentioned in the English-language media prior to any restructuring

agreement[15]. They trace financial news in the Lexis-Nexis database in order to distinguish the default dates of the government debt. The onset of currency crises in our sample is identified following Kraay (2003), and Eijffinger and Karataş (2012): A country is experiencing a currency crisis if the depreciation of domestic currency price per US dollar exceeds 10 percent in a given month following an episode of stable exchange rates (i.e. the average absolute percentage change should be lower than 2.5 percent for the twelve month-period prior to the depreciation). This limitation of the definition in allowing only crises following stable exchange rates is later relaxed in the sensitivity analyses with the application of the exchange market pressure (ERM) index in identifying currency crisis periods. For the starting months of the banking crises in our sample, we use the systemic banking crises database developed by Laeven and Valencia (2008, 2012). This database extends the banking crises database of Caprio and Klingebiel (1996), and Caprio *et al.* (2005) and provides the staring months of the banking crises which is crucial for our analyses[16].

We apply windows to the data to exclude the months following the sovereign default until the corresponding restructuring date[17]. Similarly, for currency crises any depreciation following the twelve months after the currency crisis onset is treated as the same crisis, and for banking crises the months following the onset until the end dates diagnosed by Laeven and Valencia (2012) are excluded from the dataset.

Table A1 in Appendix A gives the overview of the debt, banking and currency crises onsets for the period between January 1985 and December 2007 for the 20 emerging economies used in our study[18]. In the sample there are 45 debt, 25 currency and 25 banking crises. Following the approach of Kaminsky and Reinhart (1999), we calculate the probabilities of the occurrence of each crisis

[15] Most of the studies either select the restructuring date as the onset of a debt crisis (such as Balkan (1992) and Detragiache and Spilimbergo (2001) where a combination of restructuring and the level of arrears is used to define debt crisis), or arbitrarily set one year prior to restructuring date as the start of the sovereign debt crisis (such as Herz and Tong (2008)). The restructuring agreement represents the end of the debt crisis period. In this respect, Artera and Hale (2008) identify the months for the start of debt renegotiations corresponding to each restructuring agreement. Hence, in our study, renegotiation of debt represents the start, and the corresponding restructuring agreement is the end of the debt crisis period.

[16] Please refer to Laeven and Valencia (2012) for a detailed description of the systemic banking crisis definition.

[17] Restructuring dates are taken from Artera and Hale (2008) and refer to the Paris Club debt reschedulings. In the case that there is more than one restructuring agreement, the latest agreement refers to the end of the debt crisis.

[18] The limited availability of information about the months in which the banking crises started restricts the number of countries in our sample.

conditional on the occurrence of the other crises. The conditional probability of an occurrence of sovereign default in the same month or in the twelve-month period after a currency crisis is 16 percent. The default either occurs simultaneously with the currency crisis or few months after a currency crisis. On the other hand, after a banking crisis it takes a year for the sovereign to default, if it does not do so immediately in the same month as the banking crisis. The conditional probability of a default in the twelve months after a country experiences a banking crisis is 24 percent. The conditional probability of a country experiencing a currency crisis in the twelve months following a default is 15 percent, while the probability of a banking crisis following a default in that one year window is 19 percent in the sample.

3.2 Data[19]

In predicting the onset of sovereign debt crises, we choose the set of macroeconomic, and institutional and political variables which are widely accepted in the empirical literature[20] as significant determinants of debt crises.

To measure sovereign solvency, the public debt of a country is divided by its GDP. This data is compiled by Reinhart and Rogoff (2009) and defined as gross (external plus internal) central government debt over GDP. In order to capture whether or not a country is experiencing liquidity problems prior to a default, the ratio of short-term external debt service to foreign exchange reserves is included. High short-term external indebtedness creates maturity problems, as well as currency mismatches. This indicator is regarded as one of the best determinants of sovereign debt crises during 1990s.[21]

Manasse *et al.* (2003) find that the current account balance worsens prior to a debt crisis and improves following the crisis. In order to address the contribution of current account problems to the probability of sovereign default, the current account balance divided by foreign exchange reserves is introduced as another macroeconomic determinant.

[19] Detailed explanation, construction and sources of all the data used in the analyses is presented in Appendix B.
[20] Balkan (1992), Detragiache and Spilimbergo (2001), Manasse *et al.* (2003), and Das *et al.* (2012) amongst others.
[21] Manasse *et al.* (2003).

Apart from being the main indicator of a currency crisis, the overvaluation of the real exchange rate brings along the risk of default[22]. The reason is that the external trade position and the general macroeconomic environment of the country become vulnerable with overvalued real exchange rates. If the country has a fixed exchange rate regime it becomes costly for the government to correct the misaligned exchange rates, increasing the likelihood of the debt crisis. Therefore, the overvaluation of the real exchange rates is included as another macroeconomic variable in predicting sovereign debt crisis.

The general domestic macroeconomic environment is also essential in signaling the vulnerability of the government when servicing its external debt. Therefore the key domestic indicators which are expected to increase the likelihood of sovereign default – the monthly growth rate of GDP as an indicator of government having enough resources to repay its debt, the percentage change in the real monetary policy interest rate (since rising interest rates lead to difficulties in future debt service and that increases the incentive of the government to default), and the rate of inflation that captures monetary mismanagement – are all included in the estimations for controlling domestic macroeconomic developments.

External developments that influence the borrowing costs are also important in determining the debt management of emerging economies. Increased international interest rates may lead to lower capital flows to the emerging economies and therefore increase the country's vulnerability to rolling over its debt. As a proxy for global liquidity, the percentage change in the real US federal funds rate is used in the analysis. Arora and Cerisola (2001) claim that US policy rates are more in line with the emerging economy sovereign spreads as they serve as a benchmark in pricing other longer term assets in international markets. Most of the studies using longer term interest rates find a negative relationship, if any, between advanced economy interest rates and emerging economy sovereign spreads[23]. Additionally, theoretical considerations[24] suggest that it is the real, rather than

[22] Eaton and Gersovitz (1981), and Jahjah and Montiel (2003).
[23] Some examples are: Kamin and Von Kleist (1999), Cline and Barnes (1997), Eichengreen and Mody (1998), and Calvo *et al.* (1993).
[24] Uribe and Yue (2006), and Foley-Fisher and Guimaraes (2013).

the nominal, US interest rates that influence the default risk of the emerging economies. Therefore we use the real US federal funds rate as a proxy for global lending conditions[25].

Institutional variables are aimed at capturing the changes in the credibility of policy implementation and in the government's incentive to follow policies that guarantee the sustainability of its debt position. In this respect, elections bring political uncertainty and play an important role in increasing political tensions prior to sovereign defaults. We intend to capture this effect by including a dummy for parliamentary and presidential elections. Apart from election dates, the stability of the political system has been proven[26] to have an influence on a country's willingness to repay its debt. In order to address how risky a country is, the ratings of the International Country Risk Guide (ICRG) are taken into account. Specifically, the focus is on several political variables: government stability, bureaucracy quality, law and order, and democratic accountability; economic quality in assessing the economic weaknesses and strengths of a country; and financial quality, which assesses the ability of the country to finance its obligations in terms of official and commercial debt. The risk of high correlation in these institutional variables requires a correction before including these indicators into the analyses. Therefore we conduct factor analysis[27] in order to generate fewer unobserved, uncorrelated random variables representing the above mentioned observed and correlated seven institutional indicators for any given country in our sample. The institutional variables are represented by two factors; the factor representing the political indicators is called "political environment" and the one representing the economic and financial quality is named "market environment"[28]. The rotated loadings of the two factors is represented in Table B1 (Appendix B). The positive loadings of the two factors mean that higher scores of these factors relate to better quality of institutions.

[25] Also, using US policy rates reduces the reverse causality concerns between debt crises and US treasury rates that a decrease in the default risk in emerging markets might also change the US treasury rates due to the lower demand for the US treasury bonds.
[26] Citron and Nickelsburg (1987), and Balkan (1992) amongst others.
[27] Kim and Mueller (1978), and Torres-Reyna (2012).
[28] We use Kaiser Criterion that retains the factors with eigenvalues – the total variance accounted by each factor – equal to or greater than one.

Finally, following the results of various empirical studies[29] showing that there is a tendency for debt crises to occur together with banking and/or currency crises, we include the indicators of the onsets of currency and banking crises[30]. Additionally, in order to analyze the impact of the prior onset of debt crises on the probability of currency and banking crises, the determinants of banking and currency crises are also included in our data. As the determinants of banking and currency crises, apart from the above mentioned indicators, we include capital account openness, change in stock prices, domestic credit by banking sector over GDP, and domestic credit to private sector over GDP in our analyses[31].

An econometric concern for a sample having at most 276 observations per country is the possible non-stationarity of the variables. To take this into account, we conduct the Im-Pesaran-Shin (2003) unit root test for each variable in our dataset. This test allows for heterogeneity in the unbalanced panel data sets. The results suggest that for all variables, except public debt over GDP, domestic credit over GDP, and domestic credit to private sector over GDP, the null of non-stationarity is rejected. Hence these variables are transformed into first differences. Additionally, to minimize the concerns of endogeneity in our estimations, all regressors are lagged. In order to choose the number of lags for each variable, we apply the general-to-specific methodology: We initially include up to twelve lags for each variable in the estimations and then remove the statistically insignificant lags stage by stage. The parsimonious model in the study is estimated using the first significant lag for each variable. Lastly, the existence of statistical dependence within country observations is controlled for by using robust standard errors clustered for each country[32].

[29] Readers can refer to Dreher *et al.* (2006), and Herz and Tong (2008) for the linkages between currency and debt crises; to Borensztein and Panizza (2009), and Reinhart and Rogoff (2011) for the linkages between banking and debt crises; to Babecký *et al.* (2012), and Bordo and Meissner (2005) for the analysis of banking, currency and debt crises.
[30] The simultaneous occurrence of the three crises is explored in the second part of the empirical analysis.
[31] We select the indicators for the banking and currency crises equations following previous studies, as Lestano *et al.* (2003), Kaminsky and Reinhart (1999), Demirgüç-Kunt and Detragiache (1997), and Kaminsky (2006).
[32] The specifications are also estimated with clustering of the standard errors both across countries and across time (see Peterson (2009) for the details of this method). The results, available upon request, do not change from the estimations presented.

Table 1. Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max	Unit of Account
Sovereign Default	3211	0.008	0.090	0	1	Dummy
Currency Crisis	3058	0.005	0.068	0	1	Dummy
Banking Crisis	2854	0.005	0.070	0	1	Dummy
Δ Public Debt	3211	-0.092	0.968	-4.650	8.408	Ratio to GDP
Real International Interest Rate	3211	0.015	0.199	-0.529	1.276	Percentage Change
Real Domestic Interest Rate	3211	0.061	0.839	-8.035	24	Percentage Change
Exchange Rate Overvaluation	3211	-0.008	0.087	-0.339	0.645	Percentage Deviation
Current Account Position	3211	-0.037	0.181	-1.847	0.459	Ratio to Reserves
GDP Growth	3211	0.399	0.338	-1.010	1.543	Percentage Change
Short Term External Debt	3211	0.973	1.057	0.060	19.426	Ratio to Reserves
Stock Prices	2299	0.022	0.125	-0.559	1.786	Percentage Change
Δ Domestic Credit by Banks	3211	0.082	0.943	-7.803	3.948	Ratio to GDP
Δ Domestic Credit to Private Sector	3211	0.083	0.669	-5.383	3.276	Ratio to GDP
Capital Account Openness	3211	0.166	1.289	-1.856	2.478	Index
Inflation	3211	0.016	0.036	-0.041	0.474	Percentage Change
Election	3211	0.031	0.175	0	1	Dummy
Political Environment	3211	-0.281	0.615	-1.709	1.550	Index
Market Environment	3211	0.160	0.980	-2.974	2.574	Index

The summary statistics of the variables for our unbalanced sample running from January 1985 until December 2007 are given in Table 1. As can be observed from the table, the occurrences of sovereign default, currency and banking crises are rather rare in our sample because of the monthly frequency[33].

[33] This rare event problem might create bias in our results. We address this issue in the sensitivity analyses.

4. EMPIRICAL RESULTS: DETERMINANTS OF SOVEREIGN DEFAULTS

4.1 The Model

In order to address the determinants of the sovereign debt crises, a discrete choice model is preferred using macroeconomic and institutional indicators alongside contemporaneous and lagged starting months of currency and banking crises as predictors of sovereign debt defaults. The onset of a sovereign debt crisis is denoted by the unobservable latent random variable, $D_{i,t}^{*}$. The observable discrete variable, $D_{i,t}$ takes value of *1* if a sovereign debt crisis has started in country *i* in month *t*[34]:

$$D_{i,t} = 1 \qquad \text{if} \qquad D_{i,t}^{*} > 0 \text{ and } 0 \text{ otherwise}$$

The model is defined by the following equation:

$$D_{i,t}^{*} = \beta_0 + \beta_1 X_{i,t-k} + \beta_2 C_{i,t} + \beta_3 B_{i,t} + \beta_4 C_{i,t-1 \text{ to } t-12} + \beta_5 B_{i,t-1 \text{ to } t-12} + \beta_6 C_{i,t-1 \text{ to } t-12}' X_{i,t-k} + \beta_7 B_{i,t-1 \text{ to } t-12}' X_{i,t-k} + \mu_{i,t} \quad (1)$$

and $k = 1, 2, 3, \ldots\ldots$

The vector $X_{i,t-k}$ includes the set of macroeconomic and institutional variables which play a role in influencing sovereign defaults[35]. $C_{i,t}$ and $B_{i,t}$ are dummy variables and represent the onset of currency and banking crises, respectively, and $C_{i,t-1to\ t-12}$ and $B_{i,t-1\ to\ t-12}$ are the composite lagged crises dummies taking the value 1 if currency and/or banking crises occur in the previous twelve-month period[36]. In order to capture the channels through which each crisis affects the sovereign debt crisis, the interaction terms of lagged currency and banking crises with macroeconomic variables, $C_{i,t-1to\ t-12}' X_{i,t-k}$ and $B_{i,t-1\ to\ t-12}' X_{i,t-k}$, are included in the equation.

[34] Throughout the study, we only consider the starting months of crises as crisis events, and exclude the observations following the onset until the end of crisis periods.
[35] Lagging explanatory variables minimizes simultaneity concerns. However endogeneity might still be present. Therefore the reader should be cautious in interpreting the presented results as causal relationships.
[36] The composite lagged crises minimize the multicollinearity problem caused by including multiple lagged crisis dummies in the estimations. Debt crises do not occur immediately following banking and currency crises, therefore the composite lagged crises dummies embrace a one-year period.

The distribution of the error term, $\mu_{i,t}$, is assumed to be stationary normal. The efficient estimation of equation (1) is done by maximum likelihood estimation methods on an unbalanced panel data set composed of 20 emerging economies for the period between January 1985 and December 2007.

4.2 Pooled Probit Estimation Results

The probability of sovereign default represented by equation (1) is estimated by a pooled probit model using maximum likelihood estimation and the results are presented in Table 2. In probit models the estimated coefficients do not give the measure of the change in the conditional mean of the dependent variable given a change in each regressor. Therefore in addition to estimated coefficients and z-statistics, the marginal effects of the probability of a debt crisis with respect to each independent variable are calculated and reported in every column. In presenting the goodness of fit of the estimations, each column contains the log-likelihood, pseudo R-squared, and the percentage of correctly classified crisis and non-crisis observations. In calculating the correctly classified observations, low thresholds of predicted probabilities – greater than 10 percent and 1 per cent – are used to classify a country experiencing a debt crisis. We choose low cut-off points because the debt crisis observations are rather rare in our monthly sample, and raising these thresholds do not increase the correct classification of the non-crisis observations, but cause a significant decrease in the correctly classified crisis observations.

The estimations in column 1 of Table 2 are conducted by using macroeconomic and institutional variables leaving out the crises indicators. The following specifications after column 1 include crises indicators one by one: In column 2 the lagged onset of currency crisis is included, column 3 includes the lagged banking crisis onset, column 4 includes both lagged crises indicators, and the effect of the banking and currency crises occurring in the same period as the sovereign debt crisis is analyzed in column 5[37]. In columns 6 and 7 interaction terms with currency crisis and misaligned exchange rates, and with banking crisis and foreign short-term debt, are included in the estimations.

[37] The potential endogeneity problem due to the simultaneity of three crises is later dealt with joint probability estimations in the second part of empirical section.

Table 2. Pooled Probit Estimation Results of Sovereign Debt Crisis

Variables	(1) Estimates (z-stats) Elasticity	(2) Estimates (z-stats) Elasticity	(3) Estimates (z-stats) Elasticity	(4) Estimates (z-stats) Elasticity	(5) Estimates (z-stats) Elasticity	(6) Estimates (z-stats) Elasticity	(7) Estimates (z-stats) Elasticity
ΔPublic Debt $_{t-4}$	0.100**	0.107**	0.011	0.014	*-0.081*	0.001	*-0.001*
	(2.33)	(2.35)	(0.15)	(0.19)	(-0.85)	(0.01)	(-0.01)
	0.001	0.001	0.0001	0.0001	-0.001	0.00001	-0.00001
Real International Interest Rate $_{t-6}$	0.775**	0.764**	0.830**	0.824**	0.818*	0.814**	0.707*
	(2.54)	(2.52)	(2.45)	(2.42)	(1.93)	(2.31)	(1.91)
	0.008	0.007	0.007	0.007	0.005	0.005	0.006
Real Domestic Interest Rate $_{t-1}$	*-0.076*	*-0.076*	*-0.061*	*-0.062*	*-0.036*	*-0.127*	*-0.094*
	(-0.71)	(-0.70)	(-0.59)	(-0.59)	(-0.30)	(-1.08)	(-0.89)
	-0.001	-0.001	-0.001	-0.001	-0.0002	-0.001	-0.001
Exchange Rate Overvaluation $_{t-1}$	**-2.616****	-2.461**	**-3.321****	-3.251**	-2.847	-2.609*	**-3.869****
	(-2.63)	(-2.19)	(-2.75)	(-2.43)	(-1.58)	(-1.74)	(-2.81)
	-0.026	-0.024	-0.028	-0.027	-0.017	-0.015	-0.030
Current Account Position $_{t-1}$	-0.315	-0.282	-0.196	-0.180	*0.055*	-0.149	*0.398*
	(-1.31)	(-1.08)	(-0.77)	(-0.64)	(0.16)	(-0.48)	(0.78)
	-0.003	-0.003	-0.002	-0.002	0.0003	-0.001	0.003
GDP Growth $_{t-1}$	-0.520**	-0.536**	-0.458*	-0.462*	-0.309	-0.514*	-0.422
	(-2.19)	(-2.19)	(-1.84)	(-1.82)	(-1.10)	(-1.95)	(-1.62)
	-0.005	-0.005	-0.004	-0.004	-0.002	-0.003	-0.003
Short-Term External Debt $_{t-8}$	**0.067****	**0.063****	**0.080****	**0.078****	0.070**	**0.068****	**0.074****
	(3.32)	(2.86)	(3.70)	(3.38)	(2.52)	(2.83)	(3.15)
	0.001	0.001	0.001	0.001	0.0004	0.0004	0.001
Inflation $_{t-1}$	**4.515****	**4.470****	**4.306****	**4.321****	2.320*	**3.916****	**3.846****
	(6.45)	(6.69)	(4.30)	(4.46)	(1.91)	(4.12)	(3.62)
	0.044	0.044	0.036	0.036	0.014	0.022	0.030
Currency Crisis $_{t}$					0.941**		
					(2.02)		
					0.023		
Banking Crisis $_{t}$					**1.756****		
					(4.67)		
					0.123		
Currency Crisis $_{t-1 \text{ to } t-12}$		*-0.296*		*-0.126*		*-1.351*	*-0.108*
		(-0.64)		(-0.28)		(-1.65)	(-0.24)
		-0.002		-0.001		-0.002	-0.001
Banking Crisis $_{t-1 \text{ to } t-12}$			**0.530****	**0.528****		**0.556****	*-0.105*
			(2.63)	(2.63)		(2.81)	(-0.38)
			0.009	0.009		0.007	-0.001
Election $_{t-1}$	0.033	0.030	0.117	0.118	*-0.341*	0.116	0.155
	(0.08)	(0.07)	(0.26)	(0.26)	(-0.75)	(0.26)	(0.35)
	0.0003	0.0003	0.001	0.001	-0.001	0.001	0.001
Political Environment $_{t-1}$	**-0.424****	**-0.444****	**-0.462****	**-0.468****	-0.443**	-0.430**	**-0.490****
	(-2.66)	(-2.70)	(-2.62)	(-2.61)	(-2.11)	(-2.34)	(-2.70)
	-0.004	-0.004	-0.004	-0.004	-0.003	-0.002	-0.004
Market Environment $_{t-1}$	**-0.255****	**-0.262****	**-0.279****	**-0.280****	**-0.386****	**-0.312****	**-0.302****
	(-3.35)	(-3.31)	(-3.08)	(-3.11)	(-3.55)	(-3.75)	(-3.13)
	-0.002	-0.003	-0.002	-0.002	-0.002	-0.002	-0.002
Currency Crisis $_{t-1 \text{ to } t-12}$ X RER $_{t-1}$						**-13.542****	
						(-3.78)	
						-0.185	
Banking Crisis $_{t-1 \text{ to } t-12}$ X St Ext. Debt $_{t-8}$							**0.520****
							(3.36)
							0.028
Pseudo-R^2	0.167	0.169	0.185	0.185	0.256	0.207	0.203
Number of Observations	3211	3199	2962	2954	2754	2954	2954
Log-Likelihood	-125.943	-125.565	-109.790	-109.683	-84.438	-106.727	-107.212

Table 2 continued,

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Goodness of fit (10 percent cutoff)							
% of observations correctly predicted	98.60	98.50	98.72	98.68	98.66	98.61	98.75
% of crises correctly predicted	7.69	7.69	8.70	8.70	31.58	13.04	21.74
% of non-crises correctly predicted	99.34	99.24	99.42	99.39	99.12	99.28	99.35
Goodness of fit (1 percent cutoff)							
% of observations correctly predicted	80.63	81.03	82.58	82.77	87.18	83.18	82.26
% of crises correctly predicted	76.92	76.92	69.57	69.57	68.42	78.26	69.57
% of non-crises correctly predicted	80.66	81.06	82.68	82.87	87.31	83.21	82.36

*Notes: Robust standard errors are clustered by country. The significance levels of the variables are indicated by * (10%), ** (5%) and *** (1%). Counter intuitively signed coefficients are represented in italics. Highly significant coefficients with anticipated signs are represented in bold. The marginal effects are evaluated at the sample mean for continuous variables and for change from zero to one for dummy variables holding all other variables at their mean. In order to convert the marginal effects into percentages they should be multiplied by 100.*

Public debt to GDP ratio enters significantly with a positive coefficient in the first two specifications, indicating that increased indebtedness of central government in the four months prior to the crisis onset increases the probability of sovereign debt crisis. An increase in the monthly real US policy rate increases the default probability in the following six months by about 0.7 percent. This finding confirms the argument of Arora and Cerisola (2001) that a higher US policy rate increases the default risk of emerging economies. Slowing economic growth, higher inflation rate, and high short-term external debt[38] are also highly correlated with future debt crises. Additionally, the significant coefficient of real exchange rate overvaluation shows that exchange rate misalignment precedes the onset of a debt crisis confirming the theoretical findings of Jahjah and Montiel (2003). Generally these results are in line with the empirical findings of Manasse and Roubini (2009) regarding the economic determinants of sovereign defaults. As for the institutional factors, political environment has significant and negative coefficient, confirming the findings of Citron and Nickelsburg (1987), and Balkan (1992) that increased political riskiness of a country increases the probability of sovereign default. A unit decrease in the political environment indicator (meaning an increase in the political riskiness) increases the probability of a sovereign default by about 0.4 percent in the following month. The coefficient of market environment indicates that the negative assessment of the quality of the economic and financial situation of a country increases the debt crisis probability. A unit increase in market riskiness increases the debt crisis probability by around 0.2 percent in the subsequent month.

[38] Confirming Manasse *et al*. (2003) as having high predictive power in explaining debt crises.

The currency crisis occurring in the twelve-month period preceding sovereign default, however, does not have any significant influence on the probability of sovereign default, as shown in columns 2 and 4. Herz and Tong (2008) also find a weak relationship between lagged currency crises and debt crises. A banking crisis, on the other hand, occurring in the twelve-month period prior to a default is estimated to increase the likelihood of a default. It is predicted that a banking crisis starting in any of the previous twelve months prior to debt crisis onset increases debt crisis probability by around 9 percent. This economically important result confirms the finding of Gennaioli *et al.* (2014) for their sample with 20 emerging economies. Additionally, currency crisis and banking crisis occurring in the same month with sovereign default are highly correlated with the probability of a debt crisis which is shown in column 5. The effect of the occurrence of a banking crisis is stronger compared to that of a currency crisis. A banking crisis occurring in the same month with a sovereign default increases the contemporaneous debt crisis probability by 12 percent, whereas a currency crisis increases the contemporaneous debt crisis probability by only 2 percent[39]. The increase in the pseudo R-squared from 17 percent to 26 percent in column 5 also indicates that the contemporaneous banking and currency crises increase the explanatory power of the model significantly. These contemporaneous correlations, however, should be estimated using a system of three equations where each equation representing a crisis onset in order to discover whether common unobservable factors causing these three crises occurring jointly.

The incidence of a currency or banking crisis possibly increases the probability of a sovereign debt crisis in the presence of economic fragilities. Therefore in order to analyze the indirect links from prior banking and currency crises to sovereign debt crisis, the interaction effects of the lagged currency crises with misaligned exchange rates[40] and lagged banking crises with global illiquidity are introduced into the estimations. Columns 6 and 7 present the results with the interaction terms using the specification in column 4[41]. The interpretation of the interaction terms is different

[39] Bordo and Meissner (2005) also find that on average contemporaneous currency crisis increases debt crisis probability by 3 percent.

[40]Another indirect link from currency crisis to sovereign default might be through the high foreign indebtedness of a country. If a country is internationally illiquid, this might increase the default risk following currency depreciation. We analyse this indirect link by including the interaction of the lagged currency crisis dummy with short-term external debt. However, the term does not enter significantly into the estimations. The reason might be that this variable also includes the domestic currency-denominated external debt as well as foreign currency debt.

[41] The contemporaneous occurrence of banking and currency crises are not included in these estimations since simultaneity might lead to biased results in the estimations.

compared to the other regressors in the estimations. The magnitude and the significance of the terms change for each observation. Therefore we calculate the marginal effects and z-statistics of each interaction term at their mean, minimum and maximum levels for each observation and present them in Table 3.

Besides the direct influence of the appreciated real exchange rates, the indirect effect of this indicator on the sovereign default probability is emphasized in the literature. Jahjah and Montiel (2003) show the contribution of overvalued exchange rates on the sovereign default probability. Additionally, Jahjah *et al.* (2012) mention in their study that misaligned exchange rates corrected by a currency crisis might lead to sovereign default due to the resulting currency mismatch in the government's balance sheet. The interaction between lagged currency crisis onset and overvalued real exchange rates investigates this effect in column 6 of Table 2. The term enters significantly and that shows that appreciated real exchange rates coupled with a currency crisis increase the sovereign debt crisis probability. Table 3 indicates that the mean interaction effect is negative and for most of the observations the marginal effect is negative and significant and this supports the theoretical literature.

High short-term foreign debt to foreign exchange reserves indicates that the country has international illiquidity problems which might lead to a bank run, according to Diamond and Dybvig (1983). The historical graphical observations by Reinhart and Rogoff (2011) link this finding to debt crisis by showing that short-term foreign debt levels aggravate in the phase of a banking crisis and are immediately followed by sovereign debt crises. Since the illiquidity of the country spreads the vulnerability of the banking system to the government because of the costly bail-outs, it is expected that in a country facing illiquidity, a banking crisis might lead to sovereign default. The interaction term of lagged banking crisis with short-term external debt over foreign exchange reserves tests for this relation. The results in column 7 of Table 2 point out that the term is significant and positive, indicating that the probability of a sovereign debt crisis increases if the international illiquidity of the country is accompanied by a banking crisis prior to a default. A unit increase in the short-term external debt ratio in the presence of banking crisis raises the default probability by 2.8 percent on average which represents a significant economic effect compared to the individual effect of this variable on future debt crisis probability.

Table 3. Marginal Effects of the Interaction Terms

Interaction Terms	Mean (z-stats)	Min (z-stats)	Max (z-stats)
Currency Crisis $_{t-1 \text{ to } t-12}$ X Exchange Rate Overvaluation $_{t-1}$	-0.185	-6.362	0.733
	(-0.66)	(-5.64)	(4.54)
Banking Crisis $_{t-1 \text{ to } t-12}$ X Short-term External Debt $_{t-8}$	0.028	-0.020	0.235
	(1.38)	(-2.12)	(6.78)

Notes: The marginal effects of the interactions terms are calculated with the "inteff" command (Norton et al., 2004) in STATA 13.

The model, on average, have 20 percent pseudo R-squared which is a reasonable fit. However compared to Manasse *et al.* (2003) its success is somewhat lower in explaining the debt crisis. The reasons might be due to the fact that our models have monthly observations with a large number of tranquil periods and we do not include as extensive a set of explanatory variables as Manasse *et al.* (2003)[42]. The goodness of fit measure for the percentages of correct predictions represents a loose predictive power of the crisis variable if the threshold is set to 10 percent in defining a crisis, which is around 8 percent for the crisis months. The correct crisis prediction of the model increases to 32 percent once the contemporaneous currency and banking crises dummies are included, suggesting that these two crises variables are important in improving the model's prediction of default probability. When the threshold is set to 1 percent, the model predicts 68 – 78 percent of the actual crisis episodes and 81 – 87 percent of the actual non-crisis episodes correctly depending on the specification. This represents a relatively successful fit of the model to the data. These results are analogous to similar studies in the empirical literature for the overall prediction of observations[43].

The findings of Table 2 confirm the results of previous literature that besides solvency and liquidity, which are the two main indicators of sovereign debt crisis, worsening domestic economic activity, misaligned exchange rates and rise in the world interest rates increase the probability of sovereign default. Apart from these results, the political and institutional environment, which indicate the willingness to pay of debtor country, and the contemporaneous occurrence of currency

[42] Our results also have lower fits compared to other yearly studies as Gennaioli *et al.* (2014), and Bordo and Meissner (2005).

[43] Since every study sets a different threshold for crisis prediction, it is difficult to compare these percentages exactly with other studies. Bordo and Meissner (2005) also set their threshold to 1 percent and they have a high percentage of actual crises correctly predicted by their model. Our model is more successful in predicting non-crisis observations. The reasons might be the higher frequency data in our study and different sample coverages.

and banking crises and lagged banking crises are also among the significant determinants of debt crisis.

We also test the performance of the model by re-estimating the model with the sample until the end of 1995 and generating out-of-sample predictions for the observations after the year 1995. The estimates for the sub-sample with observations until 1995 are used to generate the predictions of the subsample for the years after 1995. Table 4 shows the percentage of the correct predictions of the observations from 1996 onwards. Once again, for classifying a crisis observation we use the same thresholds that if the predicted value of the dependent variable exceeds 10 and 1 percent it is considered as a crisis observation[44].

Table 4. Out of Sample Predictions for the sample after 1995

Goodness of fit (10 percent cutoff)		Goodness of fit (1 percent cutoff)	
% of observations correctly predicted	98.62	% of observations correctly predicted	83.52
% of crises correctly predicted	15.38	% of crises correctly predicted	38.46
% of non-crises correctly predicted	99.14	% of non-crises correctly predicted	83.80

The out-of-sample predictions with the 10 percent cut-off value perform poorly in predicting crisis observations. Two out of 13 crisis observations[45] are predicted by the model while only 18 observations are diagnosed incorrectly as crisis observations (type 1 error is 0.86 percent). Setting a lower cut-off value increases the correctly predicted crisis observations to 5, although it decreases the percentage of correct non-crisis observations predicted by the model. The crises in Argentina (2001), Brazil (1996), Colombia (1999), Ecuador (1999) and Russia (1998) are correctly predicted. The lower threshold, on the other hand, increases type 1 errors to 16.20 percent. The predictions are fairly accurate given the low number of crisis observations and high number of tranquil periods in our sample.

[44] Predictions are based on the estimations of specifications in column 1 of Table 2.
[45] Argentina (2001) and Russia (1998) crises are diagnosed correctly.

4.3 Sensitivity Analyses

In this part, we present the results of the robustness checks of the specifications in Table 2 to changes in estimation methods and an alternative definition of currency crises. Firstly, we consider the rare nature of the crisis events. Monthly data limits the actual crises observations to a small number leading to a large number of non-crises observations compared to crises observations in the sample. This might lead to a bias in the pooled probit estimations. Therefore the specifications in Table 2 are estimated with the rare events logit[46] estimator which corrects the data in the presence of the rare realizations of the dependent variable. The results are presented in Appendix C, Table C1. Apart from the insignificant interaction term of lagged currency crises with misaligned exchange rates, the results confirm the pooled probit estimations.

Another concern is that macroeconomic and institutional variables included in the analyses may not control for all the country-specific characteristics existing in the models estimated. These unobservable country effects might lead to biased results of the pooled probit estimations. The fixed-effects model assumes that the individual characteristics of each country are correlated with the regressors and eliminates the time-invariant characteristics from the predictor variables. Since fixed-effects probit model cannot be consistently estimated, the above specifications in Table 2 are estimated with the conditional logit model[47] (Chamberlain, 1980) taking into account the fixed country effects[48]. The results of the re-estimation of the specifications in Table 2 by conditional logit model are presented in Appendix C, Table C2. GDP growth and political environment have lower significance while the signs of their coefficients remain robust. Lagged banking crises together with contemporaneous banking and currency crises enter significantly as in the previous estimations. Additionally, the significant interaction terms of lagged currency crises with deviation of real exchange rate from trend, and prior banking crises with foreign illiquidity in columns 6 and 7, confirm the probit estimation results.

[46] The details of the estimation technique are explained in King and Zeng (2001).
[47] The conditional logit is the probability which is conditional on the number of the matched set. The intercept is different for each set and is not estimated by the model. Therefore, the predicted probabilities cannot be estimated, making the reader rely on the marginal effects and the percentage of correct predictions resulting from the pooled probit estimations.
[48] The joint significance of the fixed-time effects are also tested resulting in a failure in rejecting the null that all month coefficients are jointly equal to zero. Therefore they are not included in the specifications.

As the last part of the sensitivity analysis we use the exchange market pressure (EMP) index to define the onset of a currency crisis. This definition is commonly used in the empirical literature focusing on financial crisis and it allows the inclusion of not only the successful attacks to the currency, but also unsuccessful attacks where the domestic currency is defended at the expense of a large decrease in the foreign exchange reserves. Also this index brings the advantage of including currency crises occurred under both flexible and fixed exchange rate regimes. First developed by Eichengreen *et al.* (1996), in this study we construct the index by taking the weighted[49] average of changes in the exchange rates and foreign exchange reserves[50]. For every country in the sample, a particular month is defined as a crisis month if the index exceeds two standard deviations of its country specific mean[51]. Any crisis in the twelve-month window following the crisis onset is considered as the continuation of the initial crisis and excluded from the sample. The specifications in Table 2, where currency crisis and its interaction are included as explanatory variables, are estimated with the alternative currency crises onset using the pooled probit model and the results are presented in Appendix C, Table C3. The results show that neither lagged nor contemporaneous currency crises help in explaining sovereign defaults, nor does the interaction of currency crises with misaligned exchange rates. The other variables have same effect on the probability of debt crises. In general, the models with alternative currency crisis definitions predict a higher percentage of correct crisis periods, though once again the specifications are more successful in predicting non-crisis observations.

The results from this section point out that the main conclusions do not differ substantially with changes in the estimation methods and currency crisis definition. Similar to the main results, currency crisis onset defined by the EMP index does not significantly increase future debt crisis probability. But under this definition, a contemporaneous currency crisis does not increase the likelihood of a debt crisis either. Generally, we see that the effects of macroeconomic and institutional variables on debt crisis probability are robust to changes in estimation methods and currency crisis definition.

[49] Weights are applied to make the sample volatilities of the two components of the index similar.
[50] Following Kaminsky and Reinhart (1999), we also exclude the changes in the domestic interest rate since this data is not available for every country for the whole sample period.
[51] Hyperinflation periods are handled differently: The sample is divided into subsamples if the inflation in the previous six months exceeds 150 percent and the calculation is done separately for the subsamples.

5. EMPIRICAL RESULTS: DEBT, BANKING AND CURRENCY CRISES

So far our focus has been on the sovereign debt crisis and its determinants. In this part of the empirical analysis we focus firstly on the role of sovereign default in predicting future banking and currency crises, and secondly on the probability of the joint occurrence of the three crises. Initially the lagged effects of sovereign default on the probability of currency and banking crises are analyzed by estimating two separate models for currency and banking crises with a lagged debt crisis indicator included along with other determinants of these crises. Secondly, the simultaneity of the three crises models is handled with joint estimation of a three-equation system applying a multivariate probit model using maximum simulated likelihood estimation.

5.1 Debt Crisis as a Determinant of Currency and Banking Crises

The theoretical studies mentioned before also suggest that an initial debt crisis might lead to a currency and/or banking crisis. Some empirical studies look at these reverse causalities from debt crises to currency crises[52] or to banking crises[53] and their findings, outlined in this paper, are mixed. In order to analyze the predictive power of sovereign default occurring prior to banking and currency crises, we estimate the banking and currency crises models including the composite lagged occurrence of sovereign default in the previous twelve-month period together with the macroeconomic and institutional indicators[54].

The results, indicated in Table 5 suggest that debt crises do not significantly increase the likelihood of future banking and currency crises[55]. For the currency crisis, the result confirms the findings of Reinhart (2002). She also does not find any significant relationship between lagged debt crises and currency crises. For the banking crisis, the result is analogous to those of Reinhart and Rogoff (2011), and Borensztein and Panizza (2009). Thus we can conclude that the expected reverse relationship between debt crises and currency/banking crises suggested by the theoretical literature is not supported empirically.

[52] Reinhart (2002), Dreher *et al.* (2006), and Herz and Tong (2008).
[53] Reinhart and Rogoff (2011), and Borensztein and Panizza (2009).
[54] Once more we use the general-to-specific approach to determine the appropriate lag structure of the regressors.
[55] For the currency crisis equation, we also check the robustness of the results with using the EMP index to define a currency crisis. The results, available upon request, do not differ from the ones presented in Table 5.

Table 5. Pooled Probit Estimation Results of Currency and Banking Crises Models

Variables	Estimates (z-stats) Elasticity	Variables	Estimates (z-stats) Elasticity
Dependent Variable: Currency Crisis Onset		Dependent Variable: Banking Crisis Onset	
Debt Crisis $_{t-1 \text{ to } t-12}$	0.227	Debt Crisis $_{t-1 \text{ to } t-12}$	-0.084
	(0.65)		(-0.14)
	0.001		-0.000
Real International Interest Rates $_{t-1}$	*-0.036*	Exchange Rate Overvaluation $_{t-1}$	-3.176**
	(-0.07)		(-2.36)
	-0.0001		-0.014
Exchange Rate Overvaluation $_{t-1}$	-2.412**	Capital Account Openness $_{t-1}$	-0.094
	(-2.23)		(-0.81)
	-0.009		-0.001
Current Account Position $_{t-1}$	-1.318	Current Account Position $_{t-1}$	-1.879
	(-1.26)		(-1.23)
	-0.005		-0.008
Stock Prices $_{t-3}$	**-2.363*** **	Inflation $_{t-6}$	**7.732*** **
	(-2.96)		(2.65)
	-0.009		0.033
Capital Account Openness $_{t-1}$	*-0.009*	Stock Prices $_{t-2}$	-2.014**
	(-0.10)		(-2.17)
	-0.000		-0.009
Δ Public Debt $_{t-1}$	0.224**	Δ Public Debt $_{t-6}$	**0.345*** **
	(2.47)		(2.89)
	0.001		0.001
GDP Growth $_{t-1}$	-0.263	GDP Growth $_{t-1}$	**-0.711*** **
	(-1.19)		(-2.64)
	-0.001		-0.003
Δ Domestic Credit by Banking Sector $_{t-3}$	**0.487*** **	Election $_{t-1}$	**1.131*** **
	(4.46)		(4.15)
	0.002		0.026
Election $_{t-1}$	0.503	Real International Interest Rate $_{t-4}$	0.370**
	(1.22)		(2.30)
	0.004		0.002
Political Environment $_{t-1}$	-0.052	Real Domestic Interest Rate $_{t-1}$	-0.030
	(-0.28)		(-0.22)
	-0.000		-0.000
Market Environment $_{t-1}$	-0.032	Δ Domestic Credit to Private Sector $_{t-1}$	0.155
	(-0.21)		(0.78)
	-0.000		0.001
		Political Environment $_{t-1}$	*0.188**
			(1.74)
			0.001
		Market Environment $_{t-1}$	*0.377**
			(1.77)
			0.002
Pseudo-R^2	0.235	Pseudo-R^2	0.278
Number of Observations	2922	Number of Observations	2364
Log-Likelihood	-67.927	Log-Likelihood	-61.948

*Notes: Robust standard errors are clustered by country. The significance levels of the variables are indicated by * (10%), ** (5%) and *** (1%). Counter intuitively signed coefficients are represented in italics. Highly significant coefficients with anticipated signs are represented in bold. The marginal effects are evaluated at the sample mean for continuous variables and for change from zero to one for dummy variables holding all other variables at their mean. In order to convert the marginal effects into percentages they should be multiplied by 100.*

5.2 Simultaneity of Debt, Currency and Banking Crises

The contemporaneous correlations between currency/banking crises and sovereign defaults established in the earlier part of our empirical analysis raise the question of whether these crises are jointly determined by common fundamentals. In this section, we apply the method of maximum smoothly simulated likelihood estimation in order to jointly estimate the three crises equations. Initially developed by Börsch-Supan and Hajivassiliou (1993), this method uses Geweke-Hajivassiliou-Keane (GHK)[56] simulation to calculate the high dimensional normal integrals in the likelihood function resulting from estimating a system of three equations. Each replication calculates a likelihood contribution for every observation. These generated values from each replication are averaged to calculate the simulated likelihood contribution. After this, the standard maximum likelihood method is used to maximize the simulated likelihood function for the whole sample. This method provides asymptotically efficient simulation-based estimation for the banking, currency and sovereign debt crises models by computing the high dimensional integrals that define the joint probabilities in the likelihood function. The estimated extra parameter, ρ *(rho),* measures the correlation of the error terms between the three equations and addresses the endogeneity of three crises models that they might be caused by common unobservable factors. Since there are three equations, three correlation coefficients are estimated. The first one is the correlation coefficient between the error terms of sovereign debt and banking crises equations, the second one is between banking and currency crises and the last one is the correlation coefficient between debt and currency crises.

The estimation results of the multivariate probit model are represented in Table 6. For the sovereign debt crisis equation, we use the specification in column 1 of Table 2, and for currency and banking crises we use the specifications in Table 5, excluding the lagged debt crisis indicator. The estimated correlation coefficients between the models are presented in the lower part of Table 6. The results indicate that the correlation coefficient of the error terms between the sovereign default and the banking crisis equations is significant. This suggests that the unobservable factors that affect the probability of a sovereign default also influence the probability of a banking crisis. Thus these two crises are endogenous and jointly determined by common factors. On the other

[56] See Greene (2003) for further explanation.

hand, the multivariate estimation fails to find any significant correlation of the error terms between banking and currency crises, and between debt and currency crises. The likelihood ratio test for the joint probability of the three crises occurring at the same month fails to reject the null of zero correlation between the error terms of the three crises equations. Therefore with multivariate probit analysis we only evidence the joint occurrence of banking and sovereign debt crises in the same month[57].

Table 6. Multivariate Probit Estimation Results for Banking, Currency and Debt Crises

Dependent Variable: Sovereign Default	Estimates (z-stats)	Dependent Variable: Banking Crisis	Estimates (z-stats)	Dependent Variable: Currency Crisis	Estimates (z-stats)
ΔPublic Debt $_{t-4}$	0.011	ΔPublic Debt $_{t-6}$	0.279	ΔPublic Debt $_{t-1}$	0.314**
	(0.06)		(1.32)		(2.23)
Real Inter. Interest Rate $_{t-6}$	0.947**	Real Intern. Interest Rate $_{t-4}$	0.298*	Real Inter. Interest Rate $_{t-1}$	*-0.246*
	(2.16)		(1.75)		(-0.42)
Real Dom. Interest Rate $_{t-1}$	0.043	Real Dom. Interest Rate $_{t-1}$	*0.002*	ER Overvaluation $_{t-1}$	-1.361
	(1.50)		(0.02)		(-0.85)
ER Overvaluation $_{t-1}$	-4.307**	ER Overvaluation $_{t-1}$	-3.122**	Current Account Pos. $_{t-1}$	-1.895
	(-2.39)		(-2.02)		(-1.30)
Current Account Pos. $_{t-1}$	*0.213*	Current Account Pos. $_{t-1}$	-1.148	GDP Growth $_{t-1}$	-0.683
	(0.30)		(-0.70)		(-1.50)
GDP Growth $_{t-1}$	-0.357	GDP Growth $_{t-1}$	-0.791**	Election $_{t-1}$	0.653
	(-1.17)		(-2.35)		(1.57)
Inflation $_{t-1}$	*-1.771*	Inflation $_{t-6}$	6.743**	Political Env. $_{t-1}$	-0.340
	(-0.29)		(2.37)		(-1.24)
Election $_{t-1}$	0.276	Election $_{t-1}$	**1.098****	Market Env. $_{t-1}$	-0.032
	(0.69)		(3.19)		(-0.25)
Political Env. $_{t-1}$	-0.454	Political Env. $_{t-1}$	*0.367**	Stock Prices $_{t-3}$	-1.676
	(-1.42)		(1.74)		(-1.56)
Market Env. $_{t-1}$	**-0.457****	Market Env. $_{t-1}$	*0.366*	KA Openness $_{t-1}$	0.029
	(-2.65)		(1.52)		(0.20)
St External Debt $_{t-8}$	0.072**	Stock Prices $_{t-2}$	**-2.634****	ΔDomestic Credit $_{t-3}$	0.316*
	(2.52)		(-2.82)		(1.90)
		KA Openness $_{t-1}$	-0.222		
			(-1.50)		
		ΔDom. Crd. to Prv. Sect. $_{t-1}$	0.077		
			(0.40)		
Number of Observations	1926				
Rho (12)	0.550***	Rho (23)	0.325	Rho (13)	0.006
Likelihood ratio test of rho (12) = rho (23) = rho (13) = 0: chi2(3) = 4.709 Prob > chi2 = 0.194					

*Notes: The estimation is conducted by using the "mvprobit" command for STATA 13 written by Cappellari and Jenkins (2003) applying 50 number of draws in calculating the simulated likelihood. Robust standard errors are clustered by country. The significance levels of the variables are indicated by * (10%), ** (5%) and *** (1%). Counter intuitively signed coefficients are represented in italics. Highly significant coefficients with anticipated signs are represented in bold. Calculation of marginal effects is not straightforward in multivariate probit models. Hence the reader should rely on the elasticities of single equation probit estimations.*

[57] This result has also been checked by applying bivariate probit estimation between banking and debt crises equations. Confirming the above finding, the unpublished results indicate a correlation coefficient between the two equations equal to 0.652 which is significant at 5 percent level.

6. CONCLUSION

This study provides high frequency empirical analysis on the determinants of sovereign debt crises and the probability of triple – banking, currency and debt – crises in emerging economies. We include 20 countries from January 1985 until December 2007 in our sample. Initially, we analyze the determinants of sovereign debt crises. Macroeconomic and institutional indicators, together with the indicators of currency and banking crises and their influence on the likelihood of sovereign defaults, are investigated. In uncovering indirect links, we include the interactions of international illiquidity with banking crises and overvalued exchange rates with currency crises. Following these estimations, we analyze the contribution of lagged sovereign defaults on the likelihood of currency and banking crises. Finally, the simultaneity of debt, currency and banking crises is investigated by jointly estimating these three types of crises models using a multivariate probit approach.

The empirical literature gains important insights from the results of this study. Firstly, banking and debt crises tend to occur in the same month that sovereign debt crisis significantly raises the probability of a contemporaneous banking crisis, and vice versa. There is also strong evidence that an initial banking crisis increases the future sovereign default risk. However, initial sovereign defaults do not increase the banking crises likelihood. This finding is in line with the results of Reinhart and Rogoff (2011). They also find that lagged and contemporaneous banking crises help in predicting sovereign defaults in a single equation setting[58]. As for the relationship between currency and banking crises, we fail to find any relationship between the lagged onset of currency crises and sovereign defaults, and vice versa. The significant contemporaneous relationship between currency crises onsets and debt crises in single equation estimations is not confirmed in the multivariate probit analysis. This result shows the importance of the joint estimation analysis in establishing the linkages between different crises types.

Additionally, this study discovers some indirect effects of currency and banking crises on sovereign defaults through the worsening of macroeconomic variables. Currency crisis gives rise

[58] Gennaioli *et al.* (2014) and Babecký *et al.* (2012) also find a strong relationship between lagged banking crises and sovereign defaults. Babecký *et al.* (2012) and Borensztein and Panizza (2009) also fail to find any relationship between lagged defaults and banking crises.

to debt crisis probability through appreciated real exchange rates, confirming the results of Jahjah and Montiel (2003, 2012). International illiquidity – proxied by the ratio of short-term foreign debt to reserves – indirectly increases default probability if a banking crisis happens prior to a sovereign default. This result is in line with the theoretical model of Arellano and Kocherlakota (2008). As for the determinants of sovereign defaults, our results follow the previous empirical evidence. We find that both macroeconomic indicators and the quality of institutions are important determinants of sovereign defaults, apart from the banking crises onset. Sovereign defaults are more likely in countries where the public sector is highly indebted, the short-term foreign debt to reserve ratio is large, the inflation rate is rising, the real exchange rates are overvalued, there is exposure to elevated international interest rates, the growth rate of GDP is falling, and the institutional and political environments are highly risky.

The main conclusion that can be derived from this study is that banking sector problems go hand in hand with sovereign problems. The costs of financial sector crises to an economy are substantial. These costs can directly damage the fiscal budget through rescue plans or degraded tax revenues. Additionally, the economic downturn following the banking crisis itself indirectly increases the fiscal burden and decreases government income through unemployment and output costs. Governments should be careful in using fiscal policies during financial crises since, as argued by Baldacci and Gupta (2009), even in favorable external environments, banking crises are detrimental for the government deficit and hence for government debt. This is clearly demonstrated by this empirical analysis with banking crises, rising external and central government debts, and slowdowns in the growth rate of output prior to defaults. On the other hand, a highly indebted government might threaten the stability of the financial system and the result might be both banking and debt crises occurring jointly. Government solvency involves a high degree of uncertainty. A coordinated, sudden stop by foreign investors anticipating a default increases the costs of funding for the government, and hence puts pressure on the domestic financial sector. Where government relies heavily on the domestic financial sector, such as in the emerging economies, this “coordination failure” results in simultaneous debt and banking crises.

The consistency of government and the central bank in implementing their policies is crucial whether the two crises occur simultaneously or default is led by banking crisis. Unsustainable

fiscal and monetary policies might change the perception of the foreign creditors, and crisis anticipation leads them to pull their funds out of the country leaving both financial sector and government in crisis. Similarly, any loss of trust in the domestic financial sector might cause a panic in the markets, leading to a financial crisis, while the resulting economic downturn cannot be cushioned by a highly indebted government relying on the domestic financial sector for its solvency. To avoid these cases, government should focus on strengthening the growth potential of the economy and improving the fiscal budget balance. Monetary policy should support fiscal policy to sustain the markets' trust in the economy. Our finding also implies that as long as the financial sector is sound, the government postpones the default decision. In this sense, the results not only explain the default decisions by emerging economies, but also provide some insights in explaining the current sovereign debt crisis in advanced economies.

APPENDIX A: CRISES DATES

Table A1.Debt, Banking and Currency Crisis Dates between 1985 and 2007

Country	Debt Crisis	Currency Crisis	Banking Crisis
Argentina	September 1986 January 2001	January 2002	December 1989 January 1995 November 2001
Bolivia	September 1985 April 1993 April 1997 February 2000		September 1986 November 1994
Brazil	September 1989 January 1993 December 1996	January 1999 October 2002	February 1990 December 1994
Chile	December 1985 January 1988		
China		July 1986 December 1989 January 1994	November 1998
Colombia	July 1987 March 1990 June 1999		June 1998
Dominican Republic	March 1990 November 1993 April 2004	June 1987 April 1990	April 2003
Ecuador	February 1987 September 1992 April 1999	December 1985 September 1992	August 1998
India		July 1991	September 1993[59]
Indonesia	October 1997 April 2002	September 1986 August 1997	November 1997
Jamaica	August 1986 April 1988 April 1992		December 1996
Korea	August 1997	December 1997	August 1997
Malaysia		December 1997	July 1997
Mexico	June 1985 December 1994	December 1994 September 1998	December 1994

[59] The starting month is taken from Khan (2011) as the forced merger between New Bank of India and Punjab National Bank due to increased problems of New Bank of India.

Table A1., continued

Country	Debt Crisis	Currency Crisis	Banking Crisis
Paraguay	May 1986	March 1989	December 1986
	February 2003	June 2002	May 1995
Philippines	February 1985	September 1997	July 1997
	October 1986		
	April 1987		
	June 1988		
	July 1990		
Russia	January 1991	September 1998	August 1998
	January 1992		
	August 1998		
Thailand		July 1997	July 1997
Turkey	July 1998	February 2001	November 2000
Uruguay	September 1985		January 2002
	March 2003		
Venezuela	January 1986	December 1986	January 1994
	December 1988	February 2002	
	January 1994		
	January 2005		

APPENDIX B: DATA DESCRIPTIONS

Macroeconomic Variables:

1. Public Debt over GDP: Yearly ratios of the gross central government debt over GDP taken from Reinhart and Rogoff (2009), linear interpolation, levels. Source: The data is extracted from the website: < http://www.carmenreinhart.com/data/browse-by-topic/topics/9/ >
2. Short-term External Debt Position: Yearly ratios of short-term external debt of a country to non-gold reserves, converted into monthly observations by linear interpolation, levels. Source: World Bank, World Development Indicators (WDI) (short-term external debt) and IMF, International Financial Statistics (IFS), line 1.L.D (non-gold reserves).
3. Current Account Position: The monthly difference between a country's exports and imports, converted into dollars and divided by non-gold reserves, levels. Source: IFS, lines 70.D, 71.D, RF and 1LD.
4. Exchange Rate Overvaluation: The deviation of real exchange rate from the trend which is calculated using Hodrick-Prescott filter with a parameter of 129,000. Source: IFS, lines RF and 64.
5. The Growth Rate of GDP: The monthly growth rate of the nominal GDP of a country in local currency, linear interpolation. Source: World Bank, WDI.
6. Real Domestic Interest Rates: Monthly money market interest rates subtracted from inflation rate expressed in percentage changes. Source: IFS, lines 60B and 64.
7. Inflation Rate: The percentage change in the consumer price index. Source: IFS, line 64.
8. Real International Interest Rates: US Federal Funds Rates subtracted from inflation rate of US taken in percentage changes. Source: IFS, line 60B.
9. Stock Prices: The monthly percentage change in the Share Prices. Source: IFS, line 62.
10. Capital Account Openness Index: The Chinn-Ito Index (Chinn and Ito, 2006) measuring a country's degree of financial openness. Source: Extracted from the website < http://web.pdx.edu/~ito/ >
11. Domestic Credit by Banking Sector: The ratio of domestic credit provided by banking sector to GDP, linear interpolation. Source: World Bank, WDI.
12. Domestic Credit to Private Sector: The ratio of domestic credit to the private sector to GDP, linear interpolation. Source: World Bank, WDI.

Institutional and Political Variables:

1. The parliamentary and presidential election dates are taken from Election Guide website of the Consortium for Elections and Political Process Strengthening (CEPPS): http://www.electionguide.org/
2. Financial Risk Rating is an assessment of a country's ability to pay its way by financing its official, commercial and trade debt obligations. Taken from ICRG of Political Risk Services (PRS) Group.
3. Economic Risk Rating assesses the country's current economic strengths and weaknesses. Taken from ICRG of PRS Group.

4. Government Stability measures the government's ability to carry out its declared programs and its ability to stay in office. Taken from ICRG of PRS Group.
5. Bureaucracy Quality assesses the strength and quality of the bureaucracy in the political system. Taken from ICRG of PRS Group.
6. Law and Order assesses the strength of the legal system and observance of law. Taken from ICRG of PRS Group.
7. Investment Profile assesses the factors that influence the risk to investment. Taken from ICRG of PRS Group.
8. Democratic Accountability assesses how responsive the government is towards its people. Taken from ICRG of PRS Group.

Table B1. Rotated Factor Loadings of Institutional Variables

	Factor 1 Political Environment	Factor 2 Market Environment	Uniqueness
Financial Quality	0.488	**0.658**	0.329
Economic Quality	0.510	**0.644**	0.324
Government Stability	0.014	**0.849**	0.281
Investment Profile	0.228	**0.773**	0.351
Bureaucracy Quality	**0.841**	0.220	0.244
Law and Order	**0.793**	0.246	0.311
Democratic Accountability	**0.803**	0.061	0.351
Variance Explained	0.362	0.325	

Notes: The factor analysis is conducted in STATA 13 based on principal-component method. All institutional variables are lagged one-month. Orthogonal varimax rotation is implemented to generate uncorrelated factor loadings by maximizing the variance of the squared loadings within factors. The relevant variable per factor is indicated in bold. The two factors explain 68.7% of the total variance in the indicators.

Table B2. Correlation Coefficients

	Debt Crisis	Currency Crisis	Banking Crisis	ΔPub. Debt	Real Int. Int Rates	Real Dom. Int. Rates	ER Over.	CA Pos.	GDP Growth
Debt Crisis	1.000								
Currency Crisis	-0.005	1.000							
Banking Crisis	0.169	0.102	1.000						
ΔPublic Debt	0.029	0.060	0.021	1.000					
Real Int. Interest Rates	-0.001	-0.014	-0.011	-0.053	1.000				
Real Dom. Interest Rates	0.004	-0.005	0.004	0.001	0.012	1.000			
ER Overvaluation	-0.057	-0.060	-0.085	0.012	0.043	-0.002	1.000		
CA Position	-0.073	-0.043	-0.012	-0.147	0.014	0.018	0.051	1.000	
GDP Growth	-0.049	-0.067	-0.058	-0.287	0.035	0.065	0.071	0.048	1.000
St External Debt	0.088	0.047	-0.007	0.118	-0.028	-0.010	-0.053	-0.552	-0.132
Inflation	-0.001	-0.050	-0.009	0.042	-0.021	0.008	0.036	-0.155	0.167
Election	0.023	0.035	0.104	0.024	-0.008	-0.005	-0.034	-0.024	-0.037
Stock Prices	-0.017	-0.057	-0.028	0.008	-0.036	0.164	0.044	-0.053	0.049
KA Openness	0.042	-0.008	-0.031	-0.099	0.018	0.059	-0.112	0.259	-0.169
Δ Domestic Credit	-0.011	0.043	-0.007	0.175	-0.005	-0.014	-0.180	-0.076	-0.051
Δ Priv. Sector Dom. Cr.	-0.029	-0.011	-0.033	-0.024	-0.002	-0.007	-0.179	-0.035	0.108
Political Environment	-0.026	-0.027	-0.001	-0.042	0.007	-0.020	0.017	-0.112	0.111
Market Environment.	-0.081	-0.014	-0.001	-0.042	0.034	0.037	-0.033	0.474	0.210

	St Ext. Debt	Inflation	Election	Stock Prices	KA Openness	ΔDom. Credit	Δ Priv. Dom. Cr.	Polit. Env.
Debt Crisis								
Currency Crisis								
Banking Crisis								
ΔPublic Debt								
Real Int. Interest Rates								
Real Dom. Interest Rates								
ER Overvaluation								
CA Position								
GDP Growth								
St External Debt	1.000							
Inflation	0.110	1.000						
Election	0.065	-0.010	1.000					
Stock Prices	0.141	0.064	0.026	1.000				
KA Openness	-0.116	-0.277	0.018	-0.045	1.000			
Δ Domestic Credit	-0.063	-0.017	-0.022	-0.012	0.014	1.000		
Δ Priv. Sector Dom. Cr.	-0.066	-0.012	-0.019	-0.012	0.081	0.847	1.000	
Political Environment	0.056	0.025	0.022	0.003	0.364	-0.006	-0.029	1.000
Market Environment.	-0.508	-0.202	-0.058	-0.069	0.041	0.045	0.065	-0.235

APPENDIX C: RESULTS OF SENSITIVITY ANALYSES

Table C1. Rare Events Logit Estimation Results of Sovereign Debt Crises

Variables	(1) Estimates (z-stats)	(2) Estimates (z-stats)	(3) Estimates (z-stats)	(4) Estimates (z-stats)	(5) Estimates (z-stats)	(6) Estimates (z-stats)	(7) Estimates (z-stats)
ΔPublic Debt $_{t-4}$	**0.250*****	**0.250*****	0.073	0.074	*-0.094*	0.059	0.037
	(2.80)	(2.67)	(0.48)	(0.46)	(-0.47)	(0.35)	(0.21)
Real International Interest Rate $_{t-6}$	**1.878*****	1.854**	**2.085*****	2.084**	2.362**	2.026**	1.875**
	(2.59)	(2.50)	(2.58)	(2.53)	(2.03)	(2.35)	(1.98)
Real Domestic Interest Rate $_{t-1}$	0.031	0.037	0.051	0.048	0.191	*-0.319*	*-0.098*
	(0.11)	(0.13)	(0.20)	(0.19)	(0.64)	(-1.05)	(-0.37)
Exchange Rate Overvaluation $_{t-1}$	-6.205**	-5.952*	-8.073**	-8.095*	-6.781	-6.594	-9.705**
	(-2.16)	(-1.70)	(-2.23)	(-1.94)	(-1.33)	(-1.46)	(-2.42)
Current Account Position $_{t-1}$	-1.011*	-0.964	-0.683	-0.683	-0.099	-0.548	*0.355*
	(-1.95)	(-1.63)	(-1.12)	(-1.00)	(-0.11)	(-0.71)	(0.31)
GDP Growth $_{t-1}$	-1.215**	-1.224*	-1.006	-0.994	-0.514	-1.009	-0.932
	(-2.00)	(-1.94)	(-1.63)	(-1.58)	(-0.78)	(-1.58)	(-1.48)
Short-Term External Debt $_{t-8}$	**0.150*****	**0.145*****	**0.187*****	**0.187*****	**0.181*****	**0.168*****	**0.185*****
	(3.88)	(3.04)	(4.22)	(3.55)	(3.32)	(3.18)	(3.46)
Inflation $_{t-1}$	**11.733*****	**11.678*****	**12.753*****	**12.822*****	**9.137*****	**12.341*****	**12.273*****
	(6.82)	(6.57)	(5.18)	(5.22)	(3.03)	(5.98)	(4.74)
Currency Crisis $_{t}$					1.959*		
					(1.88)		
Banking Crisis $_{t}$					**3.799*****		
					(5.14)		
Currency Crisis $_{t-1 \text{ to } t-12}$		0.039		0.454		2.607	0.557
		(0.03)		(0.34)		(1.66)	(0.44)
Banking Crisis $_{t-1 \text{ to } t-12}$			**1.474*****	**1.467*****		**1.588*****	0.361
			(3.15)	(3.13)		(3.40)	(0.60)
Election $_{t-1}$	0.313	0.307	0.451	0.462	*-0.163*	0.529	0.574
	(0.28)	(0.27)	(0.38)	(0.39)	(-0.14)	(0.45)	(0.48)
Political Environment $_{t-1}$	-1.056**	-1.085**	-1.132**	-1.137**	-1.014	-1.026*	-1.188**
	(-2.14)	(-2.12)	(-2.03)	(-2.02)	(-1.57)	(-1.80)	(-2.09)
Market Environment $_{t-1}$	**-0.591*****	**-0.595*****	**-0.642*****	**-0.640*****	**-0.904*****	**-0.698*****	**0.683*****
	(-3.24)	(-3.25)	(-3.09)	(-3.08)	(-3.39)	(-3.77)	(-3.07)
Currency Crisis $_{t-1 \text{ to } t-12}$ X RER $_{t-1}$						-4.918	
						(-0.64)	
Banking Crisis $_{t-1 \text{ to } t-12}$ X St Ext. Debt $_{t-8}$							**0.908*****
							(2.64)
Number of Observations	3211	3199	2962	2954	2754	2954	2954

*Notes: The estimations are conducted using "relogit" command in STATA 13. Robust standard errors are clustered by country. The significance levels of the variables are indicated by * (10%), ** (5%) and *** (1%). Counter intuitively signed coefficients are represented in italics. Highly significant coefficients with anticipated signs are represented in bold.*

Table C2. Conditional (Fixed-Effects) Logit Estimation Results of Sovereign Debt Crisis

Variables	(1) Estimates (z-stats)	(2) Estimates (z-stats)	(3) Estimates (z-stats)	(4) Estimates (z-stats)	(5) Estimates (z-stats)	(6) Estimates (z-stats)	(7) Estimates (z-stats)
ΔPublic Debt $_{t-4}$	**0.341*****	0.356**	0.226	0.235	*-0.021*	0.249	0.246
	(2.92)	(2.53)	(1.22)	(1.06)	(-0.07)	(0.85)	(1.01)
Real International Interest Rate $_{t-6}$	1.477**	1.442**	1.834**	1.824**	1.527	1.746**	1.587
	(2.36)	(2.22)	(2.36)	(2.33)	(1.43)	(2.08)	(1.54)
Real Domestic Interest Rate $_{t-1}$	*-0.150*	*-0.142*	*-0.010*	*-0.005*	0.042	*-0.283*	*-0.048*
	(-0.49)	(-0.45)	(-0.05)	(-0.03)	(0.16)	(-0.68)	(-0.19)
Exchange Rate Overvaluation $_{t-1}$	-6.375**	-6.089*	**-9.195*****	**-9.118*****	-6.183	-7.709**	**-10.014*****
	(-2.23)	(-1.81)	(-3.30)	(-3.07)	(-1.25)	(-2.10)	(-3.34)
Current Account Position $_{t-1}$	-1.365	-1.299	*0.274*	*0.302*	-0.340	*0.833*	*0.068*
	(-1.17)	(-1.02)	(0.24)	(0.24)	(-0.26)	(0.66)	(0.05)
GDP Growth $_{t-1}$	-0.544	-0.579	-0.254	-0.268	*0.093*	-0.273	-0.329
	(-0.67)	(-0.69)	(-0.32)	(-0.34)	(0.16)	(-0.38)	(-0.40)
Short-Term External Debt $_{t-8}$	**0.137*****	0.127**	**0.153*****	**0.149*****	0.152**	0.106*	**0.131*****
	(2.83)	(2.08)	(3.84)	(2.58)	(2.28)	(1.77)	(2.68)
Inflation $_{t-1}$	**15.387*****	**15.399*****	**33.953*****	**33.918*****	**24.511*****	**30.480*****	**34.748*****
	(3.53)	(3.29)	(4.18)	(4.20)	(4.07)	(3.31)	(3.78)
Currency Crisis $_{t}$					2.396**		
					(2.46)		
Banking Crisis $_{t}$					**4.436*****		
					(4.87)		
Currency Crisis $_{t-1 \text{ to } t-12}$		*-0.496*		*-0.167*		*-3.575***	*-0.111*
		(-0.31)		(-0.11)		(-2.03)	(-0.07)
Banking Crisis $_{t-1 \text{ to } t-12}$			2.185*	2.180*		2.527**	*-0.728*
			(1.90)	(1.87)		(2.11)	(-0.34)
Election $_{t-1}$	0.092	0.079	0.319	0.316	*-0.966*	0.456	0.389
	(0.08)	(0.07)	(0.27)	(0.27)	(-1.29)	(0.41)	(0.33)
Political Environment $_{t-1}$	-0.857	-0.884	-0.834	-0.837	-0.842	-0.775	-0.871
	(-1.43)	(-1.47)	(-1.45)	(1.47)	(-1.06)	(-1.31)	(-1.45)
Market Environment $_{t-1}$	-0.586**	-0.601**	-0.758*	-0.763*	-0.752*	-0.942**	-0.674*
	(-2.38)	(-2.31)	(-1.89)	(-1.84)	(-1.87)	(2.31)	(-1.71)
Currency Crisis $_{t-1 \text{ to } t-12}$ X RER $_{t-1}$						**-30.134*****	
						(-3.19)	
Banking Crisis $_{t-1 \text{ to } t-12}$ X St Ex. Debt $_{t-8}$							2.316**
							(2.14)
Pseudo-R^2	0.154	0.155	0.217	0.217	0.297	0.242	0.242
Number of Observations	2183	2175	1857	1851	1489	1851	1851
Log-Likelihood	-102.580	-102.415	-82.251	-82.220	-59.981	-79.569	-79.601

*Notes: The time in-variant 1105 observations are dropped from the estimations. Robust standard errors are clustered by country. The significance levels of the variables are indicated by * (10%), ** (5%) and *** (1%). Counter intuitively signed coefficients are represented in italics. Highly significant coefficients with anticipated signs are represented in bold.*

Table C3. Pooled Probit Estimation Results of Sovereign Debt Crises with Alternative Currency Crisis Definition

Variables	(1) Estimates (z-stats) Elasticity	(2) Estimates (z-stats) Elasticity	(3) Estimates (z-stats) Elasticity	(4) Estimates (z-stats) Elasticity	(5) Estimates (z-stats) Elasticity
ΔPublic Debt $_{t-4}$	0.104**	0.016	*-0.056*	0.013	0.001
	(2.37)	(0.22)	(-0.58)	(0.18)	(0.02)
	0.001	0.0001	-0.0003	0.0001	0.00001
Real International Interest Rate $_{t-6}$	0.755**	0.801**	0.779*	0.811**	0.694*
	(2.50)	(2.39)	(1.95)	(2.44)	(1.90)
	0.007	0.007	0.005	0.007	0.005
Real Domestic Interest Rate $_{t-1}$	*-0.079*	*-0.063*	*-0.092*	*-0.062*	*-0.094*
	(-0.75)	(-0.62)	(-0.79)	(-0.62)	(-0.91)
	-0.001	-0.001	-0.001	-0.001	-0.001
Exchange Rate Overvaluation $_{t-1}$	-2.529**	-3.265**	-3.524**	-3.418**	**-3.871****
	(-2.47)	(-2.50)	(-2.26)	(-2.45)	(-2.86)
	-0.025	-0.027	-0.022	-0.028	-0.030
Current Account Position $_{t-1}$	-0.294	-0.153	-0.129	-0.174	*0.392*
	(-1.16)	(-0.54)	(-0.33)	(-0.57)	(0.80)
	-0.003	-0.001	-0.001	-0.001	0.003
GDP Growth $_{t-1}$	-0.539**	-0.486*	-0.401	-0.494*	-0.446*
	(-2.10)	(-1.86)	(-1.34)	(-1.89)	(-1.67)
	-0.005	-0.004	-0.002	-0.004	-0.003
Short-Term External Debt $_{t-8}$	**0.069****	**0.084****	*-0.006*	**0.083****	**0.079****
	(2.89)	(3.10)	(-0.15)	(3.01)	(2.80)
	0.001	0.001	-0.00004	0.001	0.001
Inflation $_{t-1}$	**4.553****	**4.310****	**2.714****	**4.298****	**3.855****
	(6.54)	(4.50)	(2.74)	(4.51)	(3.61)
	0.045	0.036	0.017	0.035	0.030
Currency Crisis $_{t}$			0.434		
			(0.95)		
			0.005		
Banking Crisis $_{t}$			1.755***		
			(3.77)		
			0.125		
Currency Crisis $_{t-1 \text{ to } t-12}$	*-0.146*	*-0.272*		*-0.261*	*-0.223*
	(-0.68)	(-1.36)		(-1.24)	(-1.12)
	-0.001	-0.002		-0.002	-0.001
Banking Crisis $_{t-1 \text{ to } t-12}$		**0.571****		0.556**	*-0.052*
		(2.74)		(2.43)	(-0.18)
		0.010		0.010	-0.0004
Election $_{t-1}$	0.042	0.139	*-0.106*	0.414	0.167
	(0.10)	(0.32)	(-0.28)	(0.32)	(0.38)
	0.0004	0.001	-0.001	0.001	0.002
Political Environment $_{t-1}$	**-0.441****	**-0.482****	**-0.558****	**-0.488****	**-0.502****
	(-2.68)	(-2.69)	(-3.16)	(-2.82)	(-2.74)
	-0.004	-0.004	-0.003	-0.004	-0.004
Market Environment $_{t-1}$	**-0.260****	**-0.285****	**-0.455****	**-0.287****	**-0.305****
	(-3.51)	(-3.40)	(-3.90)	(-3.47)	(-3.33)
	-0.003	-0.002	-0.003	-0.002	-0.002
Currency Crisis $_{t-1 \text{ to } t-12}$ X RER $_{t-1}$				*0.582*	
				(0.29)	
				0.036	
Banking Crisis $_{t-1 \text{ to } t-12}$ X St Ext. Debt $_{t-8}$					**0.500****
					(3.15)
					0.028

Table C.3 continued,

	(1)	(2)	(3)	(4)	(5)
Pseudo-R^2	0.168	0.189	0.223	0.189	0.206
Number of Observations	3179	2935	2614	2935	2935
Log-Likelihood	-125.466	-109.066	-83.536	-109.025	-106.787
Goodness of fit (10 percent cutoff)					
% of observations correctly predicted	98.52	98.53	98.85	98.53	98.67
% of crises correctly predicted	7.69	13.04	22.22	13.04	17.39
% of non-crises correctly predicted	99.27	99.21	99.38	99.21	99.31
Goodness of fit (1 percent cutoff)					
% of observations correctly predicted	80.43	81.98	85.69	81.84	81.70
% of crises correctly predicted	73.08	73.91	66.67	73.91	73.91
% of non-crises correctly predicted	80.49	82.04	85.82	81.90	81.77

*Notes: Robust standard errors are clustered by country. The significance levels of the variables are indicated by * (10%), ** (5%) and *** (1%). Counter intuitively signed coefficients are represented in italics. Highly significant coefficients with anticipated signs are represented in bold. The marginal effects are evaluated at the sample mean for continuous variables and for change from zero to one for dummy variables holding all other variables at their mean. In order to convert the marginal effects into percentages they should be multiplied by 100.*

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