WP/00/?

IMF Working Paper

Trade and Financial Contagion in Currency Crises

Francesco Caramazza, Luca Ricci, and Ranil Salgado

INTERNATIONAL MONETARY FUND

C:\I

IMF Working Paper

WP/00/? INTERNATIONAL MONETARY FUND

Research Department

Trade and Financial Contagion in Currency Crises

Prepared by Francesco Caramazza, Luca Ricci, and Ranil Salgado[1]

[Authorized for distribution by Tamim Bayoumi]

January 2000

Abstract

This paper investigates empirically the relevance of external, domestic, and financial weaknesses as well as trade and financial linkages in inducing financial crises for a sample of 61 emerging market and industrial countries. A panel probit estimation finds these economic indicators to be significant for emerging market countries during the Mexican, Asian, and Russian crises. In particular, the indicators of vulnerability to international financial spillover (common creditor) and of financial fragility (reserve adequacy) are highly significant and appear to explain the apparent regional concentration of these crises. Exchange rate regimes and capital controls, however, do not seem to matter.

JEL Classification Numbers: F31, F32, F34, F41, G15

Keywords: Currency Crises, Emerging Markets, Contagion, Trade and Financial Spillovers

Author's E-Mail Address: fcaramazza@imf.org, lricci@imf.org, rsalgado@imf.org

[1]This paper builds on the empirical research underlying Chapter III of the May 1999 *World Economic Outlook* of the International Monetary Fund. The authors would like to thank participants in seminars at the "International Economics Conference," Georgetown University, November 12-14, 1999 and at the IMF Research Department for useful comments and suggestions. The authors also thank Gretchen Byrne, Lisa Nugent, and Patricia Medina for excellent research and other assistance.

Contents

I. INTRODUCTION

A prominent feature of the financial crises that have engulfed emerging market economies in recent years—the Mexican crisis of 1994 95, the Asian crisis of 1997, and the Russian crisis of 1998—as well as of the earlier ERM crisis of 1992 93 which directly involved European industrial countries, was the spread of difficulties from one economy to others in the same region and beyond in a process that has come to be referred to as "contagion." The frequency and intensity of these crises have been of growing concern. Policymakers and academics have increasingly wondered about the nature of these crises, the factors responsible for their spread, and, particularly, whether a country with seemingly appropriate domestic and external fundamentals can suffer a crisis because of contagion.

This paper extends earlier work on indicators of vulnerability to currency crises by looking at factors that render a country vulnerable to contagion and thus enhance the risk that a crisis in one country will spill over to others. We examine, both individually and simultaneously, the role of various indicators during the major crisis episodes of the 1990s to analyze how the countries that experienced currency pressures soon after the outbreak of these crises differed from countries that did not. In particular, we focus on the roles of external and internal (macroeconomic) imbalances, financial weaknesses (reserve adequacy), trade and financial linkages (channels for contagion), and institutional factors (exchange rate regimes and capital controls), as well as the presence of nonlinear effects.

The results indicate that once domestic and external fundamentals as well as trade spillovers are controlled for, financial linkages and weaknesses play a significant role in explaining the spread of crises, while exchange rate regimes and capital controls do not seem to matter. In particular, a strong financial linkage to the first crisis country through a common creditor not only appears to substantially raise the probability of a crisis but also appears to explain the apparent regional concentration of these crises. While the bulk of the study focuses on emerging market economies, we also present results for industrial countries which suggest that the nature of crises in these countries may differ.

It is important to note that the economies that suffered crises during these episodes did not necessarily do so because of trade and financial contagion effects; the pressures could have arisen independently of developments in other countries or could have arisen because of common shocks, as discussed below.[2] In particular, observed differences between crisis and noncrisis economies for some variables indicate fundamental or macroeconomic imbalances, such as unsustainable monetary and fiscal policies or unsustainable current account deficits under pegged exchange rates, that may have caused a country to incur a crisis even in the absence of contagion. Differences in other variables, however, such as trade links and financial market links, may identify vulnerabilities only when other economies suffer crises. In addition, investors might reassess risk and adopt more demanding criteria for good fundamentals or, equivalently, re-evaluate fundamentals, even when the latter have remained objectively unchanged. Consequently, differences in the fundamental variables between

[2] In this paper, contagion is defined broadly to include both spillover and "pure contagion" effects as described in Masson (1998).

crisis and noncrisis countries might indicate vulnerability to contagion even when those differences might not lead to a crisis in a noncontagious global environment. Our results, and the temporal clustering of crises, suggest that trade and financial linkages and contagion may have played a role.

The rest of this paper is organized as follows. Section II briefly reviews the theoretical and empirical literature on explanations of why crises may be clustered in time. Section III describes the data—in particular, how crisis countries are identified and the differences in characteristics of the major explanatory variables between crisis and noncrisis countries. Section IV presents the main empirical analysis and results. Conclusions follow in Section V.

II. Contemporaneous Crises and Contagion: A Literature Review

This section reviews the factors found in the recent theoretical and empirical literature to explain the contemporaneous occurrence of currency crises and previous tests for the presence of contagion. A large body of empirical literature has focused on identifying economic and financial variables that prior to a crisis differ significantly between crisis and noncrisis countries. The objective of these studies is to provide an early indication of vulnerability to a currency or balance of payments crisis or, more ambitiously, to predict the likelihood that a country will experience such a crisis over a given time horizon.[3] On the whole, the findings of this literature indicate that fundamentals—represented by various macroeconomic variables—do help to explain the incidence and transmission of crises. Their explanatory power, especially as regards the spread of crises, however, has tended to be low (Berg and Pattillo, 1998). This has led researchers to broaden the scope of investigation from domestic macroeconomic fundamentals to other factors that may explain the temporal clustering of crises. These fall into several categories: common shocks, trade spillovers, and financial linkages.[4] In addition, changes in investor sentiment, particularly with regard to macroeconomic and financial fundamentals, also play a role in inducing crises and their transmission across countries because economies with weaker fundamentals may be more vulnerable when others are suffering from crises.

Common shocks, such as a rise in world interest rates, a slowdown in world aggregate demand, a decline in commodity prices, or changes in the bilateral exchange rates between the major world economies (particularly when other exchange rates are pegged to these major currencies) can play a major role in inducing pressures on the currencies of several countries simultaneously. In this case, the simultaneous occurrence of crises stems from the

---

[3]See, for instance, Goldfajn and Valdes (1998); Kaminsky, Lizondo, and Reinhart (1998); Goldstein, Kaminsky, and Reinhart (1999); IMF (1998); Berg and Pattillo (1998); Milesi-Ferretti and Razin (1998); and Kamin and Babson (1999).

[4]For a taxonomy of the linkages explaining contagion, see Masson (1998). Early papers on contagion include, Agenor and Aizenman (1998); Eichengreen, Rose, and Wyplosz (1996); and Gerlach and Smets (1995).

interaction of a common shock and domestic fundamentals. Instances of common shocks include the sharp increase in U.S. interest rates in the early 1980s, which was an important factor in the Latin American debt crisis, and the increase in world interest rates in 1994, which similarly may have played a role in the Mexican crisis of 1994-95. Also, the large appreciation of the dollar between 1995 and 1997 and the long-lasting slowdown in Japanese growth are thought to have contributed to the weakening of the external sector in several southeast Asian countries.

When a country experiences a financial crisis marked by a significant depreciation of its currency, other countries may suffer from *trade spillovers*, owing to the improved price competitiveness of the crisis country. If the exchange rate crash is accompanied, as is typically the case, by a downturn in economic activity and a compression of imports in the crisis country, the associated income effect would further depress the exports of trade partners. The price and income effects operate not only through direct bilateral trade linkages, but also through price competition and income repercussions in third markets. Furthermore, in view of the critical role played by expectations in financial markets, it is important to consider trade spillovers not only from countries that have already experienced an exchange rate crash, but also from those that might be subject to contagion effects.[5]

Financial linkages can be another channel for spillover and contagion effects. The occurrence of a crisis in one or more countries might induce investors to rebalance their portfolios for risk management, liquidity, or other reasons. For instance, when a crisis breaks out in one country, investors who have positions in that country will usually want to reduce their now increased risk exposure and will sell assets whose returns are highly variable and positively correlated with those of the assets in the crisis country. Investors may also be induced to sell liquid assets for other reasons, such as when the reduced value of the assets of a crisis country gives rise to an immediate need to raise cash to meet margin calls (Goldfajn and Valdes, 1997a and Kodres and Pritsker, 1999). In addition, investors may sell assets that are highly represented in their portfolios simply because of their greater availability. Hence, a strong financial linkage with the major lender to a crisis country (in terms of being highly indebted to such a lender as well as being highly represented in the lender's portfolio) would increase the country's financial vulnerability (this has been labeled the common creditor argument by Kaminsky and Reinhart, 1998; see Van Rijckeghem and Weder, 1999b, for a recent detailed empirical analysis of the role of the common creditor). Some countries, therefore, may experience capital outflows independently of their macroeconomic fundamentals, simply because their assets are viewed as relatively more risky (in the wake of

[5]The role of trade linkages in contagion has been explored by Eichengreen, Rose, and Wyplosz (1996) for industrial countries during the ERM crisis, and by Glick and Rose, (1998) more generally and especially for emerging market economies. See also Van Rijckeghem and Weder (1999a). For a theoretical analysis of the welfare effects of trade contagion, see Corsetti, Pesenti, and Roubini (1999).

a crisis elsewhere or because they are positively correlated with those of a crisis country), more liquid, or highly represented in the portfolio of creditors to the crisis country.[6]

Shifts in investor sentiment might also play a role in the spread of crises. A crisis in one country can serve as a wake-up call, inducing financial markets to reassess other countries fundamentals (Goldstein, 1998). Countries with mediocre fundamentals or financial vulnerabilities may then be subject to contagion effects from a shift in market sentiment or increased risk aversion. If a currency crisis in one country generates fears of speculative attacks elsewhere, investors may expect to profit from speculating against currencies that they think other investors will also sell. The most promising targets are likely to be currencies that seem likely to be defended by official exchange market intervention or increases in interest rates, but that seem most likely eventually to collapse and yield speculative gains. The risk of a crisis precipitated by a sudden change in expectations is likely to be greater, the larger is the country's share of short-term obligations and the larger is the maturity mismatch between assets and liabilities, because the economy will then be more vulnerable to a run by a fairly modest share of lenders. Low levels of international reserves in relation to the stock of short-term external debt or the domestic banking sector's liabilities may therefore signal financial vulnerability. Countries with weak domestic banking systems may also be at risk because financial market participants may see this as a constraint on the monetary authorities ability (and willingness) to raise interest rates in defense of the currency.[7]

One way in which the presence of contagion has been explored empirically has been to examine whether (co)movements in fundamentals can explain (co)movements in asset prices.[8] Failure to do so is interpreted as consistent with the existence of contagion. Often researchers have found that the fundamentals included in their model explain some but not all of the variance in asset prices: a significant residual variance remains. While informative, such findings provide only weak, indirect evidence of contagion since it is impossible to be certain that the estimated model incorporates the true fundamentals, or does so correctly. Moreover, Rigobon (1998) and Forbes and Rigobon (1999) argue that there is little evidence that the propagation mechanisms between markets differ in tranquil and crisis periods: the

---

[6] The role of financial linkages in contagion has also been explored, *inter alia*, by IMF (1999), Baig and Goldfajn (1999), Bussiere and Mulder (1999), and Gelos and Sahay (1999). For the role of mutual funds as a channel of financial spillover, see Borenzstein and Gelos (1999), Levy-Yeyati and Ubide (1999), and Frankel and Schmukler (1996). For a theoretical model of financial linkages that could support the common creditor argument, see Allen and Gale (1999) and Lagunoff and Schreft (1998). For a model of financial contagion via rebalancing of portfolio for risk-management reasons, see Choueiri (1999).

[7] See Calvo (1997, 1999); Sachs, Tornell and Velasco (1996); and Tornell (1998). For models on the information effects and financial contagion, see Huang and Xu (1998) and Calvo and Mendoza (1999). For a model of contagion due to political effects, see Drazen (1998).

[8] See Edwards (1998); Calvo and Reinhart (1996); Cashin, Kumar, and McDermott (1995); Valdes (1996); Baig and Goldfajn (1999); and Kaminsky and Schmukler (1999).

(normally measured) correlation of fundamentals increases during crisis, so that the increase in asset price correlation provides insufficient evidence of contagion.

III. DATA DESCRIPTION

A. Identifying Crises (The Dependent Variables)

To assess the characteristics of the countries that have been affected during the major financial crises in the 1990s, an operational definition of financial market pressure is required to determine which countries suffered most during these periods of financial instability. The analysis in this paper is primarily focused on currency crises—that is, episodes of intense foreign exchange market pressure. The results, however, are compared to cases of pressures in other financial markets, such as movements in stock prices.

A currency crisis can be defined simply as an episode in which a country experiences a substantial nominal devaluation or depreciation.[9] This criterion, however, would exclude instances where a currency came under severe pressure but the authorities successfully defended it —by intervening heavily in the foreign exchange market, by raising interest rates sharply, or by both. A more common approach adopted in the economic literature is to construct an index of speculative market pressures that takes into account not only movements in the exchange rate, but also movements in international reserves and interest rates that absorb the pressure and thus moderate the exchange rate changes.[10] For the main analysis in this paper, an index of speculative market pressure (CRIIND) is constructed as a weighted average of (detrended) monthly exchange rate changes and reserve changes for a group of 61 industrial and emerging market economies for the period 1990-98.[11] The weights are chosen so that the conditional variance of the two components of the index are equal, and the trends are country-specific. Periods in which the 12-month inflation rate exceeds 100 percent are excluded.

---

[9]For example, Frankel and Rose (1996) define a currency crash as a nominal depreciation of the currency of at least 25 percent in a year, along with a 10 percent increase from the previous year in the rate of depreciation. The latter condition is included so as to omit from currency crashes the large trend depreciations of high-inflation countries.

[10]Among others, see Eichengreen, Rose, and Wyplosz (1996) and Kaminsky and Reinhart (1996). As in the latter, interest rates are excluded from the index because of the lack of comparable, market-determined interest rate data for many of the emerging market economies for the full sample period.

[11]See Appendix I for the list of countries and more details on data construction and sources. The group of countries include 20 industrial countries and 41 emerging market economies. Germany and the United States serve as the reference countries for the European (other than Russia) and the non-European economies, respectively, and are therefore not included in the sample.

Countries that experienced crises during the ERM, Mexican, Asian, and Russian crisis episodes are identified as all those suffering foreign exchange market pressures exceeding a specific threshold within six months of the beginning of these episodes.[12] The start of the four crisis episodes are dated as September 1992 for the ERM crisis, December 1994 for the Mexican crisis, July 1997 for the Asian crisis, and August 1998 for the Russian crisis. In each of these months, at least one economy suffered a substantial currency depreciation. The threshold is set to 1.645 times the pooled standard deviation of the calculated index plus the pooled mean of the index, so that over the whole sample 5 percent of the monthly index values will exceed that threshold if the values are distributed normally. Relative to this threshold, about 12 percent of the countries experience currency crises in the average six-month period. The frequency of crises is similar to that found in previous studies.

To test the robustness of the results and to capture periods of financial instability that are not directly or substantially reflected in the foreign exchange market, alternative crises indices are also constructed by changing the crisis threshold (CRIHIGH and CRILOW) and by including other financial market variables as additional components (CRIINT, CRISTK, CRIINTSTK).[13] Note, however, that including other financial market variables substantially decreases the sample size because of non-available data.

For CRIIND, 16 economies are found to have experienced substantial currency pressures during a six month window of the ERM episode, 9 during the Mexican episode, 10 during the Asian episode, and 13 during the Russian episode (Figure 1).[14] The incidence of crises during these periods is much higher than during other six-month windows in the 1990s, when on average under six countries (or about 10 percent of the sample, adjusting for availability of data and excluding high-inflation countries) suffer from significant currency market pressures. During the ERM and Russian crises about 30 percent of the countries in the sample experience currency pressures, while in the Mexican and Asian crises 15 20 percent are affected.

In terms of geographic distribution, the ERM crisis primarily affected European industrial countries and emerging market economies in the Middle East and Africa; the Mexican crisis mainly Latin American countries but also other emerging market economies outside Asia; the Asian crisis mostly Asian economies; and the Russian crisis mainly the eastern European transition economies but also some Latin American countries, especially

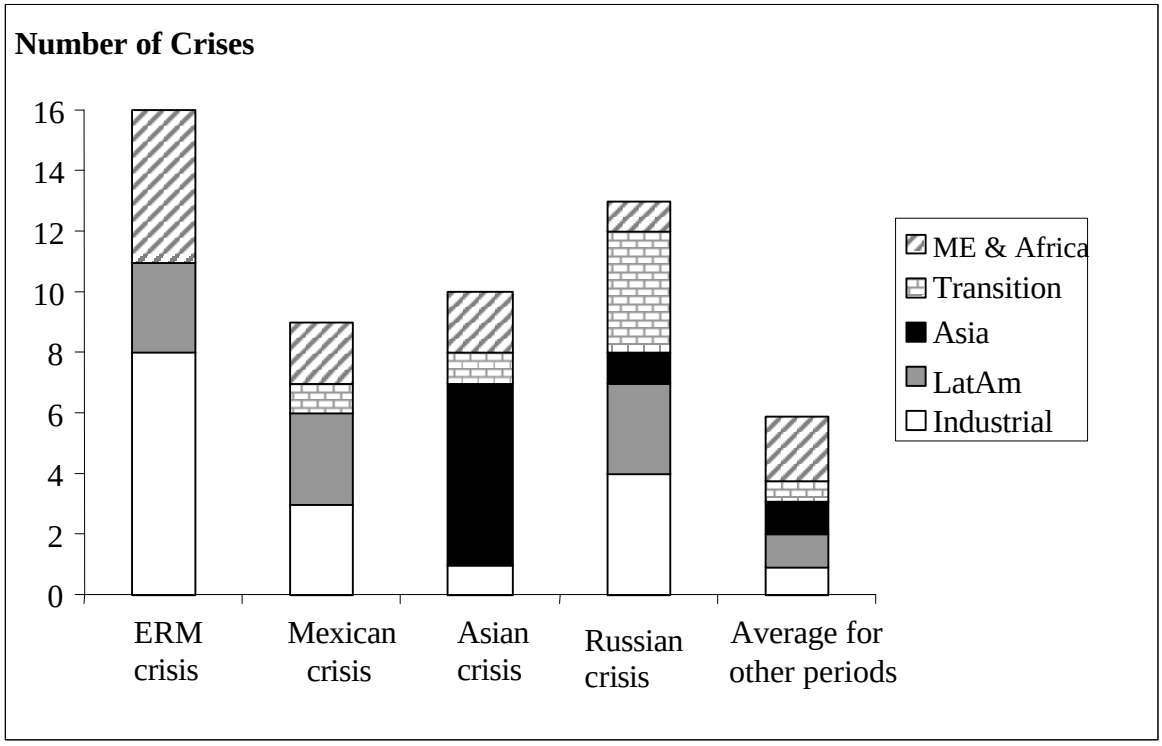
---

[12]For the Russian crisis, the crisis period is only four months because the data sample ends in November 1998.

[13]For CRIHIGH (CRILOW), the threshold is 1.96 (1.28) times the pooled standard deviation of the calculated index plus the pooled mean of the index, so that 2½ (10) percent of the monthly index values will exceed that threshold if the values are distributed normally. See Appendix I for details on the composition of the indices with additional financial market variables.

[14]For a list of these countries, see Appendix II. Appendix II also lists countries which suffer from crises identified by using the alternative indices.

Figure 1. Incidence of Currency Crises during the 1990s[1]



[1] The crisis index (CRIIND) is described in the text. The ERM crisis occured during September 1992 through February 1993; the Mexican crisis, December 1994 through May 1995; the Asian crisis, July through December 1997; and the Russian crisis, August through November 1998.

Brazil (Figure 2).[15] In our multivariate analysis, we investigate potential explanations for this apparent regional pattern of crises.

B. Characteristics of the Main Explanatory Variables

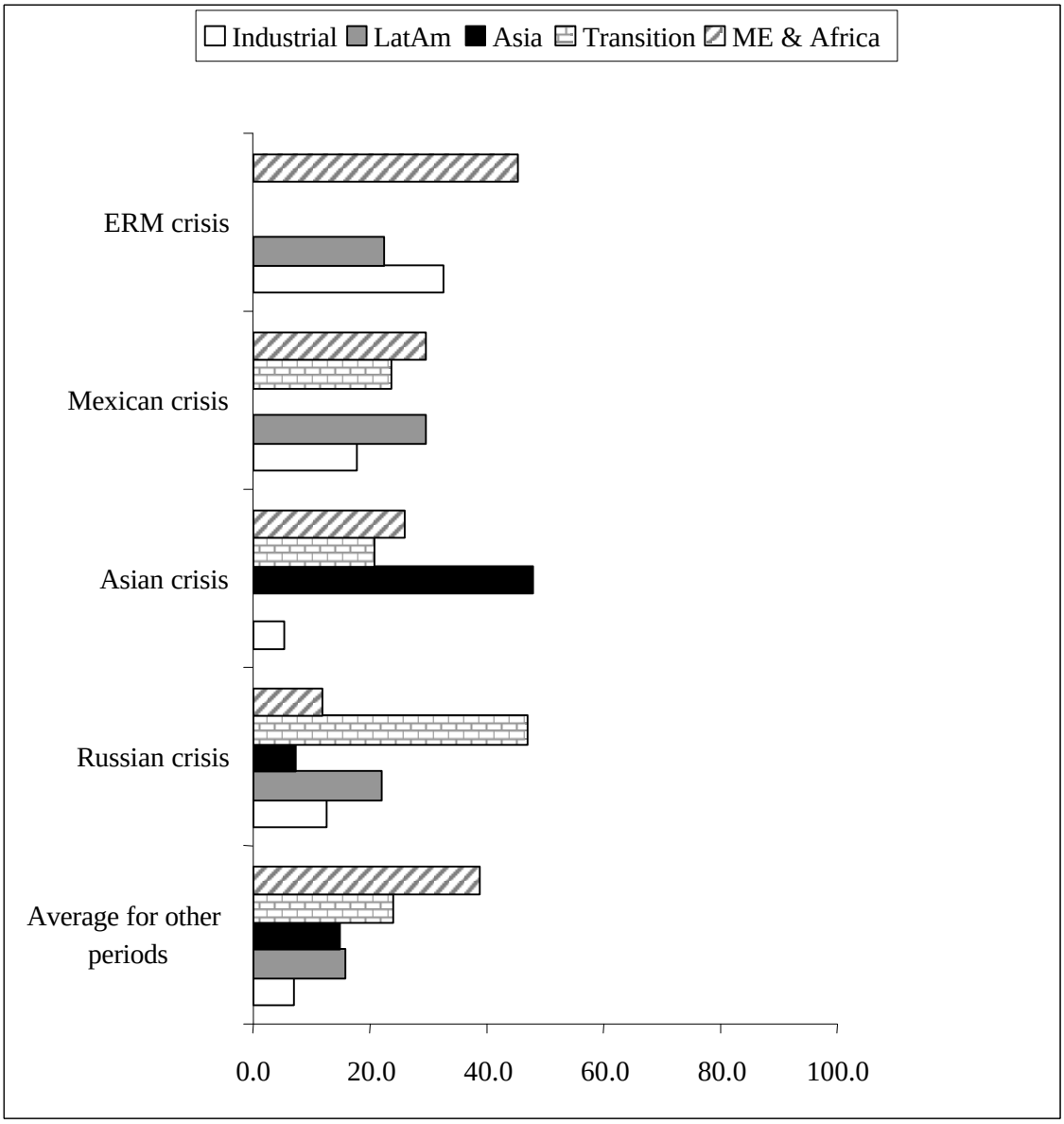
In the analysis that follows, we examine the average behaviour of a variety of macroeconomic, trade, and financial market variables[16] for economies that suffered currency market pressure during the four major financial crises of the 1990s and for economies that did not. In particular, we focus on variables that we subsequently use in the multivariate analysis.

Because the sample of countries and crises are not homogeneous, the robustness of these results is also examined by comparing the differences in behaviour between crisis and

[15]The Middle East and Africa region has experienced a larger incidence of crises than other regions because several of the countries in this region have relatively volatile international reserves. As a result, the incidence of crises for these economies may be biased somewhat upward.

[16]See Appendix I for precise definitions of these variables.

Figure 2. Frequency of Crises, by Country Group[1]
(Percent of countries in country groups experiencing crisis)



[1]The number of crises per country in country groups, adjusted for data availability and excluding periods of high inflation.

noncrisis economies for each of the four major crises individually, as well as for industrial and emerging market economies separately. In particular, for the industrial country averages, all four global crises are pooled together. For the emerging market country averages, the Mexican crisis, the Asian crisis, and the Russian crisis—the three global crises that most affected the emerging market economies—are pooled together.[17]

Countries that suffered currency pressures during the major financial crises of the 1990s appear to differ in a number of ways from countries that did not (Figure 3).[18]

- On the external side, the *appreciation of the real exchange rate* (REERG) during the three years prior to the onset of each of the major crises, a possible proxy for loss of international price competitiveness and exchange rate misalignment, is almost 15 percentage points larger on average for crisis than for noncrisis emerging market economies (Figure 3a). For the industrial countries, the appreciation is not significantly different between crisis and noncrisis countries. The *external current account deficit* (-BCAY) in the year before the crisis is also larger on average by over 2 percentage points of GDP in crisis than in noncrisis countries for both industrial and emerging market economies, which may further indicate poor trade competitiveness in the crisis countries. However, in many cases, particularly during the Mexican and Asian crises, there are no significant differences in precrisis external current account balances between economies that experienced currency crises and those that did not. As a further indication of weak external performance, the *growth of exports in relation to GDP* (XY3LG) in the three years before the crisis is also over 11 percentage points lower on average for crisis than for noncrisis emerging market countries, while not significantly different for industrial countries. Other external sector variables, apart from short-term external debt in relation to total external debt, are insignificantly different between crisis and noncrisis countries.

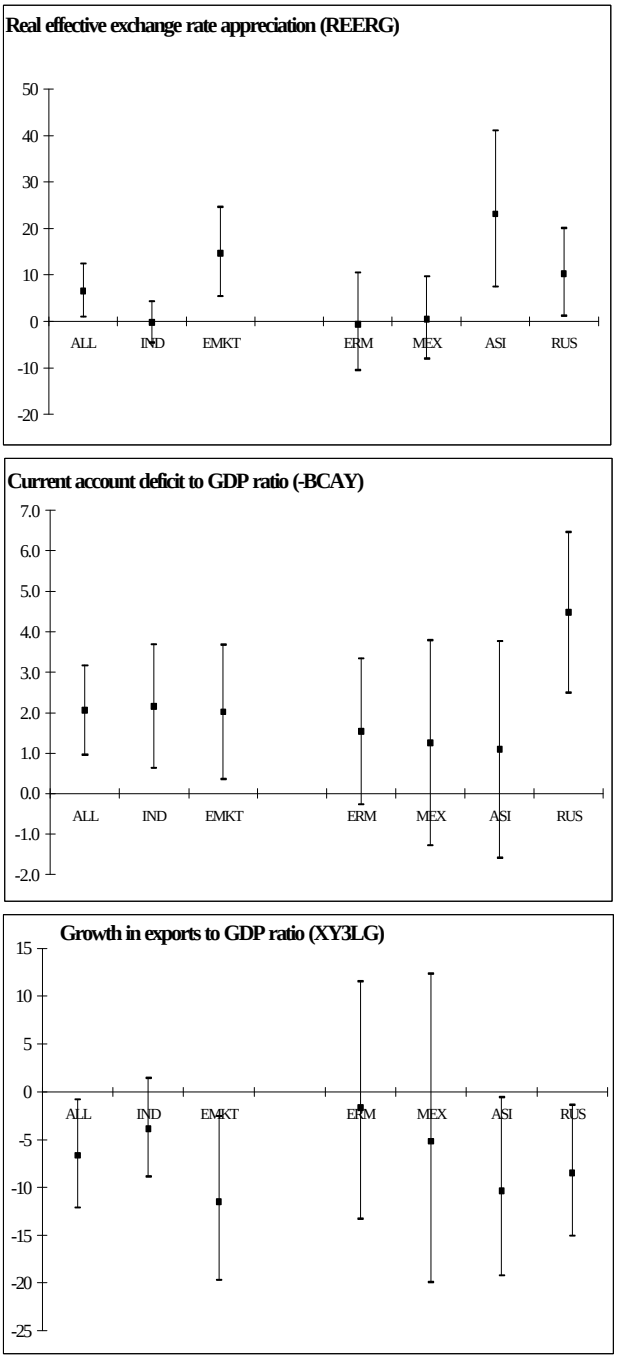
- Evidence of precrisis domestic macroeconomic imbalances that may have made a country vulnerable to financial market contagion include slow *GDP growth* (GDP3G) in the three years prior to the crisis, a high *unemployment rate* (UR), and a *banking crisis* (BKCRI). Prior to the ERM crisis, GDP growth was on average 2 percentage points lower and unemployment 4 percentage points higher in crisis than in noncrisis industrial countries (Figure 3b). The differences in output growth between crisis and noncrisis countries are smaller for the emerging market economies. (Unemployment

[17]Averages including only the ERM crisis for the industrial countries are not substantially different in general from the industrial country averages, and averages pooling all global crises for the emerging market economies or pooling only the Mexican and Asian crises for the emerging market economies are not substantially different in general from the emerging market country averages.

[18]Univariate probit regressions of a crisis dummy variable on the variables discussed below yield almost identical results, in terms of statistical significance, to those obtained from differences between averages of variables of crisis and noncrisis countries.

Figure 3a. Characteristics of External Variables [1]

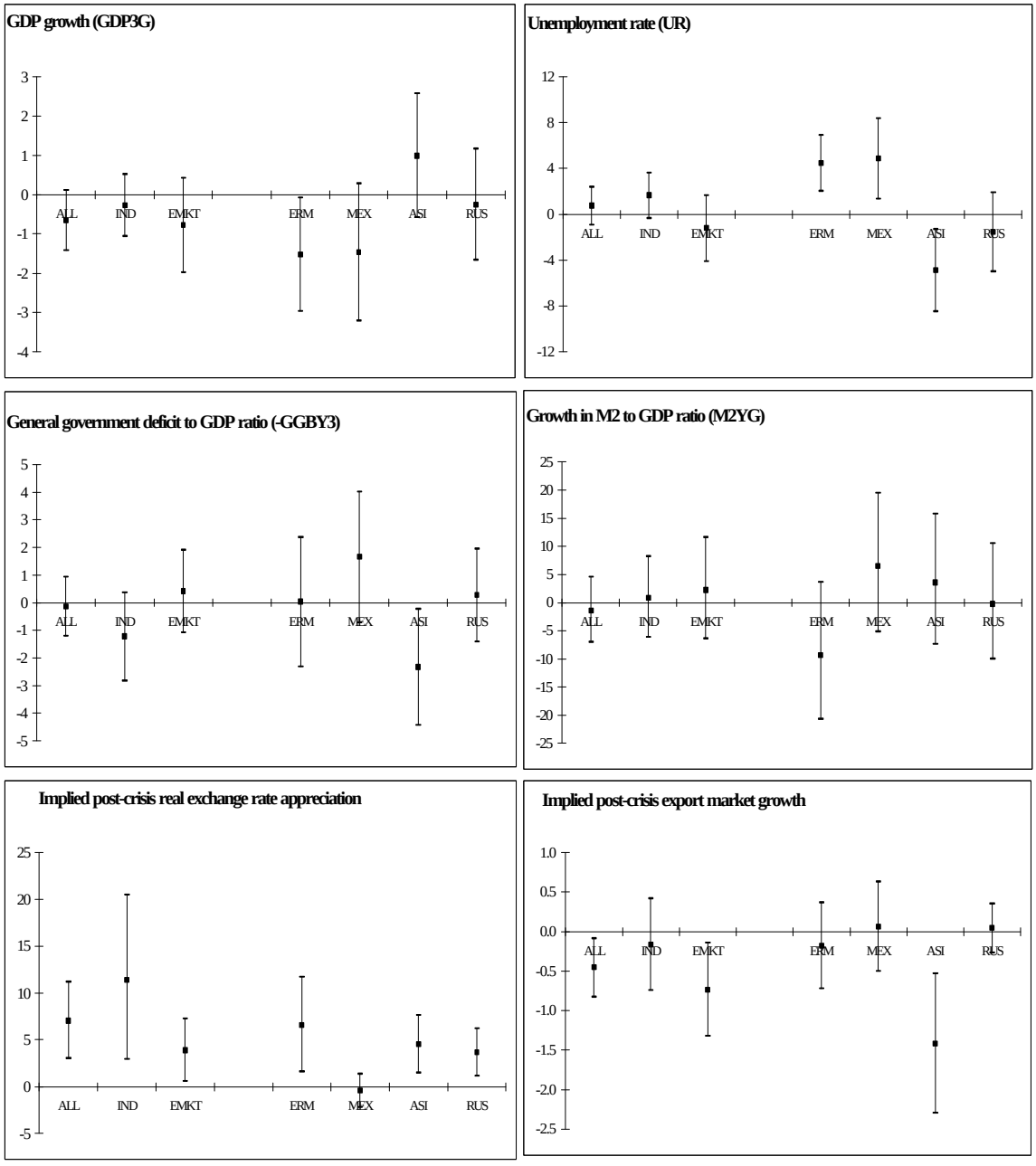
(Percentage point differences between crisis and non-crisis countries with standard error bands)



[1] The square near the mid-point of each line is the difference between the average for crisis and non-crisis countries. The top and bottom of each line represent the 1.645 standard error bands. If the variables are distributed normally, 5 percent of observations would lie above each line another 5 percent below. ALL includes all countries and crises; IND, industrial countries and all crises; EMKT, emerging market economies, excluding the ERM crisis; ERM, all countries during the ERM crisis; MEX, all countries during the Mexican crisis; ASI, all countries during the Asian crisis; and RUS, all countries during the Russian crisis. The real effective exchange rate appreciation and the growth in exports to GDP are calculated in the three years prior to the crisis while the current account deficit to GDP ratio is calculated in the year before the crisis.

Figure 3b. Characteristics of Domestic Variables and Trade Linkages [1]

(Percentage point differences between crisis and non-crisis countries with standard error bands)



[1] The square near the mid-point of each line is the difference between the average for crisis and non-crisis countries. The top and bottom of each line represent the 1.645 standard error bands. If the variables are distributed normally, 5 percent of observations would lie above each line another 5 percent below. ALL includes all countries and crises; IND, industrial countries and all crises; EMKT, emerging market economies, excluding the ERM crisis; ERM, all countries during the ERM crisis; MEX, all countries during the Mexican crisis; ASI, all countries during the Asian crisis; and RUS, all countries during the Russian crisis. GDP growth, the general government deficit to GDP ratio, and the growth in M2 to GDP are calculated in the three years prior to the crisis while the unemployment rate is calculated in the year before the crisis. The implied post-crisis real exchange rate appreciation and the implied post-crisis export market growth are defined in the text and in Appendix I.C.

rates are unavailable for most emerging market economies.) Low output growth and high unemployment may be an indicator that external or domestic imbalances may become increasingly untenable or that governments will be unwilling to defend exchange rate arrangements by implementing policies, such as raising short-term interest rates, that could slow down real activity even further. All of the industrial countries and two-thirds of the Latin American countries (but only a few other emerging market economies) that had a banking crisis in the year prior to a global currency crisis also suffered currency market pressure.[19] Domestic imbalances in terms of large *general government fiscal deficits* (-GGBY3) or substantial monetary expansions, proxied by the *growth of broad money to GDP* (M2YG), can fuel expectations of inflation and therefore lead to pressures on the currency. However, these variables are indistinguishable on average between crisis and noncrisis countries during the period before the major crises.[20]

- Trade linkages as measured by the *implied appreciation of the real exchange rate* and the *implied decline of export market growth* induced by crises in other countries (see Appendix I.C for description and discussion of these variables) are generally significantly different on average between crisis and noncrisis economies (see Figure 3b). However, for all countries during the Mexican crisis and for industrial countries during the ERM crisis, the implied appreciation of the real exchange rate for crisis and noncrisis economies is not significantly different. The difference between crisis and noncrisis countries with respect to the implied slowdown in export market growth is greatest for the Asian crisis and for emerging market economies and weakest for the industrial countries in the ERM crisis.

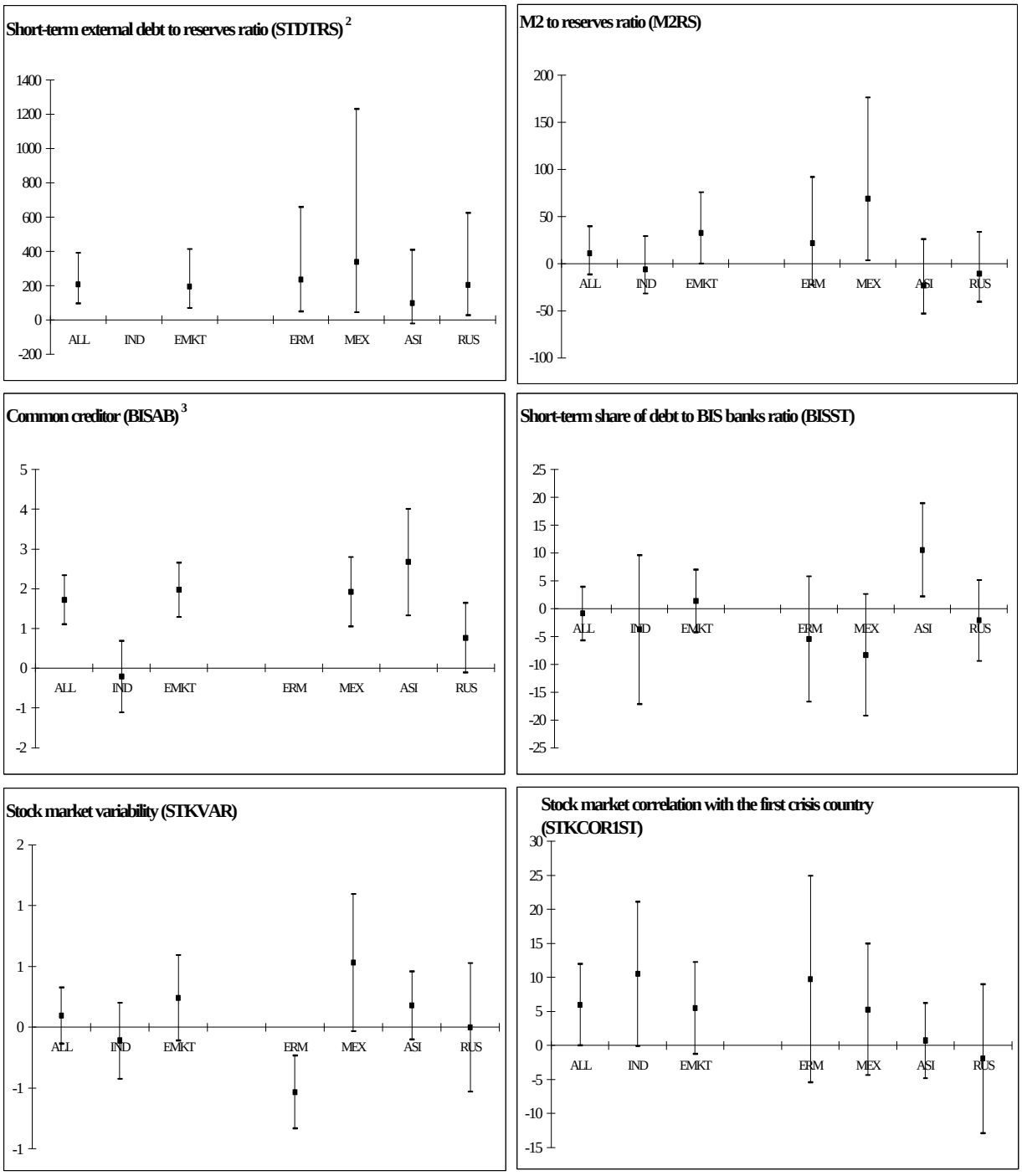
- Financial weaknesses or fragilities, proxied by the inadequacy of international reserves to cover speculative attacks, in crisis countries are significantly larger than in noncrisis ones. In particular, the ratio of *short-term debt to international reserves* (STDTRS) in the year before the crisis is almost 200 percentage points higher, in emerging market crisis economies compared with noncrisis economies (Figure 3c). This indicates that these crisis economies were vulnerable to a change in investor sentiment in an unfriendly or illiquid external environment—potential source of

[19]Banking crises may only be a lagging indicator of banking sector problems. See IMF (1998) for a more complete discussion of this issue. The data set for banking crises is described in Aziz, Caramazza, and Salgado (1999) and in IMF (1998). It was augmented to cover the additional 10 countries included in the analysis of this paper.

[20]Other studies, however, have found that other domestic macroeconomic variables may be significantly different in crisis and noncrisis countries. For example, Frankel and Rose (1996) found that public sector debt as a share of total debt helps to predict crises one year in advance, Edwards (1989) found that the fiscal deficit in the three years prior to a devaluation is higher for those countries that devalue than for a control group, and Tornell (1999) found that excess money growth plays a role in countries most affected by the Mexican and Asian crises.

Figure 3c. Characteristics of Financial Variables and Linkages [1]

(Percentage point differences between crisis and non-crisis countries with standard error bands)



[1] The square near the mid-point of each line is the difference between the average for crisis and non-crisis countries. The top and bottom of each line represent the 1.645 standard error bands. If the variables are distributed normally, 5 percent of observations would lie above each line another 5 percent below. ALL includes all countries and crises; IND, industrial countries and all crises; EMKT, emerging market economies, excluding the ERM crisis; ERM, all countries during the ERM crisis; MEX, all countries during the Mexican crisis; ASI, all countries during the Asian crisis; and RUS, all countries during the Russian crisis. The short-term external debt to reserves ratio, the M2 to reserves ratio, the common creditor variable (defined in the text), and the short-term share of debt to BIS banks ratio are calculated in the year before the crisis. Stock market variability and the stock market correlation with the first crisis country are defined in the text.

[2] Data unavailable for industrial countries.

[3] Data unavailable for ERM crisis.

financial contagion.[21] The ratio of *broad money to international reserves* (M2RS) is the inverse of the extent to which liquid domestic liabilities of the banking system are backed by foreign exchange reserves and thus is a measure of the banking system's ability to withstand currency pressures. For emerging market crisis economies, this ratio in the year before the crisis is 30 percentage points higher, on average, than in noncrisis economies. There are, however, no significant differences between crisis and noncrisis industrial countries.

- *Common creditor* financial market linkages seem to be very important in explaining differences between crisis and noncrisis emerging market economies (see Figure 3c). The common creditor is identified by the country that lent the most to the first country in crisis in each of the major crises.[22] The common creditor variables—that is, the importance of the common creditor for the borrowing country (BISA) and the importance of the borrowing country for the common creditor (BISB) in the year prior to the crisis—are significantly higher in the crisis emerging market economies than in the noncrisis ones. On average, the common creditor holds a 10 percentage point higher share of the external bank liabilities of the crisis countries than of the noncrisis countries, whereas the average crisis country holds a 5 percentage point higher share of the external loan portfolio of the common creditor than the average noncrisis country. A variable indicating mutual importance, constructed by multiplying the two common creditor variables (BISAB), is also almost always higher for crisis compared with noncrisis emerging market economies. The *short-term share of debt to BIS banks* (BISST), a proxy for the maturity composition of (bank) liabilities, is also significantly higher in crisis than in noncrisis countries before the Asian crisis. However, BISST does not bear significant differences for other crises. Risk management factors are proxied by *stock market variability* (STKVAR) and the *stock market correlation with the stock market of the first crisis country* (STKCOR1ST). Although STKVAR is not significant (or does not have the expected sign), STKCOR1ST is significantly different for crisis and noncrisis countries. These results suggest potential financial market-linked transmission mechanisms for contagion: creditors may rebalance their portfolios at the onset of a crisis for common creditor, liquidity, and risk management factors (as described in Section II). If there are regional differences in primary creditor relationships or stock market correlations, these may help to explain the regional bunching of financial crises.

[21]Data on short-term and total external debt are not available for industrial countries.

[22]These data are proxied by lending from Bank for International Settlements-reporting banks and are available only for the Mexican, Asian, and Russian crises and generally only for emerging market economies. The results for industrial countries rely on data from only 5 of the 20 countries. The common creditor in the Mexican crisis was the United States; in the Asian crisis, Japan; and in the Russian crisis, Germany. Replacing Germany with the United States as primary lender in the case of the Russian crisis yielded similar results.

IV. Multivariate Analysis and Results

As mentioned in Section II, the role of fundamentals and trade contagion in determining crises has been documented in various empirical studies. Controlling for such variables, we aim to investigate the importance of financial variables, the presence of non-linear effects, and the role of institutional factors (exchange rate regimes and capital controls) in inducing the recent world-wide crises. The bulk of the investigation will focus on emerging markets economies, whose financial vulnerability has been a rising source of concern after the recent crises. Some theoretical speculations on the sources of financial contagion would suggest that industrial countries are more likely to constitute a channel in the transmission of such contagion than a target (Kaminsky and Reinhart, 1998 and Kodres and Pritsker, 1998). Also, data for several variables that we use to proxy for financial contagion are not available for industrial countries. In a final section, we will briefly present results suggesting a different nature for the origin of crises in industrial countries, consistent with the results presented in other empirical works.

Our method of estimation is similar to the one employed in other empirical studies that investigate the determinants of crises (for example, Eichengreen et al., 1996). We employ a panel probit regression with 41 developing countries (see Appendix I.A for the list) during three crisis events (Mexican, Asian, and Russian). As some variables correspond to trade and financial linkages with the first crisis country, for each crisis event we take out the observation corresponding to that country (Mexico in the Mexican crisis, Thailand in the Asian crisis, and Russia in the Russian crisis). The main endogenous variable is CRIIND (see Section III).[23] An important difference with respect to the Eichengreen et al., approach is that our time series are made of the three crisis event windows instead of annual observations.

A. The Benchmark Model

As a first approach, we introduce in the regressions two sets of explanatory variables (as described in Section III). The first set (REERG, BCAY, XY3LG, GGBY3, M2YG, GDP3G, and TC) encompasses economic indicators which can theoretically be considered relevant in inducing crises, such as indicators of external and domestic fundamentals and proxies for trade contagion.[24] This set of control variables allows us to investigate the

[23]CRIIND is built on the basis of the whole sample of 61 countries, which includes industrial countries. This corresponds to our belief that the definition of a crisis should be universal (a certain degree of exchange rate market pressure can be identified as a crisis both for emerging market and industrial countries). Making the definition specific to the emerging market countries by rebuilding the index based on the sample of countries used in the regressions, is equivalent to changing the threshold of the full sample index to 1.81, so that this new index would be somewhat in between CRIIND and CRIHIGH. We will address the robustness of results to changes in thresholds in Section IV.B.

[24]The proxy of trade contagion (TC) combines the effects of the implied post-crisis real effective exchange rate appreciation and export market growth (see Appendix I.C).

importance of a second set of variables (BISST, BISAB, STKVAR, STKCOR1ST, M2RS, and STDTRS), which measure financial linkages and weaknesses. It is of course very difficult to discern whether speculative attacks are triggered by perceived weaknesses in financial indicators or financial contagion. In this respect, the aim of our work is simply to test which financial variable seem to indicate a higher probability of a crisis, leaving for future research the investigation of the exact mechanism.

This initial regression (Table 1) shows significant effects from the real exchange rate appreciation, the current account deficit, real output growth, the maturity of bank lending, the common creditor, and reserve adequacy to cover short-term debt. All variables are correctly signed.

We then derive the benchmark model. In terms of control variables, we keep the significant variables plus some of those that, although insignificant in our initial regression, have been found important in other studies, i.e. the variables related to domestic policies and to trade contagion (see Section II). Section IV.F will discuss the role of these latter variables when combined with indicators of external weakness.

In terms of financial variables, we keep the significant ones. Regarding the adequacy of international reserves, the ratio of M2 to reserves (M2RS) is dominated by the ratio of short term debt to reserves (STDTRS). It seems quite plausible that the inadequacy of reserves to cover short term debt should be more important, because M2 is a liability without a finite maturity while short term debt is due within the year. Because M2RS is not significant even when substituted for STDTRS in the regression, a self-fulfilling speculative attack triggered by a high ratio of M2 to reserves seems to be a theoretical case that is not confirmed by our empirical analysis, while a high ratio of short term debt to reserves seems to be a more likely catalyst for such an attack. Alternatively, our result may suggest that M2 to reserves is not a good indicator of financial vulnerability: although a shortage of reserves could induce agents to sell local for foreign currency in anticipation that others would do the same, the relatively high levels of M2 in some emerging markets may instead be associated with more developed financial markets, which may increase the confidence in the currency. The stock market variables, proxying for risk management effects, appear highly insignificant and have never been tested in such a probit approach; therefore, they are dropped from the benchmark model.[25]

B. Robustness

The benchmark model specified in Table 1 appears to be extremely robust. We control for the potential effect of various other economic indicators (listed in Appendix I) capturing monetary or fiscal weakness (such as inflation, growth in total or private domestic credit, and the level and growth of public debt to GDP) as well as external weakness

[25]They have been found relevant, however, in some empirical studies focusing on data at high frequency (for example, Baig and Goldfajn, 1999).

Table 1. Benchmark Model

	Expected Sign	Initial Model	Benchmark Model
C		-6.020 (0.052)	**-4.634** **(0.024)**
REERG	+	9.958 (0.030)	**3.588** **(0.089)**
BCAY	-	-41.189 (0.030)	**-25.273** **(0.011)**
XY3LG	-	3.922 (0.121)	
GGBY3	-	-5.986 (0.678)	**-14.547** **(0.127)**
M2YG	+	0.126 (0.921)	**1.432** **(0.197)**
GDP3G	-	-55.233 (0.024)	**-40.054** **(0.009)**
TC	+	2.448 (0.517)	**4.083** **(0.142)**
BISST	+	0.081 (0.034)	**0.049** **(0.085)**
BISAB	+	0.015 (0.029)	**0.011** **(0.002)**
STKVAR	+	-13.617 (0.791)	
STKCOR1ST	+	-0.677 (0.721)	
M2RS	+	-0.350 (0.510)	
STDTRS	+	1.260 (0.029)	**0.402** **(0.035)**
McFadden R-Squared		0.533	**0.424**
Total obs		58	**77**
Obs with Dep=0		41	**59**
Obs with Dep=1		17	**18**

(Probability levels in parentheses)

(changes in the terms of trade, the trade balance, and exports) by introducing them one at a time in our benchmark specification. None of these variables enters significantly.

Various papers have analyzed theoretically or empirically the effect of banking crises (Goldfajn and Valdes, 1997a, Kaminsky, 1998, Marion, 1998, and IMF, 1998) and banking sector vulnerabilities, associated with lending booms (Sachs, Tornell and Velasco, 1996 and Tornell, 1998), on currency crises. In our analysis, neither a dummy variable indicating the occurrence of a banking crisis in the previous year (BKCRI) nor the precrisis growth of private domestic credit to GDP (PDCYG), an indicator of lending booms, is significant, failing to provide evidence that banking crises or vulnerabilities play an independent role in inducing contagions currency crises (Table 2).[26] Note instead the significance of the growth rate of the incremental capital output ratio (ICORG) as a predictor of crisis.[27] This result supports the claim of Corsetti, Pesenti, and Roubini (1999) about the relevance of this ratio in the Asian crisis.

Because the main focus of our paper is on financial variables, we present the results of regressions controlling for numerous other indicators of financial distress, such as alternative measures of reserve adequacy (in terms of levels as well as growth rates of both M2 and foreign liabilities to foreign reserves), changes in stock prices, and indicators of external indebtedness (in terms of currency denomination, maturity, and ratios to GDP). Such indicators, however, do not enter significantly in the regressions (Tables 3a and 3b).[28]

Regarding financial linkages as proxied by the common creditor variable, it is interesting to note that the share of BIS credits that a common creditor lends to the specific country (BISB) has much more explanatory power than the share of BIS debt that the country borrows from the common creditor (BISA). In fact, when we substitute for the common creditor variable (BISAB) each of its two components in separate regressions, the

[26]Other measures of total and private domestic credit growth (as listed in Appendix I) are also insignificant.

[27]Introducing the growth rate in ICOR crowds out the significance of the current account variable, but all other variables remain significant. It however also reduces the sample by eliminating all transition economies, countries for which other regressions have shown that the current account is a particularly significant variable. Hence, we kept our benchmark model with the current account variable. It is interesting to note that most if not all the results we present in this paper would still hold if we replace the current account variable with ICOR, even though the correlation between the two is minimal (about 0.1).

[28]Only the growth rate of the ratio of foreign to total liabilities is significant and crowds out the significance of short term debt to reserves. However, the former variable is not significant in the absence of the latter.

Table 2. Robustness

	Regression 1	Regression 2	Regression 3
C	-4.796	-5.471	-10.997
	(0.022)	(0.025)	(0.017)
REERG	3.571	4.763	7.158
	(0.094)	(0.064)	(0.059)
BCAY	-25.769	-20.283	-6.765
	(0.011)	(0.059)	(0.661)
GGBY3	-13.687	-19.412	-23.591
	(0.160)	(0.088)	(0.120)
M2YG	1.442	1.813	3.276
	(0.197)	(0.183)	(0.126)
GDP3G	-41.548	-48.601	-63.045
	(0.007)	(0.012)	(0.054)
TC	4.019	5.080	11.387
	(0.150)	(0.110)	(0.051)
BISST	0.053	0.062	0.145
	(0.074)	(0.064)	(0.022)
BISAB	0.012	0.013	0.019
	(0.002)	(0.006)	(0.017)
STDTRS	0.427	0.432	1.278
	(0.029)	(0.034)	(0.021)
BKCRI	-0.830		
	(0.541)		
PDCYG		0.143	
		(0.515)	
ICORG			0.820
			(0.033)
McFadden R-Squared	0.429	0.427	0.498
Total obs	77	69	64
Obs with Dep=0	59	53	51
Obs with Dep=1	18	16	13

(Probability levels in parentheses)

significance of the coefficient and the McFadden R-squared are much higher with BISB.[29] Finally, the share of private lending from BIS banks does not appear to play a role.

[29]Also, when both BISA and BISB are introduced simultaneously in the regression, only BISB is significant.

Table 3A. Other Measures of Financial Fragility/Linkages

	Regression 1	Regression 2	Regression 3	Regression 4	Regression 5	Regression 6	Regression 7	Regression 8	Regression 9
C	-4.301 (0.040)	-5.321 (0.022)	-5.008 (0.022)	-5.053 (0.023)	-4.286 (0.045)	-5.261 (0.047)	-2.774 (0.081)	-5.156 (0.041)	-4.446 (0.035)
REERG	3.305 (0.123)	4.512 (0.065)	3.309 (0.118)	4.471 (0.061)	4.919 (0.046)	6.387 (0.034)	4.225 (0.044)	4.963 (0.053)	3.663 (0.083)
BCAY	-24.974 (0.012)	-29.744 (0.009)	-26.076 (0.011)	-28.396 (0.012)	-17.243 (0.106)	-19.304 (0.117)	-3.116 (0.702)	-21.507 (0.081)	-25.111 (0.012)
GGBY3	-14.558 (0.122)	-16.518 (0.110)	-16.303 (0.105)	-16.527 (0.097)	-24.304 (0.035)	-30.381 (0.024)	-19.330 (0.030)	-17.001 (0.143)	-15.441 (0.119)
M2YG	1.405 (0.203)	1.855 (0.119)	1.453 (0.198)	1.892 (0.177)	2.099 (0.126)	1.244 (0.446)	0.714 (0.567)	1.897 (0.227)	1.487 (0.183)
GDP3G	-41.397 (0.008)	-43.545 (0.008)	-41.292 (0.009)	-41.475 (0.009)	-28.262 (0.078)	-28.616 (0.132)	-12.308 (0.344)	-49.511 (0.013)	-39.176 (0.011)
TC	4.409 (0.121)	5.497 (0.086)	4.449 (0.121)	5.484 (0.074)	4.377 (0.129)	6.436 (0.054)	5.753 (0.033)	6.205 (0.076)	3.980 (0.156)
BISST	0.050 (0.079)	0.053 (0.080)	0.053 (0.076)	0.049 (0.096)	0.035 (0.239)	0.029 (0.383)	0.007 (0.730)	0.058 (0.086)	0.047 (0.105)
BISAB	0.012 (0.003)	0.011 (0.003)	0.012 (0.003)	0.011 (0.003)	0.015 (0.006)	0.021 (0.005)	0.015 (0.005)	0.012 (0.008)	0.011 (0.005)
STDTRS	0.517 (0.075)	0.504 (0.032)	0.450 (0.035)	0.338 (0.104)	0.335 (0.096)	0.267 (0.232)		0.333 (0.115)	0.395 (0.038)
M2RS	-0.207 (0.573)								
M2RSG		-0.412 (0.271)							
FLRS			-0.122 (0.592)						
FLRSG				0.006 (0.984)					
FLTL					-0.650 (0.590)				
FLTLG						0.858 (0.088)	0.671 (0.105)		
STKG								0.174 (0.724)	
DSHARE									-1.196 (0.691)
McFadden R-Squared	0.428	0.439	0.416	0.434	0.423	0.486	0.395	0.446	0.426
Total obs	77	77	74	73	66	63	75	61	77
Obs with Dep=0	59	59	56	56	49	47	56	46	59
Obs with Dep=1	18	18	18	17	17	16	19	15	18

(Probability levels in parentheses)

Table 3B. Other Measures of Financial Fragility/Linkages

	Regression 1	Regression 2	Regression 3	Regression 4	Regression 5	Regression 6	Regression 7	Regression 8
C	-4.385	-5.342	-4.854	-4.789	-5.066	-6.204	-2.910	-4.600
	(0.038)	(0.020)	(0.023)	(0.023)	(0.022)	(0.011)	(0.055)	(0.022)
REERG	4.196	5.019	3.817	4.070	4.283	3.412	3.555	3.748
	(0.087)	(0.060)	(0.084)	(0.076)	(0.073)	(0.108)	(0.053)	(0.058)
BCAY	-25.887	-23.412	-24.985	-26.765	-30.719	-29.367	-8.949	-24.272
	(0.011)	(0.024)	(0.013)	(0.010)	(0.011)	(0.007)	(0.212)	(0.014)
GGBY3	-15.298	-17.020	-15.895	-13.498	-14.052	-18.981	-6.740	-13.334
	(0.117)	(0.097)	(0.118)	(0.163	(0.154)	(0.063)	(0.370)	(0.135)
M2YG	1.597	1.641	1.570	1.441	1.388	1.512	1.606	1.656
	(0.171)	(0.163)	(0.184)	(0.187)	(0.198)	(0.213)	(0.114)	(0.126)
GDP3G	-40.559	-42.316	-40.617	-40.002	-41.364	-47.075	-17.215	-35.498
	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.005)	(0.088)	(0.011)
TC	3.892	5.224	4.222	4.045	4.760	3.564	3.457	3.880
	(0.166)	(0.097)	(0.134)	(0.147)	(0.105)	(0.216)	(0.138)	(0.144)
BISST	0.049	0.058	0.048	0.051	0.052	0.051	0.023	0.045
	(0.087)	(0.064)	(0.090)	(0.078)	(0.083)	(0.080)	(0.271)	(0.102)
BISAB	0.011	0.011	0.011	0.011	0.011	0.013		
	(0.005)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)		
STDTRS	0.430	0.398	0.333	0.452	0.524	0.430	0.338	0.390
	(0.030)	(0.043)	(0.197)	(0.032)	(0.036)	(0.018)	(0.037)	(0.038)
DTY	-0.608							
	(0.594)							
DTYG		1.094						
		(0.349)						
STDT			0.956					
			(0.694)					
STDTG				-0.233				
				(0.511)				
STDTRSG					-0.298			
					(0.362)			
BISPR						0.026		
						(0.156)		
BISA							0.028	
							(0.072)	
BISB								0.365
								(0.005)
McFadden R-Squared	0.427	0.435	0.426	0.405	0.411	0.450	0.280	0.421
Total obs	77	77	77	75	75	77	77	77
Obs with Dep=0	59	59	59	58	58	59	59	59
Obs with Dep=1	18	18	18	17	17	18	18	18

(Probability levels in parentheses)

We also test our benchmark model with different endogenous variables (Table 4). We use different thresholds for the same indicator (CRIHIGH and CRILOW) as well as broader indices of financial distress (CRIINT, CRISTK, and CRIINTSTK). For CRISTK and CRIINTSTK, we run additional regressions including as regressors the stock market variables capturing risk management portfolio adjustments. Comparisons are made difficult, however, by the fact that the sample changes substantially because the interest rate and the stock market variables are available only for smaller and non-overlapping sets of countries.

In the regressions with the different indices, the explanatory variables generally have the correct sign. Note that the financial variables (bank lending maturity, common creditor, and reserve adequacy) are usually significant in the benchmark model with all types of become significant when we lower the threshold (CRILOW), suggesting that in the three endogenous variables. It is interesting that the variables measuring domestic imbalances crises under analysis these variables are normally responsible for generating modest exchange rate pressure, but in the main are not enough, by themselves, to induce a full scale crisis.

C. Interpretation of the Coefficients

In order to interpret the estimation results in terms of the contribution of each variable to the probability of a crisis, we present two exercises in Table 5.[30] Column [1] calculates the increased probability of a crisis that arises from a worsening of each of the underlying factors, that is, from changing one variable at a time by one standard deviation, when all other variables are at the mean values of the whole sample. Column [2] calculates the increased probability of a crisis from changing one variable at a time from its noncrisis to its crisis mean, when all other

[30]The probability of a crisis when variables are at their mean value can be derived by calculating the Normal Cumulative Density Function (CDF) of the value of the right hand side (RHS) of the regression evaluated at mean values. Such probability is very small (0.071). As one would expect, a country with average characteristics faces a practically zero chance of entering a crisis. One can then approximate the effect of a given "deterioration" of a specific variable by adding to the RHS at mean values the given change in the variable multiplied by the "absolute value" of the corresponding estimated coefficient, and then applying the CDF to the new value for the RHS. The difference in the new CDF and the one at mean values approximate the probability effect of the change in that variable.

Table 4. Alternative Indicators of Crisis

	CRIHIGH	CRILOW	CRIINT	CRISTK	CRISTK	CRIINTSTK	CRIINTSTK
C	-2.480	-1.148	-2.752	-2.683	-4.936	-2.695	-9.234
	(0.070)	(0.364)	(0.070)	(0.070)	(0.058)	(0.060)	(0.044)
REERG	-0.525	1.729	3.198	2.418	5.244	2.667	15.955
	(0.537)	(0.283)	(0.061)	(0.143)	(0.027)	(0.115)	(0.021)
BCAY	-15.025	-19.278	-10.546	-4.460	5.128	-13.203	-26.106
	(0.065)	(0.018)	(0.224)	(0.609)	(0.712)	(0.134)	(0.213)
GGBY3	-7.379	-15.992	3.324	-9.866	-4.251	-5.873	-18.128
	(0.293)	(0.035)	(0.643)	(0.178)	(0.662)	(0.399)	(0.385)
M2YG	0.485	1.776	-1.043	-1.416	-0.967	-0.649	1.543
	(0.614)	(0.097)	(0.342)	(0.280)	(0.477)	(0.550)	(0.335)
GDP3G	-16.487	-26.391	-15.487	-20.558	-23.138	-7.132	-1.797
	(0.136)	(0.013)	(0.153)	(0.057)	(0.093)	(0.487)	(0.935)
TC	2.684	3.308	1.452	2.452	3.094	1.792	-0.738
	(0.212)	(0.152)	(0.487)	(0.279)	(0.276)	(0.390)	(0.842)
BISST	0.020	-0.004	0.034	0.037	0.067	0.028	0.077
	(0.327)	(0.823)	(0.115)	(0.089)	(0.066)	(0.176)	(0.128)
BISAB	0.003	0.009	0.005	0.006	0.002	0.005	0.005
	(0.093)	(0.002)	(0.034)	(0.022)	(0.270)	(0.035)	(0.500)
STDTRS	0.289	0.267	0.511	0.276	0.712	0.382	2.004
	(0.090)	(0.101)	(0.004)	(0.089)	(0.015)	(0.030)	(0.018)
STKVAR					21.713		9.000
					(0.566)		(0.884)
STKCOR1ST					5.138		15.461
					(0.047)		(0.092)
McFadden R-Squared	0.216	0.376	0.365	0.331	0.493	0.310	0.679
Total obs	76	78	68	65	55	59	49
Obs with Dep=0	63	54	46	45	36	36	27
Obs with Dep=1	13	24	22	20	19	23	22

(Probability levels in parentheses)

Table 5. Interpreting the Coefficient of the Probit Regression

	Mean			Standard Deviation			[1]	[2]
Variable	**Dep=0**	**Dep=1**	**All**	**Dep=0**	**Dep=1**	**All**		
REERG	0.058	0.215	0.095	0.163	0.400	0.246	0.208	0.095
BCAY	-0.027	-0.038	-0.030	0.028	0.033	0.029	0.163	0.040
GGBY3	-0.030	-0.035	-0.031	0.032	0.034	0.033	0.089	0.011
M2YG	0.046	0.071	0.052	0.253	0.224	0.245	0.061	0.005
GDP3G	0.042	0.031	0.040	0.030	0.037	0.032	0.349	0.071
TC	0.011	0.044	0.019	0.090	0.122	0.098	0.072	0.019
BISST	56.318	58.107	56.737	12.793	9.402	12.052	0.120	0.012
BISAB	26.289	106.086	44.943	58.659	171.440	101.764	0.312	0.176
STDTRS	-0.886	0.122	-0.650	1.524	0.783	1.447	0.117	0.064

[1] increased probability of a crisis from a worsening of each of the underlying factors, i.e., from changing one variable at a time by one standard deviation, when all other variables are at the mean values of the whole sample.

[2] increased probability of a crisis from changing one variable at a time from its noncrisis to its crisis mean, when all other variables are at the mean values of the whole sample.

variables are at the mean values of the whole sample. As one can see, the effects for output growth and the common creditor are very large, followed by the ones for external weaknesses, debt maturity, and reserve adequacy. For example, a country that experiences a growth rate of about one standard deviation (3.2 percentage points) below the average (4 percent) would face a 0.35 greater probability of a crisis than a country with average characteristics. Similarly, when country A enters a crisis, a country that has a common creditor linkage with A of about 1 standard deviation larger (about 100) than the average (about 45) would face a 0.31 greater probability of a crisis than the average country. In our sample, a country has a common creditor linkage that is one standard deviation above the average if it has a borrowing share from the common creditor 20 (25) percent higher than the average and a lending share in the common creditor's portfolio 5 (4) percent higher than the average.

D. Time and Regional Effects and the Importance of the Common Creditor

Emerging market crises do not appear to differ across time periods and regions once we control for the variables in the benchmark model. Time-specific effects (crisis dummies) and region-specific effects (regional dummies) are not found to be significantly different – we cannot reject the hypothesis that they have identical coefficients (Table 6). In addition to supporting the benchmark model, this result has an important implication: it suggests that differences in the three crises or in the regional patterns can therefore be imputed to time and regional differences in the economic indicators present in the benchmark model.

Figures 1 and 2 show that each of the three crises was regionally concentrated. One could therefore suspect that regional effects are time specific, so that Asian countries suffered the Asian crisis "more" than other countries, Latin American countries were more affected during the Mexican crisis, and the transition economies suffered more the Russian crisis. We therefore interact the region and crisis-specific dummies. Once the explanatory variables are controlled for, these dummies or a combination of these dummies (PROXIMITY) are not significant, suggesting again that the observed bunching of the crises is due to the explanatory variables.

This is not surprising when one considers that some variables, like trade contagion and the common creditor, have regional effects. In particular, it appears that the common creditor explains the regional bunching of crises because when the common creditor is excluded the PROXIMITY dummy becomes significant. The importance of the common creditor in explaining these crises is also highlighted by the sharp fall in the explanatory power of the regressions when the variable is excluded.

Table 6. Time and Region Specific Effects[1]

	Regression 1	Regression 2	Regression 3	Regression 4	Regression 5	Regression 6
C			-5.512	-4.668	-2.426	-2.175
			(0.017)	(0.024)	(0.083)	(0.107)
REERG	3.806	4.925	4.514	3.551	2.928	3.295
	(0.079)	(0.052)	(0.058)	(0.095)	(0.096)	(0.052)
BCAY	-24.205	-16.875	-23.689	-24.505	-7.821	-8.423
	(0.018)	(0.153)	(0.029)	(0.016)	(0.271)	(0.225)
GGBY3	-14.259	-18.184	-16.457	-14.580	-5.093	-3.677
	(0.151)	(0.096)	(0.129)	(0.126)	(0.474)	(0.593)
M2YG	1.650	2.677	2.534	1.482	1.408	1.324
	(0.175)	(0.089)	(0.095)	(0.190)	(0.147)	(0.162)
GDP3G	-38.321	-39.688	-39.289	-40.043	-15.439	-11.648
	(0.014)	(0.020)	(0.025)	(0.009)	(0.110)	(0.196)
TC	4.029	5.149	4.301	3.829	2.414	3.003
	(0.434)	(0.126)	(0.273)	(0.177)	(0.272)	(0.158)
BISST	0.050	0.070	0.058	0.050	0.022	0.019
	(0.084)	(0.058)	(0.063)	(0.084)	(0.287)	(0.329)
BISAB	0.011	0.011	0.012	0.011		
	(0.005)	(0.007)	(0.005)	(0.006)		
STDTRS	0.404	0.614	0.454	0.402	0.351	0.355
	(0.034)	(0.038)	(0.028)	(0.036)	(0.026)	(0.026)
MEX	-4.854					
	(0.024)					
ASIA	-4.936					
	(0.027)					
RUS	-4.397					
	(0.037)					
LATAM		-6.132				
		(0.017				
ASIANCO		-6.341				
		(0.014)				
TRANSIT		-4.548				
		(0.044)				
OTHEMG		-6.444				
		(0.023)				
MEX*LATAM			-0.853			
			(0.438)			
ASIA*ASIANCO			-0.229			
			(0.813)			
RUS*TRANSIT			1.720			
			(0.118)			
PROXIMITY				0.202	0.784	
				(0.707)	(0.068)	
McFadden R-Squared	N.A.	N.A.	0.474	0.426	0.279	0.239
F Stat[2]	0.542	0.356	0.238			
Chi-Square[2]	0.539	0.348	0.230			
Total obs	77	77	77	77	77	77
Obs with Dep=0	59	59	59	59	59	59
Obs with Dep=1	18	18	18	18	18	18

[1]Probability levels in parentheses.
[2]Null hypothesis is that coefficients on dummies are equal. We reject the null when the probability value is less than 0.05 or 0.10.

E. Exchange Rate Regimes and Capital Controls

Exchange rate regimes and capital controls are found not to play a role (Table 7). We use three indices for exchange rate regimes based on: the official IMF classification (EROFF), the variability of the nominal exchange rate (ERSTD), or the number of times there are substantial changes in the exchange rate (ERTIMES).[31] None of the proxies is significant.

Equally insignificant appears to be the effect of capital controls (KCONTR), as proxied by the existence of restrictions on payments for capital transactions as reported in the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions*. Such evidence should be interpreted with care given the immense difficulties of accurately and comparably measuring the extent and effectiveness of capital controls.[32] Nonetheless, our results on the role of capital controls are consistent with those of Eichengreen, et al.

We also combine the exchange rate regime and capital control dummies to investigate the probability that countries with fixed exchange rate regimes coupled with free capital flows are more vulnerable to crisis. The evidence does not confirm this suspicion (again with the caveat regarding the measurement of capital controls): such an institutional setup does not seem to increase the probability of a crisis, once we control for the variables present in our benchmark model. This result suggests that the real sources of fragility lie in external weaknesses, domestic imbalances, reserve inadequacy, and the sensitivity to trade and financial contagion.

F. Nonlinearities

In our benchmark model, the current account is significant and trade contagion is (marginally) not. However, if we add a term multiplying the two variables, the latter term is significant and the current account remains significant, suggesting that countries are sensitive to trade contagion when they exhibit external weakness as measured by the current account deficit (Table 8a).[33]

We also find extensive evidence on the interaction between external and internal imbalances. It appears that domestic imbalances (such as large fiscal deficits and excessive

---

[31]These dummies are equal to 1 in the case of a flexible exchange rate regime, and 0 otherwise. See Appendix I for the exact definition.

[32]A similar dataset has also been used by Grilli and Milesi-Ferretti (1995) to study the effects and the determinants of capital controls for a large group of countries. We thank the authors for kindly providing us with the electronic version of the dataset until 1995. We have updated the dataset to 1998 on the basis of the aforementioned IMF publication.

[33]It is interesting to note that if we exclude the transition economies from the sample, the current account variable is no longer significant. This may explain why previous studies that excluded the transition economies found no significant effect from this variable. We also find that trade contagion is almost significant when combined with an Asian countries dummy. This result, however, is due to the fact that Asian countries that suffered crises had worse current account balances than the average.

monetary expansion) become important when accompanied by external weakness (as measured by the REER appreciation). This is particularly true when a monetary expansion occurs in the presence of a fixed exchange rate regime (Table 8b).

G. Industrial Countries: A Different Pattern.

Eichengreen, et al., presented extensive empirical evidence on the determinants of crisis for industrial countries. They generally found only a few variables, such as unemployment and inflation, to be significant. For comparison with their study and with our results for the emerging market countries, we run both the initial and the benchmark models for industrial countries with and without unemployment and inflation (Table 9; due to data availability, we drop BISST, BISAB, and STDTRS). We include the ERM crisis in the regression as this is the one that largely affected industrial countries. The results do not appear to be robust, but do not differ much from those in other studies. In addition to unemployment, the current account balance and the output growth rate are significant in some specifications. The insignificance of inflation is reasonable in light of the different time span of our exercise (the 1990s) and that of Eichengreen, et al., (1960s to beginning of 1990s). These results suggest that the nature of recent crises is substantially different between emerging market and industrial countries.

Table 7. Exchange Rate Regimes and Capital Controls

	Regression 1	Regression 2	Regression 3	Regression 4	Regression 5	Regression 6	Regression 7
C	-4.606	-6.175	-5.493	-4.791	-4.641	-4.647	-4.676
	(0.025)	(0.017)	(0.020)	(0.024)	(0.024)	(0.023)	(0.024)
REERG	3.612	4.837	3.915	3.540	3.570	3.491	3.726
	(0.088)	(0.055)	(0.073)	(0.092)	(0.091)	(0.097)	(0.090)
BCAY	-24.617	-27.619	-26.696	-25.198	-25.559	-25.509	-25.250
	(0.021)	(0.010)	(0.011)	(0.012)	(0.011)	(0.011)	(0.011)
GGBY3	-14.782	-18.498	-14.901	-13.913	-14.623	-14.271	-15.185
	(0.126)	(0.081)	(0.117)	(0.152)	(0.126)	(0.134)	(0.126)
M2YG	1.481	1.503	1.191	1.490	1.529	1.554	1.420
	(0.201)	(0.187)	(0.299)	(0.189)	(0.188)	(0.175)	(0.202)
GDP3G	-39.848	-41.448	-41.936	-40.557	-40.768	-41.213	-39.753
	(0.010)	(0.009)	(0.008)	(0.009)	(0.008)	(0.008)	(0.010)
TC	4.198	4.848	4.377	4.216	4.080	4.058	4.015
	(0.144)	(0.099)	(0.120)	(0.137)	(0.142)	(0.144)	(0.151)
BISST	0.050	0.060	0.055	0.050	0.049	0.050	0.049
	(0.088)	(0.056)	(0.067)	(0.080)	(0.083)	(0.078)	(0.089)
BISAB	0.011	0.012	0.012	0.011	0.011	0.011	0.011
	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)
STDTRS	0.409	0.397	0.378	0.381	0.390	0.359	0.424
	(0.036)	(0.051)	(0.056)	(0.062)	(0.044)	(0.076)	(0.043)
EROFF	-0.117						
	(0.865)						
ERSTD		0.677					
		(0.254)					
ERTIMES			0.537				
			(0.387)				
KCONTR				0.177			
				(0.785)			
(1-EROFF)*(1-KCONTR)					-0.458		
					(0.720)		
(1-ERSTD)*(1-KCONTR)						-0.689	
						(0.534)	
(1-ERTIMES)*(1-KCONTR)							0.235
							(0.792)
McFadden R-Squared	0.424	0.441	0.434	0.425	0.426	0.429	0.425
Total obs	77	77	77	77	77	77	77
Obs with Dep=0	59	59	59	59	59	59	59
Obs with Dep=1	18	18	18	18	18	18	18

(Probability levels in parentheses)

Table 8A. Nonlinearities

	Regression 1	Regression 2	Regression 3
C	-5.201 (0.022)	-5.044 (0.013)	-4.868 (0.013)
REERG	4.819 (0.049)	0.584 (0.800)	3.701 (0.030)
BCAY	-28.263 (0.010)	-29.632 (0.007)	-25.589 (0.012)
GGBY3	-18.587 (0.076)	-4.564 (0.645)	-17.262 (0.066)
M2YG	1.599 (0.169)	2.255 (0.086)	-0.056 (0.965)
GDP3G	-44.269 (0.007)	-51.185 (0.006)	-44.825 (0.007)
TC	-0.898 (0.826)	4.963 (0.101)	4.610 (0.103)
BISST	0.052 (0.092)	0.062 (0.047)	0.054 (0.060)
BISAB	0.013 (0.003)	0.013 (0.002)	0.011 (0.004)
STDTRS	0.344 (0.084)	0.545 (0.015)	0.419 (0.031)
TC2*BCAY	-133.192 (0.092)		
GGBY3*REERG		-120.041 (0.098)	
M2YG*REERG			11.368 (0.038)
McFadden R-Squared	0.461	0.455	0.461
Total obs Obs with Dep=0 Obs with Dep=1	77 59 18	77 59 18	77 59 18

(Probability levels in parentheses)

Table 8B. Nonlinearities

	Regression 4	**Regression 5**	**Regression 6**	**Regression 7**	**Regression 8**	**Regression 9**
C	-4.334 (0.044)	-4.792 (0.026)	-4.920 (0.016)	-3.575 (0.054)	-4.699 (0.027)	-4.779 (0.015)
REERG	0.611 (0.786)	0.253 (0.913)	0.066 (0.977)			
BCAY	-27.894 (0.016)	-30.100 (0.016)	-31.254 (0.005)	-24.448 (0.017)	-30.074 (0.013)	-29.988 (0.004)
GGBY3	-2.963 (0.771)	-2.295 (0.824)	-4.562 (0.640)			
M2YG	1.580 (0.187)	-0.417 (0.784)	1.067 (0.487)			
GDP3G	-59.227 (0.004)	-62.427 (0.005)	-47.064 (0.011)	-51.920 (0.004)	-63.069 (0.003)	-41.372 (0.005)
TC	5.696 (0.073)	4.398 (0.193)	3.023 (0.355)	4.528 (0.121)	4.426 (0.179)	1.759 (0.517)
BISST	0.057 (0.080)	0.068 (0.048)	0.060 (0.058)	0.049 (0.093)	0.068 (0.043)	0.061 (0.047)
BISAB	0.013 (0.005)	0.013 (0.006)	0.012 (0.004)	0.012 (0.005)	0.013 (0.004)	0.011 (0.003)
STDTRS	0.593 (0.017)	0.644 (0.015)	0.550 (0.022)	0.534 (0.011)	0.656 (0.008)	0.566 (0.012)
GGBY3*REERG	-141.686 (0.061)	-161.468 (0.054)	-112.932 (0.117)	-120.871 (0.013)	-170.70 (0.006)	-107.817 (0.030)
(1-EROFF)*M2YG*REERG	30.498 (0.081)			25.408 (0.049)		
(1-ERTIMES)*M2YG*REERG		48.231 (0.176)			45.188 (0.154)	
(1-ERSTD)*M2YG*REERG			30.603 (0.165)			35.925 (0.099)
McFadden R-Squared	0.482	0.514	0.486	0.454	0.512	0.477
Total obs	77	77	77	77	77	77
Obs with Dep=0	59	59	59	59	59	59
Obs with Dep=1	18	18	18	18	18	18

(Probability levels in parentheses)

TABLE 9. OTHER SAMPLES: INDUSTRIAL COUNTRIES AND THE WORLD

	Industrial Countries						All Countries	
	Initial Model			Benchmark Model			Initial Model	Benchmark Model
C	0.643	-0.034	-0.398	-0.221	-0.797	-0.560	-1.308	-0.814
	(0.570)	(0.977)	(0.787)	(0.658)	(0.177)	(0.427)	(0.017)	(0.000)
REERG	-1.281	-2.789	-3.004	-1.074	-0.543	-1.481	1.931	0.455
	(0.685)	(0.432)	(0.469)	(0.603)	(0.809)	(0.563)	(0.070)	(0.406)
BCAY	-15.831	-12.044	-18.580	-12.339	-11.244	-14.782	-10.346	-9.796
	(0.029)	(0.115)	(0.092)	(0.042)	(0.076)	(0.091)	(0.006)	(0.002)
XY3LG	0.129	-2.549	-0.527				0.557	
	(0.956)	(0.348)	(0.863)				(0.521)	
GGBY3	4.966	10.005	24.041	6.798	11.016	21.645	1.820	1.419
	(0.423)	(0.142)	(0.059)	(0.210)	(0.070)	(0.028)	(0.647)	(0.654)
M2YG	-1.318	-1.890	0.913	-1.295	-1.476	0.848	0.465	0.101
	(0.402)	(0.258)	(0.769)	(0.365)	(0.304)	(0.747)	(0.437)	(0.839)
GDP3G	-23.499	-27.500	-34.519	-23.413	-27.756	-37.755	-9.124	-8.567
	(0.181)	(0.140)	(0.156)	(0.112)	(0.074)	(0.064)	(0.140)	(0.056)
TC	1.417	1.720	1.282	1.388	1.650	0.849	1.474	1.620
	(0.219)	(0.156)	(0.380)	(0.160)	(0.117)	(0.480)	(0.078)	(0.012)
STKVAR	-12.442	-21.569	-21.406				6.486	
	(0.765)	(0.564)	(0.611)				(0.712)	
STKCOR1ST	0.878	0.404	-0.180				0.795	
	(0.416)	(0.732)	(0.896)				(0.235)	
M2RS	-0.442	-0.403	-0.104				0.157	
	(0.191)	(0.262)	(0.810)				(0.369)	
UR		0.131	0.127		0.089	0.090		
		(0.029)	(0.081)		(0.041)	(0.074)		
INFL			21.946			19.754		
			(0.323)			(0.206)		
McFadden R-Squared	0.199	0.280	0.317	0.165	0.223	0.280	0.145	0.106
Total obs	71	71	60	77	77	66	154	202
Obs with Dep=0	59	59	50	63	63	54	120	160
Obs with Dep=1	12	12	10	14	14	12	34	42

(Probability levels in parentheses)

V. CONCLUSION

This paper extends earlier work on indicators of vulnerability to currency crises by examining the differences between countries that experienced currency pressures from those that did not during the major crisis episodes of the 1990s. In particular, we investigate the role of financial linkages and weaknesses while controlling for the roles of external and internal (macroeconomic) imbalances and trade spillovers using panel probit estimation for a sample of emerging market and, separately, industrial countries.

The results indicate that once we control for domestic and external fundamentals and trade spillovers, financial linkages and weaknesses play a significant role in explaining the spread of emerging market crises, while exchange rate regimes and capital controls do not seem to matter. It would appear, therefore, that countries with sound macroeconomic and external fundamentals as well as low sensitivity to trade and financial spillovers do not seem to face additional exchange rate vulnerability from adopting fixed exchange rate regimes without imposing capital controls.

The recent pattern of crises in emerging market economies does not appear to be different across crisis episodes (Mexican, Asian, and Russian) and across geographic regions, once the relevant explanatory variables common to the crises are taken into account. Moreover, these factors, particularly financial linkages through a common creditor, appear to explain why there is an apparent pattern of regional concentration specific to each crisis episode. The results thus suggest that the regional pattern of crises can be explained by economic factors and not by referring, for example, to irrational herd behavior of financial agents who assess financial stability on the basis of geographical proximity.

Among the fundamentals, weak output growth appears to play a larger role than external imbalances in reducing the probability of a crisis. While domestic imbalances generally do not appear to be significant, they become significant when combined with a recent real exchange rate appreciation. The indicators of vulnerability to international financial spillover and of financial fragility (reserve adequacy) are highly significant. In particular, a strong financial linkage with the major creditor of the first crisis country (common creditor) appears to substantially raise the probability of a crisis. Trade spillovers, from the devaluations and output contractions of other crisis countries, are particularly relevant for countries with weak current account balances.

The economies that suffered crises during these episodes did not necessarily do so because of contagion or spillover effects; the exchange rate pressures could have arisen because of domestic and external economic imbalances or because of common shocks. However, our results, in addition to the temporal clustering of crises, suggest that trade and financial linkages may have played a role.

While the bulk of the study focuses on emerging market economies, we also present estimation results for industrial countries which suggest that crises in these countries may have a different nature. For these countries, the unemployment rate, the current account balance and the output growth rate are significant in some specifications.

REFERENCES

Agenor, Pierre-Richard, and Joshua Aizenman, 1998, "Contagion and Volatility with Imperfect Credit Markets," IMF *Staff Papers*, Vol. 45 (June), pp. 207-35.

Allen, Franklin and Douglas Gale, 1998, "Financial Contagion," New York University, C.V. Starr Center for Applied Economics, Economic Research Reports No. 98-33 (October).

Aziz, Jahangir, Francesco Caramazza, and Ranil Salgado, 1999, "Currency Crises: In Search of Common Elements," IMF Working Paper, forthcoming.

Baig, Taimur, and Ilan Goldfajn, 1999, "Financial Market Contagion in the Asian Crisis," *IMF Staff Papers*, Vol. 46 (June), pp. 167-95.

Berg, Andrew, and Catherine Pattillo, 1999, Are Currency Crises Predictable? A Test, *IMF Staff Paper*, Vol. 46 (June), pp. 107-38.

Borensztein, Eduardo, and Gaston Gelos, 1999, "A Panic-Prone Pack? The Behavior of Emerging Market Mutual Funds," IMF Working Paper, preliminary.

Bussière, Matthieu, and Christian Mulder, 1999, "External Vulnerability in Emerging Market Economies: How High Liquidity Can Offset Weak Fundamentals and the Effects of Contagion," IMF Working Paper 99/88 (July).

Calvo, Guillermo, 1997, "Varieties of Capital Market Crises," in *The Debt Burden and Its Consequences for Monetary Policy*, edited by G. Calvo and M. King (New York: St. Martin's Press).

Calvo, Guillermo, 1999, "Contagion in Emerging Markets," mimeo, University of Maryland.

Calvo, Guillermo, and Enrique Mendoza, 1998, "Contagion, Globalization, and the Volatility of Capital Flows," mimeo, University of Maryland.

Calvo, Sara, and, Carmen Reinhart, 1996, "Capital Flows of Latin America: Is There Evidence of Contagion Effects?," Policy Research Working Paper No. 1619.

Cashin, Paul, Manmohan Kumar, and John McDermott, 1995, "International Integration of Equity Markets and Contagion Effects," IMF Working Paper 95/110.

Choueiri, Nada, 1999, "A Model of Contagious Currency Crisis with Application to Argentina," IMF Working Paper 99/29.

Corsetti, Giancarlo, Paolo Pesenti, and Nouriel Roubini, 1999, "What Caused the Asian Currency and Financial Crisis?" *Japan and the World Economy*, Vol. 11, p. 305-73.

Corsetti, Giancarlo, Paolo Pesenti, Nouriel Roubini, and Cédric Tille, 1998, "Trade and Contagious Devaluations: A Welfare-based Approach," unpublished.

Drazen, Allen, 1998, "Political Contagion in Currency Crises," paper prepared for an NBER conference on currency crises, Cambridge, MA (February 6-7).

Edwards, Sebastian, 1998, "Interest Rate Volatility, Capital Controls and Contagion" Working Paper No. 6756, National Bureau of Economic Research.

Edwards, Sebastian, 1989, *Real Exchange Rates, Devaluation, and Adjustment: Exchange Rate Policy in Developing Countries* (Cambridge, Massachusetts: MIT Press)

Eichengreen, Barry, Andrew K. Rose, and Charles Wyplosz, 1996, Contagious Currency Crises: First Tests, *Scandinavian Journal of Economics*, Vol. 98, No. 4, pp. 463 84.

Forbes, Kristin and Roberto Rigobon, 1999, "Measuring Contagion: Conceptual and Empirical Issues," mimeo, MIT Sloan School of Management.

Frankel, Jeffrey A., and Andrew K. Rose, 1996, Currency Crashes in Emerging Markets: An Empirical Treatment, *Journal of International Economics*, Vol. 41 (November), pp. 351-66.

Frankel, Jeffrey A., and Sergio Schmukler, 1996, Crisis, Contagion, and Country Funds: Effects on East Asia and Latin America, Federal Reserve Bank of San Francisco, Working Paper PB96-04.

Gelos, Gaston, and Ratna Sahay, 1999, "Financial Market Spillovers in Transition Economies," IMF Working Paper, preliminary.

Gerlach, Stefan, and Frank Smets, 1995, "Contagious Speculative Attacks," *European Journal of Political Economy* (March).

Glick, Reuven, and Andrew K. Rose, 1999, "Contagion and Trade: Why are Currency Crises Regional?," *Journal of International Money and Finance*, Vo.18.

Goldfajn, Ilan, and Rodrigo Valdes, 1997, Capital Flows and the Twin Crises: The Role of Liquidity, Working Paper 97/87 (July).

Goldfajn, Ilan, Rodrigo O. Valdés, 1998, "Are Currency Crises Predictable?," *European Economic Review*, Vol. 42 (May), pp. 873-85.

Goldstein, Morris, 1998, *The Asian Financial Crisis: Causes, Cures, and Systemic Implications*, Policy Analyses in International Economics No. 55 (Washington: Institute for International Economics).

Goldstein, Morris, Graciela L. Kaminsky, and Carmen M. Reinhart, 1999, Assessing Financial Vulnerability: An Early Warning System for Emerging Markets," unpublished, (Washington: Institute for International Economics).

Grilli Vittorio, and Gian Maria Milesi-Ferretti, 1995, "Economic Effects and Determinants of Capital Controls", *IMF Staff Papers*, Vol. 42 (September), pp.517-551.

Huang, Haizhon and Chenggang Xu, 1998, "Financial Institutions, Financial Contagion, and Financial Crises," mimeo, IMF and London School of Economics (December).

International Monetary Fund (1998), Financial Crises: Characteristics and Indicators of Vulnerability, Chapter IV in the May 1998 *World Economic Outlook.*

International Monetary Fund, 1999, "International Financial Contagion," Chapter III in the May 1999 *World Economic Outlook.*

Kamin, Steven B., and Oliver D. Babson, 1999, "The Contributions of domestic and External Factors to Latin American Devaluation Crisis: An Early Warning Systems Approach," Board of Governors of the Federal Reserve System, International Finance Discussion Papers, No.645 (September).

Kaminsky, Graciela L., 1998, "Currency and Banking Crises: The Eraly Warnings of Distress," Board Of Governors of the Federal Reserve System, International Finance Discussion Papers, No.629 (October).

Kaminsky, Graciela L., Sergio L. Schmukler, 1999, "What Triggers Market Jitters? A Chronicle of the Asian Crisis," Board of Governors of the Federal Reserve System, International Finance Discussion Paper, No. 634 (April).

Kaminsky, Graciela L. and Carmen M. Reinhart, 1999, The Twin Crises: The Causes of Banking and Balance-of-Payments Problems, *American Economic Review*, Vol. 89 (June), pp.473-500.

Kaminsky, Graciela L., and Carmen M. Reinhart, 1998, "On Crises, Contagion, and Confusion," paper prepared for the Duke University conference "Globalization, Capital Market Crises, and Economic Reform" (November).

Kaminsky, Graciela L., Saul Lizondo, and Carmen M. Reinhart, 1998, "The Leading Indicators of Currency Crises," IMF *Staff Papers*, Vol. 45 (March), pp. 1-48.

Kodres, Laura and Matthew Pritsker, 1998, "A Rational Expectations Model of Financial Contagion," Board of Governors of the Federal Reserve System, Finance and Economic Discussion Series, No. 1998-48 (December).

Lagunoff, Roger and Stacey Schneft, 1998, "A Model of Financial Fragility," mimeo, Georgetown University and the Federal Reserve Bank of Kansas City (September).

Levy-Yeyati, Eduardo, and Angel Ubide, 1998, "Crises, Contagion, and the Closed-End Country Fund Puzzle," IMF Working Paper 98/143 (September).

Marion, Nancy, 1999, "Some Parallels Between Currency and Banking Crises", presented at the "Conference in Celebration of the Contribution of Robert Flood", IMF, Washington, January 15-16.

Masson, Paul, 1998, Contagion: Monsoonal Effects, Spillovers, and Jumps Between Multiple Equilibria, IMF Working Paper 98/142 (September).

Milesi-Ferretti, Gian Maria and Assaf Razin, 1998, Current Account Reversals and Currency Crises: Empirical Regularities, IMF Working Paper 98/89 (June).

Rigobon, Roberto, 1999, "On the Measurement of the International Propagation of Shocks," NBER Working Paper 7354 (Cambridge, Massachusetts: National Bureau of Economic Research).

Sachs, Jeffrey D., Aaron Tornell, and Andres Velasco, 1996, Financial Crises in Emerging Markets: The Lessons from 1995, *Brookings Papers on Economic Activity*, No. 1, pp. 147 215.

Senhadji, Abdelhak, and Claudio Montenegro, 1998, Time Series Analysis of Export Demand Equations: A Cross Country Analysis , IMF Working Paper 98/149.

Tornell, Aaron, 1999, Common Fundamentals in the Tequila and Asian Crises, NBER Working Paper 7139 (Cambridge, Massachusetts: National Bureau of Economic Research).

Valdes, Rodrigo, 1996, "Emerging Markets Contagion," mimeo, MIT.

Van Rijckeghem, Caroline, and Beatrice Weder, 1999a, "Sources of Contagion: Is it Finance or Trade?," IMF Working Paper 99/146 (October).

Van Rijckeghem, Caroline, and Beatrice Weder, 1999b, "Financial Contagion: Spillovers through Banking Centers," mimeo, IMF and University of Basel (September).

Appendix I. Data Construction and Sources

A. Sample

Industrial Countries (20):

- Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom

Emerging Market Countries (41):

- Latin America (12): Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Jamaica, Mexico, Paraguay, Peru, Uruguay, and Venezuela.
- Asia (13): Bangladesh, China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan POC, and Thailand.
- Countries in Transition (7): Bulgaria, Czech Republic, Hungary, Poland, Romania, Russia, and Slovak Republic.
- Middle East and Africa (9): Egypt, Israel, Kenya, Morocco, Nigeria, Tunisia, Turkey, South Africa, and Zimbabwe.

B. Dependent and Explanatory Variables

Sources of components of dependent variables

CRIIND	Exchange rate (from *IFS*) and foreign reserves (*IFS*, line 1L)
CRIHIGH	Same as CRIIND
CRILOW	Same as CRIIND
CRIINT	Same as CRIIND and interest rates (*IFS*, lines 60b, 60, or 60p)
CRISTK	Same as CRIIND and stock prices (*IFS* or Primark Datastream)
CRIINTSTK	Same as CRIIND and interest rates (*IFS*, lines 60b, 60, or 60p) and stock prices (*IFS* or Primark Datastream)

Explanatory variables: sources and construction

Real variables

GDPG	1-year precrisis real GDP growth (*WEO*)
GDP3G	Average 3-year precrisis real GDP growth (*WEO*)
UR	Precrisis unemployment rate (*WEO*)
URG	1-year log change of the precrisis unemployment rate (*WEO*)
ICORG	3-year log change of 5-year trailing average of precrisis ICOR (*WEO*)

Monetary variables

INFL	12-month precrisis inflation rate, in log change (*IFS*)
INOM	12-month average of precrisis nominal interest rate (*IFS*, line 60b)
IREAL	Real interest rate (derived from INOM and INFL)
M2RG	3-year log change of precrisis real M2 (*IFS*, broad money deflated by CPI)
M2YG	3-year log change of precrisis M2 (*IFS*) to GDP (*WEO*)
DCYG	3-year log change of precrisis domestic credit (*IFS*) to GDP (*WEO*)

DCRG	3-year log change of precrisis real domestic credit (*IFS*, deflated by CPI)
DCRYG	3-year log change of precrisis real domestic credit (*IFS*) to GDP (*WEO*)
PDCYG	3-year log change of precrisis private domestic credit (*IFS*) to GDP (*WEO*)
PDCRG	3-year log change of precrisis real private domestic credit (*IFS*, deflated by CPI)
PDCRYG	3-year log change of precrisis real private domestic credit (*IFS*) to GDP (*WEO*)

Fiscal variables

GGBY3	3-year precrisis average of general government balance to GDP (*WEO*)
PUDY	Precrisis year total public debt (*GFS*) to GDP (*WEO*)
PUDYG	3-year log change of precrisis total public debt (*GFS*) to GDP (*WEO*)
DPUDY	Precrisis year domestic public debt (*GFS*) to GDP (*WEO*)
DPUDYG	3-year log change of precrisis domestic public debt (*GFS*) to GDP (*WEO*)
FPUDY	Precrisis year foreign public debt (*GFS*) to GDP (*WEO*)
FPUDYG	3-year log change of precrisis foreign public debt (*GFS*) to GDP (*WEO*)

External variables

REERG	3-year log change of 12-month precrisis average of REER (IMF, *INS* database)
RSG	3-year log change of 12-month precrisis average of foreign reserves (*IFS*, line 1L)
TOTG	3-year log change of 12-month precrisis average of terms of trade (*IFS*)
BCAY	Precrisis year current account balance to GDP (*WEO*)
BCAY3	3-year precrisis average of current account balance to GDP (*WEO*)
TBYG	1-year change in precrisis trade balance to GDP (*WEO*)
XG	1-year change in precrisis exports (*WEO*)
XYG	1-year change in precrisis exports to GDP (*WEO*)
XY3LG	3-year log change of precrisis exports to GDP (*WEO*)
PCAPYG	3-year level change in precrisis net private capital flows to GDP (*WEO*)
DTY	Precrisis external debt to GDP (*WEO*)
DTYG	3-year log change of precrisis external debt to GDP (*WEO*)
STDT	Precrisis short-term to total external debt (*WEO*)
STDTG	3-year log change of precrisis short-term to total external debt (*WEO*)
DSHARE	Precrisis share of external debt denominated in local currency (*WEO*)
TC	See Appendix I.C for description and sources of TC variable and components.

Financial variables

BISST	Short-term share of debt to BIS banks (*BIS*)
BISAB	Common creditor variable-product of BISA and BISB. Common creditor is identified by the country that lends the most to the first country in crisis (Mexico, Thailand, Russia).
BISA	Precrisis share of BIS debt that each country borrows from common creditor (*BIS*)
BISB	Precrisis share of BIS credits that common creditor lends to borrower (*BIS*)

BISPR	Precrisis private sector share of debt owed to BIS banks (*BIS*)
STDTRS	Log of precrisis short-term debt (*WEO*) to reserves (*IFS*)
STDTRSG	3-year log change of precrisis short-term debt (*WEO*) to reserves (*IFS*)
M2RS	Log of M2 to reserves ratio in year prior to crisis (*IFS*)
M2RSG	3-year log change of M2Rs (*IFS*)
FLRS	Foreign liabilities to reserves ratio in year prior to crisis (*IFS*)
FLRSG	3-year log change of FLRs (*IFS*)
FLTL	Foreign to total liabilities ratio in year prior to crisis (*IFS*)
FLTLG	3-year log change of FLTL (*IFS*)
STKT	Precrisis year share turnover (IFC Emerging Market database)
STKT3	3-year average of precrisis share turnover (IFC Emerging Market database)
STKG	12-month log change of precrisis stock prices in U.S.$ or DM (*IFS* and Primark Datastream)
STKVAR	1-year precrisis (ending two weeks before the crisis) standard deviation of daily stock prices (Primark Datastream)
STKCOR1ST	1-year precrisis correlation of stock prices with stock prices in the first crisis country (Primark Datastream)

Dummy variables

MEX	Mexican crisis dummy
ASIA	Asian crisis dummy
RUS	Russian crisis dummy
BKCRI	Banking crisis in pre-crisis year (described in IMF, 1998 and Aziz, Caramazza, and Salgado, 1999)
ASIANCO	Developing Asian country dummy
LATAM	Latin American country dummy
TRANSIT	Transition country dummy
OTHEMG	Other developing country dummy
EROFF	Set equal to 1 if a flexible exchange rate regime in IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions*, and 0 if otherwise.
ERSTD	Set equal to 1 if the standard deviation of the monthly change of the exchange rate with respect to the U.S. dollar (except for the deutsche mark for European countries other than Russia) was larger than 0.5, and 0 if otherwise.
ERTIMES	Set equal to 1 if at least one monthly change of the exchange rate (as above) is greater than 1 percent, and 0 if otherwise.
KCONTR	Set equal to 1 if there are restrictions on payments for capital transactions as reported in the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* and 0 if otherwise.
PROXIMITY	Equals MEX*LATAM + ASIA*ASIANCO + RUS*TRANSIT

C. Measuring Trade Contagion

The simplest measure is the share of bilateral trade with the crisis country. This measure, however, does not take into account the substantial indirect trade effects via competition on third markets. Glick and Rose (1998) propose a measure of trade contagion which combines a direct bilateral linkage component and a third markets linkage component. The problem with the first component is that even if the bilateral trade flows are minimal it would indicate a very large direct trade linkage when bilateral trade is almost balanced. The problem with the second component is that it aggregates proxies for third markets competition which are biased; these proxies would indicate that the degree of competition faced by country 0 (say USA) from country I (say Uganda) in market K (say Germany) is the same as the degree of competition faced by country I (say Uganda) from country 0 (say USA) in market K (say Germany).

We build a new measure of trade contagion to avoid some shortcomings of measures previously used. Our proposed *trade contagion* variable averages the *price and income effects* induced by crises in other countries during the crisis window. A relative weight of one to two for the price and the income effect is chosen on the basis of the export elasticities estimated by Senhadji and Montenegro (1998) over a large sample of countries.

Ideally, the *implied post-crisis real exchange rate appreciation* is the expected loss of competitiveness for each country arising from exchange rate crashes in other countries (price effect) and should be calculated by adding all the effects of competitor-country devaluations, both via bilateral trade linkages and via competition in third markets, but should exclude own-country exchange rate changes. By construction, INS (IMF) data on real effective exchange rates (REER) account for both the direct and indirect effects of exchange rate movements of all partner countries. To neutralize the own-country real exchange rate effect, the data are adjusted by replacing the actual exchange rate changes and inflation of the specified country during the six-month crisis window with projections based on the trend in the three years prior to the crisis. This provides a proxy of the loss of competitiveness that the financial markets may have expected this country to suffer if its exchange rate and price levels maintained the pre-crisis path, while the rest of the world underwent the actual events.[34]

---

[34] Some caveats: First, such a measure overestimates/underestimates the trade contagion effect from devaluations to the extent that financial markets expected the crisis to induce less/more severe devaluations than it actually did. Second, it underestimates by construction the relevance of trade contagion by biasing upwards the figures for noncrisis countries: it in fact measures for each of the noncrisis countries the competitiveness effect from all crisis countries, but for each of the crisis countries it captures the effect of competition from all crisis countries minus the own effect. Third, it automatically incorporates actual events which may not have been expected or may not be ascribed to the crisis. (It is virtually impossible to control for global events, as it is very difficult to assess whether some global effects during the crisis, such as changes in the dollar exchange rate, are or are not related to the crisis.)

A similar methodology is used to measure the *implied post-crisis export market growth* – i.e., the expected output contraction of partner countries due to the crisis (income effect). It is a trade-weighted average of the slowdown in output growth of partner countries during the year after the crisis (from IMF *World Economic Outlook* projections for 1998 and 1999) with respect to the average growth rate during the three years before the crisis.[35]

[35] This measure is subject to similar caveats as mentioned above for the indicator of price effects.

Appendix II. Crisis Countries [1,2]

	CriInd	CriHigh	CriLow	CriInt	CriStk	CriIntStk
Industrial						
Canada	E, R	E, R	E, R	E	E, R	E, R
Denmark	E	E	E			
Finland	E	E	E, A	E	E	E
Greece	R		E, R		E, R	R
Iceland	M	M	E, M	M		
Ireland	E, R	E, R	E, A, R		E, R	
Italy	E, M	M	E, M	E, M	E, M	E, M
New Zealand	R	R	R		R	
Norway	A		E, A	E		E, R
Portugal			E, M	E		E
Spain	E, M	E	E, M	E, M		
Sweden	E	E	E, M	E	E	E
Switzerland			E			
United Kingdom	E	E	E	E	E	E
Emerging Market: Latin America						
Argentina	M		M	E, M		E, M
Brazil	M, R	R	M, R	M, A, R	M, A, R	M, A, R
Colombia			R	R		R
Ecuador	E, R	E, R	E, R	E, R	R	R
Mexico	M, R	M, R	M, R	M, R	M, R	M, R
Paraguay			E			
Peru	E	E	E			
Uruguay				M, R		
Venezuela	E		E		R	R
Emerging Market: Asia						
Hong Kong, SAR				R		R
India			A			
Indonesia	A	A	A	A	A	A
Korea	A	A	A, R	A	A	A
Malaysia	A	A	E, A	A	A	A
Pakistan	R	R	E, A, R	E, A, R	R	E, A, R
Philippines	A	A	M, A	A	A, R	A, R
Singapore			A	A		A
Sri Lanka				E		E
Taiwan POC	A		A		A	
Thailand	A	A	A	M, A	A	M, A
Emerging Market: Countries in Transition						
Czech Republic	R		R		R	R
Hungary	M	M	M	M	M	M
Poland			R		R	R
Romania	R			R	R	
Russia	A, R	R	A, R	A, R	A, R	A, R
Slovak Republic	R	R	R			

Appendix II, Crisis Countries [1,2] (Cont.)

	CriInd	CriHigh	CriLow	CriInt	CriStk	CriIntStk
Emerging Market: Middle East and Africa						
Israel	R		R			
Kenya	E, M, A	M, A	E, M, A	M, A	M, A	M, A
Morocco			E			
Nigeria	E	E	E	E	E	E
Tunisia	E		E			
Turkey					R	R
South Africa	E, M	E, M	E, M	E, M	M, R	R
Zimbabwe	E, A	E, A	E, M, A	E, A	E, A	E, A

[1] E refers to ERM crisis, M to Mexican crisis, A to Asian crisis, and R to Russian crisis.

[2] Countries without any crises in these indices - Industrial: Australia, Austria, Belgium, France, Japan, and Netherlands; Latin America: Chile, Costa Rica, and Jamaica; Asia: Bangladesh and China; Countries in Transition: Bulgaria; and Middle East and Africa: Egypt.