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## **CAPITAL CONTROLS AND EXCHANGE RATE INSTABILITY IN DEVELOPING ECONOMIES**

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# **Capital Controls and Exchange Rate Instability in Developing Economies**

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## **Abstract**

A large literature on the appropriate sequencing of financial liberalization suggests that removing capital controls prematurely may contribute to currency instability. This paper investigates whether legal restrictions on international capital flows are associated with greater currency stability. We employ a comprehensive panel data set of 69 developing economies over the 1975–1997 period, identifying 160 currency crises. We control for macroeconomic, political, and institutional characteristics that influence the probability of a currency crisis, employ alternative measures of restrictions on international payments, and account for possible joint causality between the likelihood of a currency attack and the imposition of capital controls. We find evidence that restrictions on capital flows *do not* effectively insulate economies from currency problems; rather, countries with less restrictive capital controls and more liberalized regimes appear to be less prone to speculative attacks.

Keywords: Currency Crises, Balance of Payments Crises, Capital Controls

JEL: F34, F15, F2, F31, G15, G18

## 1. Introduction

In the aftermath of the East Asian, Russian, and Brazilian currency crises of the 1990s, many economists and policymakers have focused on large and volatile capital flows as an underlying source of instability to the international financial system. A growing conventional wisdom (e.g. Radelet and Sachs, 1998; Stiglitz, 2000) holds that liberalization of international capital flows, especially when combined with fixed exchange rates, is either an underlying cause or at least a contributing factor behind the rash of currency crises experienced in recent years. A common policy prescription under these circumstances is to impose restrictions on capital flows and other international payments with the hope of insulating economies from speculative attacks and thereby creating greater currency stability.

An older literature on the optimal sequencing of economic reform also suggests the importance of capital controls during the process of development. In this view, liberalization of the capital account should not be undertaken until the end of the process; freeing up capital flows prematurely before domestic and trade liberalization could lead to economic instability (McKinnon, 1973, 1991; Edwards, 1984).

While there is an extensive empirical literature measuring the effects of capital controls on particular economic variables—e.g. capital flows, interest differentials, inflation, and output—surprisingly little systemic work has been undertaken regarding their impact on exchange rate stability in developing countries.<sup>1</sup> Several papers have investigated the experiences of capital controls for a few selected countries (e.g. Edison and Reinhart, 2001a, 2001b; Edwards, 1999; Gregorio, Edwards, and Valdes, 2000), while Edwards (1989) has investigated the role of capital account restrictions for twenty-four developing countries in the period prior to devaluation crises. However, we are aware of no systematic studies that investigate the link between capital flow restrictions and exchange rate stability for a broad set of developing economies; our sample consists of 69 developing countries over a 23-year period.<sup>2</sup>

The objective of this study is to systematically investigate whether capital account restrictions help to insulate developing countries from speculative attack on their currencies. We

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<sup>1</sup> Dooley (1996) provides a recent survey of the relevant literature.

<sup>2</sup> Eichengreen, Rose, and Wyplosz (1995) find evidence that capital controls may limit the vulnerability of industrial countries to speculative attacks.

investigate the occurrence of currency crises, the maintenance of capital market restrictions, and the link between the two, over time and across countries. More formally, we employ an empirical model of the determinants of currency crises as a benchmark from which to investigate the marginal effects of capital account restrictions. In particular, we investigate the extent to which capital controls effectively insulate countries—i.e., lower the probability—from a currency attack.

A key challenge of our inquiry is to identify key factors that both lead countries to impose capital controls and contribute to currency attacks, since there is a risk that excluding certain country or economic characteristics from the empirical model might lead to incorrect inferences. To this end, we control for a host of economic, political, and institutional factors usually associated with currency instability and capital controls. We also develop an empirical model of the factors explaining governments' decisions to maintain capital controls, jointly explaining this decision with the onset of a currency attack.

Section 2 reviews the literature linking capital account restrictions and currency stability. Section 3 describes the empirical methodology and data. Section 4 presents an overview of the data and shows the frequencies of currency crises, both unconditional and conditional on the presence of capital controls. Section 5 presents the results from testing the effect of capital market restrictions on the likelihood of currency crises using a probit model. A series of robustness and sensitivity tests are undertaken, including utilizing alternative measures of payments restrictions. Section 6 motivates and presents estimates of the bivariate probit model where currency crises and capital restrictions are jointly determined. Section 7 concludes the study.

## **2. Capital Controls, Sequence of Financial Liberalization and Instability**

The idea of restricting capital mobility as a means of reducing macroeconomic instability has a long history. Indeed, stringent restrictions and limitations on capital flows were the norm during the Bretton Woods era, and over much of the immediate post-war period they were officially sanctioned by most governments in the large industrial countries and by the International Monetary Fund. With the turbulence in exchange markets following the introduction of generalized floating, Tobin (1978) argued that a global tax on foreign exchange

transactions would reduce destabilizing speculation in international financial markets. After the European currency crisis of 1992-93, Eichengreen and Wyplosz (1993) proposed Tobin taxes to discourage short-term speculators from betting against major currencies. In the aftermath of the Asia currency crisis of 1997-98, Krugman (1998) proposed limiting capital flows for developing countries that were unsuitable for either currency unions or free floating exchange rate regimes. In a similar vein, Stiglitz (2000) and Eichengreen (1999) have argued that developing countries should manage and limit capital flows under certain market conditions.

A large literature on the appropriate sequencing of financial liberalization also suggests that early lifting of controls on the capital account may destabilize the economy. McKinnon (1973, 1993), for example, maintains that decontrol of the capital account should come at the end of the reform sequence, following domestic financial liberalization, bank reform, and trade liberalization. In particular, McKinnon argues that a rapid inflow of (official or private) capital will cause real appreciation of the exchange rate, making it difficult for domestic tradeables producers “to adjust to the removal of protection” (1993, p. 117). Thus, “[a] big injection of capital at the time the liberalization occurs finances an unusual increase in imports while decreasing exports and throws out the wrong long-run price signals in private markets” (*ibid.*, see also Edwards 1984, pp. 3–4).

On the other hand, capital controls may also have a destabilizing effect. Restrictions on the international capital account may in fact lead to a net capital outflow and precipitate increased financial instability. Dooley and Isard (1980) point out that controls preventing investors from withdrawing capital from a country act like a form of investment irreversibility: by making it more difficult to get capital out in the future, controls may make investors less willing to invest in a country. Following this reasoning, Bartolini and Drazen (1997a, b) show that imposing capital controls can send a signal of inconsistent and poorly designed future government policies.

Capital controls may also be ineffective and distortionary. Edwards (1999), for example, argues that legal capital restrictions frequently prove ineffective, and are easily sidestepped by domestic and foreign residents and firms. He documents how capital controls may lead to economic distortions and government corruption that in turn contribute to economic instability.

Several empirical papers have investigated the experiences with capital controls of selected developing countries. Edison and Reinhart (2001a) focus on the recent experiences of

Malaysia and Thailand<sup>3</sup>, while Edwards (1999) and Gregorio, et al. (2000) examine Chile. In general, these studies have found little effect of capital controls in averting currency crises, at least not without other supporting economic policies. Using various econometric tests and a detailed case study of Chilean controls imposed in the 1980s, for example, Edwards (1999) finds that “...the relative absence of contagion effect on Chile [during the currency crises of the 1990s] is due to its sturdy banking regulation and not to its capital controls policy” (p. 22). This finding is supported by Edwards’ (1989) analysis of the role of capital controls in thirty-nine devaluation episodes for twenty-four developing countries over the period 1961-82. He finds that countries typically intensified their control programs in the year before devaluation, and concludes that “[a]t most one can argue that these heightened impediments to trade managed to slow down the unavoidable balance of payments crisis” (pp. 189–90).

Other studies provide a more mixed view of the effects of capital controls on the factors contributing to currency pressures in developing countries. On the one hand, Bartolini and Drazen (1997a), who survey a number of episodes of capital account liberalization, find that the easing of restrictions on capital outflows often represented early ingredients of a broad set of reforms (including the lifting of various elements of financial repression) and frequently led to large capital inflows. On the other hand, Grilli and Milesi-Ferretti (1995), investigating the effects of restrictions on capital flows in a panel of industrial and developing economies, find that capital controls have a significant negative effect on foreign borrowing, interpreting their use as a means of enforcing financial repression of the economy. They also find that capital controls are associated with lower domestic interest rates, consistent with the view that they limit international arbitrage in asset markets. However, they do not investigate the link between capital restrictions and the likelihood of currency crises.

We are aware of no empirical studies that systematically investigate the link between capital controls (or international payments restrictions generally) and currency stability for a broad sample of developing economies. Our study fills this void. Another contribution of our work is to enhance understanding of the empirical factors explaining both currency crises and capital account restrictions, and causal linkages between the two phenomena.

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<sup>3</sup> Edison and Reinhart (2001b) also include Brazil and Spain in their analysis.

In focusing on the effects of international capital controls *per se*, however, we do not directly address the broader issue of the optimal sequencing of economic reforms and liberalization. Measuring the specific pattern and dynamics involved in implementing the different phases of a broad program of economic reform (e.g. domestic versus external, financial versus real reforms) for a large sample of developing countries is a difficult task, one that we do not undertake in this study. Nevertheless, by analyzing the extent to which a country that has external controls in place experiences more or less currency instability, our analysis provides insight into the extent to which such controls can limit a country's vulnerability to external shocks as broader reforms are undertaken.<sup>4</sup>

### 3. Data and Methodology

#### 3.1 Defining Currency Crises

Our indicator of currency crises is constructed from “large” changes in an index of currency pressure, defined as a weighted average of monthly real exchange rate changes<sup>5</sup> and monthly (percent) reserve losses.<sup>6</sup> Following convention (e.g. Kaminsky and Reinhart, 1999), the weights attached to the exchange rate and reserve components of the currency pressure index are inversely related to the variance of changes of each component over the sample for each

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<sup>4</sup> In Section 5, we do consider domestic financial restrictions as an alternative measure of controls and utilize it in a robustness check of our results.

<sup>5</sup> Real exchange rate changes are defined in terms of the trade-weighted sum of bilateral real exchange rates (constructed in terms of CPI indices, line 64 of the *IFS*) against the U.S. dollar, the German mark, and the Japanese yen, where the trade-weights are based on the average of bilateral trade with the United States, the European Union, and Japan in 1980 and 1990 (from the IMF's *Direction of Trade*). Most panel studies of currency crises define the currency pressure measure in terms of the bilateral exchange rate against a single foreign country. For example, Kaminsky, Lizondo, and Reinhart (1998) and Kaminsky and Reinhart (1999) measure the real exchange rate for all of the developing countries in their sample against the U.S. dollar. In defining the effective rate in terms of the three major nations likely to be the main trading partners of most developing countries, our approach provides a broader measure than these other studies and is computationally easier to construct than a multilateral exchange rate measure defined in terms of all of a country's trading partners. Possible alternatives, such as the effective exchange rate measures constructed by the IMF, OECD, and others, are not available for a broad sample of developing countries.

<sup>6</sup> Ideally, reserve changes should be scaled by the level of the monetary base or some other money aggregate, but such data is not generally available on a monthly basis for most countries.

country.<sup>7</sup> The exchange rate and reserve data are drawn from the International Monetary Fund's *International Financial Statistics* CD-ROM (lines ae and 11.d, respectively).

Our measure presumes that any nominal currency changes associated with exchange rate pressure should affect the purchasing power of the domestic currency, i.e. result in a change in the real exchange rate (at least in the short run). This condition excludes some large depreciations that occur during high inflation episodes, but it avoids screening out sizable depreciation events in more moderate inflation periods for countries that have occasionally experienced periods of hyperinflation and extreme devaluation.<sup>8</sup> Large changes in exchange rate pressure are defined as changes in our pressure index that exceed the mean plus 2 times the country-specific standard deviation, provided that it also exceeds 5 percent.<sup>9</sup> The first condition insures that any large (real) depreciation is counted as a currency crisis, while the second condition attempts to screen out changes that are insufficiently large in an economic sense relative to the country-specific monthly change of the exchange rate.

### 3.2 Measuring Restrictions on International Payments

Our main focus is on the effects of restrictions on international capital flows. The underlying source for our measures of external restrictions is the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions (EAER)*. A country is classified as either "restricted" (value of unity) or "liberalized" (value of zero) depending on the existence of controls on the capital account at year-end. Specifically, for the 1975-94 period the *EAER* coded countries (published in the reports through 1995) for the existence (or not) of "restrictions on

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<sup>7</sup> Our currency pressure measure of crises does not include episodes of defense involving sharp rises in interest rates. Data for market-determined interest rates are not available for much of the sample period in many of the developing countries in our dataset.

<sup>8</sup> This approach differs from that of Kaminsky and Reinhart (1999), for example, who deal with episodes of hyperinflation by separating the nominal exchange rate depreciation observations for each country according to whether or not inflation in the previous 6 months was greater than 150 percent, and they calculate for each sub-sample separate standard deviation and mean estimates with which to define exchange rate crisis episodes.

<sup>9</sup> Other studies defining the threshold of large changes in terms of country-specific moments include Kaminsky and Reinhart (1999); Kaminsky, Lizondo, and Reinhart (1998); and Esquivel and Larrain (1998). Kaminsky and Reinhart (1999) use a three standard deviation cut-off. While the choice of cut-off point is somewhat arbitrary, Frankel and Rose (1996) suggest that the results are not very sensitive to the precise cut-off chosen in selecting crisis episodes.

payments for capital transactions.” From 1996, the *EAER* (starting with the 1997 Annual Report) reported 10 separate categories for controls on capital transactions (11 categories in the 1998 Annual Report). We defined the capital account to be restricted for the 1996-97 observations (i.e. not liberalized) if controls were in place in 5 or more of the *EAER* sub-categories of capital account restrictions and “financial credit” was one of the categories restricted.<sup>10</sup>

In our sensitivity tests, we also consider three alternative measures of restrictions on international payments and one measure of restrictions on domestic financial institutions. Specifically, we consider: (i) a dichotomous measure of the requirement to surrender or repatriate export proceeds;<sup>11</sup> (ii) a dichotomous measure of restrictions placed on the current account of the balance of payments; (iii) an overall balance of payments controls measure, defined as a simple average of dichotomous indices of capital account restrictions, requirements to surrender or repatriate export receipts, and the presence of an official system of multiple exchange rates;<sup>12</sup> and (iv) a measure of domestic financial controls, defined as official restrictions on bank deposit interest rates.<sup>13</sup>

### 3.3 *Determinants of Currency Crises*

An important part of our work is to identify appropriate control variables in our multivariate probit models. We want to ensure that empirical links between external controls and currency crises are not spurious, attributable to variables omitted from the probit regressions. The theoretical and empirical literature has identified a vast array of variables potentially

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<sup>10</sup> The 11 classifications under capital restrictions reported in the 1998 *EAER* were controls on: (1) capital market securities, (2) money market instruments, (3) collective investment securities, (4) derivatives and other instruments, (5) commercial credits, (6) financial credits, (7) guarantees, sureties, and financial backup facilities, (8) direct investment, (9) liquidation of direct investment, (10) real estate transactions, and (11) personal capital movements.

<sup>11</sup> Note that, for the 1975-94 period *EAER* coded countries (published in the reports through 1995) for the existence (or not) of “surrender or repatriation requirement for export proceeds.” For 1995 on, the *EAER* began (with the 1996 Annual Report) to disaggregate controls on export proceeds as follows: “repatriation requirements for export proceeds” and “surrender requirements for export proceeds.” We use the union of these measures for the 1996-97 observations.

<sup>12</sup> This measure of balance of payments controls has been employed by Bartolini and Drazen (1997b).

<sup>13</sup> Data on deposit interest rate restrictions is from Demirguc-Kunt and Detragiache (1998) and was augmented to cover additional countries with information from Williamson and Mahar (1998), Honohan (2000), Galbis (1993), and other IMF studies.

associated with currency crises (see, e.g. Frankel and Rose, 1996; Kaminsky, Lizondo, and Reinhart, 1998; Kaminsky and Reinhart, 1999). The choice of explanatory variables in our benchmark model for the analysis was determined by the questions we posed earlier, the availability of data, and previous results found in the literature. We postulate a “canonical” model of currency crises in order to form a basic starting point to investigate the effects of capital controls. The main source of the macro data is the IMF’s *International Financial Statistics* (CD-ROM).

Our basic canonical model consists of five macroeconomic control variables that are lagged to limit simultaneity problems. (Data employed in extensions of the benchmark model are discussed in Section 5.2.) These variables are the log ratio of broad money to foreign reserves (lines 34 plus 35 divided by 11d times ae), domestic credit growth (line 32), the current account to GDP ratio (line 78ald times xrrf divided by 99b) real GDP growth (line 99b.r or 99b.p), and real exchange rate overvaluation.<sup>14</sup>

We expect the growth rate of M2/foreign reserves to be relatively high prior to a currency crisis. A rise in the M2/foreign reserves ratio implies a decline in the foreign currency backing of the short-term domestic currency liabilities of the banking system. This would make it difficult to stabilize the currency if sentiment shifts against it. Similar reasoning suggests that a larger current account surplus-to-GDP ratio would be expected to lessen the likelihood of a currency crisis, while rapid credit growth would be anticipated to precede a currency crisis. We also expect relatively large exchange rate overvaluation and declining real output growth to be associated with increased likelihood of a currency crisis. Substantially overvalued exchange rates may lead to the expectation that a large adjustment may occur, and declining real GDP growth may signal worsening economic conditions and undermine investor confidence in home-country investment opportunities.

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<sup>14</sup> Following Kaminsky *et al* (1998) and Kaminsky and Reinhart (1999), among others, we construct the degree of real exchange rate overvaluation from deviations from a fitted trend in the real trade-weighted exchange rate index, where the exchange rate index we fit is the annual average of the monthly series used in constructing the exchange rate component of our currency pressure index (see footnote 5). As reported in Section 5.1, we also consider other measures of overvaluation as a robustness check.

### 3.4 Data Sample and Measurement Concerns

Our data sample is determined by the theoretical determinants of currency market volatility and by the availability of data. We do not confine our analysis to countries experiencing currency crises. That is, we include developing countries that both did and did not experience a severe currency crisis/speculative attack during the 1975-97 sample period. Using such a broad control group allows us to make inferences about the conditions and characteristics distinguishing countries encountering crises and others managing to avoid crises.

The minimum data requirements to be included in our study are that GDP are available for a minimum of 10 consecutive years over the period 1975-97. This requirement results in a sample of 69 developing countries.<sup>15</sup> We use annual crisis observations in our analysis. While we employ monthly data for our (real) exchange rate pressure index to identify currency crises and date each by the year in which it occurs, using annual data enables inclusion of a relatively large number of countries.

For each country-year in our sample, we construct binary measures of currency crises, as defined above (1 = crisis, 0 = no crisis). A currency crisis is deemed to have occurred for a given year if the change in currency pressure for any month of that year satisfies our criteria (i.e. two standard deviations above the mean as well as greater than five percent in magnitude). To reduce the chances of capturing the continuation of the same currency crisis episode, we impose windows on our data. In particular, after identifying each “large” monthly change in currency pressure, we treat any large changes in the following 24-month window as a part of the same currency episode and skip the years of that change before continuing the identification of new crises. With this methodology, we identify 160 currency crises over the 1975-97 period. Appendix A lists the countries included in the sample and corresponding currency crisis dates, if any.

Appendix B reports the periods for which international payments controls (either in the form of capital account, export receipt, or current account restrictions) and domestic finance restrictions were *not* in place, i.e. periods of liberalization, for the countries in the sample. It is interesting to note that the measures differ somewhat in indicating the presence of controls for

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<sup>15</sup> Our developing country sample excludes major oil-exporting countries.

individual countries, but usually at least one measure picks up commonly recognized episodes of liberalization.

For example, the IMF measure of capital controls does not catch the liberalization episodes of Argentina and Brazil in the late 1970s. However, the other measures, such as the presence of current account restrictions and the measure of domestic financial repression, do capture these experiences. Argentina liberalized its current account during 1977-81 and from 1993 on (along with the capital account) and domestic interest rates were liberalized over 1977-82 (but later restricted again until 1987). The measure of domestic interest rate controls indicates Brazil financially liberalized during 1976-78, reverted to restrictions in 1979, and liberalized again after 1988.

Thus, no one measure may adequately capture all of the nuances in the extent to which controls are present for any given country or point in time. Taken overall, however, we feel that the set of measures we employ do an adequate job in capturing the financial control regime in place during the occurrence of currency crises for a broad panel of countries.

We conclude this section by acknowledging that the measures of capital controls, current account restrictions, and other restrictions on balance of payments flows published by the IMF are somewhat crude. By providing only a dichotomous indication of the existence of controls, they are limited in their ability to measure the extent to which restrictions are applied and enforced. They also do not distinguish between controls on inflows vs. outflows, and hence do not help address the ongoing debate about the efficacy of controls or taxes on capital inflows, as in the case of Chile. However, the IMF measures are the only source of data available that can be collected with some consistency across a broad group of developing countries and over a reasonably long period of time. This is a constraint faced by any panel study in this literature.<sup>16</sup> Concerns about measurement should be allayed by our use of a range of restriction indicators.

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<sup>16</sup> See Edison *et al* (2002) for a comparison of different measures of capital controls in the context of an analysis of the effects of capital account liberalization on long-run economic growth.

## **4. Descriptive Statistics and Conditional Frequencies**

### *4.1 Descriptive Statistics on Currency Crises and Capital Controls*

Table 1 shows the occurrence of currency crises and capital controls over the 1975-97 period, and by 5-year intervals (except for the 1995-97 sub-sample). The table reports the unconditional frequency of currency crises and presence of capital controls (number of “crisis” or “controls in place” observations, divided by the total number of observations).

The 69 developing countries in our dataset experienced 160 currency crises over the 1975-97 period, implying a frequency of 11.7 percent of the available country-year observations. Crises were least frequent during the 1975-79 period (9.9 percent average frequency) and most frequent during the 1985-89 period (14.3 percent frequency). In our sample, the recent spate of currency crises around the world is not an uncommon event, and does not indicate a rise in the frequency of currency crises over time.<sup>17</sup>

Table 1 also reports the frequency of restrictions on capital flows during the period. Most of the time capital controls were in place in developing economies (83.4 percent of the observations). Although this frequency was always high during the sample period, it rose noticeably from 1975 through 1989 and then declined in the 1990s. The high point was an average frequency of 89.0 percent during 1985-89, and the low point was 76.4 percent during 1995-97.

### *4.2 Currency Crises: Frequencies Conditional on Capital Controls*

Table 2 shows the frequency of currency crises conditional upon a country’s having restricted capital flows. This table sheds light directly upon the main question of interest: whether restrictions on capital flows affect the probability of a currency crisis. To take account of the possibility that controls are implemented in response to a crisis, we report results conditional on the presence of controls at the end of the year *prior* to a crisis as well as at the end

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<sup>17</sup> Currency crises were most frequent in Africa (16.2 percent frequency), and least frequent in Asia (9.6 percent). Despite recent high profile currency crises in Thailand, Malaysia, Indonesia, and Korea, the developing economies in Asia have been less frequently affected by currency instability.

of the year in which a crisis occurs.  $\chi^2$  statistics for tests of the null hypothesis of independence between the frequency of crises and the presence of controls are also presented.

The most striking result from Table 2 is that the country-year observations associated with more restrictions on capital flows have substantially higher frequencies of currency crises than those observations where no controls were in place. Specifically countries with restricted capital flows had crises contemporaneously 12.7 percent of the time, compared to 6.8 percent for those not having restrictions. The  $\chi^2$  statistics reject the null of independence and indicate that this difference is significant (at better than 5 percent). The difference in currency crisis frequency according to whether the capital account restrictions were in place or not in the preceding year is smaller (12.5 percent versus 8.0 percent), but is still significant at the 10 percent level. This is suggestive *prima facie* evidence that controls may not be effective and, indeed, may increase the likelihood of a currency crisis (e.g. Bartolini and Drazen, 1997a). It suggests that the presence of capital controls does not reduce a country's exposure to currency instability.

## 5. Estimation Results

Our use of probit models allows us to go beyond the conditional frequencies reported in the previous section and to focus on the contribution of payment restrictions to currency crises, while controlling for other macroeconomic and institutional factors that vary across time and country. We estimate the probability of currency crises using a multivariate probit model for our data set of developing countries over the 1975-97 period. We observe that either a country at a particular time (observation t) is experiencing the onset of a crisis (i.e. the binary dependent variable, say  $y_t$ , takes on a value of unity), or it is not ( $y_t = 0$ ). The probability that a crisis will occur,  $\Pr(y_t = 1)$ , is hypothesized to be a function of a vector of characteristics associated with observation t,  $x_t$ , and the parameter vector  $\beta$ . The likelihood function of the probit model is constructed across the n observations (the number of countries times the number of observations for each country) and the log of the function

$$\ln L = \sum_{t=1}^n [y_t \ln F(\beta' x_t) + (1 - y_t) \ln(1 - F(\beta' x_t))]$$

is then maximized with respect to the unknown parameters using non-linear maximum likelihood. The function  $F(\cdot)$  is the standardized normal distribution.

In these equations we employ a 24-month window following the onset of a crisis (i.e. episode of exchange rate pressure), as discussed in Section 3.4, and we eliminate from the dataset these observations. Following Eichengreen and Rose (1998), we use a weighted-probit regression where the weight is GDP (in dollars) per capita. Countries with higher GDP per capita generally have more reliable data, and the observations are correspondingly given greater weight in the analysis. An implication of this specification is that more importance is attached to relatively high income developing economies.

In each table we report the effect of a one-unit change in each regressor on the probability of a crisis (expressed in percentage points so that .01=1%), evaluated at the mean of the data. We include the associated z-statistics in parentheses; these test the null of no effect. Note that the sample size of the probit analysis varies depending on the set of variables considered.

We also report various diagnostic measures. The in-sample probability forecasts are also evaluated with “pseudo” R<sup>2</sup> statistics. For dependent binary variables, it is natural to ask what fraction of the observations are “correctly called,” where, for example, a crisis episode is correctly called when the estimated probability of crisis is above a given cut-off level and a crisis in fact occurs. Greene (2000) points out the chosen cut-off point should reasonably differ depending on the unconditional probability of the event and problem at hand. For our “goodness-of-fit” statistics we consider two different probability cut-offs: 25 percent and 10 percent. These cut-offs bracket the unconditional crisis frequency of roughly 12 percent (see Table 1).

### 5.1 Benchmark Model Estimates

Table 3 reports the results from the benchmark probit equations without and with (lagged) macroeconomic factors to explain the likelihood of the *onset* of a currency crisis in any given year, controlling for the presence of capital account restrictions. The inclusion of the macroeconomic variables reduces the sample range from 1174 to 921 observations. Columns (1) and (2) report results of including contemporaneous capital controls; columns (3) and (4) report the corresponding results for capital controls in place during the *preceding* year. Our main interest is in the latter.

The benchmark equations (with the macroeconomic variables) explain a substantial fraction of the currency crises in our sample. Focusing on column (4), the pseudo R-squared is 35 percent and the percentage of observations correctly predicted is 82 (56) percent when the

probability threshold is 25 percent (10 percent). All of the macroeconomic controls have the expected signs and, except for lagged credit growth, are significant at the 1 percent level. A high M2/reserves ratio, current account deficits, overvalued real exchange rates<sup>18</sup>, and sluggish GDP growth are significant leading indicators of the onset of a currency crisis.

Consistent with the conditional frequencies (Table 2), these results indicate a statistically significant and economically meaningful *negative* link between liberalization and the likelihood of a currency crisis. This result holds when either the contemporaneous or lagged value of capital account restrictions is included. After controlling for macroeconomic factors, the likelihood of a currency crisis in developing economies appears to increase by 5.2 percent (8.4 percent) when capital controls were in place during the previous (current) year. When macroeconomic controls are not included, the estimates are substantially higher.

## 5.2 *Sensitivity Analysis: Additional Macroeconomic and Political Determinants*

Table 4a shows the sensitivity of the benchmark model estimates to the inclusion of additional macroeconomic and political variables in the regressions. The objective is to control for a variety of economic and political factors that might help distinguish those countries that tend to be more prone to currency crises from those experiencing greater stability. Our main concern here is that excluding one or several explanatory variables that are highly correlated with both currency crises and the decision to maintain capital controls could bias the estimates in the benchmark model. (Issues of joint determination are considered in Section 6.)

The “twin crisis” phenomenon suggests that a domestic banking crisis could make a speculative attack on the currency more likely (Kaminsky and Reinhart, 1999; Glick and Hutchison, 2001). Our banking crisis measure (contemporaneous and lagged) is constructed as a binary variable, with unity indicating the onset of a banking crisis, i.e. first year of a period of bank distress and zero otherwise.<sup>19</sup> Column (1) includes contemporaneous and lagged bank

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<sup>18</sup> An alternative measure of overvaluation, the magnitude of real exchange rate change over the prior two-year period (cf. Corsetti *et al.*, 1998) was less significant than our benchmark measure based on deviations from trend. However, it did not affect the basic result that capital controls significantly raise the probability of currency crises.

<sup>19</sup> We report results using only Caprio and Klingebiel’s (1999) “major” or “systemic” bank crisis; the results are similar with their more inclusive measure of crises.

crises as additional explanatory variables in the benchmark regression. Contemporaneous bank crises are significant at the 10 percent level and are associated with a higher likelihood (about 6 percent) of the onset of a currency crisis. The point estimate on lagged capital controls is 5.25 (significant at the 1 percent level).

The international factors that we consider in our sensitivity tests are the level of U.S. real long-term interest rates (line 61..zf minus the percent change in 99b.r over 99b) and the possibility of regional contagion in currency crises. The measure of contagion takes on a value of unity if a currency crisis has occurred in some other country in the region. Eichengreen and Rose (1998) and others have found that high foreign (“Northern”) interest rates increase the likelihood of debt repayment and increase pressure on currencies in developing countries. Glick and Rose (1999) and others find that contagion, primarily based on regional trade linkages, is an important element in the transmission of currency crises internationally.

Column (2) of Table 4a reports the results from including international factors in the benchmark regression. Neither contagion nor high U.S. real interest rates play a significant systematic role in helping to predict the onset of currency crises in our sample of developing countries. The point estimate on lagged capital controls is robust—above 5 in magnitude and significant at the 1 percent level.

We also consider two political variables in our sensitivity tests—the frequency of change in government and the degree of political freedom. These factors also could help to distinguish historically unstable countries and economies—those presumably with greater currency instability and more frequent imposition of capital controls—from more stable situations. We attempt to control for political instability and political conditions by measuring the total number of democratic and undemocratic (e.g. coups) changes in government over the period 1970–97, as determined from Zarate’s Political Collections website ([www.terra.es/personal2/monolith](http://www.terra.es/personal2/monolith)), supplemented by information from the Encarta Encyclopedia website ([www.encarta.msn.com](http://www.encarta.msn.com)). The political freedom measure is taken from the Freedom House website ([www.freedomhouse.org](http://www.freedomhouse.org), coded on a scale from 1–3, with 3 indicating the highest degree of political freedom).

Column (3) includes these two political variables in the benchmark model with the macroeconomic variables. The number of changes in government is significantly positive, indicating that greater political instability raises the likelihood of the onset of a currency crisis.

Political freedom, however, is not statistically significant at conventional levels. The point estimate on lagged capital controls is again around 5 and statistically significant at the 1 percent level.

### 5.3 *Sensitivity Analysis: Alternative Measures of Restrictions on Transactions*

The capital account controls measure is a rather rudimentary measure of balance of payments restrictions and, by providing only a dichotomous indication of the existence of controls, does not allow one to measure variations in the extent to which controls are applied and enforced. As discussed in section 3, we assess the robustness of the benchmark estimates by using four alternative measures of balance of payments and financial restrictions.

The results from these sensitivity tests are reported in Table 4b. In each case, the coefficient on the exchange "control" variable is positive and statistically significant (at either the 1 percent or 5 percent level). The explanatory power of the equations and the estimated coefficients of the other explanatory variables in Table 4b are also very similar to the other estimated equations.<sup>22</sup> Thus, all of our measures of financial restrictions gives the same result—countries with restrictions, however measured, are more prone to currency attacks. At a minimum, one may conclude that there is no evidence that restrictions on capital flows, balance of payments, or domestic financial markets effectively insulate countries from currency instability.

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<sup>22</sup> In addition, a fifth measure was constructed: the first principle component of the indices of capital account controls, export receipt controls, and multiple exchange rates. The results are almost identical to the other results in Table 4b. They are not reported for brevity but are available from the authors upon request.

## 6. Joint Determination of Currency Crises and a Regime of Capital Controls

We wish to further explore the causal linkages between currency crises and the decisions of governments to maintain a system of capital controls. To this end, we estimate a recursive bivariate probit equation jointly explaining these two phenomena (see Greene, 2000, Chapter 19). The first equation explaining the onset of currency crises is our benchmark specification. The second equation is our attempt to capture the economic and political factors that make countries more likely to maintain a system of restrictions on international capital flows. The system is recursive in that capital controls (either contemporaneous or lagged) are treated as a determinant of currency crises, but not vice versa.<sup>23</sup>

Several studies have investigated the factors that explain why governments maintain a system of capital controls. Grilli and Milesi-Ferretti (1995), Bartolini and Drazen, (1997a, b); and Alesina, Grilli, and Milesi-Ferretti (1994), for example, present empirical results on a number of possible determinants of capital controls. Among other factors, they find countries with a higher level of government expenditure, relatively closed to international trade, and with large current account deficits are more likely to restrict capital flows. Grilli and Milesi-Ferretti (1995) also report evidence that political instability is associated with fewer capital account restrictions in developing economies. Bartolini and Drazen (1997b) link a high degree of restrictions on international payments in developing economies with high world real interest rates—measured as the weighted real interest rate in the G-7 industrial countries—in a yearly time-series regression. They view the causality as running from world interest rates to capital restrictions: restrictions are removed when the cost of doing so is low, i.e. only a small outflow of capital is expected when world interest rates are low. Edwards (1989), investigating the experiences of twenty countries over the 1961-82 period, finds that capital controls are frequently intensified in the year prior to the onset of a currency crisis. This suggests that a common set of factors may contribute both to the onset of a currency crisis and lead governments to impose or maintain capital account restrictions.

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<sup>23</sup> The recursive structure is necessary to satisfy the logical consistency condition for models of simultaneous binary variables (see Maddala, 1983, Chapter 5, model 6).

Following these studies, we consider a number of potential structural, political, and economic determinants of capital controls. In particular, we consider two macroeconomic variables, two economic structure variables, and two political variables. The macroeconomic variables are the current account (as a percent of GDP) and the level of “Northern” real interest rates (proxied by the level of the U.S. real long-term interest rate). We expect that large current account surpluses place less pressure on countries to maintain a system of controls on international payments. High Northern interest rates, by contrast, make capital liberalization—and integration with world capital markets—more costly in terms of the service of domestic government debt (Bartolini and Drazen, 1997a). The maintenance of capital controls in this circumstance would be expected.

The economic structure factors considered are the relative size of government spending and openness to world trade. Countries with high levels of government spending may both be more prone to currency instability and more likely to impose some form of exchange controls. High government spending indicates that governments have large funding requirements, and have a greater incentive to resort for seigniorage finance and capital controls as a source of revenue. By contrast, relatively open economies in terms of international trade (measured by the sum of exports and imports as a percentage of GDP) are also more likely to be open to international capital flows, and less prone to impose controls. International openness is also found by Romer (1993) to be associated with lower inflation rates, that in turn may lead to greater economic stability and less pressure for capital controls. Finally, the two political explanatory variables included in our model are the total changes in government and the measure of political freedom.

We first estimate the parameters of the bivariate probit model using maximum likelihood, with the correlation between disturbances ( $\rho$ ) in the two equations allowed to vary freely.  $\rho$  measures (roughly) the correlation between currency crises and capital controls after accounting for the effects of the included determinants. The low estimated value of  $\rho$  suggests that any omitted effects may well be uncorrelated across the two equations of our bivariate model.<sup>24</sup> That

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<sup>24</sup> The estimated value of  $\rho$  is .16 in the case capital controls affect currency crises contemporaneously and .22 when they enter lagged.

is, after the direct effect of capital controls on currency crisis is taken account of, the correlation of any omitted determinants of crises and controls is low.

To formally test the significance of  $\rho$ , we estimate the model with  $\rho$  fixed at zero. We then used the two sets of results to test for the significance of our  $\rho$  estimate against the null that  $\rho$  equals zero using a likelihood ratio test, a Wald test, and Lagrange multiplier test.<sup>25</sup> On the basis of these tests, we rejected the alternative that  $\rho$  is not equal to zero, and report only results with  $\rho$  constrained to equal zero.

Columns 1a and 1b of Table 5 report the bivariate probit equations where the capital control variable enters the two equations contemporaneously. Columns 2a and 2b report the bivariate probit equations where the capital control variable enters the two equations lagged one year. The results for the currency crisis equations (columns 1a and 2a) are quite similar to the standard probit results, both in terms of the overall explanatory power of the equations and the point estimates of the coefficients. The point estimates on the capital control variable in the bivariate probit equations are very close to the earlier estimates. Lagged capital controls are again associated with about a 5 percent rise in the likelihood of a currency crisis.

As expected, current account surpluses and more open economies are associated with a lower likelihood of capital controls. Countries with relatively large government sectors are more likely to have capital controls. These findings are consistent with Grilli and Milesi-Ferretti (1995). Unlike other studies, however, we find that more political instability (changes in government) is associated with a lower likelihood of capital controls in developing countries. Northern interest rates and political freedom, however, are not statistically significant explanatory factors.

## 7. Concluding Remarks

We find that restrictions on capital controls are associated with higher probability of an exchange rate crisis. This result is clearly evident in the calculation of conditional frequencies and in the context of probit models estimating the likelihood of the onset of a currency crisis

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<sup>25</sup> The likelihood ratio statistic, distributed as  $\chi^2$  with one degree of freedom under the null, equaled .23, well below the five percent critical value of 3.84. The Wald statistic was .14, also well below the critical value of 3.84. The Lagrange multiplier statistic was .45, which was consistent.

where account is taken of a host of macroeconomic and institutional factors. We find no evidence that countries with no or few restrictions on the capital account are more prone to speculative attacks.

We are aware of concerns about the quality of data on capital controls used in our analysis. Measures of capital controls, current account restrictions, and other restrictions on the balance of payments published by the IMF are rough proxies for controls and do not pick up many nuances in the extent of controls over time and across countries; nor do they clearly distinguish between restrictions on capital inflows and outflows. However, they are the only source of data available that can be collected with some consistency across a broad group of developing countries and over a reasonably long period of time—a constraint faced by every study in this literature. Moreover, this constraint may not be too problematic, since a close inspection of our alternative measures of financial restrictions indicates that almost all commonly recognized episodes are identified by at least one of the measures. Furthermore, the results are not sensitive to the particular measure of financial restrictions used.

This evidence is supportive, of course, of previous work questioning the effectiveness of capital controls in insulating countries from speculative attacks on inconsistent policy regimes.<sup>26</sup> It also indicates that, in the context of the sequencing literature on economic reform, an environment where the capital account is liberalized does not appear to be more vulnerable to exchange rate instability. Surprisingly, the opposite appears to be the case. Countries without capital controls appear to have greater exchange rate stability and fewer speculative attacks. This result holds even when taking account of macroeconomic factors—*inconsistent policy regimes*—that lead to speculative attacks, as well as country-specific political and institutional factors that induce countries to maintain a system of capital controls in the first place.

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<sup>26</sup> Dooley (1996), summarizing the literature, concludes: “Capital controls or dual exchange rate systems have been effective in generating yield differentials, covered for exchange rate risk, for short periods of time, but they have little power to stop speculative attacks on regimes that were seen by the market as inconsistent” (p. 677).

## References

- Alesina, Alberto, Vittorio Grilli, and G.-M. Milesi-Ferretti (1994). “The Political Economy of Capital Controls.” In Leonardo Leiderman and Assaf Razin, eds., *Capital Mobility: The Impact on Consumption, Investment and Growth*. Cambridge, UK: Cambridge University Press, pp. 289-321.
- Bartolini, Leonardo and Allan Drazen (1997a). “Capital Account Liberalization as a Signal,” *American Economic Review* 87, pp. 138-54.
- Bartolini, Leonardo and Allan Drazen (1997b). “When Liberal Policies Reflect External Shocks, What Do We Learn?” *Journal of International Economics* 42, pp. 249-73.
- Caprio, Gerard, and Daniela Klingebiel (1999). “Episodes of Systemic and Borderline Financial Crises,” Mimeo. World Bank, Washington, D.C.
- Corsetti, Giancarlo, Paolo Pesenti, and Nouriel Roubini ((1998). “Paper Tigers? A Model of the Asian Crisis.” NBER Working Paper No. 6783 (November).
- Demirguc-Kunt, Asli and Enrica Detragiache (1998). “Financial Liberalization and Financial Fragility.” IMF Working Paper WP/98/83 (June).
- Dooley, Michael (1996). “A Survey of Literature on Controls over International Capital Transactions,” *IMF Staff Papers* 43 (4), December, pp. 639-687.
- Dooley, Michael and Peter Isard (1980). “Capital Controls, Political Risk, and Deviations from Interest Rate Parity,” *Journal of Political Economy* 88(2), pp. 370-84.
- Edison, Hali J., Michael Klein, Luca Ricci, and Torsten Slok (2002). “Capital Account Liberalization and Economic Performance: Survey and Synthesis.” NBER Working Paper No. 9100 (August).
- Edison, Hali J. and Carmen M. Reinhart (2001a). “Capital Controls During Financial Crises: The Cases of Malaysia and Thailand.” In Reuven Glick, Ramon Moreno, and Mark M. Spiegel, eds., *Financial Crises in Emerging Markets*, Chapter 12. Cambridge, UK: Cambridge University Press. Also issued as International Finance Discussion Paper No. 662 (March). Board of Governors of the Federal Reserve System.
- Edison, Hali J. and Carmen Reinhart (2001b). “Stopping Hot Money.” *Journal of Development Economics* 66(2), pp. 533-553.
- Edwards, Sebastian (1984). “The Order of Liberalization of the External Sector in Developing Countries.” *Princeton Essays in International Finance* No. 156.

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

Edwards, Sebastian (1999). "On Crisis Prevention: Lessons from Mexico and East Asia," NBER Working Paper No. 7233 (July).

Eichengreen, Barry (1999). *Towards a New International Financial Architecture: A Practical Post-Asia Agenda*. Washington, DC: Institute for International Economics.

Eichengreen, Barry and Charles Wyplosz (1993). "The Unstable EMS," *Brookings Papers on Economic Activity*, No. 1, pp. 51-143.

Eichengreen, Barry and Andrew Rose (1998). "Staying Afloat When the Wind Shifts: External Factors and Emerging-Market Banking Crises." NBER Working Paper No. 6370 (January).

Eichengreen, Barry, Andrew Rose, and Charles Wyplosz (1995). "Exchange Market Mayhem. The Antecedents and Aftermath of Speculative Attacks," *Economic Policy* 21 (October), pp. 249-312.

Esquivel, Gerardo and Felipe Larraín (1998). "Explaining Currency Crises," Mimeo, Harvard Institute for International Development Working Paper No. 609.

Frankel, Jeffrey and Andrew Rose (1996). "Currency Crashes in Emerging Markets. An Empirical Treatment," *Journal of International Economics* 41 (November), pp. 351-366.

Galbis, Vicente, (1993) " High Real Interest and under Financial Liberalization: Is There a Problem? IMF Working Paper No. 93/7 (January), Table 1.

Glick, Reuven and Michael Hutchison (2001), "Banking and Currency Crises: How Common Are Twins?" In Reuven Glick, Ramon Moreno, and Mark M. Spiegel, eds. *Financial Crises in Emerging Markets*. Cambridge, UK: Cambridge University Press, Chapter 2. Previously issued as Federal Reserve Bank of San Francisco Center for Pacific Basin Studies Working Paper No. PB99-08, Federal Reserve Bank of San Francisco.

Glick, Reuven and Andrew Rose (1999). "Contagion and Trade. Why Are Currency Crises Regional?" *Journal of International Money and Finance* 18 (August), pp. 603-618. Earlier versions issued as CEPR Discussion Paper 1947 and NBER Working Paper 6806.

Greene, William H. (2000). *Econometric Analysis*. Second Edition. Upper Saddle River, NJ: Prentice Hall.

Gregorio, José, Sebastian Edwards and Rodrigo Valdés (2000). "Controls on Capital Inflows: Do They Work?" NBER Working Paper No. 7645 (April).

Grilli, Vittorio and G.-M. Milesi-Ferretti (1995). "Economic Effects and Structural Determinants of Capital Controls," *IMF Staff Papers* 42, pp. 517-51.

Honohan, Patrick (2000) "How Interest Rates Changed under Financial Liberalization: A Cross-Country Review," World Bank Policy Working Paper No. 2313.

Hutchison, Michael M. and Kathleen McDill (1999). "Are All Banking Crises Alike? The Japanese Experience in International Comparison," Federal Reserve Bank of San Francisco, Center for Pacific Basin Studies Working Paper PB99-02.

International Monetary Fund (various issues). *Annual Report on Exchange Arrangements and Exchange Restrictions*. Washington, DC.

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

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

Krugman, Paul (1998). "Saving Asia: It's Time to Get Radical." *Fortune*, September 7, pp. 74-80.

Maddala, G.S. (1983). *Limited Dependent and Qualitative Variables in Econometrics*. New York: Cambridge University Press.

McKinnon, Ronald (1973). *Money and Capital in Economic Development*. Washington, DC. Brookings Institution.

McKinnon, Ronald (1993). *The Order of Economic Liberalization: Financial Control in the Transition to a Market Economy*. Second Edition. Baltimore: Johns Hopkins Press.

Radelet, Steven and Jeffrey Sachs (1998). "The East Asian Financial Crisis Diagnosis, Realities, Prospects," *Brookings Paper on Economic Activity*, No. 1, pp. 111-174.

Romer, David (1993). "Openness and Inflation: Theory and Evidence," *Quarterly Journal of Economics* 93(108), pp. 869-903.

Stiglitz, Joseph (2000). "What I Saw at the Devaluation," *The New Republic*, April 24.

Tobin, James (1978). "A Proposal for International Monetary Reform," *Eastern Economic Journal* 4, pp. 154-59.

Williamson, John and Molly Mahar (1998). "A Review of Financial Liberalization," Mimeo, World Bank Working Paper.

**Table 1. Currency Crises and Capital Controls, Unconditional Frequency (in percent)**

|                               | 1975-1997 | 1975-1979 | 1980-1984 | 1985-1989 | 1990-1994 | 1995-1997 |
|-------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Currency crises <sup>a</sup>  | 11.7      | 9.9       | 12        | 14.3      | 11.8      | 9.7       |
| (Number of crises)            | (160)     | (26)      | (34)      | (43)      | (38)      | (19)      |
| Capital controls <sup>b</sup> | 83.8      | 79.4      | 84.2      | 89.0      | 86.6      | 76.2      |

<sup>a</sup> Number of crises divided by total country-years with available data. Number of crises in parentheses.

<sup>b</sup> Number of country-years with capital controls in place at end of year divided by total country-years with available data

**Table 2. Currency Crises, Frequency Conditional on Capital Controls (in percent)**

|   | Yes <sup>a</sup> | No <sup>b</sup> | $\chi^2$ <sup>c</sup> |
|---|------------------|-----------------|-----------------------|
| Controls in place during current year?  | 12.7             | 6.8             | 6.11**                |
| Controls in place during previous year? | 12.5             | 8.0             | 3.50*                 |

<sup>a</sup> Number of currency crises for which capital controls in place at end of current or previous year, divided by total number of country-years with controls in place.

<sup>b</sup> Number of currency crises for which capital controls *not* in place at end of current or previous year, divided by total number of country-years with controls *not* in place.

<sup>c</sup> Null hypothesis of independence between frequency of currency crises and controls is distributed as  $\chi^2(1)$ . \*\* and \* indicate rejection of null at 5 and 10 percent significance levels, respectively.

**Table 3. Currency Crises: Probit Benchmark**

| <b>Explanatory Variable</b>                     | (1)               | (2)                | (3)               | (4)                |
|---|-------------------|--------------------|-------------------|--------------------|
| Capital account controls t                      | 11.49**<br>(5.32) | 8.38**<br>(3.70)   |                   |                    |
| Capital account controls t-1                    |                   |                    | 8.62***<br>(4.02) | 5.24***<br>(2.31)  |
| Log(M2/Reserves) t-1                            |                   | 1.85**<br>(2.11)   |                   | 2.21***<br>(2.44)  |
| Credit growth t-1                               |                   | 0.02<br>(1.29)     |                   | 0.03<br>(1.37)     |
| Current account/GDP t-1                         |                   | -0.34***<br>(2.58) |                   | -0.37***<br>(2.69) |
| Real overvaluation t-1                          |                   | 0.11***<br>(3.21)  |                   | 0.11***<br>(3.25)  |
| Real GDP growth t-1                             |                   | -0.39**<br>(2.28)  |                   | -0.43***<br>(2.38) |
| <b>Summary statistics</b>                       |                   |                    |                   |                    |
| No. of Crises                                   | 157               | 120                | 157               | 120                |
| No. of Observations                             | 1174              | 921                | 1173              | 921                |
| Log likelihood                                  | -370.8            | -268.9             | -376.9            | -273.2             |
| Pseudo-R2                                       | 0.33              | 0.36               | 0.31              | 0.35               |
| <b>Goodness-of-fit (25% cutoff)<sup>a</sup></b> |                   |                    |                   |                    |
| % of obs. correctly called                      | 87                | 82                 | 87                | 82                 |
| % of crises correctly called                    | 0                 | 18                 | 0                 | 15                 |
| % of non-crises correctly called                | 100               | 92                 | 100               | 92                 |
| <b>Goodness-of-fit (10% cutoff)<sup>a</sup></b> |                   |                    |                   |                    |
| % of obs. correctly called                      | 28                | 52                 | 27                | 56                 |
| % of crises correctly called                    | 90                | 80                 | 89                | 80                 |
| % of non-crises correctly called                | 18                | 48                 | 18                | 52                 |

Note: The table reports the change in the probability of a crisis in response to a 1 unit change in the variable evaluated at the mean of all variables (x 100, to convert into percentages) with associated z-statistic (for hypothesis of no effect) in parentheses below. Results significant at 1, 5, and 10 percent levels are indicated by \*\*\*, \*\*, and \*, respectively. Constant included, but not reported. Observations are weighted by real GDP per capita (in dollars).

<sup>a</sup> Goodness-of-fit statistics defined respectively as  $(A + D) / (A + B + C + D)$ ,  $A / (A + C)$ , and  $D / (B + D)$ , where A(C) denote number of crises with predictions of crises above (below) probability cutoff and B(D) denote number of corresponding non-crises with predictions of crises above (below) the cutoff.

**Table 4a. Sensitivity Analysis: Additional Macroeconomic and Political Determinants**

| Explanatory Variable                            | (1)                | (2)                | (3)                |
|---|--------------------|--------------------|--------------------|
| Capital acct. controls t-1                      | 5.25***<br>(2.33)  | 5.42***<br>(2.39)  | 5.01**<br>(2.23)   |
| Log(M2/Reserves) t-1                            | 2.52***<br>(2.81)  | 2.07***<br>(2.32)  | 2.34***<br>(2.55)  |
| Credit growth t-1                               | 0.02<br>(0.96)     | 0.02<br>(1.30)     | 0.02<br>(1.25)     |
| Current account/GDP t-1                         | -0.27**<br>(1.96)  | -0.33***<br>(2.44) | -0.37***<br>(2.72) |
| Real overvaluation t-1                          | 0.09***<br>(2.55)  | 0.09***<br>(2.58)  | 0.11***<br>(3.16)  |
| Real GDP growth t-1                             | -0.43***<br>(2.43) | -0.39**<br>(2.16)  | -0.41**<br>(2.30)  |
| Contagion t                                     |                    | 2.73<br>(1.18)     |                    |
| U.S. real interest rate t-1                     |                    | 0.62<br>(1.45)     |                    |
| Change of government t                          |                    |                    | 3.83*<br>(1.73)    |
| Freedom t-1                                     |                    |                    | -1.55<br>(1.16)    |
| Bank crisis t                                   | 5.75*<br>(1.65)    |                    |                    |
| Bank crisis t-1 or t-2                          | 4.68<br>(1.48)     |                    |                    |
| <b>Summary statistics</b>                       |                    |                    |                    |
| No. of Crises                                   | 119                | 120                | 120                |
| No. of Observations                             | 912                | 921                | 921                |
| Log likelihood                                  | -265.3             | -271.3             | -271.1             |
| Pseudo-R2                                       | 0.36               | 0.36               | 0.36               |
| <b>Goodness-of-fit (25% cutoff)<sup>a</sup></b> |                    |                    |                    |
| % of obs. correctly called                      | 82                 | 81                 | 83                 |
| % of crises correctly called                    | 15                 | 17                 | 15                 |
| % of non-crises correctly called                | 93                 | 91                 | 93                 |
| <b>Goodness-of-fit (10% cutoff)<sup>a</sup></b> |                    |                    |                    |
| % of obs. correctly called                      | 56                 | 55                 | 57                 |
| % of crises correctly called                    | 75                 | 79                 | 73                 |
| % of non-crises correctly called                | 53                 | 52                 | 55                 |

Note: See Table 3.

**Table 4b. Sensitivity Analysis: Alternative Measure of Financial Restrictions**

| Explanatory Variable                            | Export Receipt Restrictions<br>(1) | Current Account Restrictions<br>(2) | Balance of Payments Controls<br>(3) | Domestic Financial Controls<br>(4) |
|---|------------------------------------|-------------------------------------|-------------------------------------|------------------------------------|
| Controls t-1                                    | 5.80**<br>(2.25)                   | 4.63***<br>(2.52)                   | 8.77***<br>(2.88)                   | 5.81***<br>(2.76)                  |
| Log(M2/Reserves) t-1                            | 2.55***<br>(2.86)                  | 2.79***<br>(3.19)                   | 2.34***<br>(2.64)                   | 3.19***<br>(3.38)                  |
| Credit growth t-1                               | 0.02<br>(0.92)                     | 0.02<br>(1.06)                      | 0.01<br>(0.56)                      | 0.01<br>(0.73)                     |
| Current account/GDP t-1                         | -0.27**<br>(1.97)                  | -0.29**<br>(2.10)                   | -0.27*<br>(1.95)                    | -0.26<br>(1.49)                    |
| Real overvaluation t-1                          | 0.09***<br>(2.55)                  | 0.08***<br>(2.36)                   | 0.09***<br>(2.50)                   | 0.06<br>(1.65)                     |
| Real GDP growth t-1                             | -0.41***<br>(2.33)                 | -0.36**<br>(2.01)                   | -0.39**<br>(2.20)                   | -0.45***<br>(2.33)                 |
| Bank Crisis t                                   | 5.62<br>(1.63)                     | 6.01*<br>(1.71)                     | 5.98*<br>(1.75)                     | 8.80***<br>(2.39)                  |
| Bank Crisis t-1 or t-2                          | 4.84<br>(1.52)                     | 5.19<br>(1.62)                      | 4.78<br>(1.54)                      | 6.84**<br>(2.01)                   |
| <b>Summary statistics</b>                       |                                    |                                     |                                     |                                    |
| No. of Crises                                   | 119                                | 119                                 | 119                                 | 112                                |
| No. of Observations                             | 914                                | 914                                 | 912                                 | 808                                |
| Log likelihood                                  | -265.6                             | -265.0                              | -263.9                              | -246.7                             |
| Pseudo-R2                                       | 0.36                               | 0.36                                | 0.36                                | 0.36                               |
| <b>Goodness-of-fit (25% cutoff)<sup>a</sup></b> |                                    |                                     |                                     |                                    |
| % of obs. correctly called                      | 83                                 | 82                                  | 82                                  | 80                                 |
| % of crises correctly called                    | 17                                 | 15                                  | 13                                  | 21                                 |
| % of non-crises correctly called                | 93                                 | 92                                  | 92                                  | 90                                 |
| <b>Goodness-of-fit (10% cutoff)<sup>a</sup></b> |                                    |                                     |                                     |                                    |
| % of obs. correctly called                      | 57                                 | 54                                  | 57                                  | 53                                 |
| % of crises correctly called                    | 72                                 | 70                                  | 71                                  | 78                                 |
| % of non-crises correctly called                | 55                                 | 51                                  | 55                                  | 49                                 |

Note: See Table 3. Alternative control measures: export receipt controls defined by presence of surrender or repatriation requirements for export receipts; current account controls; balance of payments controls defined as average (i.e. 0, .33, .67, or 1) of presence of capital account controls, export receipt controls, and multiple exchange rates; and domestic financial controls defined by presence of domestic interest rate restrictions.

**Table 5. Bivariate Probit Results for Currency Crises and Capital Controls**

| Explanatory Variable                            | Currency Crises (1a) | Capital Controls t (1b) | Currency Crises (2a) | Capital Controls t-1 (2b) |
|---|----------------------|-------------------------|----------------------|---------------------------|
| Capital acct. controls t                        | 8.34***<br>(3.59)    |                         |                      |                           |
| Capital acct. controls t-1                      |                      |                         | 5.20**<br>(2.14)     |                           |
| Log(M2/Reserves) t-1                            | 1.94**<br>(2.11)     |                         | 2.30***<br>(2.43)    |                           |
| Credit growth t-1                               | 0.02<br>(1.31)       |                         | 0.02<br>(1.40)       |                           |
| Current account/GDP t-1                         | -0.34***<br>(2.55)   | -1.05***<br>(3.53)      | -0.37***<br>(2.64)   | -1.26***<br>(4.16)        |
| Real overvaluation t-1                          | 0.11***<br>(3.41)    |                         | 0.11***<br>(3.48)    |                           |
| Real GDP growth t-1                             | -0.40**<br>(2.25)    |                         | -0.43***<br>(2.37)   |                           |
| Govt. Spdg/GDP t-1                              |                      | 1.21***<br>(2.83)       |                      | 0.80*<br>(1.79)           |
| Openness t                                      |                      | -0.29***<br>(6.48)      |                      | -0.27***<br>(6.96)        |
| U.S. real interest rate t-1                     |                      | -0.40<br>(0.51)         |                      | -1.14<br>(1.50)           |
| Total changes of government                     |                      | -2.24***<br>(2.55)      |                      | -2.48***<br>(2.93)        |
| Freedom t-1                                     |                      | -2.11<br>(0.73)         |                      | -4.70<br>(1.64)           |
| <b>Summary statistics</b>                       |                      |                         |                      |                           |
| No. of crises/presence of controls              | 117                  | 721                     | 117                  | 724                       |
| No. of observations                             | 892                  |                         | 892                  |                           |
| Log likelihood                                  | -708.1               |                         | -708.0               |                           |
| McFadden-R2                                     | 0.35                 |                         | 0.35                 |                           |
| <b>Goodness-of-fit (25% cutoff)<sup>a</sup></b> |                      |                         |                      |                           |
| % of obs. correctly called                      | 82                   |                         | 82                   |                           |
| % of crises correctly called                    | 19                   |                         | 16                   |                           |
| % of non-crises correctly called                | 92                   |                         | 92                   |                           |
| <b>Goodness-of-fit (10% cutoff)<sup>a</sup></b> |                      |                         |                      |                           |
| % of obs. correctly called                      | 47                   |                         | 52                   |                           |
| % of crises correctly called                    | 85                   |                         | 84                   |                           |
| % of non-crises correctly called                | 42                   |                         | 47                   |                           |

Note: See Table 3. Results from estimate of bivariate (recursive) probit model for currency crises and (current or lagged) capital controls with cross-equation correlation between disturbances restricted to 0.

## Appendix A. Currency Crisis Episodes

|                        |                                    |
|------------------------|------------------------------------|
| Argentina              | 1975, 1982, 1989                   |
| Bangladesh             | 1975                               |
| Belize                 |                                    |
| Bolivia                | 1981, 1983, 1988, 1991             |
| Botswana               | 1984, 1996                         |
| Brazil                 | 1982, 1987, 1990, 1995             |
| Burundi                | 1976, 1983, 1986, 1989, 1997       |
| Cameroon               | 1982, 1984, 1994                   |
| Chile                  | 1985                               |
| China, P.R.: Hong Kong |                                    |
| Colombia               | 1985                               |
| Costa Rica             | 1981                               |
| Cyprus                 |                                    |
| Dominican Republic     | 1985, 1987, 1990                   |
| Ecuador                | 1982, 1985, 1988                   |
| Egypt                  | 1979, 1989                         |
| El Salvador            | 1986, 1990                         |
| Equatorial Guinea      | 1991, 1994                         |
| Ethiopia               | 1992                               |
| Fiji                   | 1986                               |
| Ghana                  | 1978, 1983, 1986                   |
| Grenada                | 1978                               |
| Guatemala              | 1986, 1989                         |
| Guinea-Bissau          | 1991, 1996                         |
| Guyana                 | 1987, 1989                         |
| Haiti                  | 1977, 1991                         |
| Honduras               | 1990                               |
| Hungary                | 1989, 1994                         |
| India                  | 1976, 1991, 1995                   |
| Indonesia              | 1978, 1983, 1986, 1997             |
| Jamaica                | 1978, 1983, 1990                   |
| Jordan                 | 1983, 1987, 1989, 1992             |
| Kenya                  | 1975, 1981, 1985, 1993, 1995, 1997 |
| Korea                  | 1980, 1997                         |
| Lao People's D. R.     | 1995                               |
| Madagascar             | 1984, 1986, 1991, 1994             |
| Malawi                 | 1982, 1985, 1992, 1994             |
| Malaysia               | 1986, 1997                         |

|                      |                              |
|----------------------|------------------------------|
| Mali                 | 1993                         |
| Malta                | 1992, 1997                   |
| Mauritius            | 1979                         |
| Mexico               | 1976, 1982, 1985, 1994       |
| Morocco              | 1983, 1990                   |
| Mozambique           | 1993, 1995                   |
| Myanmar              | 1975, 1977                   |
| Nepal                | 1975, 1981, 1984, 1991, 1995 |
| Nicaragua            | 1993                         |
| Nigeria              | 1986, 1989, 1992             |
| Pakistan             |                              |
| Panama               |                              |
| Paraguay             | 1984, 1986, 1988, 1992       |
| Peru                 | 1976, 1979, 1987             |
| Philippines          | 1983, 1986, 1997             |
| Romania              | 1990                         |
| Sierra Leone         | 1988, 1990, 1997             |
| Singapore            | 1975                         |
| South Africa         | 1975, 1978, 1984, 1996       |
| Sri Lanka            | 1977                         |
| Swaziland            | 1975, 1979, 1982, 1984       |
| Syrian Arab Republic | 1977, 1982, 1988             |
| Thailand             | 1981, 1984, 1997             |
| Trinidad & Tobago    | 1985, 1988, 1993             |
| Tunisia              | 1993                         |
| Turkey               | 1978, 1994                   |
| Uganda               | 1981, 1987, 1989             |
| Uruguay              | 1982                         |
| Venezuela            | 1984, 1986, 1989, 1994       |
| Zambia               | 1985, 1994                   |
| Zimbabwe             | 1982, 1991, 1994, 1997       |

<sup>a</sup> Currency crises defined by criteria described in text, with 24-month exclusion windows imposed.

## Appendix B. Balance of Payments and Domestic Financial Liberalization Dates

|                        | <b>Capital Account Liberalization</b> | <b>Current Account Liberalization</b> | <b>Export Receipts Liberalization</b> | <b>Domestic Financial Liberalization</b> |
|------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--|
| Argentina              | 1993–                                 | 1977-81, 1993–                        | 1993–                                 | 1977-82, 1987–                           |
| Bangladesh             |                                       | 1994-95                               |                                       | 1989–                                    |
| Belize                 | 1981-85                               | 1984-95                               |                                       |  |
| Bolivia                | 1975-80, 1986-95                      | 1975-80, 1986-95                      | 1997–                                 | 1985–                                    |
| Botswana               |                                       | 1975-79, 1995, 1997                   | 1987-92                               |  |
| Brazil                 |                                       |                                       |                                       | 1976-78, 1989–                           |
| Burundi                |                                       |                                       |                                       | 1989–                                    |
| Cameroon               |                                       | 1975-86, 1993-95                      |                                       | 1990–                                    |
| Chile                  |                                       | 1976-81, 1995                         |                                       | 1974-81, 1985–                           |
| China, P.R.: Hong Kong | 1975–                                 | 1975–                                 | 1975–                                 | 1975                                     |
| Colombia               |                                       |                                       |                                       | 1980–                                    |
| Costa Rica             | 1980-81, 1995–                        | 1975-80, 1994–                        |                                       | 1986–                                    |
| Cyprus                 |                                       | 1993-95                               |                                       | NA                                       |
| Dominican Republic     |                                       | 1995                                  |                                       |  |
| Ecuador                | 1975-85, 1988-92, 1995                | 1975-81, 1993–                        |                                       | 1986-87, 1992–                           |
| Egypt                  |                                       | 1996–                                 | 1994–                                 | 1991–                                    |
| El Salvador            | 1996–                                 | 1993–                                 | 1996–                                 | 1991–                                    |
| Equatorial Guinea      |                                       | 1994-95                               |                                       | NA                                       |
| Ethiopia               |                                       |                                       |                                       |  |
| Fiji                   |                                       | 1975-87, 1992-95                      |                                       | 1985–                                    |
| Ghana                  |                                       | 1993-95                               |                                       | 1987–                                    |
| Grenada                |                                       | 1993-95                               | 1975-78                               | NA                                       |
| Guatemala              | 1975-79, 1989–                        | 1975-79, 1989–                        | 1975-79                               | 1989–                                    |
| Guinea-Bissau          |                                       |                                       |                                       | NA                                       |
| Guyana                 |                                       | 1993–                                 | 1996–                                 | 1991–                                    |
| Haiti                  |                                       | 1975–                                 | 1975-80, 96–                          | 1995–                                    |
| Honduras               | 1975-79, 1993-95                      | 1975-80, 1993–                        | 1975-77                               | 1990–                                    |
| Hungary                |                                       | 1996–                                 |                                       | 1987–                                    |
| India                  |                                       |                                       |                                       | 1991–                                    |
| Indonesia              | 1975-95                               | 1975-76, 1978–                        | 1982–                                 | 1983–                                    |
| Jamaica                | 1996–                                 | 1996–                                 | 1992–                                 | 1991–                                    |
| Jordan                 |                                       | 1979-86, 1997–                        | 1995–                                 | 1988–                                    |
| Kenya                  | 1996–                                 | 1996–                                 | 1996–                                 | 1991–                                    |
| Korea                  |                                       | 1978-81, 1988-95                      |                                       | 1984-88, 1991–                           |
| Lao People's D. R.     |                                       | 1996–                                 |                                       |  |
| Madagascar             |                                       | 1997–                                 |                                       | 1985–                                    |
| Malawi                 |                                       | 1995                                  |                                       | 1988–                                    |

|                      | <b>Capital Account Liberalization</b> | <b>Current Account Liberalization</b> | <b>Export Receipts Liberalization</b> | <b>Domestic Financial Liberalization</b> |
|----------------------|---------------------------------------|---------------------------------------|---------------------------------------|--|
| Malaysia             | 1975-95                               | 1975-                                 | 1982-92                               | 1978-                                    |
| Mali                 |                                       | 1975-95                               |                                       |  |
| Malta                |                                       | 1994-95                               |                                       | NA                                       |
| Mauritius            | 1996-                                 | 1993-                                 | 1997-                                 | 1981-                                    |
| Mexico               | 1975-81                               | 1975-81, 1987-                        | 1975-81, 1993-                        | 1977-81, 1989-                           |
| Morocco              |                                       | 1993-95                               |                                       | 1991-                                    |
| Mozambique           |                                       |                                       |                                       |  |
| Myanmar              |                                       |                                       |                                       | NA                                       |
| Nepal                |                                       | 1995                                  |                                       | 1986-                                    |
| Nicaragua            | 1975-77, 1996-                        | 1975-77, 1993-                        | 1975-77, 1996-                        | NA                                       |
| Nigeria              |                                       | 1986-88                               |                                       | 1990-93                                  |
| Pakistan             |                                       |                                       |                                       | 1991-                                    |
| Panama               | 1975-                                 | 1975-                                 | 1975-                                 | NA                                       |
| Paraguay             | 1982-83, 1996-                        | 1978-81, 1992-95                      | 1997-                                 | 1991-                                    |
| Peru                 | 1978-83, 1993-                        | 1978-83, 1992-95, 1997-               | 1992-                                 | 1980-84, 1990-                           |
| Philippines          |                                       | 1985, 1995                            | 1992-                                 | 1981-                                    |
| Romania              |                                       |                                       | 1992                                  | 1991-                                    |
| Sierra Leone         |                                       | 1986-91, 1995                         | 1995-                                 | 1987-                                    |
| Singapore            | 1978-                                 | 1975-96                               | 1978-                                 | 1974-                                    |
| South Africa         |                                       | 1975-77, 1993-95                      |                                       | 1980                                     |
| Sri Lanka            |                                       | 1978-79, 1992-95                      | 1992-                                 | 1980-                                    |
| Swaziland            |                                       | 1975-95                               |                                       | NA                                       |
| Syrian Arab Republic |                                       |                                       |                                       |  |
| Thailand             |                                       | 1975-                                 |                                       | 1989-                                    |
| Trinidad & Tobago    | 1994-                                 | 1975-81, 1992                         | 1993-                                 | 1994-                                    |
| Tunisia              |                                       | 1992-95                               |                                       | 1987-                                    |
| Turkey               | 1997-                                 | 1989-95                               |                                       | 1980-82, 1988                            |
| Uganda               | 1997-                                 | 1994-                                 | 1995-                                 | 1991-                                    |
| Uruguay              | 1978-92, 1996-                        | 1976-                                 | 1981, 1996-                           | 1976-                                    |
| Venezuela            | 1975-83, 1996-                        | 1975-82, 1988-92, 1996-               | 1976-82, 1997-                        | 1981-84, 1991-93, 1996-                  |
| Zambia               | 1996-                                 | 1996-                                 | 1996-                                 | 1992-                                    |
| Zimbabwe             |                                       |                                       | 1995                                  | 1992-                                    |

Note: “–” indicates liberalization continues until the end of the sample in 1997; blank cell indicates liberalization never implemented; NA indicates no data available.