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HOW BAD ARE TWINS? OUTPUT COSTS OF CURRENCY AND BANKING CRISES

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Abstract

We investigate the output effects of severe banking and currency crises in emerging markets, focusing on whether "twin crises" (simultaneous occurrence of currency and banking crises) exist as a unique phenomenon and whether they entail especially large losses. Recent literature, mostly relating to the East Asian crisis, emphasizes the interplay and reinforcement between currency and banking crises, presumably making twin crises particularly damaging to the real economy. Using a panel data set over the 1975–97 period and covering 24 emerging-market economies, we find that twin crises do *not* contribute any additional (marginal) negative impact on output growth. That is, twin crises do not adversely impact output over and above the independent effects associated with a currency and banking crisis taken together. We find that currency (banking) crises are very damaging, reducing output by about 5–8 (8–10) percent over a two-four year period. The cumulative output loss of both types of crises occurring at the same time is therefore very large, around 13–18 percent, and should alarm policymakers. However, twin crises are "bad" only in that they entail output losses associated with both currency and banking crises, not because there are additional feedback or interactive effects further damaging the economy. This result is robust to alternative model specifications, lag structures and using IV and GMM estimation procedures that correct bias associated with simultaneity and estimation of dynamic panel models with country-specific effects.

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1. Introduction

Severe financial crises occur with some frequency in emerging-market economies—more than 51 (33) currency (banking) crises episodes over the past 25 years and 20 occurrences of "twin crises" (currency and banking crises that occurred simultaneously, shown in Appendix A). Moreover, this frequency of financial crises appears to be a reoccurring phenomenon, persistent over time and across regions of the world (Bordo et al., 2001; Glick and Hutchison, 2001). A large and growing empirical literature attempts to explain the factors that cause currency, banking and twin crises, as well as their timing, on the basis of macroeconomic, institutional and structural factors. See, for example, Arteta and Eichengreen, forthcoming; Demirgüç-Kunt and Detragiache, 1998; Eichengreen, Rose, and Wyplosz, 1995; Frankel and Rose, 1996; Glick and Hutchison, 2001; Hutchison and McDill, 1999; Kaminsky and Reinhart, 1999; and Sachs, Tornell and Velasco, 1996.

Recent theoretical literature emphasizes the potential impact of financial crises on *output growth*. A sharp devaluation (*currency/balance of payments crisis*) may have a contractionary effect on output, working through such channels as a wealth effect on aggregate demand, higher production costs, disruption in credit markets, or a sudden cessation in capital inflows limiting imported capital goods.[1] *Banking crises* may have adverse effects on output by disrupting the process of credit intermediation.[2] Any number of factors may induce a banking crisis (e.g. exogenous shock reducing the collateral value of assets, sunspot bank runs, and so on), and the transmission to the real economy may take the form of a financial accelerator, credit constraints, decrease in collateral values, disruption in the payments system, bankruptcies and other channels (e.g. Bernanke and Gertler, 1989; Bernanke et al., 1996; Kiyotaki and Moore, 1997). There is also an emerging theoretical literature linking banking and currency crises, and how these *twin crises* may emerge—where the initial disturbance could emanate from a currency crisis, a bank crisis, or a common shock to both sectors (Glick and Hutchison, 2001).

However, there is no simple theoretical rationale for why a twin crisis need have an adverse effect on the economy greater than the cumulative effect of a currency and banking crisis measured

[1] A traditional view of currency crises, however, is that, with wage and price rigidities, a sharp nominal devaluation would produce a real depreciation in the short-run, increase exports and stimulate employment and output. Indeed, a sharp devaluation in the past was often accompanied by accusations that a country was pursuing a "beggar thy neighbour" policy and "exporting" unemployment.

[2] Allen and Gale (1998), by contrast, show that financial sector crises may be "optimal" from a welfare point of view, increasing long-run efficiency and growth in the economy as they are used as a mechanism to optimally distribute risk.

separately. Clearly, the simultaneous occurrence of a currency and banking crisis could have disruptive effects on the real economy working through currency exposure and bank balance sheets, bank runs, and disruption in international credit markets and capital flows (e.g. Chang and Velasco, 1999; Dekle and Kletzer, 2001; Goldfajn and Valdés, 1997). But is there something special about a twin crisis making output losses greater than would be anticipated simply by consider the additive effect of a currency and bank crisis? It is possible that feedback effects, contagion and linkages between domestic and international financial markets *might make output losses of twin crises particularly severe,* but difficult to model theoretically. Nonetheless, policy discussions attempting to explain why some economies, such as those in East Asia, seemed to suffer disproportionately from financial crises frequently point to the linkage between currency and banking crises. And casual observation would seem to bear this out.

There is surprisingly little empirical literature, however, systematically testing the extent to which financial crises impact output growth and no empirical article of which we are aware that focuses on twin crises. A few articles, reviewed in Section 2, consider the impact of either a currency or a banking crisis separately on the real economy. But we believe the key issue regarding the impact of twin crises is the *marginal* output growth effect of a simultaneous occurrence of a currency and banking crisis.[3] In particular, in this study we ask whether output losses associated with a twin crisis are significantly greater than would have been predicted by the combined effect of a currency and banking crisis measured independently. That this question has not been fully addressed is surprising, given its enormous theoretical and policy import. Indeed, if there is no marginal output effect of a twin crisis, one may question whether a twin crisis is an interesting phenomenon in its own right. We investigate this issue directly and apply our analysis to answer whether East Asian output collapse in 1998 was likely associated with the fact that all of these nations experienced severe twin crises.

Our objective is to test the output effects of a twin crisis by decomposing that part associated with a currency crisis, a banking crisis, and the interaction between the two. The latter element is our focus. We investigate the particular aspect of a twin crisis that may make it worse for the economy—as suggested by recent policy discussions—than the typical crisis or even the combined effect of a currency and banking crisis treated as if they were independent events. To this end, we investigate

[3] Indeed, only Bordo et al. (2001) address the potential effects of a twin crisis. They look at a cross-section of countries in recession and focuses on whether the costs of financial crises are the same today as over the century ending in 1971 (the collapse of Bretton Woods).

output growth developments for emerging-market economies in a panel data set over 1975–97. We measure the impact of twin crises, carefully controlling for domestic and external factors, country time-invariant effects, and state of the business cycle. Simultaneity between financial crises and output growth is likely in this context, and we employ the fixed-effects panel IV and GMM estimation procedures, respectively, of Hausman and Taylor (1981) and Arellano and Bond (1991) to address this issue.

We concentrate our investigation on emerging markets since they are the focus of policy discussions and recent experiences of twin crises and output collapses. Several recent studies indicate that emerging markets may be different with respect to the factors that make them susceptible to a financial crisis (Glick and Hutchison, 2001) and how they respond to them (IMF, 1998). Specifically, emerging markets tend to be open to international capital inflows, and have experienced large private capital inflows that are typically short-term. This debt is also usually denominated in foreign currency (generally the US$). These large short-term foreign-currency debt positions increase the vulnerability of these economies to swings in exchange rates and cessation of new capital to roll over existing debt (the "sudden stop" syndrome of Calvo, 1998). Emerging markets therefore appear most vulnerable to twin crises and, potentially, their adverse consequences.

Section 2 reviews the empirical literature on financial crises and highlights our contribution to the literature. Section 3 presents the basic empirical model. Section 4 discusses the data employed in the study. Section 5 reports before/after (currency, banking and twin crises) summary statistics on key macroeconomic variables and the primary empirical results of the study. This section presents estimation results of the output equations, model dynamics and robustness checks. Section 6 presents predictions for output development in the East Asian crisis obtained by simulating our empirical results for the out-of-sample data for the five Asian 1998 crisis countries. Section 7 concludes the paper.

2. Literature on the Output Costs of Currency and Banking Crises

Several studies in the literature investigate the output costs of currency crises, but very few systematically analyze the costs of banking crises or both forms of crises taken together. Most important for our purposes, no studies of which we are aware measure the feedback and interactive affect on output arising from a twin crisis.

Most of the limited empirical literature on the output costs of currency and balance of payments crises focus on single crisis episodes (e.g. Calvo and Mendoza, 1996; Lane and Phillips, 1999) or on episodes that are known to have been contractionary (e.g. Calvo and Reinhart, 1999). Exceptions that analyse output developments around the time of a currency crisis in a broad sample of countries are Aziz et al. (2000), Barro (2001), Bordo et al. (2001), Gupta et al. (2000) and Milesi-Ferretti and Razin (2000).

McDill (2000) and Demirgüç-Kunt et al. (2001) focus on the output cost of a banking crisis. McDill (2000) investigates the effect of banking crises on a panel data set comprising industrial, emerging and developing economies. She regresses output growth on contemporaneous banking crises and several control variables (lagged exchange rate depreciation, the real interest rate, lagged money growth and lagged change in stock price). She finds that banking crises are associated with 1.2–1.8 percentage point decline in output growth during each year of the banking crisis. Demirgüç-Kunt et al. (2000) consider a cross-section of 36 banking crises, investigating macroeconomic developments before, during and after crisis episodes. They test differences in the developments of each variable (e.g. output growth) during these different periods (before, during and after) using a regression that accounts for heterogeneity across countries. They find that a banking crisis is associated (contemporaneously) with a 4-percentage point decline in output growth and that growth remains depressed in the year following the crisis.

Output Costs of Twin Crises

Barro (2001) and Bordo et al. (2001) are the only papers of which we are aware that attempt to measure the output cost of a currency crisis and a banking crisis in the same model. Barro (2001), however, measures the effects of these crises separately—the twin crisis phenomenon is not investigated. Bordo et al. (2001) consider the output costs of twin crises, but measure this phenomenon independently of currency and banking crises.

Specifically, Barro (2001) considers the pattern of 5-year average output growth in a broad panel data set covering industrial, emerging and developing economies. He regresses 5-year output growth on conventional control variables (e.g. per capita GDP, schooling, life expectancy) and contemporaneous and lagged currency and banking crises. The crisis variable measures a (1,0) dummy for a crisis occurrence anytime during the focal 5-year period. He finds that a currency (banking) crisis is associated with a 1.3 percentage point decline (0.6 percent decline) in average

output growth over the 5-year period. He concludes that the combination of a currency and a banking crisis reduces growth contemporaneously by about 2 percent per year.[4]

Bordo et al. (2001), in work most closely related to our own article, conduct a cross sectional investigation of the effect of both kinds of financial crises and their 'twin' effect on recessions. For their modern (1973-1997) sample, they find that the cumulative output loss for a 'twin' crisis over and above the average recession is 16% of GDP. This effect is measured separately from the 13% cumulative output loss that is found to be the combined effect of a banking and currency crisis (4.4% and 8.7% respectively).[5] Overall, their result is ambiguous about the exact difference in outcomes between a 'twin' and a combined currency-and-banking crisis phenomenon.

3. Estimating the Effects of Currency, Banking and Twin Crises on Real Output Growth

Our contribution is to measure the *additional* output cost of a twin crisis, over and above that that may be associated with currency and banking crises viewed as separate phenomena**.** Unlike other literature in this area, we also control for simultaneity issues, and biases associated with estimation of fixed-effects dynamic panel data models. Estimating this model for emerging market economies, we are also able to address whether twins are especially problematic in general terms and whether the deep recession in East Asia was typical of the "bad" outcome of a twin crisis.

Our methodological approach begins by explaining output growth in emerging markets by a standard set of variables as well as currency, banking and twin crises. The determinants of output in this model are a set of domestic policy, structural, and external factors, as well as country-specific effects and lagged output growth. Domestic policy factors are changes in government budget surpluses and credit growth. External factors are growth in foreign output and real exchange rate overvaluation. The structural factor we consider is the openness of the economy to international trade. Country-specific effects are introduced in order to account for the widely varying growth experiences in our set of emerging-market economies over the past 25 years. All of the variables, with the exception of foreign output, are introduced with a one-year lag in order to capture the delayed response of output to macroeconomic developments. This formulation of the model also

[4] It is noteworthy, however, that Barro (2001) also finds that the currency (banking) crisis is followed by a 0.6 (0.9) percentage point and statistically significant *rise* in average output growth during the subsequent 5-year period. The net effect is an average 0.2 percentage point decline in output growth per year over the decade when a currency crisis coincides with a banking crisis.

[5] The equivalent results for their 1880-1997 sample are 14.8%, 3.2% and 7.8% respectively.

avoids the potential for biased coefficient estimates on the domestic policy variables due to feedback effects from output growth to policy formulation (simultaneous equation bias). Our main concern in this context is to introduce relevant control variables into the regression equation so that the identified impact of a crisis on output growth is not simply due to omitted-variables bias.

In the context of our "benchmark" model, we test for the additional effect on output growth arising from a currency, banking and twin crises. We consider both lagged and contemporaneous effects of crises on output growth, and also estimate several variants of the model, including changes in the lag structure and definition of crises, to check the robustness of the basic results. The coefficient estimates on our crises measures may be interpreted as the marginal effects of crises, after controlling for several of the other factors that may influence the evolution of output growth.

The formal specification of the empirical model is as follows. The growth of real GDP for the *i*th country at time *t* (y_{it}) is explained by policy variables ($x_{i(t-1)}$); external and structural factors ($w_{i(\cdot)}$); the recent occurrence of a currency or a banking crisis ($D^{CC}_{i(\cdot)}$, $D^{BK}_{i(\cdot)}$), a 'twin' crisis ($D^{CC}_{i(\cdot)} * D^{BK}_{i(\cdot)}$), and an unobservable random disturbance (ε_{it}).

$$y_{it} = \mu_0 + \beta_k x_{i(t-1)} + \alpha_h w_{i(\cdot)} + \beta^{CC} D^{CC}_{i(\cdot)} + \beta^{BK} D^{BK}_{i(\cdot)} + \beta^{TW} (D^{CC}_{i(\cdot)} \cdot D^{BK}_{i(\cdot)}) + \varepsilon_{it} \qquad (1)$$

where *x* is a *k*-element vector of policy variables for country *i* at time *t,* w is an *h*-element vector of external variables for country *i* at times (*t* or *t-1)*, $D^{CC}_{i(t)}$ is a dummy variable equal to unity if the country has recently experienced a currency crisis or balance of payments crisis (and zero otherwise) and likewise for a banking and twin crises. ε_{it} is a zero mean, fixed variance, disturbance term. μ_0 is a vector of country effects (allowing average growth rates to vary across countries in the sample), β_k is a *k*-element vector measuring the impact of policy changes on output, α_h is an *h*-element vector measuring the impact of exogenous factors on output, and β^{CC} , β^{BK} and β^{TW} measure the output growth effects of currency, banking and twin crises respectively.

In our main estimates we follow a procedure first suggested by Hausman and Taylor (1981) that takes into account the bias in estimation of a dynamic panel with predetermined and endogenous variables (for a rigorous formulation of this bias, see Nickel, 1981). This three-step estimation methodology is an instrumental variable estimator that takes into account the possible correlation between the independent variables and the individual country-specific effects, as well possible

simultaneity issues running from output growth (our dependent variable) and currency, banking and twin crises (three of the explanatory variables). When a correlation exists between the independent variables and the individual country-specific effects, estimation of a dynamic model creates a correlation between time-invariant country-fixed effects and the error term. A similar correlation between the "crisis" explanatory variables and the error term exists when output fluctuations contribute to the onset of a crisis.

In the first step, least squares estimates (with fixed effects) are employed to obtain consistent but inefficient estimates for the variance components for the coefficients of the time-varying variables. In the second step, an FGLS procedure is employed to obtain variances for the time-invariant variables. The third step is a weighted IV estimation using deviation from means of lagged values of the time-varying variables as instruments.[6] The procedure requires specifying which explanatory variables are to be treated as endogenous. In our specification, the endogenous explanatory variables are the three binary crisis measures (currency, banking and twin) and consideration is also taken for the lagged dependent variable.[7]

While the Hausman-Taylor (HT) procedure provides asymptotically unbiased estimates, a recent literature suggests it is not the most efficient estimator possible. A more efficient General Methods of Moments (GMM) procedure relies on utilizing more available moment conditions to obtain a more efficient estimation (e.g., Ahn and Schmidt, 1995; and Arellano and Bond, 1991 and 1998).[8] This procedure, however, is usually employed in estimation of panels with a large number of individuals and short time-series such as in the literature on long-run growth (Bond et al., 2001). In our case, the data makes this procedure difficult to implement for most specifications of the model. We provide results using the Arellano and Bond (1998) GMM framework and show that our

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[6] In the final step all variables are transformed by: $v_{it}^* = v_{it} - (1 - \theta_i)\bar{v}_i$ where $\theta_i = \sqrt{\frac{\sigma_\varepsilon^2}{\sigma_\varepsilon^2 + T_i\sigma_u^2}}$

where v_{it} denotes any of the aforementioned variables and $\bar{v}_i$ denotes a group mean and the variance components are the one obtained in first two steps. For exact details on the motivation and estimation procedure, see Greene (2001) and Hausman and Taylor (1981).

[7] Assuming any of the other control variables is not exogenous does not change our empirical results.

[8] For a detailed survey of asymptotic consistency results and GMM estimation methods casting doubts on some of the results in this literature, see Arellano and Honoré (forthcoming) and Bond et al. (2001).

coefficients to do not change noticeably when compared to the benchmark Hausman and Taylor (1981) estimates.[9]

4. Data Description

Defining Currency and Balance of Payments Crises

Our indicator of currency and balance of payments crises is constructed by identifying "large" values in an index of currency pressure, defined as a weighted average of monthly real exchange rate changes and monthly (percent) international reserve losses.[10] Following convention (e.g. Kaminsky and Reinhart, 1999) the weights are inversely related to the variance of changes of each component over the sample for each country. This excludes some large depreciations that occur during high inflation episodes, but it avoids screening out sizeable depreciation events in more moderate inflation periods for countries that have occasionally experienced periods of hyperinflation and extreme devaluation.[11] Our measure, taken from Glick and Hutchison (2000 and 2001), presumes that any nominal currency changes or reserve 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). An episode of serious exchange rate pressure, i.e. a standard crisis episode, is defined as a value in the index—a threshold point—that exceeds the mean plus 2 times the country-specific standard deviation, provided that it also exceeds 5 percent.[12] The first condition insures that, relative to its own history, unusually large values of the index of currency pressure are counted as a crisis while the second condition attempts to screen out values that are insufficiently large in an economic (real) sense.

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[9] We use the Limdep software suite in all our estimations. We thank Professor William Greene for providing us with a update of the LINDEP package and the statistical procedure to estimate the GMM model

[10] Our currency pressure measure of crises does not include episodes of defence 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 countries in our dataset.

[11] 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.

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 currency pressure index for any month of that year satisfies our criteria. 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" indication of currency pressure, we treat any similar threshold point reached 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 51 currency crises, 68 crisis years and 42 major currency crises for our emerging markets dataset over the 1975-97 period (see Table 1).

Defining Banking Crises

Banking problems are usually difficult to identify empirically because of data limitations. The potential for a bank run is not directly observable and, once either a bank run or large-scale government intervention has occurred, the situation most likely will have been preceded by a protracted deterioration in the quality of assets held by banks. Identifying banking sector distress by the deterioration of bank asset quality is also difficult since direct market indicators of asset value are usually lacking. This is an important limitation since most banking problems in recent years are not associated with bank runs but with deterioration in asset quality and subsequent government intervention. Moreover, it is often laxity or failure of government analysis in identifying banking fragility, and slow follow-up action once a problem is recognized, that allows the situation to deteriorate to the point of a systemic crisis involving large-scale government intervention.

Our measure identifies and dates episodes of banking sector distress following the criteria of Caprio and Klingebiel (1996, and updated on the IMF Web page) and Demirgüç-Kunt and Detragiache (1998). If an episode of banking distress is identified in either study, it is included in our sample. If there is ambiguity over the timing of the episode, we use the dating scheme of Demirgüç-Kunt and Detragiache (1998) since it tends to be more specific about the precise start and end of

[12] 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. Our output equation estimates using "major" currency crises, evaluated with the 3-standard deviation threshold, are very similar to the benchmark crisis measure.

each episode.[13] Major bank crises are taken from Caprio and Klingebiel and defined as posing a substantial threat to the entire financial system.

Our emerging markets dataset over the 1975-97 period includes 33 banking crises, 105 crisis years, and 21 major banking crises. Thus, the average duration of a banking crisis is 3.2 years while the average duration of a currency crisis is only 1.3 years.

Defining Twin Crises

Our definition of twin crises, taken from Glick and Hutchison (2001), marks a crisis if the onset of a banking crisis occurred two years before, during, or after the onset of a currency crisis. We use this definition to allow for the imprecise identification of banking crises previously discussed. Using a narrower one-year band does not qualitatively alter our results. We identify 20 instances of a 'twin' crisis in our dataset.

Control Variables in the Output Growth Equation

As discussed in section 2, the domestic policy factors included in our estimation are lagged changes in government budgets and lagged credit growth; external factors are (trade-weighted) external growth rates of the G-3 and lagged index of real exchange rate overvaluation; and the structural factor we consider is the openness of the economy to international trade.[14] All of the macroeconomic data series are taken from the International Monetary Fund's IFS CD-ROM.

[13] Demirgüç-Kunt and Detragiache (1998) identify banking sector distress as a situation where one of the following conditions hold: ratio of non-performing assets to total assets is greater than 2 percent of GDP; cost of the rescue operation was at least 2 percent of GDP; banking sector problems resulted in a large scale nationalization of banks; and extensive bank runs took place or emergency measures such as deposit freezes, prolonged bank holidays, or generalized deposit guarantees were enacted by the government in response to the crisis. Caprio and Klingebiel (1996) do not offer a systematic identification scheme but rely on expert opinions solicited from varied sources. They identify a systemic crisis as one in which "much or all of bank capital [was] being exhausted". Arteta and Eichengreen (forthcoming) compare these sources and others and conclude that their empirical results do not depend on the banking identification scheme used.

[14] The 'openness' variable is defined as the sum of imports and exports relative to GDP. Real exchange rate overvaluation is defined as deviations from a fitted trend in the real trade weighted exchange rate. The real trade-weighted exchange rate is the trade-weighted sum of the bilateral real exchange rates (defined in terms of CPI indices) against the U.S. dollar, the German mark, and the Japanese yen. The trade-weights are based on the average bilateral trade with the United States, the European Union, and Japan in 1980 and 1990.

The minimum data requirements to be included in our study are that GDP figures are available for a minimum of 10 consecutive years over the period 1975–97. We use annual observations. We employ monthly data for our (real) exchange rate and international reserves pressure index to identify currency crises and date each by the year in which it occurs. While some of our control variables are available for quarterly or even monthly frequency, banking crises are typically identifiable only in annual data.

5. Empirical Results

Conditional Probabilities for Crises Onsets

Table 2 presents hypothesis tests on the likelihood that currency and banking crises (twins) are statistically independent. The hypothesis that banking and currency crisis are not correlated can be rejected with probability of more than 99%. For our sample, the onsets of 31% of banking crises were accompanied by currency turmoil. Furthermore, there is a statistically significant correlation between lagged banking crises and contemporaneous currency crises but not vice versa. This result is similar to that found in Glick and Hutchison (2001) for a dataset including developing countries as well as emerging markets.[15]

Macro Developments: Before/After Crises Statistics

Table 3 present summary statistics on key macroeconomic developments around currency (upper panel) and banking (lower panel) crises. It presents before-after statistics for the standard definitions of 'normal' currency, banking, and twin crises mentioned above. Four-year windows are imposed on the data to clearly delineate the macroeconomic developments around the time of crisis.

Our focus variable, real GDP growth, shows an average decline of about 1.3 percentage points in the year a currency crisis takes place, and it recovers only minimally the following year (by 0.3 percentage points). Average output growth goes back to its previous level two years after the crisis, and this upturn is statistically significant. This pattern is almost identical for standard and major crises (not reported for brevity). Average losses appear to be even smaller for our sub-sample of currency crises without banking crises (reducing output growth by only 0.5 percentage points).

[15] This result is consistent with the find, reported in Glick and Hutchison (2000), that causality is more likely to run from banking to currency crises and not, as is sometimes portrayed for the turmoil in East Asia, from a currency crisis to a systemic banking failure.

By contrast, output developments around banking crises are striking by the very large costs involved (4.1 percentage points for each year of the crisis). Output growth dynamics surrounding twin crises are similar and appear to entail a reduction of 4.2 percentage points in the year of the crisis, followed by sustained depressed output for the following two year. Hence, at first pass, the summary statistics indicate significant and—in some cases—prolonged effects of financial crises and twin crises in particular. We focus on more formal tests of this proposition in the sub-sections below.

Interestingly, there are no evident statistical trends in the evolution of the budget surplus.[16] Inflation rates trend upward starting from before the onset of either a currency or twin crisis, but not a banking one. More pertinent is the fact that twin crises occur more frequently in countries with higher inflation rates before, during and after the crisis episode when compared to other crisis episodes. Our index for real exchange rate overvaluation shows dynamics that can be expected given the fact that it is a key element used to identify currency crises.

Benchmark Model Estimates

Table 4 presents results from our benchmark model. Judging by the adjusted R-square statistics, the benchmark without any of the crisis variables explains 27 percent of the variation in output growth. The statistically significant control variables are external output growth, real exchange rate overvaluation, and lagged output growth. A one- percent rise in the growth rate of the G-3 economies raises output growth in emerging-market economies by about, on average, 0.3–0.4 percentage points. A rise in real exchange rate overvaluation significantly reduces output growth. This is noteworthy in its own right, indicating that emerging market economies should avoid currency overvaluation, but also because real exchange rate overvaluation is a reliable predictor of future currency crises (see Glick and Hutchison, 2001). However, budget changes, credit growth and the openness measure are not statistically significant. The coefficient estimates for the control variables are consistent across alternative specifications of the model reported in columns (1)–(5) of Table 4 and in the other tables.

Turning to the key variables of interest, the coefficient estimates reported in column (2) indicate that a currency crisis is associated with a contemporaneous (lagged) fall in GDP growth of about 2.9

[16] While not presented here, the same is true for credit growth rates. Foreign interest rates typically rise about 100 basis points on average and foreign growth rates decline modestly surrounding currency crises.

(2.5) percentage points. Very similar results are obtained, but not reported for brevity, when including only the contemporaneous or the lagged currency crisis binary variable. After a two-year period, the cumulative negative effect of a currency crisis on output is about 5.5 percent.

Table 4 also presents more information on the dynamics of output adjustment to currency crises. To allow for additional lagged values, we focus attention on the currency crisis "onset"—the initial year of the currency crisis. Column (3) reports the analogous regression to (2) using the onset version of the variable. Not surprisingly, since most currency crises have duration of only about one year, the results of columns (3) are very similar to those reported in column (2) with a cumulative output effect of 5.1 percentage points. Adding further lags (second, third and fourth year lags) to the model, reported in column 4, indicate that the contemporaneous and one-year ahead effects of a currency crisis remain negative and highly significant and with roughly the same magnitudes as reported previously. This is followed by a substantial negative, but statistically insignificant, effect on the second year following a crisis and eventually a (insignificant) positive output effect in the third- and fourth years. Thus, currency crises in emerging markets seem to affect output 1–2 years following a crisis. This result remains when some of the insignificant lags are dropped. Our results therefore do not indicate a persistent effect—beyond a two-year horizon—of crises on output growth.

We also include lead values of currency crises in the equations, shown in columns (5), to further investigate the dynamic responses. Only one of the lead value coefficients, the one-year lead value of currency crises, is statistically significant. This result indicates that a currency crisis tends to follow, by about a year, a decline in real output growth. On the other hand, a currency crisis also is associated with a further decline in output growth contemporaneously and over a period of two years. These model estimates suggest that, within 2–3 years, output declines cumulatively by almost 8 percent for an average currency crisis in an emerging-market economy.

An important question is whether a particularly severe crisis—substantially larger than the normal crisis—has an especially severe effect on growth. To investigate this issue, we introduce a "major" currency crisis variable that is identified by a threshold point in our pressure index that exceeds 3-standard deviations from the mean. For brevity we do not report these results. Somewhat surprisingly, the output effects of a major crisis are not larger than the typical crisis situation. Coefficients for a version of column (3) using the major crisis measure yield coefficients of –2.3 and –2.8 for the contemporaneous and lagged major currency crisis variables, respectively. Major

currency and balance of payments crises do not appear to have a substantially different impact on output growth than the average crisis (identified using a 2-standard deviation threshold).

Banking and Twin Crises

The full results for our model are reported in Table 5. Columns (1) and (2) report the cost of a banking crisis with and without the inclusion of lagged and contemporaneous currency crises variables. In both cases, banking crises are costly: 3–3.5 percentage points of GDP growth is lost for each year of the crisis. As an average banking crisis lasts 3.3 years the cumulative output loss amounts to around 10 percent of GDP.

Our main results are presented in columns (3)—the coefficient on the twin crisis interactive variable is negative but not statistically significant from zero. Furthermore, the coefficients on the currency and banking crises variables stay almost exactly the same (–4.2 and –3.0 respectively). Neither does the inclusion of leads and lags for the banking crisis dummy, reported in column (4), change the magnitude of these coefficients.[17]

The joint occurrence of crises has a very large average effect on output growth—depressing GDP by about 15–18 percent over a 3–4 year period. Moreover, it appears that contagion between crises is a serious problem in emerging markets so that the threat (probability) of a twin crisis is significant given that either a banking or a currency crisis occurs (Table 2). However, twin crises do not seem to have any additional marginal effect on output above and beyond the effect of the contemporaneous occurrence of a banking and currency crisis. Twin crises are "bad" in that they entail output losses associated with both a currency and banking crisis, but there does not appear to be additional feedback effects further damaging the economy.

Robustness Tests

To check the robustness of our results we first examine whether our estimation technique, based on the Hausman and Taylor (1981) IV estimator, gives similar coefficient estimates from those obtained by the standard least squares fixed effect estimator with a White heteroscedasticity correction (LSDV) or the more efficient first-differenced GMM estimator suggested by Arellano and Bond (1991, 1998). These results are reported in Table 6 columns (1)-(3) where we also include the

[17] Interestingly, both the coefficients on the lead and lag of banking crises are insignificantly different from zero as well.

HT estimation for exactly the same sample.[18] There is very little difference between the coefficients obtained on our focus variables—currency and banking crises—in all three estimation techniques. As can be expected, the GMM estimator yields much higher t-statistics.

We also run the same model for a larger sample including 42 developing countries as well as the emerging markets sample. Data availability guided our choice of additional countries.[19] Comparisons of column (4) with column (2) in Table 6 leads us to conclude that both currency and banking crises have a weaker impact on output growth in our larger sample of developing countries— –2.0 instead of –3.3 for lagged currency crises and –2.6 instead of –3.1 for banking crises. Column (5) examines the robustness of our central result. The insignificance of the marginal effect of a twin crisis is also evident in our larger sample of developing countries as well. That is, the effects of both currency and banking crises are somewhat weaker and the coefficient on the twin crisis variable is still insignificantly different from zero.

In column (6) in Table 6 we investigate whether the main results are robust when the variables of interest are severe or major banking and currency crises. As was reported previously for currency crises, the severity of a banking crisis does not appear to influence its economic cost in terms of foregone output growth. (Of course, a severe banking crisis most probably entails larger fiscal costs.[20]) Our central finding is indeed robust to the "major crises" specification—major twin crises do not seem to have any statistically discernible marginal impact on output growth beyond the separate effects of major currency and banking crises.

It is possible that the results reported to this point are subject to sample selection bias. Countries that experience a currency or banking crises may be different in important respects from other countries or episodes. That is, it may not be the currency/banking crisis per se but several other factors contributing to them that are causing the decline in output growth. This is a variant of the sample selection bias problem.

We employ Heckman's (1979) Inverse Mills Ratio (IMR) to control for sample selection bias of this form. This statistic is constructed from the results of probit regressions explaining both currency

[18] The sample here is somewhat smaller than the one used in the results reported in Tables 4 and 5. The GMM estimator poses both data restrictions and restrictions on the models that could be estimated with our data (because of insufficient variation of the 'twin' variable within individual countries).

[19] We also restricted our sample for non-OECD countries with a population of more than one million.

[20] See, for example, Honohan and Klingebiel (2000) for estimates of the fiscal costs of banking crises. These might be construed, though, as involving only a transfer of resources and not imposing real costs on the economy.

and banking crises and added as an additional explanatory variable in the output growth regressions.[21] Including the IMR in the regression of interest prevents possible bias in our coefficient estimates and is a standard approach to account for sample selection bias.[22] For brevity, these results are not reported. In no case is the IMR coefficient statistically significant and, assuming the probit equations were correctly specified, sample selection bias may be rejected. More importantly, the coefficient estimates on the other explanatory factors, both control and crises variables are very similar to those reported in Table 5.

6. Out of Sample Growth Forecasts for the 1998 East Asian Crisis

Table 7 presents the predicted values for output growth for the five East Asian countries that experienced a severe financial crisis in 1997 and large output contractions in 1998—Indonesia, Korea, Malaysia, the Philippines and Thailand. These predictions are for 1998 output growth rates and are based on 1997 values of the explanatory variables and the coefficient estimates obtained from the model presented in column (4) of Table 5. Predicted values are decomposed into: (a) domestic factors (lagged output growth, change in budget surplus, credit growth, and country-specific effects), (b) external-structural factors (external growth, real exchange rate overvaluation and openness), (c) the currency, banking, and twin crisis effects.

Predicted output growth for all 5 countries is close to zero in 1998—small negative predictions for Indonesia and Thailand and small positive predictions for Korea, Malaysia and the Philippines. The forecast errors (unexpected declines in output) are therefore very large. The significant negative effect exerted by the crisis variables is dominated by a strong positive domestic effect—mainly a history of very strong growth in the region and the consequently large country-specific effects—and a modestly supportive external-structural growth environment.

It appears that the depth of the East Asian output collapse in 1998 is much greater than could have been expected based on the average effect of financial crises on emerging markets in the post Bretton-Woods period. Our research suggests that currency, banking and twin crises only explain a small part of the collapse of output observed in these countries. There appears to have been a common shock or common vulnerability in these countries—unobserved in this model—causing the

[21] The exact specifications of the probit regressions are taken from Glick and Hutchison, 2001. Details available from the authors upon request.

[22] For a survey of sample selection correction methodologies see Blundell and Costa Días, 2000.

unexpectedly large collapse in output. Alternatively, the effects of the crisis may have impacted output in the region much faster than generally occurs, i.e. the lagged effect of a typical crisis may have manifested earlier in the East Asian case. This could also explain the short but sharp duration of the recession in most East Asian countries at the time.

7. Conclusions

Despite the popular perception, we find no support for the conjecture that twin crises exert especially large output costs in emerging-market economies. The cost of either a currency or a banking crisis is highly significant and, taken together, is of course even larger. But twin crises do *not* contribute any additional (marginal) negative impact on output growth. In particular, we find that currency (banking) crises are very damaging, reducing output by about 5–8 (8–10) percent over a two-four year period. The combined effect of the two crises occurring simultaneously is therefore about 13–18 percent of output. These are very large estimates of output losses, and should alarm policymakers, particularly in light of the robustness of the empirical results to model specification and estimation technique

Nonetheless, twin crises are "bad" only in that they entail output losses associated with both currency and banking crises, apparently not because additional feedback or interactive effects further damage the economy. And the cumulative effects of a currency, banking and twin crisis also do not satisfactorily explain the deep recessions in East Asia in 1998.

If not due to a twin crisis, what then is responsible for the massive output losses seen in East Asia? First, we do not entirely discount twin crises—or at least the combined effect of a currency and a banking crisis—since it is possible that the cumulative effects occurring over a 2–4 year period may have manifested sooner. This is not typical for the response of economies to financial crises, but is possible. A second explanation lies elsewhere, perhaps a common unobserved shock hitting the region that lowered expectations of long-run growth potential and investment. This shock may be linked in turn to international capital markets that become virtually dysfunctional in the face of a financial crisis and perhaps overreact by reversing capital flows entirely. However, these are conjunctures beyond the scope of this article. The underlying cause of the *depth* of the East Asian recession remains an open question.

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Table 1 - Frequency of Banking and Currency Crises in Emerging Markets

	Threshold	Number of events [a]
Currency crisis episodes [b]	Standard	51 (9%)
	Major	42 (8%)
Currency crisis years	Standard	68 (12%)
Banking Crisis episodes	Standard	33 (7%)
	Major	21 (4%)
Banking crisis years	Standard	105 (21%)
Twin Crisis episodes [c]	Standard	20 (3%)

[a] The number in parentheses is the percent of total observations in the sample associated with each type of crisis.
[b] A standard crisis is defined as a deviation of the currency pressure index of more than 2 standard deviations from the country-specific mean (3SD for major crises). See text for details on banking crises.
[c] Standard currency crisis at (t) with a banking crisis for a 2 year band.

Table 2 - Banking and Currency Crises: Conditional Probabilities [a]

	Standard Banking Crises	Major Banking Crises
% of banking crisis onsets associated with a contemporaneous onset of currency crisis	31 (0.00)	38 (0.00)
% of currency crisis onsets associated with a contemporaneous banking crisis	20 (0.00)	16 (0.00)
% of banking crisis onsets associated with a previous (t-1) currency crisis	6 (0.52)	5 (0.45)
% of currency crisis onsets associated with a following (t+1) banking crisis	4 (0.52)	2 (0.45)
% of banking crisis onsets associated with a following (t+1) currency crisis	21 (0.03)	24 (0.06)
% of currency crisis onsets associated with a previous (t-1) banking crisis	13 (0.03)	9 (0.06)

[a] chi square probability of independence of the two series in parenthesis.

Table 3 - Descriptive Statistics [a]

	Type of Crisis	t-2	t-1	t	t+1	t+2
A. Currency Crises						
Real GDP growth rate (%)	Currency	4.0	2.7	1.4	1.7	3.6*
	currency (no banking)	3.6	2.4	1.9	1.7	3.6*
	Twin (currency and banking)	4.3	4.9	0.7***	1.0	2.1
Change in budget surplus (%)	Currency	-1.2	-1.4	-1.1	-1.0	-1.1
	currency (no banking)	-0.9	-1.1	-1.2	-1.2	-1.2
	Twin (currency and banking)	-1.4	-2.1	-1.1	-1.9	-0.5
Inflation rate (%)	Currency	30.5	31.6	36.3	43.4	42.0
	currency (no banking)	28.1	25.9	23.8	33.0	35.0
	Twin (currency and banking)	43.2	53.2	67.9	57.6	50.1
RER over-valuation measure	Currency	8.0	14.7*	1.6***	-6.8**	-4.3
	currency (no banking)	12.1	18.1	4.1***	-6.7***	-4.8
	Twin (currency and banking)	-0.4	7.4	3.0	4.0	-2.8
B. Banking Crises						
Real GDP growth rate (%)		5.1	5.1	1.0***	5.9***	6.5
Change in budget surplus (%)		-0.5	-1.3	-0.8	-0.4	-0.2
Inflation rate (%)		29.7	32.5	33.6	29.0	26.5
RER overvaluation measure		1.5	8.3*	4.1	-6.5***	-3.7

[a] *, **, and *** denote rejection of same mean as the number to the left with 10, 5 and 1 percent confidence levels.

Table 4 - Output Growth and Currency Crises – Benchmark [a]

Dependent Variable: real GDP growth rate (Hausman-Taylor Estimation)

	(1)	(2)	(3)	(4)	(5)
Real GDP growth (t-1)	0.327*** (6.75)	0.213*** (4.33)	0.266*** (5.47)	0.249*** (4.87)	0.240*** (4.72)
Change in budget surplus to real GDP ratio (t-1)	-1.601 (-0.21)	-1.369 (-0.19)	-0.385 (-0.05)	-0.678 (-0.09)	-2.460 (-0.32)
Credit growth (t-1)	-0.009 (-1.38)	-0.008 (-1.21)	-0.007 (-1.05)	-0.007 (-1.04)	-0.006 (-0.88)
External growth rates - weighted average (t)	0.360*** (3.42)	0.394*** (3.96)	0.381*** (3.75)	0.386*** (3.77)	0.390*** (3.81)
Real exchange rate overvaluation (t-1)	-0.024* (-1.88)	-0.033*** (-2.73)	-0.028** (-2.28)	-0.029** (-2.28)	-0.019 (-1.39)
Openness (t)	0.011 (1.05)	0.010 (0.92)	0.010 (0.97)	0.010 (0.95)	0.010 (0.89)
Currency crises onset dummy - lead (t+2)					-0.457 (-0.66)
Currency crises onset dummy - lead (t+1)					-1.558** (-2.21)
Currency crises onset dummy (t)		-2.930*** (-5.02)	-2.453*** (-3.78)	-2.622*** (-3.93)	-2.793*** (-4.16)
Currency crises onset dummy – lag (t-1)		-2.547*** (-4.12)	-2.634*** (-3.77)	-2.671*** (-3.64)	-2.838*** (-3.87)
Currency crises onset dummy - lag (t-2)				-1.008 (-1.31)	-1.034 (-1.35)
Currency crises onset dummy - lag (t-3)				0.545 (0.71)	0.470 (0.61)
Currency crises onset dummy - lag (t-4)				-0.066 (-0.08)	0.010 (0.01)
Adjusted R^2 [b]	0.27	0.37	0.32	0.32	0.33
Number of observations	374	374	373	370	370
Correlation of error terms	0.09	0.11	0.09	0.11	0.12

[a] The regression in column (2) uses a 'no window' definition of crises instead of the 'onset' variable used in columns (3)-(5).
[b] The Adjusted R^2 reported is for the fixed-effects least squares stage in the Hausman-Taylor procedure.

Table 5 - Output Growth, Banking Crises and Twin Crises
Dependent Variable: real GDP growth rate (Hausman-Taylor Estimation)

	(1)	(2)	(3)	(4)
Real GDP growth (t-1)	0.234*** (4.60)	0.139*** (2.84)	0.146*** (2.88)	0.193*** (3.73)
Change in budget surplus to real GDP ratio (t-1)	-2.497 (-0.34)	6.030 (0.85)	6.172 (0.87)	6.453 (0.88)
Credit growth (t-1)	-0.008 (-1.20)	0.002 (0.35)	0.003 (0.45)	0.002 (0.36)
External growth rates - weighted average	0.397*** (3.85)	0.335*** (3.42)	0.337*** (3.43)	0.330*** (3.27)
Real exchange rate overvaluation (t-1)	-0.004 (-0.30)	-0.016 (-1.41)	-0.016 (-1.36)	-0.013 (-1.07)
Openness	0.019 (1.36)	0.016 (1.23)	0.017 (1.26)	0.023* (1.92)
Currency crises dummy (t)		-2.427*** (-4.28)	-2.363*** (-4.09)	
Currency crises dummy (t-1)		-1.853*** (-3.15)	-1.852*** (-3.14)	-1.885*** (-3.12)
Leading Banking crises dummy (t+1)				0.467 (0.58)
Banking crises dummy (t)	-3.541*** (-6.36)	-3.074*** (-5.84)	-2.958*** (-5.21)	-3.108*** (-5.23)
Banking crises dummy (t-1)				0.809 (0.87)
Twin crises dummy (t)			-0.559 (-0.57)	-1.344 (-1.37)
Adjusted R^2	0.34	0.47	0.45	0.41
Number of observations	342	333	333	333
Correlation of error terms	0.22	0.24	0.25	0.22

Table 6 – Output Growth – Robustness Tests
Dependent Variable: real GDP growth rate

	(1) LSDV	(2) HT	(3) GMM1	(4) HT	(5) HT	(6) HT [a]
Real GDP growth (t-1)	0.151*** (2.55)	0.177*** (3.04)	0.248*** (10.36)	0.315*** (8.39)	0.316*** (8.39)	0.244*** (4.87)
Change in budget surplus to real GDP ratio (t-1)	-14.038 (-1.50)	-10.564 (-1.17)	6.167** (2.09)	5.340 (1.25)	5.450 (1.27)	4.871 (0.64)
Credit growth (t-1)	0.001 (0.06)	-0.001 (-0.14)	0.009*** (4.83)	-0.004 (-0.97)	-0.003 (-0.91)	0.001 (0.12)
External growth rates - weighted average (t)	0.432*** (3.65)	0.418*** (3.55)	0.359*** (8.74)	0.311*** (3.97)	0.311*** (3.97)	0.318*** (3.03)
Real exchange rate overvaluation (t-1)	-0.035** (-2.10)	-0.040** (-2.52)	-0.025*** (-4.88)	-0.021*** (-2.58)	-0.020*** (-2.56)	-0.024** (-1.98)
Openness	0.069** (2.16)	0.027* (1.90)	0.014*** (8.19)	0.019** (2.50)	0.019** (2.48)	0.019* (1.65)
currency crises dummy (t-1)	-3.343*** (-4.39)	-3.260*** (-4.33)	-3.396*** (-14.09)	-1.952*** (-4.31)	-1.931*** (-4.24)	-2.086*** (-3.26)
Onset of Banking crises dummy (t)	-3.187*** (-3.69)	-3.109*** (-3.64)	-3.139*** (-10.90)	-2.553*** (-4.20)	-2.169** (-2.50)	-2.284*** (-3.21)
Twin crises dummy (t)					-0.673 (-0.62)	-1.073 (-1.01)
Sample	280	280	280	574	574	333

[a] The column reports the results for a Major Banking Crises variable (and its corresponding 'twin' definition) – see text for details.

Table 7 - Out of Sample Growth Forecasts for East Asian Crisis Countries – 1998

	Domestic Variables	External Variables	Currency Crises	Banking Crises	Twin Crises	Predicted Growth	Actual Growth
Indonesia	5.15	0.56	-4.22	-2.96	-0.56	-2.03	-14.16
Korea	5.37	0.89	-1.85	-2.96	-0.56	0.90	-6.92
Malaysia	5.81	0.62	-1.85	-2.96	-0.56	1.05	-7.65
Philippines	5.95	0.59	-1.85	-2.96	-0.56	1.17	-0.54
Thailand	4.40	0.71	-1.85	-2.96	-0.56	-0.26	-10.73

Appendix A

Data for Banking and Currency Crises

	Banking Crisis	Currency Crisis	Twin Crisis
Argentina	1980-1982, 1989-1990, 1995-1997	1975-1976, 1982-1983, 1989-1991	1980, 1989
Brazil	1990, 1994-1997	1982-1983, 1987, 1990-1991, 1995	1990, 1994
Chile	1976, 1981-1983	1985	
China, P.R.: Hong Kong	1982-1986		
Columbia	1982-1987	1985	
Costa Rica	1987, 1994-1997	1981	
Cyprus			
Indonesia	1994, 1997	1978, 1983, 1986, 1997	1997
Jordan	1989-1990	1983, 1987-1989, 1992	1989
Korea	1997	1980, 1997	1997
Malaysia	1985-1988, 1997	1986, 1997	1985, 1997
Malta		1992, 1997	
Mauritius	1996	1979, 1981	
Mexico	1981-1991, 1995-1997	1976, 1982, 1985, 1994-1995	1981, 1995
Panama	1988-1989		
Philippines	1981-1987, 1997	1983-1984, 1986, 1997	1981, 1997
Singapore	1982	1975	
South Africa	1977, 1985, 1989	1975, 1978, 1984-1986, 1996	1977, 1985
Thailand	1983-1987, 1997	1981, 1984, 1997	1983, 1997
Trinidad & Tobago	1982-1993	1985, 1988, 1993	
Tunisia	1991-1995	1993	
Turkey	1982-1985, 1991, 1994-1995	1978-1980, 1994	1994
Uruguay	1981-1984	1982-1983	1981
Venezuela	1978-86, 1994-1997	1984, 1986, 1994-1996	1994