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Sudden stops and the Mexican wave: Currency crises, capital flow reversals and output loss in emerging markets

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Abstract

Sudden stops are the simultaneous occurrence of a currency/balance of payments crisis with a reversal in capital flows. We investigate whether sudden-stop crises are a unique phenomenon and whether they entail an especially large and abrupt pattern of output collapse (a "Mexican wave"). Using a panel data set over 1975–1997 and covering 24 emerging-market economies, we distinguish between the output effects of currency crises, capital inflow reversals, and sudden-stop crises. Sudden-stop crises have a large negative, but short-lived, impact on output growth over and above that found with currency crises. A currency crisis typically reduces output by about 2–3%, while a sudden stop reduces output by an additional 6–8% in the year of the crisis. The cumulative output loss of a sudden stop is even larger, around 13–15% over a 3-year period. Our model estimates correspond closely to the output dynamics of the 'Mexican wave' (such as seen in Mexico in 1995, Turkey in 1994 and elsewhere), and out-of-sample predictions of the model explain well the sudden (and seemingly unexpected) collapse in output associated with the 1997–1998 Asian Crisis.

JEL classification: F32; F43; O16
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1. Introduction

Sudden stops in capital flows to emerging market economies are a key characteristic of several recent financial crises. The sudden stop problem, first emphasized by Calvo (1998), features an abrupt cessation in foreign capital inflows and/or a sharp capital outflow concurrently with a currency/balance of payments crisis. Calvo et al. (2002), for example, provide a sudden-stop interpretation for the current crisis in Argentina in which the capital flow reversal together with a dramatic real exchange rate depreciation significantly worsened the government's fiscal position and led to default. In a broad historical examination, Bordo et al. (2001) argue that the sudden stop problem has become more severe since the abandonment of the gold standard in the early 1970s. Kaminsky (2003) argues that sudden stops are a special variety of currency crisis. Finally, Mendoza and Smith (2002) define three key features of Sudden Stops: "sharp reversals in capital inflows and current account deficits, large downward adjustments in domestic production and absorption, and collapses in asset prices and in the relative prices of nontradable goods relative to tradables" (p. 1).

An examination of the data reveals that many currency/balance of payments crises are *not* characterized by sudden stops (Table 1). Capital inflow reversals occur with some regularity in emerging markets (about 22% of the observations in our sample), and currency crises are also fairly common (11% of the observations). But many currency crises do not occur *jointly* with a capital flow reversal—those episodes we term sudden stops. Sudden stops occur in only about 6% of the observations in our sample of emerging market economies and constitute a bit more than half of the number of currency crises we identified. By our metric, there have been 34 episodes of sudden stops among emerging markets since the collapse of the Bretton Woods system of fixed exchange rate parities in the early 1970s till before the 1997 Asian crisis and another 10 between 1998 and 2002. With the higher threshold levels for 'major' crises shown in the lower panel, the frequency of occurrences is lower but the basic pattern is the same as with the standard crisis definitions. Clearly, sudden-stop crises are *not* one and the same as currency crises nor are

Table 1
Sudden stop events

	Currency crisis	No crisis
A. 'Normal' crises and capital flow reversals		
Capital flow reversal	34 (6%)	85 (16%)
No reversal	26 (5%)	389 (73%)
B. Major crises and major capital flow reversals		
Capital flow reversal	26 (5%)	49 (9%)
No reversal	23 (4%)	436 (82%)

The table includes all crises from 1975 to 2002 for the 24 emerging markets in our sample (see endnote 7). The number in parentheses is the percent of country years. The upper-left quadrant stands for Sudden Stops according to our definition of the term (see text). For currency crises, a normal crisis is defined as the deviation in the currency pressure index of more than 2 standard deviations from the country-specific mean (3 standard deviations for major crises). For current account reversals, a standard reversal is defined as a positive change in the current account to GDP ratio of more than 3 percentage points (5% points for a major CA reversal).

capital flow reversals. It is not uncommon to have capital flow reversals without currency crises and vice versa. Sudden stops are clearly distinct phenomena.

Sudden stops may have severe consequences for the economy, as the abrupt reversal in foreign credit inflows in conjunction with a realignment of the exchange rate may cause a sharp drop in domestic investment, domestic production and employment. The adverse consequences of a sharp reversal in foreign capital inflows could be the reason that only a subset of currency/balance-of-payments crises in emerging market economies are found to be associated with recessions (Hutchison and Noy, 2002a, in press; Gupta et al., 2003). The pattern of a currency crisis followed by an abrupt, but short lived, output collapse has been termed the "Mexican Wave" by the *Financial Times* in light of the Mexican experience in 1995.

Recent theoretical literature, following the work of Calvo (1998) and Calvo and Reinhart (2000), emphasizes the linkages between sudden stops and output losses. By contrast with the theoretical literature, the empirical literature to date has not clearly distinguished between the different types of currency/balance of payments crises, and in particular has not focused on the link between capital flow reversals and currency crises—what we believe is a natural way to define a sudden stop. We believe that focusing on the joint occurrence of reversals and currency crises may help explain the mixed results of studies attempting to measure the output effects of financial crises. Analysis of sudden stops may provide the key to understanding why some currency crises entail very large output losses, while others are frequently followed by expansions.

To address this issue, we investigate the output growth dynamics following currency crises, capital flow reversals and Sudden Stops in a panel data set of 24 emerging-market economies covering the 1975–1997 period. We measure the impact of crises in a panel regression framework, carefully controlling for domestic and external factors, country time-invariant effects, and state of the business cycle. Simultaneity between financial crises and output growth and biases arising from the estimation of a dynamic panel are likely in this context, and we employ the panel IV and GMM estimation procedures, respectively, of Hausman and Taylor (1981) and Arellano and Bond (1991, 1998) to address these issues.

We find that sudden-stop crises have a large negative, but short-lived, impact on output growth over and above the effect found with currency crises. Our results also correspond very closely with the output dynamics of the 'Mexican wave' (such as seen in Mexico in 1995, Turkey in 1994 and elsewhere), and out-of-sample predictions of the model explain the sudden (and seemingly unexpected) collapse in output associated with the 1997–1998 Asian Crisis. Our study supports the hypothesis that sudden stops have a much larger adverse effect on output than other forms of currency attack. Ours is the first empirical study that we are aware of to statistically differentiate between the output effects of different crises types and rigorously measure this effect. Our results possibly explain the wide divergence in economies' performances following international financial crises. Furthermore, we believe that establishing this empirical regularity is the first step in empirically identifying the transmission mechanism through which sudden stops have such large output effects.

Section 2 reviews the literature on sudden stops and highlights our contribution. Section 3 presents the basic empirical model. Section 4 discusses the data. Section 5 reports summary statistics 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 evidence as to the channel through which a sudden stop in capital inflows affects the real economy, how well the dynamics of the model correspond with the Mexican Wave pattern, and also present predictions for output development for the out-of-sample East Asian crisis of 1997–1998. Section 7 concludes the paper.

2. Why should a sudden stop cause a collapse in output?

The sudden stop phenomenon involves a reversal in capital inflows associated with a currency or balance of payments crisis. There are several reasons why one would expect a sudden stop to cause a severe recession. Calvo (1998, 2000, 2003) and Calvo and Reinhart (2000) analyze several mechanisms through which a sudden stop in international capital flows may bring about a currency and balance of payments crisis and the reasons that an output collapse may follow.

The first channel Calvo and Reinhart (2000) describe, termed the Keynesian effect, entail a fall in credit, attributable to the sudden stop in capital inflows combined with an external financing premium and a "financial accelerator." This reduces aggregate demand and causes a fall in output (e.g. Bernanke et al., 1999). The second channel, termed the Fisherian channel by Mendoza (2001), emphasizes that a sudden stop enhances the severity of a currency crisis since it hits the financial sector and, given collateral constraints, induces a debt-deflation and a real contraction (e.g. Kiyotaki and Moore, 1997). Furthermore, firm bankruptcies may cause negative externalities—banks may become more cautious and reduce loans. This in turn induces a further fall in credit–the "vanishing credit effect" described in Calvo (2000)–and contributes to recession.

A number of new theoretical studies have developed models further formalizing the linkages between sudden stops in capital inflows, financial crises and declining output in emerging markets. This literature includes, among others, the works of Aghion et al. (2001a,b), Arellano and Mendoza (2002), Caballero and Krishnamurthy (2000, 2002, 2003, in press), Céspedes et al. (2004), Daniel (2002), Gopinath (2004), Mendoza (2001), Razin and Sadka (2001), Schneider and Tornell (2004) and Tornell and Westermann (2002a, b).

2.1. Empirical literature on sudden stops and output collapse

By contrast with the rapidly emerging theoretical literature linking sudden stops with output losses, there is no empirical literature formally addressing this issue. Several recent papers empirically analyze output developments around the time of currency crises in broad samples of countries (e.g. Aziz et al., 2000; Gupta et al., 2003; Hutchison and Noy, 2002a).[1] Similarly, Barro (2001), Bordo et al. (2001) and Hutchison and Noy (in press)

[1] Hutchison and Noy (2002a), for example, examines a large sample of developing and emerging markets and describes, using a simple regression methodology, the average output costs of currency crisis (defined as a large fluctuation in the exchange rate or in international reserves). The paper finds relatively modest costs associated with these crises. Similar findings are described in Aziz et al. (2000) and Gupta et al. (2003). Here, in contrast, we argue that there are varieties of currency crises and distinguish between their differing costs.

measure output costs associated with the occurrence of both currency crises and banking crises. Kaminsky (2003), however, argues that sudden stops are a special variety of currency crises, and using a regression-tree classification methodology finds that her set of explanatory/causal factors are different. This finding, in turn, suggests that the effects of a sudden stop crisis on the economy should in principle be distinguishable from other varieties of currency crises.

As Table 1 indicates, there are many instances of a currency crisis that are not associated with a capital flow reversal (about 50% of the cases). Our objective is to focus on the joint occurrences that we believe are the best empirical representations of the sudden stop problem and investigate systematically the output losses associated with these phenomena.

Milesi-Ferretti and Razin (2000), Edwards (2002, 2004) and Kaminsky (2003) are the work most closely related to ours on sudden stops. Milesi-Ferretti and Razin (2000) analyse *separately* the output costs of current account reversals and the output costs of currency crises.[2] Unlike our paper, however, they do not attempt to measure directly the marginal effect of a crisis or reversal on output growth either separately or jointly (holding other macroeconomic and institutional factors constant) in a panel data set of emerging markets.

Edwards (2002, 2004) considers the output effects of current account reversals, but not of financial crises. Edwards (2004) focuses on the output effects that may arise from a current account reversal in countries with particularly high international openness, substantial dollarization, and under different degrees of exchange rate fixity. He finds that current account reversals generally have a large adverse impact on output, and the effect is larger in countries that are relatively "closed to trade" and with greater exchange rate fixity.

Kaminsky (2003) develops a procedure to classify different varieties of currency crises. She defines six types of currency crises, four that are associated with domestic imbalances (current account deficits, fiscal deficits, financial excesses and unsustainable foreign debt burdens), one that occurs in 'immaculate' countries (a self-fulfilling crisis) and one that is associated with sudden stops in capital inflows. Kaminsky provides before–after statistics on the output dynamics in the different types of crisis episodes and concludes that the sudden stop/currency crisis phenomenon is not associated with significant adverse output effects (relative to trend over the full sample) unless it is also associated with domestic fragility.

A few papers (e.g., Tornell and Westermann, 2002b) have demonstrated that there may be sectoral differences in the response to financial crises. For example, the tradables sector might recover quickly from a currency crisis (due, perhaps, to an export sector booms) while the non-tradables sector might enter into a deep and prolonged recession in reaction to an adverse shift in relative prices. Thus, aggregate measures of output costs only

[2] Milesi-Ferretti and Razin (1998) explore the determinants of the costs of reversals only. Milesi-Ferretti and Razin (2000) examine a cross section of currency crises and current account reversals in a broad set of 105 low and middle-income countries (for 1970–1996). They identify the determinants of reversals and currency crises in probit regression and also provide an analysis of the determinants of the costs of each separately (in terms of output growth). They estimate a linear cross-sectional model with average output growth in the 3 years following the episode in question as the dependent variable and identify macroeconomic variables that determine the costs of such episodes (either a currency crisis or a current account reversal).

provide a rough indicator of net aggregate welfare changes and do not account for the possibly sizable distributional impacts of financial crises.

3. Estimating the effects of sudden-stop crises on real output growth

Our contribution is to provide an empirical definition of sudden-stop crises and identify the dynamics and magnitudes of their aggregate output costs. We control for simultaneity issues, and biases associated with estimation of dynamic panel data models. We are also able to examine whether sudden-stop crises are unique to emerging markets and whether the deep recessions in East Asia were typical of the "bad" outcome associated with sudden-stop crises.

Our approach begins by explaining output growth in emerging markets by a standard set of variables. 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 1-year lag in order to capture the delayed response of output to macroeconomic developments. Our main concern with the benchmark model 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.[3]

In the context of our benchmark model, we test for the additional effect on output growth arising from a currency crisis, a capital flow reversal and a sudden stop. The formal specification of the empirical model is as follows. The growth of real GDP for the ith country at time t (y_{it}) is explained by past growth, policy variables ($x_{i(t-1)}$), external and structural factors ($w_{i(\cdot)}$), the recent occurrence of a currency crisis and a current account reversal ($D^{\mathrm{CC}}_{i(\cdot)}$, $D^{\mathrm{KA}}_{i(\cdot)}$, respectively), a sudden-stop crisis ($D^{\mathrm{SS}}_{i(\cdot)}$=($D^{\mathrm{CC}}_{i(\cdot)}$*$D^{\mathrm{KA}}_{i(\cdot)}$)), and an unobservable random disturbance (ε_{it}).

$$y_{it} = \mu_i + \alpha y_{i(t-1)} + \alpha_k x_{i(t-1)} + \alpha_h w_{i(\cdot)} + \beta^{\mathrm{CC}} D^{\mathrm{CC}}_{i(\cdot)} + \beta^{\mathrm{KA}} D^{\mathrm{KA}}_{i(\cdot)} + \beta^{\mathrm{SS}} D^{\mathrm{SS}}_{i(\cdot)} + \varepsilon_{it} \quad (1)$$

where x is a k-element vector of policy variables for country i at time $t-1$, w is an h-element vector of external variables for country i (at times t or $t-1$), $D^{\mathrm{CC}}_{i(\mathrm{sub}\cdot)}$ is a dummy variable equal to unity if the country has experienced a currency crisis (and zero otherwise) and likewise for a capital account reversal. The interactive sudden-stop term is therefore equal to unity if a currency crisis and a capital account reversal were observed in the same year. 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

[3] We refrain from including a larger set of macroeconomic variables as these are typically not robust to model specification (Levine and Renelt, 1992).

sample), α_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^{KA} and β^{SS} measure the output growth effects of a currency crisis, a capital account reversal and a sudden-stop crisis, respectively. In additional specifications we search for possible dynamics, non-linearities, and size effects for the crises variables, and employ a larger sample including developing countries and different estimation methods.

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 Nickell, 1981). When a correlation exists between the independent variables and the individual country-specific effects, a least-squares estimation of a dynamic model ignores the correlation between the time-invariant country-fixed effects and the error term. The Hausman–Taylor 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.

In the first step of the Hausman–Taylor (HT) algorithm, 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.[4] The procedure requires specifying which explanatory variables are to be treated as endogenous.

In our specification, the endogenous explanatory variables are the binary crisis measures (currency crises and capital flow reversals; and their interaction, sudden stops).[5] All specifications of the model are estimated with a baseline of five predetermined variables and, with the instruments noted above, imply that the output equations are over-identified. The exclusionary restrictions in the HT algorithm are the instruments (deviation from means of lagged values of the time-varying variables) excluded from Eq. (1). To gain some insight on the specification of the model, we implement the over-identification test suggested in Wooldrige (2002; pp. 123–124) and based on Hausman (1978). Although these are subject to low power, they do provide some indication of the validity of the identifying assumptions. The test is predicated on the idea that under the null (for our case, no over-identifying restrictions) an efficient estimator will have zero covariance with its difference from a consistent but inefficient estimator. The test-statistic is obtained from a second-stage regression of the residuals from a first stage regression on the set of exogenous instruments available. The statistic has a χ^2_l distribution with l being the difference between the number of instruments and potentially endogenous variables.

[4] 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 Hausman and Taylor (1981) and Greene (2002), respectively.

[5] Assuming different sets of control variables are not exogenous does not change our empirical results.

In no case can the test reject our over-identifying restrictions. For example, the "base model" specification described in column 3 of Table 4 yields a test statistic of 1.398 while rejection at the 90% confidence level requires a test statistic of at least 6.25. Equally, for the more detailed specification of column 5 in Table 4 the test statistic is 0.313 with the 90% confidence level at 2.706. Moreover, the over-identifying restrictions cannot be rejected for any of the specifications we detail in Tables 4 and 5 including the one that includes a much larger dataset of developing countries in addition to the emerging market sample that we focus on in this paper.

While the HT procedure provides consistent 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; Arellano and Bond, 1991, 1998).[6] This procedure is usually employed in estimation of panels with a large number of individuals and short time-series such as in labor or 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 some results using the Arellano and Bond (1998) GMM framework. The coefficient estimates are very similar to those obtained from the benchmark HT procedure.

4. Data description

We concentrate our investigation on emerging markets since they are the focus of policy discussions and recent experiences of financial 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, in press; Caballero and Krishnamurthy, 2002; Tornell and Westermann, 2002b). Specifically, emerging markets tend to be more open to international private capital inflows than poorer developing countries. Most had also experienced pre-crisis large private inflows that are typically short-term. 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. Emerging markets therefore appear most vulnerable to sudden-stop crises and, potentially, their adverse consequences.

Our basic annual panel consists of 24 emerging markets. We define emerging markets as developing economies with real income of at least $2000 (PPP adjusted) in 1992. The descriptive tables include data from 1975 to 2002 while regression results are based on a 1975–1997 panel data. We use the coefficient estimates from our regression panel to obtain out-of-sample predictions for the output losses following the 1997 East Asian

[6] 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 (2004) and Bond et al. (2001). While GMM estimation is consistent even if all the instruments are pre-determined, the estimated results are biased downward.

crisis.[7] To further examine the uniqueness of emerging markets, we repeat the same specifications for a larger sample of developing countries (not restricted by income). Other requirements are that each country in the sample has at least 10 years of continuous annual GDP data and a population of at least 1 million. Data availability further restricts the sample (especially for the earlier years).

4.1. Defining currency crises, capital account reversals and sudden-stop 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.[8] Following convention the weights are inversely related to the variance of changes of each component over the sample for each country. 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%. For each country-year in our sample, we construct binary measures of currency crises, as defined above (1=crisis, 0=no crisis). We impose windows on the crisis data by treating 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 49 currency crises, 68 crisis years and 40 major currency crises for our emerging markets sample over the 1975–1997 period. For further tests, we also estimate several specifications using the actual values of the currency pressure index.

As in Milesi-Ferretti and Razin (1998, 2000) we identify capital account reversals by examining changes in the current account deficit. Edwards (2004) demonstrates that current account reversals are highly correlated with capital flow reversals. As our focus is on the short and medium term costs of sudden-stop events, we define a capital account reversal as a positive change in the annual current account surplus that is bigger than a pre-specified threshold (measured as a percentage of current GDP).[9] Following Milesi-Ferretti

[7] The countries and the sudden stop crises we identified and investigate in this paper are Argentina (1982, 1990, 2002), Brazil (1987), Chile, Columbia (1985), Costa Rica (1981), Cyprus, Hong Kong, Indonesia (1983, 1986, 1998), Jordan (1989, 1992), Korea (1998), Malaysia (1986, 1998), Malta (1997), Mauritius, Mexico (1982, 1995), Panama, Philippines (1983, 1986, 1998), Singapore (1975), South Africa (1985), Thailand (1981, 1998), Trinidad and Tobago (1985), Tunisia, Turkey (1978, 1994, 2001), Uruguay (1982, 2002) and Venezuela (1986, 1989, 1994, 2002). Details on the currency crisis dates are available in the working paper version (Hutchison and Noy, 2002b). A list of the larger developing countries sample used in Table 5 column 4 is available in Hutchison and Noy (2002a). (Tables 1, 2 and 7) describe the whole data set while the regressions described in Tables 3–5 include the data from 1975 to 1997. Using structural estimates based on the 1975–1997 data sample, we compare out-of-sample predictions with actual observations for output developments following the 1997 East Asian financial crisis (see Table 6).

[8] 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 countries in our dataset.

[9] In contrast, Milesi-Ferretti and Razin (1998) examine changes in 3-year rolling averages of the current account. They also impose a condition that the maximum deficit after the reversal must be no larger than the minimum deficit in the 3 years preceding the reversal. In our identification of reversal episodes we are interested in short-run to medium run phenomena and therefore we examine annual changes in the current account.

and Razin (1998) we use thresholds of 3% (5%) for standard (major) current account reversals.[10] Similarly to our currency crisis variable, we construct, for each country-year, a binary measure of reversals (1=reversal, 0=no reversal) for both thresholds and impose a 24-month window on our data.[11] We use alternative definitions in our robustness tests.

We define a sudden-stop crisis as one in which there is the contemporaneous occurrence of a currency crisis, and a capital account reversal. As we examine contemporaneous occurrences, we do not speculate on the exact causality structure between the two.

4.2. Control variables in the output growth equation

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.[12] The macroeconomic data series are taken from the International Monetary Fund's IFS CD-ROM.

5. Empirical results

We first test the hypothesis that the likelihood a currency crisis may occur is statistically independent from the occurrence of a capital account reversal. Only 10% (20%) of current account reversals (currency crises) are contemporaneously associated with currency crises (current account reversal). The hypothesis that the occurrence of a currency crisis is not correlated with a current account reversal in the following year is rejected at the 99% confidence interval. However, the hypothesis that the occurrence of a capital account reversal is not associated with a currency crisis in the following year cannot be rejected. We find that 20% of current account reversals are associated with currency crises in the preceding year and, more significantly, 46% of currency crises are followed by current

[10] Their work indicates that the exact (and admittedly ad-hoc) threshold used does not affect their results significantly. We present results to that effect as well.

[11] Bagnai and Manzocchi (1999) use a different statistical methodology to differentiate between permanent and transitory changes in current account trends and define permanent changes as reversal episodes. They find that GDP growth is not statistically significant in their regression for the determinants of positive reversals, giving some support to our sudden stop argument that reversal episodes are a leading causal factor in declining output growth.

[12] 'Credit growth' is the change in the sum of domestic claims on the government, the private sector and financial institutions (line 32 in the IFS). Deflating the measure by end of period inflation does not change any of the conclusions presented. The 'openness' variable is defined as the sum of imports and exports as percent of 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.

Table 2
Descriptive statistics

	Type of crisis	$t-2$	$t-1$	t	$t+1$	$t+2$
A. Currency crises						
Real GDP growth rate (%)	Currency	−0.5	−3.1***	−4.1***	−1.0*	−0.2
	Currency (no reversal)	−1.0	−4.1***	−2.5***	−0.8	0.05
	Sudden stop	−1.2	−2.7***	−6.1***	−1.2	−0.2
Change in budget surplus (%)	Currency	−0.3	0.4	0.01	0.1	−0.9**
	Currency (no reversal)	−0.4	0.5	0.3	0.4	−1.2***
	Sudden stop	0.6	0.5	−0.5	−0.5	−0.6
Inflation rate (%)	Currency	3.1	10.1***	9.1***	2.0	2.0
	Currency (no reversal)	1.7	10.6***	5.7	2.6	2.5
	Sudden stop	10.1**	12.3**	9.5**	3.4	−2.2
Current account to GDP ratio (%)	Currency	1.8**	2.0***	−0.5	−0.6	−0.1
	Currency (no reversal)	1.8**	1.4*	−2.0**	−0.6	−0.5
	Sudden stop	1.1	1.7	0.7	−1.5	−0.4
B. Capital account reversals						
Real GDP growth rate (%)		0.04	−0.3	−2.9***	−1.2**	0.3
Change in budget surplus (%)		0.1	0.2	0.5*	−0.6**	−0.1
Inflation rate (%)		−3.8	−3.9	−1.5	−3.4	−4.1
Current account to GDP ratio (%)	1.9***	3.7***	4.5***	−0.6	−0.4	

The data, from the *World Development Indicators* (2004), includes all crises we identified between 1975 and 2002 for the 24 emerging markets in our sample (see endnote 7). The table record results of fixed effect regressions of the row variables when the independent variables were the crisis lags and leads (each row). *, **, and *** denote rejection of the null (same mean as the mean during tranquil periods) with 10%, 5% and 1% confidence levels, respectively. The means for tranquil periods are 5.2 for real GDP growth, 0.003 for change in budget surplus, 15.3 for the inflation rate, and −1.6 for the CA/GDP ratio.

account reversals in the following year. These observations are suggestive, but we do not assume any particular causal link in the empirical work and discussion that follows.[13]

Table 2 presents summary statistics on key macroeconomic developments around currency crises (upper panel) and capital account reversals (lower panel). It presents before–after statistics for the standard definitions of a ‘normal’ currency crisis and the standard (3%) capital account reversals. Four-year windows are imposed on the data to clearly delineate the macroeconomic developments around the time of crises.

Our focus variable, real GDP growth rate, shows an average decline of 3.6 percentage points in the 2 years leading to a currency crisis, and it recovers the following year (by 3.1 percentage points). Average output growth goes back to its previous level 2 years after the crisis. This pattern is almost identical for standard and major crises (not reported for brevity). Average losses appear to be substantially bigger for our sub-sample of sudden stops—reducing output growth by 4.9 percentage points; with currency crises with no reversals experiencing a smaller but still discernible output loss of 1.5 percentage points. Output developments around capital account reversals are interesting because of the rapid growth turnaround. Hence, at first pass, the summary statistics indicate significant and–in some cases–prolonged effects of financial crises and a short-lived but pronounced effect of a capital account reversal. The dynamics for changes in the fiscal position and inflation

[13] For more details, see Hutchison and Noy (2002b).

Table 3
Growth equation–HT–benchmark

Real GDP growth ($t-1$)	0.327*** (6.75)	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)	−0.385 (−0.05)	−0.678 (−0.09)	−2.460 (−0.32)
Credit growth ($t-1$)	−0.009 (−1.38)	−0.007 (−1.05)	−0.007 (−1.04)	−0.006 (−0.88)
External growth rates−weighted average (t)	0.360*** (3.42)	0.381*** (3.75)	0.386*** (3.77)	0.390*** (3.81)
Real exchange rate overvaluation ($t-1$)	−0.024* (−1.88)	−0.028** (−2.28)	−0.029** (−2.28)	−0.019 (−1.39)
Openness (t)	0.011 (1.05)	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)		−2.453*** (−3.78)	−2.622*** (−3.93)	−2.793*** (−4.16)
Currency crises onset dummy-lag ($t-1$)		−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	0.27	0.32	0.32	0.33
Number of observations	374	373	370	370
Breusch–Godfrey autocorrelation test statistic	0.73	0.57	0.65	0.65
Over-identification test statistic	0.09	0.22	4.58	0.57

Dependent variable: real GDP growth rate (DLRGDP).
The panel data set used in regressions includes 24 emerging markets for the 1975–1997 period (see endnote 7). *, **, and *** denote rejection of same mean as the number to the left with 10%, 5% and 1% confidence levels. The Adjusted R^2 reported is for the fixed-effects least squares stage in the Hausman–Taylor procedure. The autocorrelation test statistic has a χ^2 distribution with 1 degree of freedom; we test for AR(1). The null of no-autocorrelation is never rejected. The over-identification statistic has a χ^2_l distribution with l being the difference between the number of instruments and potentially endogenous variables. In no case can the test reject the null of no over-identification (see Section 3 for details).

rates are less pronounced, though a statistically visible increase in the inflation rate is found for currency crises and sudden stops.[14]

5.1. Model estimates

Table 3 presents results from our benchmark model. The statistically significant control variables are external output growth, real exchange rate overvaluation, and lagged output growth. A 1% rise in the growth rate of the G-3 economies raises output growth in emerging-market economies by, on average, 0.3–0.4 percentage points. A rise in real

[14] These descriptive statistics were constructed using a fixed effects regression framework. This allows us to control for country effects as well as heteroscedasticity in the variance. Simple averages of the relevant variable for before–after crisis periods are available in the working paper version (Hutchison and Noy, 2002a,b).

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, the coefficients for budget changes, credit growth and the openness measure are not significantly different from zero. The coefficient estimates for the control variables are consistent across many alternative specifications of the model reported in columns (1)–(4) of Table 3 and elsewhere.

Turning to the currency/balance of payments crisis variables, the coefficient estimates reported in column (2) indicate that the onset of a contemporaneous (lagged) currency crisis is associated with a fall in GDP growth of about 2.5 (2.6) percentage points. Very similar results are obtained, but not reported, when including only the contemporaneous or the lagged currency crisis binary variable. After a 2-year period, the cumulative negative effect of a currency crisis on output is therefore about 5.1%.

Table 3 also presents more information on the dynamics of output adjustment to currency crises. Adding further lags (second, third and fourth year lags) to the model, reported in column (3), indicate that the contemporaneous and 1-year ahead effects of a currency crisis remain negative and highly significant and with the same magnitudes as previously reported. This is followed by statistically insignificant effects on the second, third and fourth year following a crisis. This result remains when some of the insignificant lags are dropped. Our results indicate that the output costs of a currency crisis do not extend beyond a 2-year horizon and we therefore do not include additional lags in subsequent regressions.

We also include lead values of currency crises in the equations, shown in column (4), to further investigate the dynamic responses. The 1-year lead coefficient for the currency crisis variable is statistically significant. This result indicates that a currency crisis tends to follow a moderate decline in real output growth. On the other hand, a currency crisis is also associated with a further decline in output growth contemporaneously and over a period of 2 years.

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. The output effects of a major crisis are not larger than the typical crisis situation. This result is not particularly surprising as most of the crises in our sample are defined as major. A version of column (2) using only events identified as major crises 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 therefore do not appear to have a substantially different impact on output growth than a broader sample that includes more moderate crisis periods (identified using a 2-standard deviation threshold).

The full results for our model are reported in Table 4. Columns (1) and (2) report the cost of a capital account reversal for the 5% and 3% thresholds, respectively, with the inclusion of lagged and contemporaneous currency crises variables. In both cases, reversals are costly. Our main results are presented in columns (3)–(4). The coefficient on the sudden-stop crisis interactive variable is negative, *large* and statistically significant. The output costs of sudden-stop crises appear to be very large—a drop in output growth of

Table 4
Growth equation–HT–current account reversals

Real GDP growth ($t-1$)	0.218*** (4.46)	0.207*** (4.31)	0.207*** (4.32)	0.239*** (5.04)	0.197*** (4.02)
Change in budget surplus to GDP ratio ($t-1$)	1.212 (0.16)	2.351 (0.33)	3.607 (0.51)	4.146 (0.58)	11.706 (1.61)
Credit growth ($t-1$)	−0.009 (−1.47)	−0.009 (−1.49)	−0.007 (−1.16)	−0.007 (−1.25)	0.002 (0.26)
External growth rates−weighted average	0.399*** (4.03)	0.394*** (4.05)	0.393*** (4.09)	0.390*** (4.01)	0.341*** (3.36)
Real exchange rate overvaluation ($t-1$)	−0.033*** (−2.70)	−0.034*** (−2.83)	−0.036*** (−3.11)	−0.037*** (−3.14)	−0.037*** (−3.19)
Openness	0.019* (1.91)	0.018** (2.05)	0.010 (1.11)	0.011 (1.20)	0.014 (1.15)
Current account reversal (5% threshold)	−1.122* (−1.75)				
Lead−current account reversal (3%) (t+1)					−0.683 (−0.90)
Current account reversal (3% threshold)		−1.958*** (−3.88)	−1.243** (−2.33)	−0.924* (−1.75)	−1.685*** (−3.03)
Lag for current account reversal (3%) ($t-1$)					−0.480 (−0.58)
Currency crises dummy (t)	−2.862*** (−4.92)	−2.961*** (−5.18)	−1.902*** (−2.97)		−2.029*** (−3.09)
Currency crises dummy ($t-1$)	−2.333*** (−3.73)	−2.052*** (−3.33)	−1.894*** (−3.11)	−1.874*** (−3.04)	−1.425** (−2.33)
Sudden-stop crises dummy (t)			−4.727*** (−3.59)	−6.593*** (−5.63)	−5.066*** (−3.80)
Adjusted R^2	0.35	0.37	0.39	0.38	0.44
Number of observations	374	374	374	374	320
Breusch–Godfrey autocorrelation test statistic	1.58	1.86	1.71	1.49	0.38
Over-identification test statistic	0.39	0.23	1.40	1.83	0.31

Dependent variable: real GDP growth rate (DLRGDP).

The panel data set used in regressions includes 24 emerging markets for the 1975–1997 period (see endnote 7). *, **, and *** denote rejection of same mean as the number to the left with 10%, 5% and 1% confidence levels. The Adjusted R^2 reported is for the fixed-effects least squares stage in the Hausman–Taylor procedure. The autocorrelation test statistic has a χ^2 distribution with 1 degree of freedom; we test for AR(1). The null of no-autocorrelation is never rejected. The over-identification statistic has a χ^2_l distribution with l being the difference between the number of instruments and potentially endogenous variables. In no case can the test reject the null of no over-identification (see Section 3 for details).

4.7–6.5 percentage points in the same year of the crisis. Furthermore, while the coefficients on the currency crisis variables are smaller they are still statistically significant for the 99% confidence level. Neither does the inclusion of leads and lags for the capital account reversal dummy, reported in column (5), change the magnitude of these coefficients. We find that a sudden-stop crisis is associated with a decline in GDP of about 10% over a short (2-year) period.[15]

5.2. 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 to those obtained by the (possibly biased) least-squares fixed effects estimator with a White heteroscedasticity correction (LSDV) or the more efficient (and un-biased) first-differenced GMM estimator suggested by Arellano and Bond (1991, 1998). These results are reported in Table 5, columns (1)–(3), where we also include the HT estimation for exactly the same sample.[16] There is relatively little difference between the coefficients obtained on our focus variables–currency crises and reversals–in all three estimation techniques. As can be expected, the GMM estimator yields higher t-statistics.

We also run the same model for a larger sample including 42 developing countries as well as the 24 emerging markets sample we use throughout.[17] A comparison of column (4) with column (4) in Table 4 leads us to conclude that sudden stops have a weaker impact on output growth in the larger sample of developing countries—−3.6 instead of −6.6 for sudden-stop crises. The larger set of developing countries does indeed seem to be less vulnerable, on average, to the sudden stop problem. This may simply be attributable to the fact that poor developing countries attract very little private capital inflows, they face tighter credit constraints and their domestic consumption is less vulnerable to swings in the real exchange rate (as suggested, for example, in Calvo et al., 2002; Tornell and Westermann, 2002b).

Column (5) investigates whether the main results are robust when we account for the magnitude of the currency crisis. To our central specification we add a variable that for every crisis observation includes the deviation of the currency pressure index from the country specific mean (measured in standard deviations) and zero for non-crisis observations. More generally, in a specification we do not report, we examine whether our non-linear binary identification scheme for currency crisis events is appropriate. In addition to our binary measure we include the currency pressure index (for all observations). The coefficients on the binary variables do not change significantly and

[15] A possible caveat is that while the drop in output is indeed sharp following a sudden stop, pre-crisis output growth could have been 'unsustainably' high as a result of the ex-ante capital inflows. This would suggest that our estimated effects are an upper bound. However, evidence presented by Gourinchas et al. (2001) suggests that domestic lending booms (which are partially correlated with capital inflows) do not increase output growth markedly.

[16] The GMM estimator poses both data restrictions and restrictions on the specifications that could be estimated with our data. Detailed discussions of these problems are found in Greene (2002). For the model we were able to estimate, we provide the HT and the GMM-AB estimation for the exact same data showing that results are similar.

[17] The sample is still restricted to those countries with at least 10 consecutive years of GDP figures and a population of at least 1 million.

Table 5
Growth equation—robustness

	(1) LSDV	(2) HT	(3) GMM1	(4) HT	(5) HT	(6) HT	(7) HT
Real GDP growth ($t-1$)	0.133** (2.23)	0.175*** (3.03)	0.193*** (7.74)	0.257*** (6.73)	0.196*** (4.00)	0.228*** (4.73)	0.263*** (5.31)
Change in budget surplus to GDP ratio ($t-1$)	−12.296 (−1.30)	−9.492 (−1.05)	5.972** (2.01)	6.420 (1.49)	11.465 (1.58)	13.751* (1.85)	8.987 (1.19)
Credit growth ($t-1$)	−0.007 (−0.83)	−0.008 (−1.09)	0.003* (1.96)	−0.002 (−0.61)	0.002 (0.29)	0.001 (0.16)	−0.002 (−0.23)
External growth rates (t)	0.394*** (3.31)	0.387*** (3.29)	0.360*** (8.75)	0.343*** (4.38)	0.332*** (3.25)	0.326*** (3.19)	0.308*** (2.95)
Real exchange rate overvaluation ($t-1$)	−0.041** (−2.46)	−0.045*** (−2.82)	−0.033*** (−6.40)	−0.025*** (−3.11)	−0.038*** (−3.16)	−0.038*** (−3.25)	−0.037*** (−3.07)
Openness	0.053* (1.67)	0.021* (1.88)	0.016*** (8.98)	0.023** (2.53)	0.014 (1.14)	0.025** (2.00)	0.023* (1.83)
Current account reversal (3%) (t)	−1.972*** (−3.28)	−2.050*** (−3.45)	−1.249*** (−11.90)	−1.355*** (−3.01)	−1.581*** (−2.89)	0.169 (0.17)	0.421 (0.55)
Currency crises dummy (t)				−1.624*** (−3.31)	−2.021*** (−2.99)		
Currency crises dummy ($t-1$)	−2.612*** (−3.29)	−2.492*** (−3.19)	−2.951*** (−6.24)	−1.421*** (−3.09)	−1.442** (−2.36)	−1.328** (−2.15)	−1.892*** (−3.02)
Sudden-stop crises dummy (t)				−1.957* (−1.92)	−5.018*** (−3.77)	−6.554*** (−5.40)	−8.021*** (−5.76)
Reversal's size (t)						−0.234* (−1.72)	
Currency crisis magnitude (t)					−0.212 (−0.34)		
Sample	280	280	280	550	320	320	320
Breusch–Godfrey autocorrelation test statistic	0.55	2.87	0.51	3.66	1.18	1.89	1.08
Over-identification test statistic	0.00	0.60	0.00	0.42	0.00	2.34	2.55

Dependent Variable: real GDP growth rate (DLRGDP).
*, **, and *** denote rejection of same mean as the number to the left with 10%, 5% and 1% confidence levels. The autocorrelation test statistic has a χ^2 distribution with 1 degree of freedom; we test for AR(1). The null of no-autocorrelation is rejected at the 10% confidence level only for column (4). The over-identification statistic has a χ^2_l distribution with l being the difference between the number of instruments and potentially endogenous variables (see Section 3 for details). The sample in column (4) contains also developing countries (with per capita income of less the 2000 in PPP$ for 1992). Column (7) includes a different definition of current account reversals. In addition to (1) a change of at least 3% of GDP, it includes (2) the post-reversal current account deficit is less than 1% of GDP.

the coefficient on the index is insignificantly different from zero, which leads us to conclude that the effect is indeed highly non-linear and plausibly binary.

In column (6) of Table 5 we investigate whether the main results are robust when we account for the size of the capital account reversal. To our central regression–reported in Table 4 column (4)–we add the size of the capital flow reversal as a percentage of GDP. The coefficient on the reversal's size variable is statistically different from zero and indicates that any flow reversal of 1% of GDP reduced output growth by 0.2 percentage points. Central to our argument is the finding that the coefficient on the sudden-stop dummy does not change much—indicating that non-linearities are important in understanding the effects of crises. A sudden stop is a unique event that is important above and beyond the actual size of the reversal.

In column (7) of Table 5 we modify the definition used for a current account reversal and its corresponding sudden-stop interactive term. We now use only a subset of our reversal observations—only those for which the reversal actually meant a full stop of capital inflows. Technically, we discard reversal observations for which the current account deficit, following the reversal event, was still bigger than 1% of GDP. As can be expected the coefficient on the newly defined sudden-stop variable is now even bigger and indicates a drop of 8 percentage points in GDP growth in the same year of the crisis. This further supports our other findings on the very substantial negative average effects of sudden stops.

It is possible that the results reported to this point are subject to selection bias. Country-year observations where a crisis was experienced may be different in important respects from other countries or episodes. It may not be the currency crisis per se but differences between crisis and non-crisis country-years decline in output growth. This is a variant of the selection bias problem, as we do not observe what would have been the output dynamics in a crisis episode without the crisis occurring (see Heckman, 1990; Heckman et al., 1997).[18]

In order to estimate what would have been the output dynamics of a crisis country had it not had a financial crisis, we employ Heckman's (1979) Inverse Mills Ratio (IMR) to control for selection bias of this form.[19] This statistic is constructed from the results of a probit regression explaining currency crises and added as an additional explanatory variable in the output growth regressions.[20] Including the IMR in the regression of interest prevents this possible bias in our coefficient estimates and is a standard approach.[21] For

[18] Output dynamics in the absence of a currency crisis or sudden stop cannot be directly observed. This is a variant of the problem addressed by Heckman et al. (1997) in approaching the evaluation problem: "The evaluation problem is a missing data problem. At any time, persons may be in either one of two potential states but not in both...The evaluation problem arises because ordinary observational data do not provide sample counterpart for the missing counterfactual $Y(0)$ values for participants..." (pp. 608–609).

[19] Alternatively, one could ask what would have been the output dynamics of a non-crisis country had it had a crisis (Heckman, 1990).

[20] Identification is achieved through the inclusion of variables in the probit regression that are excluded from the output equation, rather than by the assumption of normality in the probit equation which generates non-linearity in the IMR. Variables in the probit equation excluded from the output equation are: change in CA to GDP ratio, capital account liberalization dummy, an exchange rate regime dummy, export growth, and change in M2 to reserves ratio. Export growth and the change in the M2 to reserves ratio are significant at the 5% level, and the XR regime dummy is significant at the 12% level. The specification of the probit equation is taken from Glick and Hutchison (2001).

[21] For a survey of sample selection correction methodologies see Blundell and Costa Días (2000).

brevity, these results are not reported. In no case is the IMR coefficient statistically significant and, assuming the probit equation was correctly specified, bias may be rejected. More importantly, the coefficient estimates on the other explanatory factors, both the control and the crisis variables, are very similar to those previously reported.

6. Predictive accuracy, dynamics and channels of transmission

6.1. Out of sample predictions

The models in the previous section explain up to 45% of the variation in output growth in our sample of emerging market economies. As an additional test of the robustness of the findings, we consider out-of-sample predictions for countries involved in the 1997–1998 Asian crisis and subsequent collapse in output. All of these countries experienced sudden stops. In particular, Table 6 presents the predicted values for output growth for the five East Asian countries that experienced a severe financial crisis 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 4. Predicted values are decomposed into three different groups of explanatory variables: (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); and (c) the currency crisis, the capital account reversal and the sudden-stop crises.

Predicted output growth for all five countries is around negative 5% in 1998. Output is predicted to be lower for the Philippines (−5.2%) and highest for Korea (−4.5%), with intermediate predictions for Indonesia, Malaysia and Thailand. The forecast errors (unexpected declines in output) are therefore substantial as the growth performances were very different in 1998. At the extremes, the Philippines experienced the mildest recession (−0.5 output growth rate) while Indonesia experienced a −14.1% contraction of its economy. More importantly for our focus, the contemporaneous negative effect of a sudden-stop crisis is dominating our predictions with a cumulative negative effect of −9.4 percentage point decline in GDP growth. There is a positive domestic effect–mainly a

Table 6
Out of sample growth forecasts for East Asian crisis countries—1998

	Domestic variables	External variables	Currency crises	CA reversal	Sudden stop	Predicted growth	Actual growth
Indonesia	3.69	0.58	−1.87	−0.92	−6.59	−5.11	−14.16
Korea	3.78	1.13	−1.87	−0.92	−6.59	−4.47	−6.92
Malaysia	3.83	0.54	−1.87	−0.92	−6.59	−5.01	−7.65
Philippines	3.74	0.40	−1.87	−0.92	−6.59	−5.24	−0.54
Thailand	3.63	0.81	−1.87	−0.92	−6.59	−4.94	−10.73

Estimates are based on Table 4 column (4) coefficients. The first column also includes the time invariant effects.

history of very strong growth in the region and the consequently large country-specific effects–and a modestly supportive external structural growth environment.

Although the forecast errors of the sudden-stop model are fairly large, the average prediction of a substantial decline in output (−5.0%) across four of the East Asian countries (Korea, Malaysia, Philippines and Thailand) is quite close to the actual average decline (−6.5%). Indonesia, due to political and social turmoil, seems to be a special case and experienced a much larger 14.2% drop in output.[22] Moreover, besides this model, we are not aware of other models that forecast (out-of-sample) large *declines* in output for East Asia in 1998. Hutchison and Noy (in press), for example, examined the output effects of currency, banking and “twin” crises. They conclude that “twin” crises lead to significant real costs, but cannot explain the depth of the recessions and the rapid recovery that the Asian-5 experienced between 1997 and 1999.

The V-shaped output developments of the Asian-5 following the financial crisis also appear to fit the pattern associated with the Mexican Wave. Panel A of Fig. 1 presents the output developments around some of the most famous sudden-stop crises: Turkey (94), Mexico (95), Indonesia (98) and Korea (98). Turkey, Indonesia and Korea follow the same output dynamics as Mexico—sharp output declines at the time of the crisis followed by large rebounds. The sudden-stop model predictions, in Panel B of Fig. 1, correspond closely with the country experiences shown above. The panel shows the dynamic predictions for output around the time of a (i) currency crisis, (ii) a capital flow reversal, and (iii) a sudden stop.[23] Both currency crises and capital flow reversals, taken alone, are associated with modest declines in output. Taken together, however, they constitute a sudden stop and induce a very large but short-lived drop in output. The model estimates mimic very closely the actual observed dynamics.

6.2. Channels of transmission: sudden stops and collapsing investment

The sudden-stop theory reviewed in Section 2 discussed several potential transmission mechanisms through which sudden stops could cause an output collapse. A common element in these explanations is that a sudden stop causes domestic investment to collapse, perhaps through financing constraints that sharply limit imported investment goods or imported intermediate goods. This view appears to be borne out. Table 7 shows average domestic investment growth, domestic fixed investment growth, exports and import growth around the 31 sudden-stop crises that we have identified 1975–2002 in our emerging-markets sample. Investment and imports are sharply reduced at the time of sudden stops. In particular, investment (import) growth was 5.2% (8.2%) 2 years prior to the sudden stop, and then shows a very large 15.4% (11.1%) *drop* at the time of the sudden stop. The slowdown in investment and imports continues the next year, and then sharply rebound 2 years after the sudden-stop crisis. By contrast, exports boom the year of the crisis and after.

[22] See Rodrick (1999).

[23] These predictions are derived from an output equation, not reported in the text for brevity, where two leads and lags of currency crises, capital flow reversals, and sudden stops are included. The control variables are the same as in the benchmark equations (e.g. Table 4, column 1).

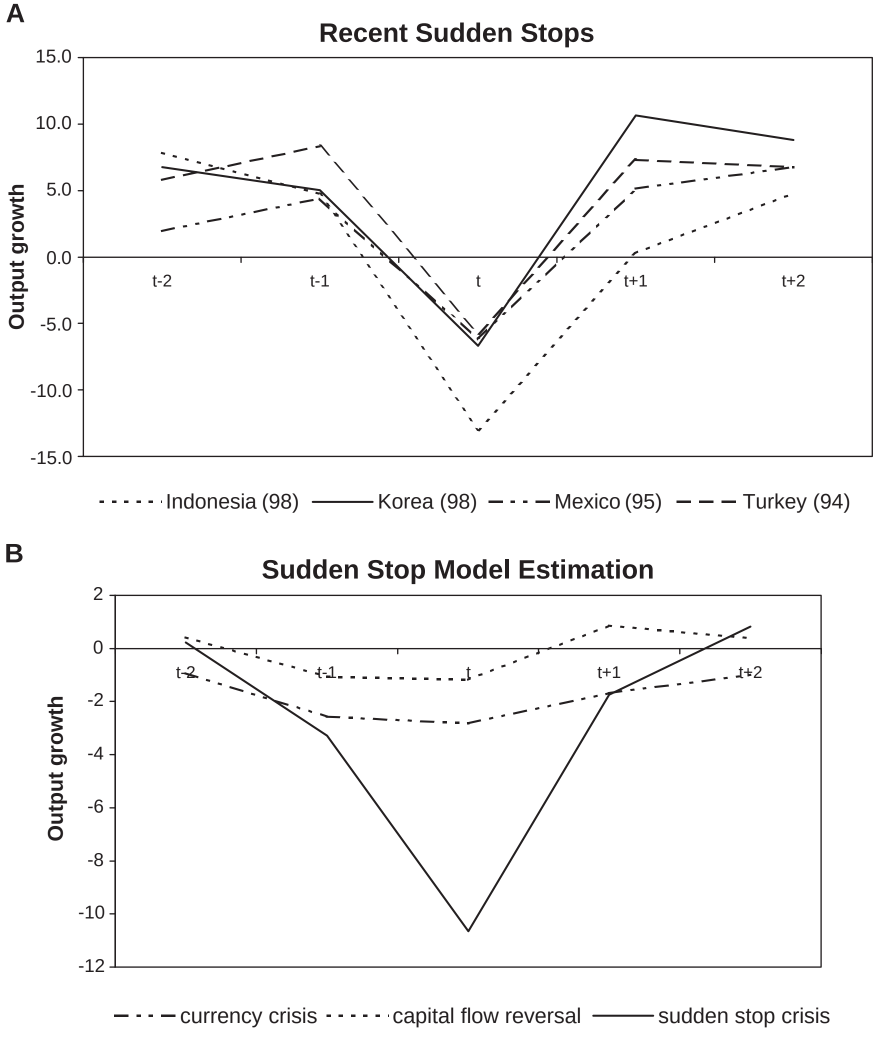

Fig. 1. Output developments. Panel A—recent sudden stops. Panel B—sudden stop model estimation.

This interpretation is consistent with the findings of Edwards (2002). Estimating investment equations, he finds that current account reversals significantly reduce investment (relative to GDP). A 3% or larger reversal in the current account as a fraction of GDP (from deficit to surplus) reduces investment by about 3% of GDP within 2 years. These stylised facts are consistent with several case studies. Agénor et al. (2000) find, for example, that the sharp contraction in bank lending accompanying Thailand's financial crisis was due to a "supply crunch" on credit (presumably due to foreign financial constraints). Ghosh and Ghosh (1999) report similar findings for Korea and Indonesia as do Ito and Pereira da Silva (1999). Mody and Murshid (2002) find almost a one-to-one relationship between capital inflows and domestic fixed investment in non-crisis times.

Table 7
Investment, exports and imports around sudden stops

	$t-2$	$t-1$	t	$t+1$	$t+2$
Domestic investment growth	5.2	−0.2	−15.4	1.6	7.5
Domestic fixed investment growth	3.4	0.8	−12.9	−3.2	5.1
Export growth	5.0	3.2	10.6	6.1	4.2
Import growth	8.2	2.7	−11.1	4.4	11.0
Exports (as % of GDP)	27.9	28.0	33.1	33.1	32.7
Imports (as % of GDP)	30.8	30.7	31.2	31.5	32.1
Exports (in billion constant 1995 US$)	23.1	24.3	26.8	28.1	28.2
Imports (in billion constant 1995 US$)	25.8	27.8	22.9	24.1	25.5

Data is from the World Bank's *World Development Indicators*, 2004 and reflects averages before/after the sudden stops we identified in endnote 7 (1975–2002 for 24 emerging markets).

Microeconomic research into firms' responses to changes in the exchange rate also suggests that firms generally reduce their investment when facing large domestic currency depreciation (Forbes, 2002; Nucci and Pozzolo, 2001).

7. Conclusions

Recent work by Calvo (1998), Kaminsky (2003) and others suggests that the fundamental causes of a currency crisis associated with sudden reversals in capital flows are empirically distinguishable from other varieties of currency crisis. We argue that the effects on output dynamics associated with different forms of currency crisis are also likely to vary, and may explain the wide variety of experiences across countries. Using a panel data set over the 1975–1997 period and covering 24 emerging markets, we distinguish between the output dynamics associated with currency crises, capital flow reversals, and sudden stops. We find that sudden stops have a large negative, but short-lived, impact on output growth; and that these effects are substantially larger (almost three times greater) than those associated with a currency crisis alone.

The Mexican Wave pattern that the empirical model predicts was seen not only in Mexico at the time of the 1995 crisis, but also in such disparate countries facing sudden stops as Turkey, Indonesia and Korea. The evidence we present on the channel of transmission appears consistent with theory that points to an external "credit crunch" as a key element in capital flow reversals at the time of a currency crisis. Sudden stops are associated with a collapse of imported goods and a dramatic fall in domestic investment. Clearly, the large output costs associated with sudden stops are a policy concern; even more so if the underlying cause of the capital inflow reversal and currency crisis are not attributable to "fundamentals" but rather to multiple equilibria or imperfections in the working of international capital markets.

The sudden-stop phenomenon helps us to understand why some currency/balance of payments crisis entail very large output losses in some emerging market economies, while others are frequently followed by expansions. Our study supports the hypothesis that sudden stops have a much larger adverse effect on output than other forms of currency attack–the first empirical study that we are aware of using dynamic panel methods to rigorously differentiate between the output costs of alternative varieties of crises in developing economies and to measure these effects–and explains the wide divergence in economies' performances following international financial crises.

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