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Abstract

We analyse how reversals of several types of capital flows impact currency crises in emerging market and developing economies. Estimates of logit models show that reversals of (equity and debt) portfolio flows significantly increase the likelihood of currency crises in emerging market economies. In developing economies, reversals of portfolio debt flows and banking flows have a significant positive impact on currency crises. Finally, our results suggest that countries with mature financial systems and fixed exchange rate regimes are less likely to experience a currency crisis after a capital flow shock. The mediating role of capital account liberalization varies by country type.

JEL-Codes: E440, E510, F340, F410.

Keywords: capital flow reversals, currency crises, event study approach, logit models, domestic financial factors.

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1. Introduction

This paper re-examines the question of whether sharp falls in net capital flows, often referred to as capital flow reversals, are linked to currency crises. Previous studies examining the extent to which capital flow reversals and currency crises are related reach different conclusions.¹ Some point out that capital flow reversals and currency crises frequently occur simultaneously (Calvo, 1998; Calvo et al., 2004). Others argue that the two events may come up jointly as well as independently (Hutchison & Noy, 2006; Bordo et al., 2010; Efremidze et al., 2011), while the probability of capital flow reversals followed by currency crises is higher if domestic fundamentals are fragile (Bordo, 2006; Zhao et al., 2014). However, for a large sample of emerging market economies and different types of capital flow reversals and currency crises, Almahmood et al. (2020) report that most of the time the two events do not occur together. These authors argue that capital flow reversals and currency crises have different determinants: global factors tend to cause capital flow reversals, while domestic factors are driving currency crises.

The literature generally utilizes constant thresholds for the reduction in capital flows to identify capital flow reversals. This approach has some weaknesses. For instance, capital flows have shown an upward trend over the years due to financial liberalization, which a constant threshold does not take into account. In addition, most research focuses on aggregate net flows rather than inflows and outflows of different types of capital flows (direct investments, portfolio equity investments, portfolio debt investments, and bank credit). Generally speaking, direct investments are more stable and less likely to be reversed (Sula & Willett, 2009; Baum et al., 2017) than short-term portfolio flows and banking flows (Ahmed & Zlate, 2014; Yang et al., 2019).

This paper utilizes panel data covering 59 emerging market and developing economies from 1990 to 2021 to investigate the relationship between capital flow reversals and currency crises, with a particular focus on the heterogeneity of different types of capital flows. We contribute to the literature in several ways.

First, we distinguish between inflows and outflows, as well as various types of capital flows, including portfolio flows, portfolio equity flows, portfolio debt flows, and banking flows. Second, this paper employs the Bry-Boschan algorithm to identify capital flow reversals in an event study approach. Third, based on the results of the event study analysis, we conjecture that capital inflow reversals are one of the key drivers of currency crises. A logit model is employed to test this hypothesis. Our results suggest that capital flow reversals, in this case identified by examining deviations from the trend in capital flows, precede currency crises. The reversals of net flows before crises reflect reversals of inflows (sudden stops) rather than reversals of outflows (capital flight). Fourth, we divide the sample into emerging market economies and developing economies as the relationship between capital flow reversals and currency crises may differ across these subsamples. Our results provide evidence for this. Reversals of (equity and debt) portfolio flows significantly increase the likelihood of currency crises in emerging market economies, while in developing economies only reversals of portfolio debt flows and banking flows have a significant impact on currency crises. Finally, we assess how financial development, the exchange rate regime, and capital controls affect the relationship between capital flow reversals and currency crises. We observe that financial development first increases the likelihood that capital flow reversals lead to currency crises

¹ Reversals in net capital flows can be inflow-driven or outflow-driven. A reversal due to a decrease of capital inflows is often referred to as “sudden stop”, while a reversal caused by capital outflows is usually referred to as “capital flight” (Faucette et al., 2005; Cowan & De Gregorio, 2005; Rothenberg & Warnock, 2011; Calderón & Kubota, 2013; Wong & Wong, 2021). Note that a reversal may not imply negative net capital flows. Still, a sharp drop in capital flows may already cause financing or adjustment problems (Sula & Willett, 2009).

and then decreases it, demonstrating the “short-run pain, long-run gain” effect of financial development. Countries with a fixed exchange rate regime are less likely to experience a currency crisis after a capital flow shock. The mediating role of capital account liberalization varies by country type.

The remainder of the paper unfolds as follows. Section 2 uses an event study method to describe the relationship between capital flow reversals and currency crises. Section 3 analyzes the effect of capital flow reversals on currency crises and the mediating effect of financial development, the exchange rate regime, and capital controls. Section 4 concludes.

2. Stylized facts: Event study on the relationship between capital flow reversals and currency crises

To come up with stylized facts, we first utilize the event study approach to capture changes in capital flows within the currency crisis window. The event study is based on panel data and focuses on average effects, where we distinguish between emerging market economies and developing economies.

There are three possible scenarios for the timing: the capital flow reversal precedes the currency crisis, the currency crisis precedes the capital flow reversal, and the two events occur together. If the capital flow reversal occurs first, it may be the cause of the currency crisis. If the currency crisis occurs first, the capital flow reversal might be the result of a crisis. If both events coincide, there may be a third common factor influencing both reversals and crises.

2.1 Data

Our sample covers quarterly data from 1990 to 2021 for 59 economies of which 18 are emerging market economies (EMEs) and 41 developing economies (DEs). Data availability, not only of capital flows but also of the variables included in the empirical analysis, dictates inclusion in the sample. Table A1 in Appendix A provides the list of countries and their classification. In order to have as large a sample as possible, a country is included if more than forty consecutive quarters of capital flows data are available. 1990 is selected as the starting year, because the post 1990-period saw frequent capital flow reversals due to the process of financial liberalization in emerging market and developing economies (Cavallo & Frankel, 2008).

Capital flow data is obtained from the balance of payments statistics of the IMF International Financial Statistics (IFS) database; all flows are scaled by GDP. Table 1 lists the capital flow types and their definitions.

The peak and trough of a capital flow cycle can be regarded as the beginning and end of a capital flow reversal, respectively. The time (difference) between the peak and the trough is taken as the duration (amplitude) of the capital flow reversal. This approach is applied to inflows and outflows in the event study. We utilize Harding & Pagan’s (2002) quarterly approximation of the Bry-Boschan (B.B.) algorithm (Bry & Boschan, 1971) to identify the peaks and troughs of the capital flow cycle. Appendix B provides the details.

Table 1. Capital flow definitions

Capital flow type:	Definition:
Net capital flows	The balance of private-sector financial account
Capital inflows	Change in private-sector financial liabilities
Capital outflows	Change in private-sector financial assets
Net portfolio flows	The balance of portfolio investment
Portfolio inflows	Change in portfolio investment liabilities
Portfolio outflows	Change in portfolio investment assets
Net portfolio equity flows	The balance of portfolio equity investment
Portfolio equity inflows	Change in portfolio equity investment liabilities
Portfolio equity outflows	Change in portfolio equity investment assets
Net portfolio debt flows	The balance of portfolio debt investment
Portfolio debt inflows	Change in portfolio debt investment liabilities
Portfolio debt outflows	Change in portfolio debt investment assets
Net banking flows	The balance of other investment
Banking inflows	Change in other investment liabilities
Banking outflows	Change in other investment assets

Notes: Net capital flows are obtained from the private-sector financial account, which records transactions that involve financial assets and liabilities and that take place between residents and non-residents excluding reserve assets. Portfolio investment is defined as cross-border transactions and positions involving debt and equity securities, other than those included in direct investment or reserve assets. Portfolio equity investment includes equity and investment fund shares, which are recorded under securities investment and shall be tradable. Portfolio debt investment refers to a negotiable debt instrument that proves that its holder has the right to collect principal or interest from its issuer at some point in the future. Other investment is a residual category that includes positions and transactions other than those included in direct investment, portfolio investment, financial derivatives, and mainly consists of banking capital flows.

We employ the exchange market pressure (EMP) index proposed by Eichengreen et al. (1996) to identify currency crises.² The EMP index, which captures changes in the exchange rate and reserves, is calculated as follows:

$$EMP = \frac{1}{\sigma_e} \cdot \frac{\Delta e}{e} - \frac{1}{\sigma_R} \cdot \frac{\Delta R}{R} \quad (1)$$

where e denotes the nominal exchange rate and R represents foreign exchange reserves, σ_e and σ_R are the standard deviations of the rate of change of the exchange rate and the rate of change of reserves, respectively. The exchange rate refers to domestic currency per U.S. dollar. A crisis occurs if the EMP index exceeds the threshold of three standard deviations above the mean (Kaminsky & Reinhart, 1999). Two crises will be merged into one if they occur within four quarters. Table A2 in Appendix A provides a list of currency crises identified.

2.2 Methodology

The event study method provides information on the extent to which capital flows during a currency crisis period differ from those in a non-crisis period. The crisis window is defined as 12 quarters centered around the crisis date; a window of 20 quarters centered around the crisis date is used as a robustness check. Following Gourinchas & Obstfeld (2012) and Almahmood et al. (2020), we estimate the following fixed-effects panel model:

² Due to the lack of interest rate data, we do not consider interest rate changes in the EMP index, following Kaminsky & Reinhart (1999).

$$Y_{i,t} = \delta_i + \theta_{t+j}CC_{t+j} + \varepsilon_{i,t} + \eta \quad (2)$$

The dependent variable Y represents different types of capital flows divided by GDP. CC is a binary dummy variable, which equals 1 when j quarters away from the crisis date, and the range of j is from -12 to 12 (or from -20 to 20). δ denotes the country fixed effect, ε is the error term, and η represents a seasonal effect, which is specified by adding quarterly dummy variables. The θ parameters capture the extent to which the value of Y during a crisis period deviates from its value during a non-crisis period.

2.3 Empirical findings

Figures 1-5 plot the estimates of the parameter θ for several types of capital flows. In each figure, the upper and lower graphs represent net flows and inflows, respectively. The findings for outflows are presented in Figure A1 in Appendix A. The graphs on the left and right show the results for emerging market economies (EME) and developing economies (DE), respectively.

In each figure, the origin of the coordinate system represents the moment of crisis, the region to its left represents the pre-crisis period, and the region to its right is the post-crisis period. The vertical axis shows the parameter θ . Red lines represent outcomes using windows of 25 quarters and blue lines represent the estimates for windows of 41 quarters. The two lines are generally very similar. Our discussion refers to the results for the short window.

Fig. 1. Capital flows over the crisis window

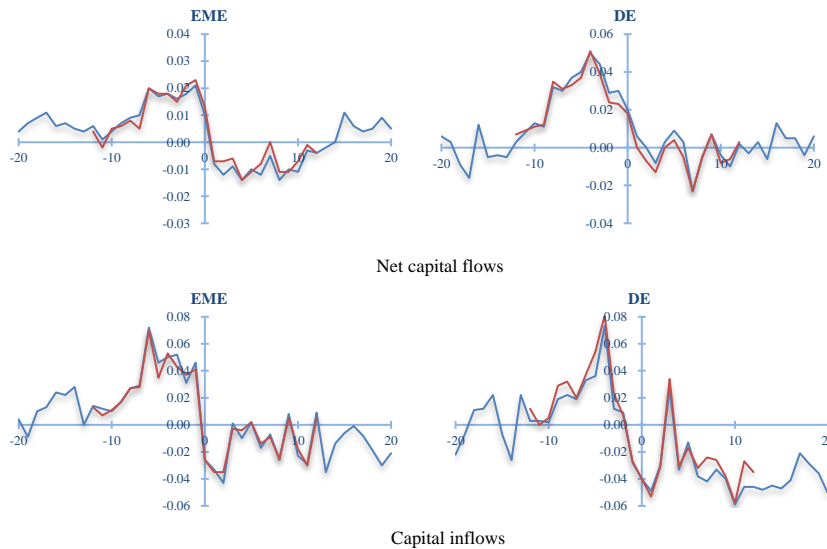


Figure 1 shows the results for aggregate capital flows. We observe that capital flows first increase and then reverse near or during the currency crisis. Table B1 in Appendix B presents the characteristics of capital flow cycles. It shows that net capital flows to EMEs go up significantly prior to the crisis, reaching a peak of 2.3 percent of GDP in the quarter before the crisis. The downtrend lasts two quarters before reaching a trough of -0.7 percent of GDP. Capital inflows begin to decline slowly after peaking at 0.7 percent of GDP in the sixth pre-crisis quarter, but do not drop sharply until the onset of the crisis. Inflows have longer durations and larger amplitudes than net flows.

The duration of reversals of capital flows to DEs is significantly longer than the duration of reversals of capital flows to EMEs. Net flows continue to rise in the fourth quarter before the crisis and then decline until they reach a trough in the third quarter after the crisis. The amplitude from peak to trough is 6.4 percentage points of GDP. The tendency of inflows and net flows is similar, but the amplitude of inflows is twice as large as that of net flows. A reversal of net flows can be attributed to the reversals of inflows (sudden stops) or reversals of outflows (capital flight). Figure A1 in Appendix A shows that capital outflows are characterized by wild swings rather than capital flight during a currency crisis period. Hence, we can conclude that capital flow reversals are primarily resulting from sudden stops. This conclusion holds true for almost all types of capital flows.

Fig. 2. Portfolio flows over the crisis window

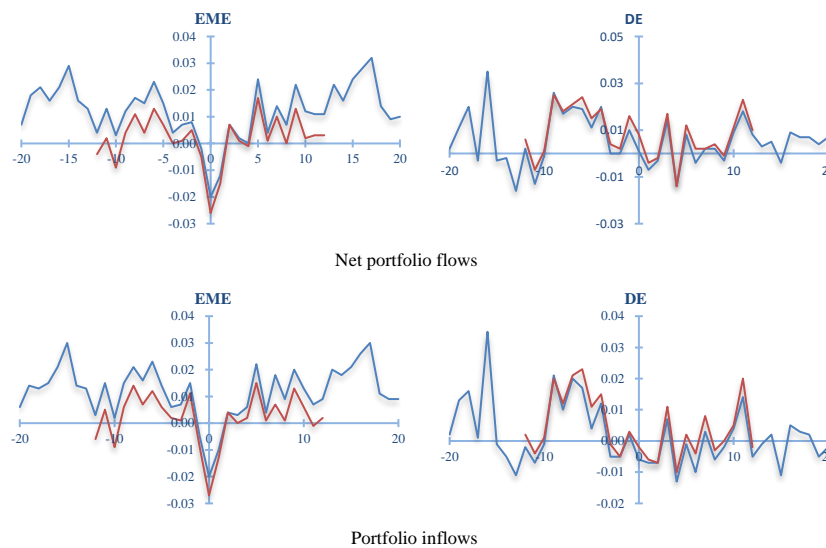


Figure 2 presents portfolio flows during periods of crisis. The performance of portfolio flows in EMEs is similar to that of the aggregate capital flows, but peaks earlier. Net flows and inflows peak in the sixth and eighth quarter before the crisis, respectively, and both reach the trough at the outbreak of the crisis. Portfolio and aggregate capital flows in developing countries differ markedly in two aspects. First, the decline in portfolio flows from peak to trough is more gradual and smaller than that in aggregate capital flows. Second, the amplitude of the capital inflow cycle is 13.4 percent of GDP, while that of the portfolio inflow cycle is only 3.0 percent of GDP (see Table B1).

Portfolio flows can be divided into equity and debt flows. The debt component mainly includes bonds, while stocks are the dominant part of the equity component. Figures 3 and 4 depict portfolio equity flows and portfolio debt flows in crisis periods, respectively. As for EMEs, both portfolio equity and portfolio debt flows demonstrate cyclicity. However, the portfolio equity cycle peaks earlier and lasts longer than the portfolio debt cycle. There is no portfolio equity flow cycle in DEs during the crisis window. The portfolio flow cycle is driven by changes in portfolio debt.

Figure 5 shows banking flows. Before the crisis, EMEs maintain a high level of net inflows, which do not drop sharply until the crisis and fall only slightly in the first three quarters of the crisis. Banking flows in DEs behave in a similar way as net capital flows, entering a downward cycle about five quarters before the crisis and bottoming out when the crisis hits. For DEs, the downward cycle of banking flows is much steeper than that of other capital flow categories.

Fig. 3. Portfolio equity flows over the crisis window

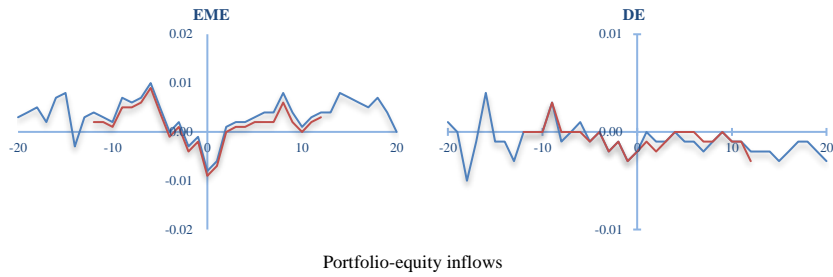
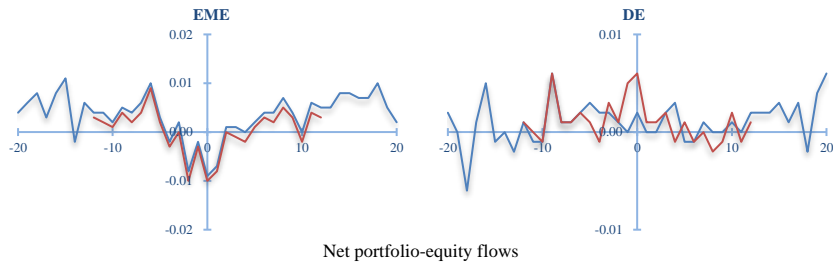


Fig. 4. Portfolio debt flows over the crisis window

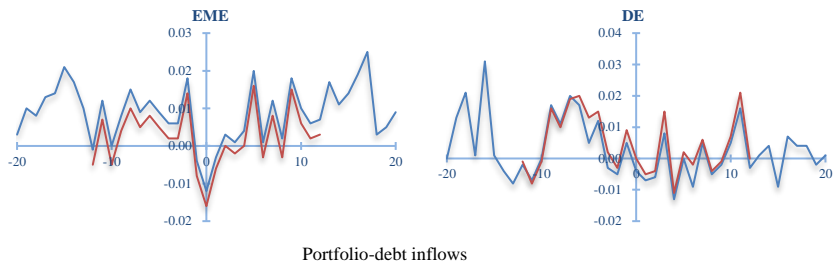
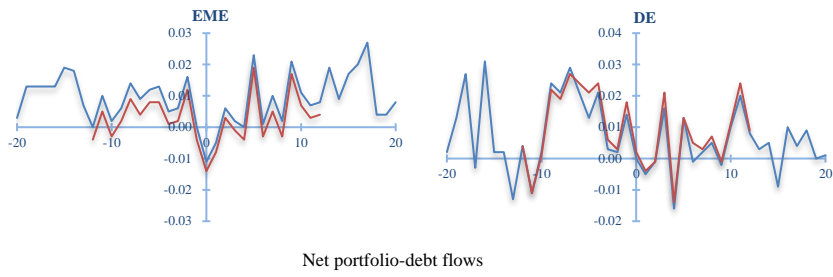
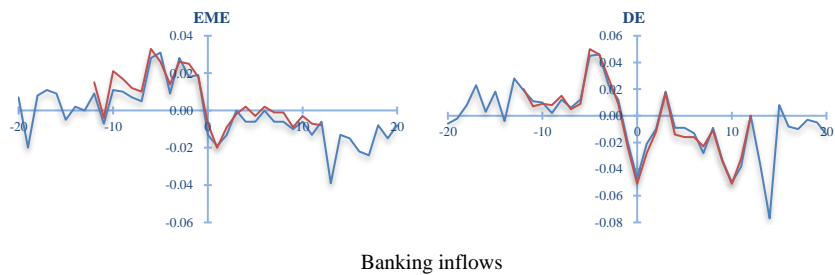
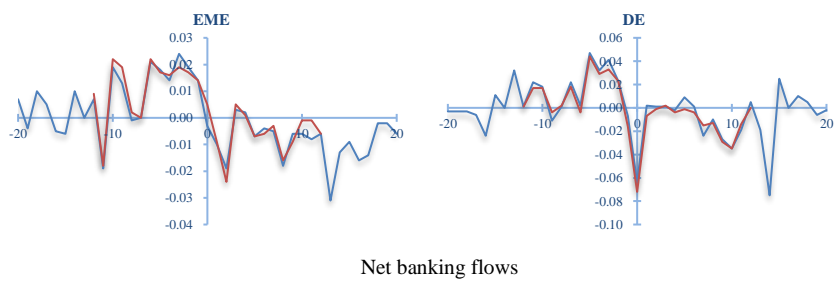


Fig. 5. Banking flows over the crisis window



The analysis yields several conclusions. First, currency crises come with extreme volatility in capital flows: a sustained surge of inflows is followed by a sudden reversal before the crisis. The two events may be connected as follows. The reduction of capital flows reduces the demand and increases the supply of the domestic currency in the foreign exchange market, causing the currency to depreciate under flexible exchange rates. Expectations that the currency may depreciate further can spur speculators to sell the currency aggressively, which eventually may cause a currency crisis. For countries with fixed exchange rate regimes, central banks will intervene in the foreign exchange market by means of selling foreign exchange reserves or raising interest rates in order to neutralize the exchange market pressure. If the capital flow reversal is lasting and the central bank runs out of reserves, the fixed exchange rate will collapse.

Second, currency crises are related to sudden stops rather than capital flight. This may be attributed to stricter restrictions on capital outflows than inflows imposed by emerging and developing countries (Ghosh & Qureshi, 2016). Policymakers tend to take a positive attitude towards capital inflows because they broaden a country's financing means and entail knowledge, production technologies, and management expertise, all of which are crucial for economic growth (Kaminsky et al., 2008; Benigno et al., 2015; Igan et al., 2020). However, these inflows may be reversed notably due to international rather than domestic developments. Calderón & Kubota (2013) argue that information asymmetries can explain the high sensitivity of foreign investors. Foreign investors typically have limited information regarding the changes of economic circumstances compared to domestic investors. Thus, they tend to rely on others' actions when making investment decisions and herd when observing that others sell their assets (Borensztein & Gelos, 2003). However, others argue that foreign investors' behavior is primarily driven by new information concerning similar countries that make them re-assess the receiving countries' fundamentals rather than simply by following forerunners (Willett et al., 2004; Efremidze et al., 2017). Arguably, this was the case for the Asian Crisis in 1997, which originated in Thailand.

Third, the importance of reversals of different types of capital flows varies across country groups. For emerging markets, reversals of portfolio flows are most frequent, whereas reversals of banking flows and portfolio debt flows are more prevalent in developing economies. Large short-term positions, together with information asymmetry and herding behavior, increase the occurrence of sudden stops. Specifically, portfolio investors can sell their bonds and stocks quickly. Banks tend to pull out from crisis countries in order to minimize their losses (Sula & Willett, 2009). Our results show that a reversal of portfolio inflows generally takes place before a reversal of banking flows in the periods of crisis, demonstrating that portfolio flows are likely to be the initial source of shocks for emerging market economies.

3. Econometric analysis of the effect of capital flow reversals on currency crises

3.1 Methodology

The above event study demonstrates that a currency crisis is usually preceded by a capital flow reversal. This suggests that capital flow reversals might be one of the key determinants of currency crises. More importantly, the role of different types of capital flows varies by country group. In order to further examine the relationship, we use logit models to estimate the impact of different types of capital flow reversals on currency crises across countries. The specification is as follows:

$$P(Y = 1 | X = x) = \frac{e^{(X'\beta)}}{1 + e^{(X'\beta)}} \quad (3)$$

Y is a binary variable denoting currency crises. It takes 1 when a crisis occurs, otherwise it equals 0. X' represents capital flow reversals and a set of control variables. As a currency crisis may also result in a reversal, there is a potential endogeneity problem. We therefore use lags of the capital flow reversal variable. In addition, we control for the global financial cycle which has been shown to be driven, amongst others, by the VIX (Miranda-Agrippino & Rey, 2020).³ We use cluster-robust standard errors.

In our analysis we distinguish between emerging and developing economies as the stylized facts about capital flow reversals and currency crises as shown in section 2 suggest very different patterns across both country groups. Likewise, the models estimated (presented in section 3.3) suggest important differences in the relation of capital flow reversals and currency crises across both country groups.⁴

The selection of control variables is based on currency crisis models. First-generation currency crisis models stress fundamental factors such as fiscal conditions, inflation, and the current account balance as the causes of currency crises (Krugman, 1979; Connolly & Taylor, 1984). Second-generation models focus on countercyclical policies and expectations of investors (Obstfeld, 1996), while third-generation models emphasize financial factors (Krugman, 1999; Corsetti et al., 1999; Radelet & Sachs, 1998). The list of control variables, which is based on previous studies (Kaminsky & Reinhart, 1999; Kaminsky, 2006; Arduini et al., 2012; Frost & Saiki, 2014; Yang et al., 2019; Almahmood et al., 2020; Aftab & Phylaktis, 2022), is shown in Table 2.^{5 6}

Table 2. Control variables

Variables	Measurement	Source
Fiscal policy	Fiscal balance/GDP	Kose et al. (2017)
Output growth	Annual growth rate of nominal GDP	WDI
Inflation	Annual change in consumer price index	WDI
Current account balance	Current account/GDP	WDI
External debt level	External debt stocks/GDP	Kose et al. (2017)
Foreign exchange reserves	Foreign reserves/external debt	WDI
Financial development	Financial development index ⁷	IMF
Exchange rate regime	Categorical variable: Peg=2/softpeg=1/nonpeg=0	Shambaugh (2004)
Capital account openness	Capital control index: 0~1, 0 represents completely forbidden, 1 means completely free.	Chinn & Ito (2008)
Global financial cycle	CBOE Volatility Index (VIX)	Miranda-Agrippino & Rey (2020)

3.2 Measuring capital flow reversals

We argue against setting a fixed threshold to define a capital flow reversal dummy variable and prefer to employ a continuous measure of capital flow reversals using the deviation of capital flows

³Adding year dummies to control for time fixed effects, is problematic as currency crises are clustered in a few years and they would thus be picked up by year dummies. We therefore include a proxy for the global financial cycle to capture world-wide common shocks.

⁴ The regression results for the full sample are listed in Table A3 in the appendix and will not be discussed in the main text.

⁵ We also considered monetary policy as a potential control variable. However, data on short-term interest rates is missing for many countries, while there is a high correlation with inflation.

⁶ With regard to the sample used in the regression, although data on capital flows and currency crises are available for many more countries than included in our sample, lack of data for control variables resulted in their exclusion.

⁷ The financial development index summarizes how developed financial institutions and financial markets are in terms of their depth (size and liquidity), access (ability of individuals and companies to access financial services), and efficiency (ability of institutions to provide financial services at low cost and with sustainable revenues and the level of activity of capital markets). The website of the database is <https://data.imf.org/?sk=F8032E80-B36C-43B1-AC26-493C5B1CD33B>

from their trend. We do so for various reasons. First, the gradual progress of a capital flow reversal cannot be identified precisely by employing a constant threshold. Second, the threshold approach does not account for the upward trend of capital flows over recent decades. Therefore, we take the deviations from the trend in capital flows (scaled by GDP) as a proxy for reversals. The trend is estimated using the Hodrick-Prescott (HP) filter. The reversal equals the trend value minus the actual value of capital flows.

As a robustness test, we utilize a method proposed by Forbes & Warnock (2012). The resulting dummy measure has been widely used in the literature, although it does not take the magnitude of the reversal into account. Constructing the dummy variable requires four steps. The first step is calculating a four-quarter moving sum of capital flows (denoted as C_t) to eliminate seasonal effects:

$$C_t = \sum_{i=0}^3 \text{capitalflow}_{t-i} \quad (4)$$

Second, we compute the annual change of C_t , which is denoted as ΔC_t :

$$\Delta C_t = C_t - C_{t-4} \quad (5)$$

The third step is to calculate the 12-quarter moving average and moving standard deviation of ΔC_t , which are denoted as $Mean_t$ and SD_t , respectively:

$$Mean_t = \frac{(\Delta C_{t-12} + \Delta C_{t-11} + \dots + \Delta C_{t-1} + \Delta C_t)}{12} \quad (6)$$

$$SD_t = \sqrt{\frac{\sum_{i=1}^{12} (\Delta C_i - Mean_t)^2}{11}} \quad (7)$$

Finally, a capital flow reversal begins if ΔC_t is one standard deviation below its mean and ends when ΔC_t is no longer one standard deviation below its mean. In order to qualify as a reversal episode, at least one quarter is required to be two standard deviations below the mean during the crisis period:

$$\text{reversals}_{i,t} = \begin{cases} 1, & \text{if } \Delta C_{t1} \leq Mean_t - SD_t, \Delta C_{t2} \leq Mean_t - 2SD_t, \Delta C_{t3} \leq Mean_t - SD_t, t1 \leq t2 \leq t3 \\ 0, & \text{otherwise} \end{cases} \quad (8)$$

3.3 Empirical findings

Tables 4 and 5 report the baseline logit estimation results for model (3) for emerging market economies and developing economies, respectively. While the estimated coefficient of the capital flow reversal variable in the logit model is the odds ratio, we report the marginal effect in the following tables. In each table, columns (1)-(5) correspond to different categories of net capital flows, namely net capital flows, portfolio flows, equity portfolio flows, debt portfolio flows, and banking flows. Similarly, columns (6)-(10) refer to the respective capital inflows.

The estimation results reported in Table 4 suggest that both reversals of net flows and inflows increase the likelihood of crisis in emerging market economies. In terms of flow types, portfolio flows play a major role. Both the equity and debt components of portfolio flows are closely associated with crises, while the estimated coefficient of equity is almost three times as large as that of debt. Moreover, inflows have more important explanatory power than net flows. Our event study has demonstrated that reversals of inflows in emerging markets are more intense than reversals of net flows. Among the control variables, economic growth has a negative impact on currency crises. The external debt burden resulting from the accumulation of external liabilities over time

significantly increases the probability of a currency crisis. Foreign exchange reserves help to prevent currency crises. Emerging market economies have accumulated large foreign exchange reserves. Thus, their central banks have the ability to intervene in foreign exchange markets at critical times to keep the value of their currency stable. Countries with more mature and developed financial institutions are more likely to avoid a crisis. Countries with fixed exchange rates are less prone to currency crises than those with floating exchange rates. The opening of the capital account makes it easier for external risks to be transmitted domestically, leading to currency crises. A higher VIX index corresponds to a higher likelihood of a currency crisis. A higher VIX index means that international investors are more uncertain, which may lead to the withdrawal of foreign capital which, in turn, may trigger a currency crisis.

Table 4. Reversals in capital flows and currency crises in emerging market economies

Independent variables	Dependent variables: Currency crises									
	Reversal of net capital flows					Reversal of capital inflows				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Capital flow types	net capital flows	net portfolio flows	net portfolio equity flows	net portfolio debt flows	net banking flows	capital inflows	portfolio inflows	portfolio equity inflows	portfolio debt inflows	banking inflows
Capital flow reversals	0.098 (0.134)	0.393*** (0.131)	0.641*** (0.219)	0.273* (0.134)	0.025 (0.107)	0.038 (0.004)	0.469*** (0.152)	0.980*** (0.312)	0.334* (0.171)	0.059 (0.111)
Fiscal policy	0.019 (0.066)	-0.022 (0.070)	-0.008 (0.067)	0.059 (0.081)	0.016 (0.066)	0.018 (0.065)	-0.021 (0.071)	-0.006 (0.068)	0.004 (0.068)	0.020 (0.066)
Output growth	-0.131** (0.065)	-0.118* (0.062)	-0.113* (0.064)	-0.096 (0.069)	-0.117* (0.062)	-0.105* (0.060)	-0.143** (0.066)	-0.151** (0.066)	-0.103* (0.060)	-0.104* (0.062)
Inflation	-0.013 (0.015)	-0.018 (0.012)	-0.014 (0.014)	-0.013 (0.013)	-0.013 (0.014)	-0.012 (0.014)	-0.020 (0.013)	-0.014 (0.015)	-0.016 (0.013)	-0.012 (0.015)
Current account Balance	0.011 (0.014)	0.000 (0.014)	0.007 (0.014)	0.004 (0.015)	0.008 (0.013)	0.008 (0.013)	-0.001 (0.014)	0.009 (0.014)	0.004 (0.014)	0.008 (0.013)
External debt level	0.218** (0.100)	0.234** (0.102)	0.253** (0.109)	0.262** (0.100)	0.226** (0.102)	0.243** (0.099)	0.248** (0.107)	0.278** (0.110)	0.191** (0.095)	0.241** (0.101)
Foreign exchange reserves	-0.031*** (0.011)	-0.036*** (0.012)	-0.026** (0.012)	-0.047*** (0.015)	-0.031*** (0.011)	-0.031*** (0.011)	-0.036*** (0.012)	-0.029** (0.011)	-0.039*** (0.013)	-0.031*** (0.011)
Financial development	-7.969* (4.379)	-9.323** (4.599)	-10.069** (4.654)	-6.189 (4.855)	-7.892* (4.349)	-7.856* (4.366)	-9.272** (4.663)	-10.390** (4.588)	-7.181 (4.520)	-7.731* (4.381)
Exchange rate Regime	-2.667** (1.103)	-2.354** (1.111)	-2.610** (1.167)	-1.989* (1.149)	-2.636** (1.100)	-2.671** (1.106)	-2.212** (1.104)	-2.537** (1.130)	-2.262** (1.117)	-2.685** (1.102)
Capital acc. openness	5.011*** (1.927)	5.355*** (2.012)	4.577** (2.133)	6.311*** (2.337)	4.950*** (1.912)	5.004*** (1.928)	5.449*** (2.036)	4.948** (2.068)	5.239*** (1.981)	4.927** (1.924)
Global financial cycle	0.146*** (0.040)	0.131*** (0.043)	0.134*** (0.044)	0.157*** (0.046)	0.147*** (0.041)	0.150*** (0.041)	0.124*** (0.044)	0.130*** (0.044)	0.143*** (0.043)	0.148*** (0.040)
N	389	389	389	389	389	389	389	389	389	389
ID	14	14	14	14	14	14	14	14	14	14
R2_p	0.343	0.421	0.381	0.358	0.340	0.342	0.437	0.440	0.362	0.339

Notes: The estimated coefficients shown are marginal effects. Cluster-robust standard errors in parentheses. *, **, *** denote significance levels at the 10%, 5%, and 1%, respectively. The positive coefficient of reversals means that they will increase the probability of currency crises. N is sample size. ID is the number of economies. R2_p is the Pseudo R-squared, which is used to measure the goodness of fit. The estimation results in each column are based on reversals of different types of capital flows.

Table 5 presents the results for developing countries. We observe a statistically significant and positive impact of capital inflows on currency crises. In terms of capital flow types, the coefficients of portfolio debt inflows and banking inflows are significantly positive. The stock markets of developing countries are underdeveloped and small, so that they can only rely on international borrowing for financing. Bank credit is extremely sensitive to risks and can easily be reversed. It turns out that the significance of the control variables is very different in developing economies compared to emerging market economies. In developing economies, a sound fiscal position reduces

the probability of a currency crisis, while inflation makes a currency crisis more likely. Foreign exchange reserves and a fixed exchange rate regime help to prevent currency crises. In contrast to emerging market economies, capital account openness reduces the risk of currency crises in developing economies. As in our sample of emerging markets, the coefficient of our proxy for the global financial cycle is positive for the sample of developing countries.

Table 5. Reversals in capital flows and currency crises in developing economies

Independent variables	Dependent variables: Currency crises									
	Reversal of net capital flows					Reversal of capital inflows				
Capital flow types	(1) net capital flows	(2) net portfolio flows	(3) net portfolio equity flows	(4) net portfolio debt flows	(5) net banking flows	(6) capital inflows	(7) portfolio inflows	(8) portfolio equity inflows	(9) portfolio debt inflows	(10) Banking Inflows
Capital flow reversals	0.035 (0.061)	0.324 (0.069)	0.766 (0.508)	0.067 (0.086)	0.085 (0.095)	0.074* (0.033)	0.059 (0.088)	0.089 (0.598)	0.052** (0.025)	0.054** (0.025)
Fiscal policy	-0.059* (0.032)	-0.073** (0.034)	-0.081 (0.051)	-0.100** (0.041)	-0.065** (0.033)	-0.091** (0.037)	-0.094*** (0.036)	-0.089* (0.051)	-0.098** (0.039)	-0.064* (0.033)
Output growth	-0.055 (0.041)	-0.036 (0.044)	-0.066 (0.078)	-0.022 (0.049)	-0.048 (0.042)	-0.013 (0.047)	-0.019 (0.046)	-0.003 (0.072)	-0.009 (0.050)	-0.044 (0.043)
Inflation	0.008** (0.004)	0.011*** (0.004)	0.021*** (0.007)	0.011*** (0.004)	0.008** (0.004)	0.011*** (0.004)	0.011*** (0.004)	0.021*** (0.007)	0.011*** (0.004)	0.008** (0.004)
Current account Balance	0.042 (0.035)	0.020 (0.029)	-0.012 (0.047)	0.006 (0.033)	0.018 (0.030)	-0.002 (0.032)	0.006 (0.031)	-0.020 (0.039)	-0.007 (0.035)	0.024 (0.030)
External debt level	0.001 (0.003)	0.005 (0.004)	0.011 (0.009)	0.005 (0.004)	0.001 (0.003)	0.005 (0.004)	0.005 (0.004)	0.005 (0.008)	0.005 (0.004)	0.001 (0.003)
Foreign exchange reserves	-0.011** (0.005)	-0.011** (0.005)	-0.014** (0.006)	-0.011** (0.005)	-0.011** (0.004)	-0.011** (0.004)	-0.011** (0.004)	-0.009* (0.005)	-0.011** (0.005)	-0.011** (0.004)
Financial development	-0.729 (3.188)	-2.169 (3.308)	3.252 (4.252)	2.157 (3.726)	-0.866 (3.195)	-2.366 (3.343)	-2.254 (3.326)	-0.859 (3.844)	2.029 (3.695)	-0.790 (3.213)
Exchange rate regime	-1.773*** (0.455)	-1.695*** (0.442)	-1.691*** (0.584)	-1.351*** (0.482)	-1.801*** (0.459)	-1.687*** (0.444)	-1.637*** (0.439)	-1.814*** (0.549)	-1.448*** (0.483)	-1.838*** (0.462)
Capital acc. openness	-3.571*** (1.200)	-3.333*** (1.196)	-5.235** (2.517)	-3.969*** (1.465)	-3.517*** (1.195)	-3.774*** (1.329)	-3.640*** (1.312)	-4.050** (1.894)	-3.933*** (1.480)	-3.543*** (1.201)
Global financial cycle	0.077*** (0.028)	0.091*** (0.029)	0.120*** (0.042)	0.096*** (0.034)	0.079*** (0.028)	0.097*** (0.030)	0.099*** (0.030)	0.121*** (0.038)	0.104*** (0.033)	0.076*** (0.028)
N	685	685	685	685	685	685	685	685	685	685
ID	26	26	26	26	26	26	26	26	26	26
R2_p	0.303	0.348	0.457	0.371	0.312	0.375	0.371	0.418	0.392	0.314

Notes: The estimated coefficients shown are marginal effects. Cluster-robust standard errors in parentheses. *, **, *** denote significance levels at the 10%, 5%, and 1%, respectively. The positive coefficient of reversals means that they will increase the probability of currency crises. N is sample size. ID is the number of economies. R2_p is the Pseudo R-squared, which is used to measure the goodness of fit. The estimation results in each column are based on reversals of different types of capital flows.

Next, we apply two robustness checks. First, we use the alternative measure of capital flow reversals as proposed by Forbes & Warnock (2012). The estimation results are displayed in Appendix A. We find that the significance and sign of most of the coefficients are consistent with the results of the baseline regressions. Table A4 shows the estimation results for emerging market economies. With the exception of banking flows and aggregate flows, the coefficients of capital flow reversals are significant. The equity component of portfolio flows is more influential compared to the debt component. The effect of a reversal of capital inflows on currency crises is more substantial compared to the effect of a capital flow reversal. The estimation results for developing economies are presented in Table A5. The coefficients of reversals of portfolio debt inflows and banking inflows are both significant, while the coefficient of the latter is higher.

Second, we use an alternative measure of currency crises. Nguyen et al. (2022) identify currency crises based on the depreciation of the domestic currency against the US dollar, and then construct

a new dataset of currency crises covering 206 countries. The estimation results for emerging market economies and developing economies based on the alternative dataset are shown in Tables A6 and A7 in Appendix A, respectively. The results are basically the same as those of the baseline estimation.

3.4 The intermediating role of financial variables

Finally, we examine whether and how financial development, the exchange rate regime, and capital account openness influence the relationship between capital flow reversals and currency crises. Theoretically, countries with a high level of financial development, flexible exchange rate regimes, and strict capital controls are less sensitive and more resilient to capital flow shocks. Given that the estimated parameters of an interaction term are difficult to interpret in a logit model, we turn to a marginal effects at representative values (MER) analysis (Williams, 2012). We first calculate the marginal effect of capital flow reversals at representative values of financial development, the exchange rate regime, and capital account openness. Then we plot the results in line graphs.

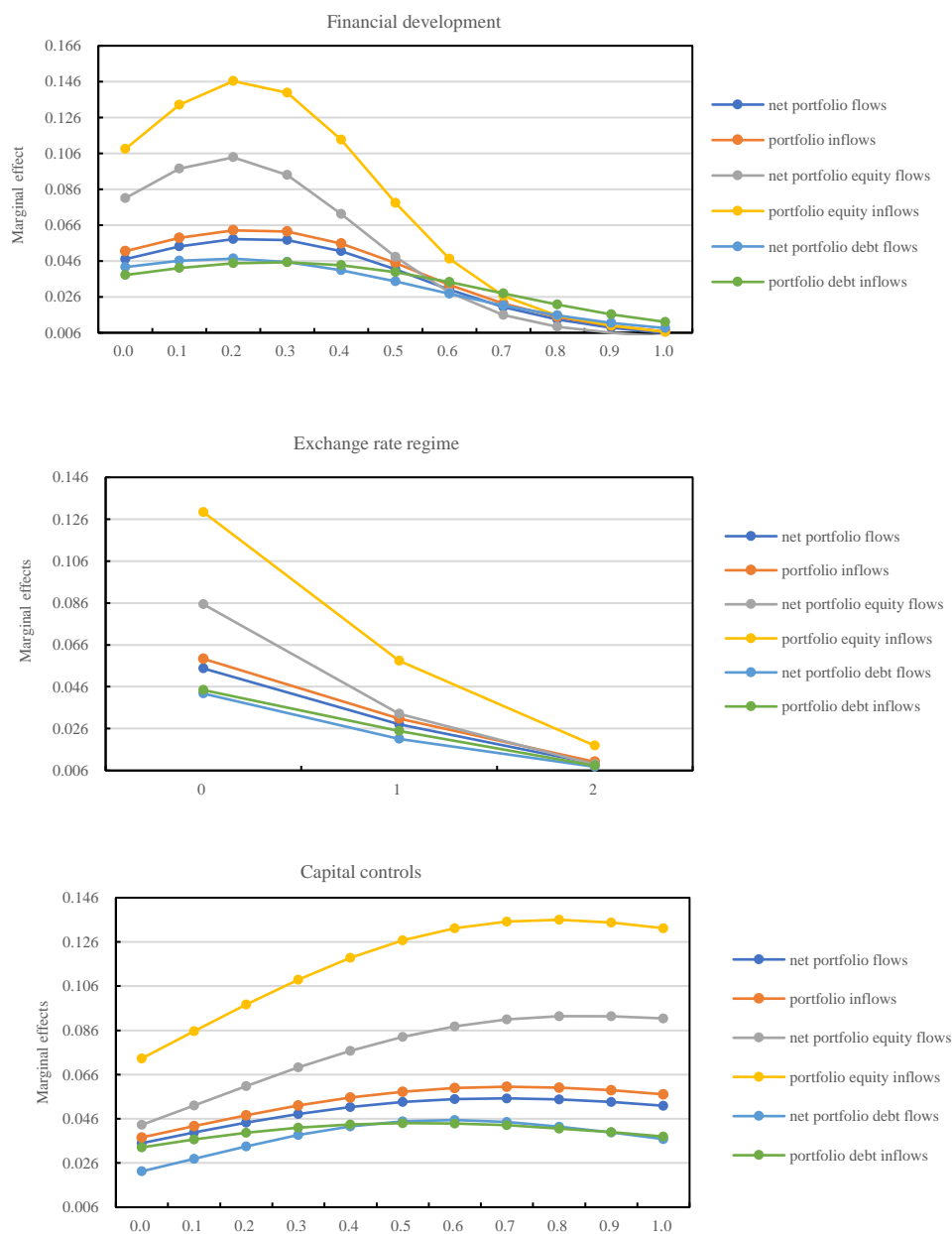
However, the MER analysis will be conducted only if the coefficients of capital flow reversals are significant. In emerging market economies, six types of capital flow reversals have a significant impact on currency crises, namely reversals of net portfolio flows, net portfolio equity flows, and net portfolio debt flows, as well as reversals of portfolio inflows, portfolio equity inflows, and portfolio debt inflows. Their corresponding logit models are selected for the MER analysis.

Figure 6 shows the results for emerging market economies. We can observe that the level of financial development (based on the IMF financial development index) in emerging market economies ranges from 0.1 to 0.7. We obtain seven representative values adopting an interval of 0.1. The MER of capital flow reversals first rises and then falls along with financial development. In other words, the impact of capital flow reversals on currency crises first gets larger as financial development increases, but after the index reaches a level of around 0.25 (about 65% of the sample has a level of financial development of 0.25 or higher) a higher level of financial development decreases the impact of capital flow reversals on currency crises. Financial development is a process of removing restrictions and reforming institutions. Kaminsky & Schmukler (2008) claim that liberalization often precedes institutional reforms. Countries in the primary stage of financial development attach importance to financial liberalization but ignore institutions or lack the ability to improve institutions, resulting in a fragile financial system that is vulnerable to speculative attacks. As institutional quality improves, the financial system will become more resilient to capital flow shocks.

Our results for the exchange rate regime suggest that in a fixed exchange rate regime capital flow reversals have less impact compared to a flexible exchange rate regime. Theoretically, a flexible exchange rate is better positioned to mitigate the volatility of capital flows. Yet in times of crisis, information asymmetry will lead to irrational behavior of international investors (Drazen, 2003; Esaka, 2010; Nakatani, 2018). For instance, exchange rate fluctuations caused by large-scale capital flows are likely to result in more intense speculative attacks.

The (normalized) Chinn-Ito capital control variable ranges between 0 and 1, where 1 means complete openness. The data shows that more than half of the sample is close to fully open or complete immobility. Using an interval of 0.1, we obtain eleven representative values. The value of MER increases as the degree of capital account openness rises. In other words, removing capital account restrictions enlarges the effect of capital flow reversals on the likelihood of a currency crisis.

Fig. 6. The marginal effect of capital flow reversals at representative values of three financial factors in emerging market economies

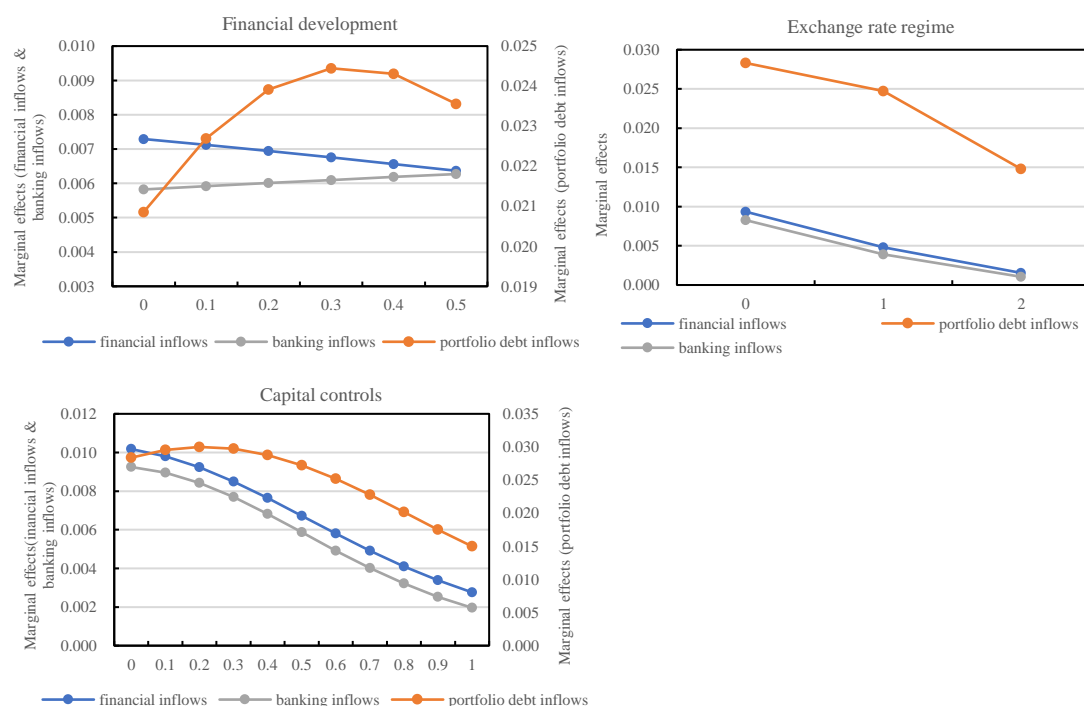


The baseline regressions for developing economies reveal that reversals in financial inflows and sudden stops in portfolio debt inflows and banking inflows play a significant role in driving currency crises. We repeat the analysis of marginal effects for the group of developing countries. The results are displayed in Figure 7. The level of financial development in developing economies is on average lower than that in emerging market economies, ranging from 0 to 0.6. The pattern of the marginal effects differs across capital flow type. Specifically, the MER of sudden stops of portfolio debt inflows first increase and then decrease, while the MER of banking inflows increase linearly. As emphasized above, financial deepening without a sufficient degree of institutional quality will intensify instabilities.

Similar to emerging market economies, we observe that in developing economies a more flexible exchange rate regime increases the effect of capital flow reversals on the likelihood of a currency

crisis. Furthermore, countries with a more open capital account witness a weaker effect of extreme capital flows on currency crises. This result is in contrast to that found in emerging market countries. Why does a more open capital account imply risk for emerging market countries, while the situation is exactly the opposite for developing countries? One reason could be that the degree of liberalization in emerging market economies has already reached a high level, making them reliant on foreign capital. Further relaxation of capital controls might exacerbate the vulnerability when faced with violent capital flows. Although liberalization is accompanied by risks, it might bring more benefits to economic growth and financial development of developing countries, thereby enhancing the ability of these countries to cope with crises. Another possible explanation is that capital account openness is more about portfolio flows rather than banking flows, and emerging market countries are more sensitive to portfolio flows than developing countries.

Fig. 7. Marginal effect of capital flow reversals at representative values of three financial factors in developing economies



4. Conclusions

This paper provides new facts on the behavior of capital flows during a currency crisis. First, we adopt a novel method combining the event study approach and the Bry-Boschan algorithm to investigate the behavior of capital flows during a currency crisis. It is found that currency crises tend to follow capital flow reversals. The reduction of capital inflows is the main source of the net flow reversal. Capital outflows do not matter. Moreover, various capital flow types behave in different ways across economies. In emerging market economies, portfolio flows are the most likely type of capital to be reversed, while in developing economies banking flows and portfolio debt flows are more likely to be reversed. Our logit estimations to examine the impact of capital flow reversals on currency crises demonstrate that reversals of portfolio flows have significant effects on currency crises in emerging market economies. In developing economies, reversals of portfolio debt flows and banking flows increase the likelihood of currency crises. Finally, our results show that countries with mature financial systems are more resilient to shocks. A flexible exchange rate regime amplifies rather than absorbs shocks. Emerging market economies that have a high degree of capital

account openness tend to suffer more severe shocks, unlike developing economies.

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Appendix A.

Fig. A1. Capital outflows over the crisis window

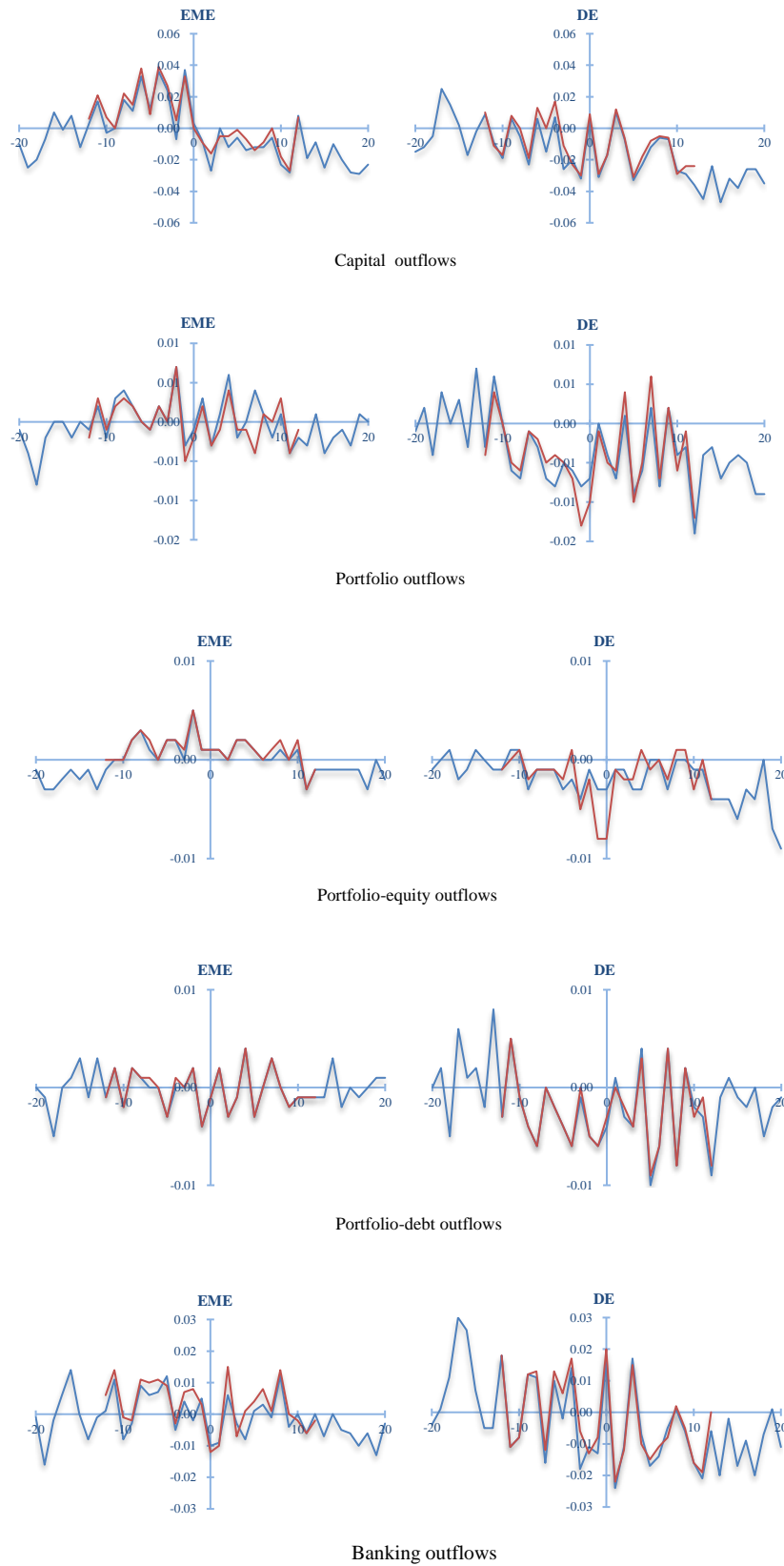


Table A1. List of countries

Emerging market economies (18)	Developing economies (41)
Argentina	Albania
Brazil	Armenia
Chile	Azerbaijan
China	Bulgaria
Colombia	Belarus
Egypt	Belize
Hungary	Bolivia
Indonesia	Costa Rica
India	Dominica
Mexico	Ecuador
Malaysia	Fiji
Philippines	Georgia
Poland	Guatemala
Russia	Honduras
Thailand	Croatia
Turkey	Kazakhstan
South Africa	Laos
Saudi Arabia	Peru
	Sri Lanka
	Lithuania
	Latvia
	Moldova
	Morocco
	Montenegro
	Mongolia
	Mauritius
	Namibia
	Nicaragua
	Pakistan
	Papua New Guinea
	Qatar
	Romania
	El Salvador
	Serbia
	Suriname
	Seychelles
	Ukraine
	Uruguay
	Venezuela
	Kosovo
	Zambia

Table A2. Currency crisis events

Country				Country			
Albania	1995Q3	1997Q1	1999Q2	Mauritius	1997Q1		
Argentina	1990Q1	2019Q2		Mexico	1990Q1	1994Q2	2008Q4
Armenia	1994Q1			Moldova	1998Q4	2015Q1	
Azerbaijan	1995Q3	2015Q1		Mongolia	1993Q1	2003Q4	
Belarus	1999Q1	2015Q1		Montenegro	2008Q4		
Belize	2004Q2	2007Q1		Namibia	1992Q3		
Bolivia	1990Q1			Nicaragua	1993Q2		
Brazil	1990Q1	1998Q2	2000Q2	Norway	1992Q4	1997Q4	2008Q4
Bulgaria	1994Q2	1996Q2		Pakistan	1996Q4	2000Q3	
China	1990Q1	1992Q2	1994Q1	Papua New Guinea	1993Q3	1994Q4	1997Q4
Colombia	2008Q2	2020Q1		Peru	1990Q1		
Croatia	1993Q2	2008Q4	2015Q1	Philippines	1990Q1	1997Q4	
Czech	1997Q2	2008Q4		Poland	1990Q1	2008Q4	
Dominica	1990Q3	2003Q1		Qatar	1998Q2	2000Q1	2008Q1
Ecuador	2014Q4	2017Q3	2020Q1	Romania	1990Q1	1991Q2	1993Q4
Egypt	1990Q3	2016Q4		Russia	1997Q4	2014Q4	
El Salvador	1990Q2			Saudi Arabia	1990Q3		
Fiji	1998Q1	2008Q4		Serbia	2008Q4		
Georgia	1998Q4		2011Q3	Seychelles	2004Q1	2007Q4	2020Q2
Guatemala	1990Q1		2011Q3	Slovak	1993Q2	2008Q3	2011Q3
Honduras	2016Q4			Slovenia	1992Q1	2008Q3	2011Q3
Hungary	1990Q1	2008Q4	2010Q2	South Africa	1996Q2	1998Q3	2001Q4
India	1990Q3	1993Q1	2008Q4	Sri Lanka	2009Q1		
Indonesia	1997Q4			Suriname	1994Q1	1999Q1	2000Q4
Kazakhstan	1994Q1	1999Q2	2015Q3	Thailand	1997Q3		
Laos	1997Q4	2010Q1		Turkey	1994Q1	2001Q1	2018Q3
Latvia	2008Q4	2011Q4		Ukraine	1993Q1	1994Q1	2015Q1
Lithuania	1993Q1			Uruguay	2002Q3		
Malaysia	1997Q3	2008Q3		Venezuela	2009Q1	2011Q1	2018Q1
				Zambia	1995Q1		

Table A3. Reversals in capital flows and currency crises in emerging market and developing economies (full sample)

Dependent variables: Currency crises										
Independent variables	Reversal of net capital flows					Reversal of capital inflows				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Capital flow types	net capital flows	net portfolio flows	net portfolio equity flows	net portfolio debt flows	net banking flows	capital inflows	portfolio inflows	portfolio equity inflows	portfolio debt inflows	banking inflows
Capital flow reversals	-0.013 (0.055)	0.123** (0.062)	0.304* (0.164)	0.102* (0.054)	0.052** (0.025)	0.039 (0.027)	0.192** (0.077)	0.586*** (0.210)	0.140* (0.083)	0.058** (0.024)
Fiscal policy	0.022 (0.031)	0.034 (0.033)	0.080* (0.041)	0.055 (0.037)	0.025 (0.031)	0.055 (0.034)	0.049 (0.034)	0.087** (0.040)	0.055 (0.035)	0.028 (0.032)
Output growth	-0.098*** (0.025)	-0.109*** (0.026)	-0.130*** (0.036)	-0.129*** (0.032)	-0.101*** (0.025)	-0.121*** (0.027)	-0.126*** (0.027)	-0.131*** (0.034)	-0.132*** (0.028)	-0.100*** (0.025)
Inflation	0.001 (0.001)	0.001** (0.001)	0.001** (0.001)	0.001** (0.001)	0.001 (0.001)	0.001** (0.001)	0.001** (0.001)	0.001** (0.001)	0.001** (0.001)	0.001 (0.001)
Current account balance	0.019 (0.032)	0.002 (0.025)	-0.049 (0.037)	-0.013 (0.030)	0.000 (0.026)	-0.016 (0.028)	-0.011 (0.026)	-0.035 (0.034)	-0.026 (0.030)	0.005 (0.026)
External debt level	0.004 (0.003)	0.006* (0.003)	0.010 (0.006)	0.007* (0.004)	0.004 (0.003)	0.006* (0.003)	0.005 (0.003)	0.010 (0.006)	0.007* (0.004)	0.004 (0.003)
Foreign exchange reserves	-0.015*** (0.004)	-0.016*** (0.004)	-0.013*** (0.004)	-0.014*** (0.004)	-0.015*** (0.004)	-0.015*** (0.004)	-0.016*** (0.004)	-0.016*** (0.004)	-0.014*** (0.004)	-0.015*** (0.004)
Financial development	4.812 (4.437)	6.029 (4.339)	4.429 (4.742)	2.784 (4.751)	4.529 (4.424)	4.780 (4.394)	6.045 (4.377)	6.668 (4.537)	4.376 (4.513)	4.736 (4.434)
Exchange rate regime	-1.921*** (0.407)	-1.848*** (0.396)	-1.840*** (0.467)	-1.559*** (0.424)	-1.958*** (0.411)	-1.848*** (0.397)	-1.788*** (0.396)	-1.927*** (0.463)	-1.644*** (0.424)	-1.988*** (0.414)
Capital acc. openness	-0.988 (0.722)	-1.168 (0.742)	-1.786* (1.015)	-1.357* (0.817)	-1.035 (0.731)	-1.375* (0.791)	-1.251 (0.771)	-1.534 (0.953)	-1.239 (0.803)	-1.056 (0.735)
Global financial cycle	0.086*** (0.021)	0.090*** (0.021)	0.113*** (0.026)	0.098*** (0.024)	0.088*** (0.021)	0.097*** (0.022)	0.092*** (0.022)	0.104*** (0.025)	0.100*** (0.023)	0.086*** (0.021)
N	1074	1074	1074	1074	1074	1074	1074	1074	1074	1074
ID	40	40	40	40	40	40	40	40	40	40
R2_p	0.243	0.280	0.310	0.280	0.250	0.288	0.299	0.319	0.301	0.253

Notes: The measurement of capital flow reversals follows Forbes & Warnock (2012). The estimated coefficients shown are marginal effects. Cluster-robust standard errors in parentheses. *, **, *** denote significance levels at 10%, 5%, and 1%, respectively. The positive coefficient of reversals means that they will increase the probability of currency crises. N is sample size. ID is the number of economies. R2_p is the Pseudo R-squared, which is used to measure the goodness of fit. The estimation results in each column are based on reversals of different types of capital flows.

Table A4. Determinants of currency crises in emerging market economies
(using the alternative measure of capital flow reversals)

Dependent variables: Currency crises										
Independent variables	Reversal of net capital flows					Reversal of capital inflows				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Capital flow types	net capital flows	net portfolio flows	net portfolio equity flows	net portfolio debt flows	net banking flows	capital inflows	portfolio inflows	portfolio equity inflows	portfolio debt inflows	banking inflows
Capital flow reversals	0.704 (0.617)	1.312** (0.511)	1.642** (0.662)	0.993* (0.582)	0.923 (0.563)	0.764 (0.565)	1.500*** (0.522)	1.875*** (0.496)	1.399** (0.560)	0.936 (0.576)
Fiscal policy	0.064 (0.062)	0.067 (0.062)	0.058 (0.060)	0.166** (0.082)	0.048 (0.059)	0.059 (0.065)	0.058 (0.062)	0.059 (0.060)	0.075 (0.062)	0.090 (0.066)
Inflation	-0.090 (0.070)	-0.132* (0.069)	-0.126* (0.067)	-0.162** (0.076)	-0.100 (0.073)	-0.121* (0.071)	-0.143** (0.072)	-0.126* (0.068)	-0.136** (0.069)	-0.101 (0.074)
Current account balance	-0.002 (0.007)	-0.003 (0.011)	-0.003 (0.010)	-0.004 (0.012)	-0.004 (0.009)	-0.004 (0.010)	-0.004 (0.012)	-0.004 (0.010)	-0.003 (0.010)	-0.002 (0.007)
External debt level	-0.088 (0.073)	-0.115 (0.077)	-0.076 (0.075)	-0.072 (0.077)	-0.083 (0.078)	-0.051 (0.076)	-0.124 (0.079)	-0.076 (0.076)	-0.086 (0.076)	-0.073 (0.077)
Foreign exchange reserves	0.005*** (0.001)	0.005*** (0.001)	0.006*** (0.001)	0.005*** (0.001)	0.005*** (0.001)	0.004*** (0.001)	0.005*** (0.001)	0.005*** (0.001)	0.004** (0.002)	0.005*** (0.001)
Financial development	-0.037*** (0.011)	-0.036*** (0.011)	-0.039*** (0.012)	-0.046*** (0.013)	-0.033*** (0.011)	-0.036*** (0.011)	-0.037*** (0.011)	-0.036*** (0.011)	-0.042*** (0.012)	-0.034*** (0.011)
Exchange rate regime	-3.472*** (1.124)	-3.472*** (1.127)	-2.572*** (1.058)	-1.948*** (1.319)	-4.328*** (1.165)	-3.405*** (1.304)	-3.815*** (1.165)	-2.646*** (1.993)	-2.031*** (1.096)	-3.117*** (1.157)
Capital acc. openness	-2.325** (1.059)	-2.394** (1.078)	-2.468** (1.070)	-2.618** (1.134)	-2.239** (1.058)	-2.124** (1.070)	-2.311** (1.079)	-2.465** (1.068)	-2.175** (1.060)	-2.262** (1.064)
Global financial cycle	5.451*** (1.935)	5.362*** (1.919)	5.206*** (1.900)	5.354*** (1.856)	5.569*** (2.012)	5.041*** (1.957)	5.912*** (1.994)	4.889** (1.913)	5.922*** (2.019)	4.223** (1.973)
	0.149*** (0.040)	0.146*** (0.040)	0.140*** (0.039)	0.157*** (0.043)	0.140*** (0.041)	0.141*** (0.041)	0.140*** (0.040)	0.135*** (0.040)	0.145*** (0.042)	0.150*** (0.041)
N	384	384	384	384	384	384	384	384	384	384
ID	14	14	14	14	14	14	14	14	14	14
R2_p	0.388	0.408	0.386	0.415	0.406	0.429	0.418	0.382	0.392	0.407

Notes: The measurement of capital flow reversals follows Forbes & Warnock (2012). The estimated coefficients shown are marginal effects. Cluster-robust standard errors in parentheses. *, **, *** denote significance levels at 10%, 5%, and 1%, respectively. The positive coefficient of reversals means that they will increase the probability of currency crises. N is sample size. ID is the number of economies. R2_p is the Pseudo R-squared, which is used to measure the goodness of fit. The estimation results in each column are based on reversals of different types of capital flows.

Table A5. Determinants of currency crises in developing economies
(using the alternative measure of capital flow reversals)

Dependent variables: Currency crises										
Independent variables	Reversal of net capital flows					Reversal of capital inflows				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Capital flow types	net capital flows	net portfolio flows	net portfolio equity flows	net portfolio debt flows	net banking flows	capital inflows	portfolio inflows	portfolio equity inflows	portfolio debt inflows	banking inflows
Capital flow reversals	0.049 (0.260)	-0.193 (0.257)	-0.236 (0.365)	-0.114 (0.311)	0.319 (0.255)	-0.110 (0.308)	0.072 (0.255)	-0.006 (0.334)	0.671** (0.272)	0.895*** (0.263)
Fiscal policy	-0.077*** (0.022)	-0.082*** (0.022)	-0.099*** (0.029)	-0.092*** (0.025)	-0.076*** (0.022)	-0.088*** (0.023)	-0.086*** (0.023)	-0.113*** (0.028)	-0.088*** (0.024)	-0.079*** (0.022)
Output growth	-0.012 (0.027)	0.000 (0.029)	0.014 (0.037)	0.010 (0.031)	-0.013 (0.027)	0.005 (0.029)	0.006 (0.029)	0.013 (0.034)	0.015 (0.030)	-0.009 (0.028)
Inflation	0.037** (0.016)	0.040** (0.016)	0.049** (0.020)	0.048*** (0.018)	0.038** (0.016)	0.048*** (0.017)	0.049*** (0.017)	0.052*** (0.019)	0.050*** (0.017)	0.037** (0.016)
Current account balance	-0.002 (0.002)	-0.002 (0.003)	-0.010** (0.005)	-0.004 (0.004)	-0.002 (0.002)	-0.002 (0.003)	-0.002 (0.003)	-0.007* (0.004)	-0.002 (0.003)	-0.002 (0.002)
External debt level	0.002** (0.001)	0.002** (0.001)	-0.000 (0.004)	0.003** (0.001)	0.002** (0.001)	0.002** (0.001)	0.003** (0.001)	-0.003 (0.004)	0.003** (0.001)	0.002* (0.001)
Foreign exchange reserves	-0.006* (0.004)	-0.007* (0.004)	-0.005 (0.004)	-0.006 (0.004)	-0.006* (0.004)	-0.006* (0.004)	-0.006 (0.003)	-0.005 (0.004)	-0.006 (0.003)	-0.006* (0.003)
Financial development	-0.360 (1.642)	-0.062 (1.673)	2.529 (1.999)	0.979 (1.850)	-0.446 (1.640)	-0.327 (1.706)	-0.127 (1.700)	1.362 (1.929)	0.484 (1.763)	-0.597 (1.646)
Exchange rate regime	-1.133*** (0.205)	-1.181*** (0.211)	-1.293*** (0.246)	-1.181*** (0.231)	-1.145*** (0.206)	-1.260*** (0.217)	-1.242*** (0.216)	-1.377*** (0.241)	-1.171*** (0.223)	-1.186*** (0.209)
Capital acc. openness	-1.965*** (0.631)	-2.108*** (0.637)	-1.128 (0.733)	-1.791*** (0.679)	-2.014*** (0.633)	-1.909*** (0.648)	-1.846*** (0.649)	-1.197* (0.711)	-1.809*** (0.652)	-2.118*** (0.638)
Global financial cycle	0.055*** (0.016)	0.058*** (0.016)	0.065*** (0.019)	0.056*** (0.018)	0.054*** (0.016)	0.056*** (0.017)	0.064*** (0.017)	0.062*** (0.019)	0.062*** (0.017)	0.051*** (0.016)
N	789	789	789	789	789	789	789	789	789	789
ID	31	31	31	31	31	31	31	31	31	31
R2_p	0.162	0.164	0.186	0.173	0.164	0.185	0.176	0.190	0.171	0.178

Notes: The measurement of capital flow reversals follows Forbes & Warnock (2012). The estimated coefficients shown are marginal effects. Cluster-robust standard errors in parentheses. *, **, *** denote significance levels at 10%, 5%, and 1%, respectively. The positive coefficient of reversals means that they will increase the probability of currency crises. N is sample size. ID is the number of economies. R2_p is the Pseudo R-squared, which is used to measure the goodness of fit. The estimation results in each column are based on reversals of different types of capital flows.

Table A6. Determinants of currency crises in emerging market economies
(using the alternative dataset of currency crises)

Dependent variables: Currency crises										
Independent variables	Reversal of net capital flows					Reversal of capital inflows				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Capital flow types	net capital flows	net portfolio flows	net portfolio equity flows	net portfolio debt flows	net banking flows	capital inflows	portfolio inflows	portfolio equity inflows	portfolio debt inflows	banking inflows
Capital flow reversals	-0.355 (0.292)	0.551*** (0.186)	0.808** (0.327)	0.374 (0.231)	-0.042 (0.152)	0.329** (0.165)	0.747*** (0.251)	0.934*** (0.326)	0.578* (0.334)	0.011 (0.145)
Fiscal policy	2.073 (2.241)	2.111 (2.556)	1.099 (2.637)	4.408 (3.303)	2.055 (2.266)	1.875 (2.287)	2.018 (2.561)	1.754 (2.366)	2.093 (2.341)	2.012 (2.264)
Output growth	0.187 (0.860)	0.633 (0.954)	0.201 (1.042)	1.384 (1.157)	0.316 (0.860)	0.395 (0.847)	0.559 (0.973)	0.101 (0.915)	1.018 (1.007)	0.319 (0.855)
Inflation	0.056 (0.049)	0.042 (0.053)	0.046 (0.052)	0.082 (0.055)	0.070 (0.049)	0.041 (0.052)	0.039 (0.054)	0.047 (0.052)	0.058 (0.050)	0.068 (0.049)
Current account balance	-0.270 (0.201)	-0.424** (0.186)	-0.355** (0.173)	-0.421** (0.172)	-0.368** (0.182)	-0.494*** (0.184)	-0.413** (0.179)	-0.365** (0.178)	-0.435*** (0.167)	-0.385** (0.182)
External debt level	-0.045 (0.035)	-0.036 (0.035)	-0.011 (0.044)	0.006 (0.048)	-0.040 (0.033)	-0.029 (0.032)	-0.036 (0.033)	-0.050* (0.030)	-0.021 (0.040)	-0.038 (0.032)
Foreign exchange reserves	-0.076*** (0.029)	-0.090*** (0.033)	-0.054* (0.033)	-0.059 (0.038)	-0.082*** (0.030)	-0.077*** (0.029)	-0.089*** (0.033)	-0.088*** (0.031)	-0.070** (0.034)	-0.080*** (0.030)
Financial development	13.068** (6.522)	15.725** (7.032)	8.683 (6.925)	10.228 (8.261)	14.346** (6.738)	12.661* (6.774)	16.152** (7.000)	14.532** (6.638)	14.402* (7.404)	14.007** (6.787)
Exchange rate regime	-0.352*** (0.116)	-0.295*** (0.111)	-0.289*** (0.108)	-0.285** (0.114)	-0.316*** (0.108)	-0.267** (0.113)	-0.306*** (0.112)	-0.323*** (0.112)	-0.273*** (0.105)	-0.311*** (0.108)
Capital acc. openness	0.158* (0.085)	0.207** (0.088)	0.147* (0.080)	0.233** (0.097)	0.186** (0.085)	0.178** (0.085)	0.211** (0.087)	0.171** (0.084)	0.213** (0.086)	0.185** (0.085)
Global financial cycle	0.003*** (0.001)	0.003** (0.001)	0.002** (0.001)	0.004** (0.002)	0.003*** (0.001)	0.002** (0.001)	0.003** (0.001)	0.003*** (0.001)	0.003* (0.002)	0.003*** (0.001)
N	384	384	384	384	384	384	384	384	384	384
ID	14	14	14	14	14	14	14	14	14	14
R2_p	0.343	0.378	0.354	0.365	0.333	0.386	0.394	0.360	0.364	0.364

Notes: The measurement of capital flow reversals follows Forbes & Warnock (2012). The estimated coefficients shown are marginal effects. Cluster-robust standard errors in parentheses. *, **, *** denote significance levels at 10%, 5%, and 1%, respectively. The positive coefficient of reversals means that they will increase the probability of currency crises. N is sample size. ID is the number of economies. R2_p is the Pseudo R-squared, which is used to measure the goodness of fit. The estimation results in each column are based on reversals of different types of capital flows.

Table A7. Logit estimation: Determinants of currency crises in developing economies
(using the alternative dataset of currency crises)

Dependent variables: Currency crises										
Independent variables	Reversal of net capital flows					Reversal of capital inflows				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Capital flow types	net capital flows	net portfolio flows	net portfolio equity flows	net portfolio debt flows	net banking flows	capital inflows	portfolio inflows	portfolio equity inflows	portfolio debt inflows	banking inflows
Capital flow reversals	0.781 (0.852)	0.811 (0.722)	1.012 (1.212)	0.389 (0.839)	1.121** (0.556)	0.839 (3.777)	0.618 (0.779)	0.641 (1.347)	1.021** (0.441)	0.978** (0.452)
Fiscal policy	-0.021 (0.048)	-0.016 (0.050)	-0.029 (0.063)	-0.042 (0.058)	-0.020 (0.051)	-0.017 (0.049)	-0.015 (0.049)	-0.021 (0.057)	-0.023 (0.050)	-0.015 (0.049)
Output growth	0.029 (0.038)	0.036 (0.038)	0.003 (0.048)	0.010 (0.045)	0.027 (0.039)	0.034 (0.039)	0.037 (0.039)	0.031 (0.041)	0.036 (0.040)	0.027 (0.038)
Inflation	0.002 (0.002)	0.002 (0.002)	-0.000 (0.002)	0.001 (0.002)	0.002 (0.002)	0.002 (0.002)	0.002 (0.002)	0.001 (0.002)	0.002 (0.002)	0.002 (0.002)
Current account balance	0.013 (0.057)	-0.030 (0.039)	-0.009 (0.066)	0.011 (0.044)	-0.057 (0.045)	-0.029 (0.038)	-0.031 (0.038)	-0.021 (0.050)	-0.033 (0.044)	-0.030 (0.041)
External debt level	-0.004 (0.004)	-0.002 (0.005)	-0.026* (0.016)	-0.000 (0.006)	-0.004 (0.004)	-0.001 (0.005)	-0.002 (0.005)	-0.029** (0.015)	-0.000 (0.006)	-0.004 (0.005)
Foreign exchange reserves	-0.031* (0.018)	-0.028 (0.018)	-0.059** (0.028)	-0.040* (0.021)	-0.025 (0.018)	-0.028 (0.018)	-0.028 (0.018)	-0.049** (0.024)	-0.030 (0.019)	-0.028 (0.018)
Financial development	-0.699 (0.478)	-0.723 (0.483)	-0.523 (0.544)	-0.195 (0.502)	-0.668 (0.484)	-0.732 (0.478)	-0.731 (0.477)	-0.779 (0.533)	-0.382 (0.481)	-0.649 (0.476)
Exchange rate regime	-7.291 (4.567)	-8.096* (4.602)	0.953 (6.198)	-6.409 (5.073)	-7.914* (4.631)	-8.410* (4.613)	-8.244* (4.617)	0.044 (5.761)	-6.411 (4.845)	-7.515 (4.583)
Capital acc. openness	-3.813** (1.835)	-3.754** (1.773)	-2.209 (1.635)	-3.725** (1.865)	-3.580** (1.711)	-3.649** (1.765)	-3.724** (1.778)	-2.064 (1.541)	-3.896** (1.880)	-3.536** (1.720)
Global financial cycle	0.105*** (0.037)	0.107*** (0.038)	0.134** (0.053)	0.096** (0.043)	0.111*** (0.039)	0.102*** (0.038)	0.104*** (0.038)	0.113** (0.048)	0.086** (0.040)	0.106*** (0.038)
N	741	741	741	741	741	741	741	741	741	741
ID	31	31	31	31	31	31	31	31	31	31
R2_p	0.208	0.219	0.231	0.215	0.228	0.212	0.216	0.219	0.200	0.204

Notes: The measurement of capital flow reversals follows Forbes & Warnock (2012). The estimated coefficients shown are marginal effects. Cluster-robust standard errors in parentheses. *, **, *** denote significance levels at 10%, 5%, and 1%, respectively. The positive coefficient of reversals means that they will increase the probability of currency crises. N is sample size. ID is the number of economies. R2_p is the Pseudo R-squared, which is used to measure the goodness of fit. The estimation results in each column are based on reversals of different types of capital flows.

Appendix B: The identification of capital flow cycles

The peak and trough of a capital flow cycle can be regarded as the beginning and end of a capital flow reversal. We apply Harding & Pagan's (2002) quarterly approximation of the Bry-Boschan (B.B.) algorithm (Bry & Boschan, 1971) to identify the peaks and troughs of the capital flow cycle. The method is widely used to identify the turning points of macroeconomic data. Some rules are imposed on the time series:

First, we identify the local maxima ($y_{t-k}, \dots, y_{t-1} < y_t > y_{t+1}, \dots, y_{t+k}$) and minima ($y_{t-k}, \dots, y_{t-1} > y_t < y_{t+1}, \dots, y_{t+k}$) in the capital flow series. Second, the duration of a phase of the cycle (peak to trough or trough to peak) is required to be at least two quarters ($k \geq 2$), and the length of the complete cycle should not be less than five quarters. Third, the peaks and troughs must appear alternately. If there are continuous peaks or troughs, we keep the higher peak and the lower trough. When consecutive peaks or troughs take the same value, we select the former peak and the latter trough. If there is more than one capital flow cycle in the currency crisis window, we only pay attention to the peak to trough cycle (the period of capital flow reversal) closest to the currency crisis.

Table B1. Characterizing the capital flow cycle

		Peak		Trough		Amplitude	Duration (in quarters)
		Date (in quarters)	Magnitude	Date (in quarters)	Magnitude		
Net capital flows	EMEs	-1	0.023	1	-0.007	0.030	2
	DEs	-4	0.051	3	-0.013	0.064	7
Capital inflows	EMEs	-6	0.070	2	-0.035	0.105	8
	DEs	-4	0.081	1	-0.053	0.134	5
Net portfolio flows	EMEs	-6	0.013	0	-0.026	0.039	6
	DEs	-6	0.024	1	-0.004	0.028	7
Portfolio inflows	EMEs	-8	0.014	0	-0.027	0.041	8
	DEs	-6	0.023	2	-0.007	0.030	8
Net portfolio equity flows	EMEs	-6	0.009	0	-0.01	0.019	6
	DEs	-	-	-	-	-	-
Portfolio equity inflows	EMEs	-6	0.009	0	-0.009	0.018	6
	DEs	-	-	-	-	-	-
Net portfolio debt flows	EMEs	-2	0.012	0	-0.014	0.026	2
	DEs	-7	0.027	1	-0.004	0.031	8
Portfolio debt inflows	EMEs	-2	0.014	0	-0.016	0.030	2
	DEs	-6	0.020	1	-0.005	0.025	7
Net banking flows	EMEs	-3	0.019	2	-0.024	0.043	5
	DEs	-5	0.044	0	-0.072	0.116	5
Banking inflows	EMEs	-6	0.033	2	-0.024	0.057	8
	DEs	-5	0.044	0	-0.051	0.095	5

Note: Date refers to the number of quarters before/after the start of the currency crisis.

Table B1 summarizes the features of the capital flow cycle. Our results suggest that the reversal of net flows mainly comes from inflow reversals rather than outflow reversals, so that we exclude outflows from the table. In the table, date refers to the number of quarters before/after the start of a currency crisis. It takes a negative value if occurring before the currency crisis and a positive value when taking place after the currency crisis. The magnitude of the peak (or the trough) corresponds to the parameter θ in equation (2). Amplitude means the difference between the magnitude of peak and trough. Duration is the time between peaks and troughs. As capital flow cycles do not exist in all cases, those without obvious periodicity are denoted by “-“