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Impact of large international capital flows on currency crises

***Chen-Yao Zhang*[1] *and Meng-Wen Wu*[2]**

1. *Ph.D. candidate, Department of Business Administration, National Taipei University*
2. *Department of Business Administration, National Taipei University*

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ABSTRACT

We follow Forbes and Warnock (2012) to define four types of large international capital flows, namely, capital flight and capital retrenchment of domestic residents, and capital surge and sudden stop of foreigners. Using data from 56 countries from 1985 to 2017, we find that only the sudden stop would likely increase the probability of a currency crisis. Then, based on the significant results of the sudden stops, we further investigate which type of large capital inflows combined with the sudden stop would increase the probability of a currency crisis. We argue that the large capital inflows, including capital surges and capital retrenchments, are driven by different entities, which may affect the impact of sudden stop on currency crises. We find that a capital surge followed by a sudden stop would increase the probability of a currency crisis, but the capital retrenchment followed by a sudden stop does not.

Keywords: capital flight, capital retrenchment, capital surge, sudden stop, currency crisis
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[1] Email: smilegoodluck333@gmail.com
[2] Email: mwwu@mail.ntpu.edu.tw

1. Introduction

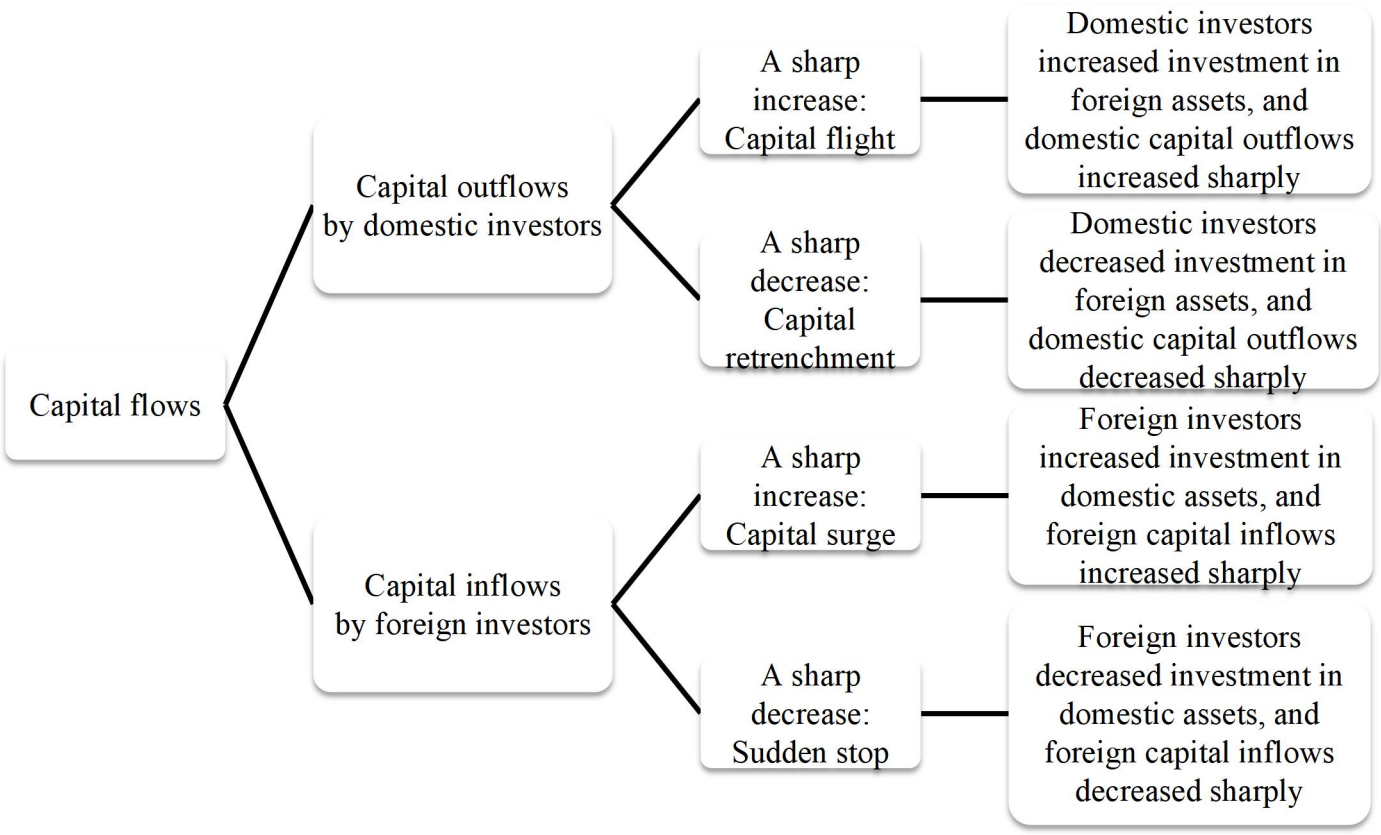
Many factors influence the occurrence of a currency crisis in a country, including the macroeconomic and financial market fundamentals (Frankel and Rose, 1996; Kaminsky and Reinhart, 1999; Kaminsky, Lizondo, and Reinhart, 1998). Among them, large international capital flow is an important reason for a country's currency crisis. For example, a large sudden reduction in capital inflows or large capital outflows can trigger a sharp depreciation of the exchange rate and then cause financial instability and a currency crisis. The famous case is the sharp depreciation of the peso in the Mexican crisis of 1994–1995 (Dornbusch, Goldfajn, and Valde's, 1995; Eichengreen and Gupta, 2016).[1] However, past studies on the relationship between large international capital flows and a country's currency crisis have inconsistent results. Catão (2007), Yazdani and Tayebi (2013), and Bordo, Cavallo, and Meissner (2010) found that a large sudden stop of capital inflow tends to induce a currency crisis. By contrast, Efremidze, Schreyer, and Sula (2011) found a low correlation.[2] Ghosh, Ostry, and Qureshi (2016) found that only approximately 20% of their 152 sharp capital inflows ended in a financial crisis. Sula (2010) found that the capital reversal may end in crisis.[3] The results were inconsistent may be because of the different driving factors behind these large capital flows. For example, some recent studies argued that the large sudden reduction in capital inflows by foreigners is associated with more pronounced slowdowns in the gross domestic product (GDP) and sharper currency depreciations than the large domestic capital outflow (Rothenberg and Warnock, 2011). Accordingly, these capital flows with different driving entities, such as domestic or foreign residents, may have different effects on the probability of a currency crisis.

International capital flows can be divided into two types based on their entities: The first one is from the perspective of domestic residents, which includes the increasing capital outflow from domestic residents increasing their investments in foreign assets, and the decreasing capital outflow from domestic residents decreasing their investments in foreign assets. The second one is from the perspective of foreign residents, which includes the increasing capital inflow from foreign residents increasing their investments in the host country, and the decreasing capital inflow from foreign residents reducing their investments in the host country. Considering the concept of large amount, Forbes and Warnock (2012) considered a sharp increase in capital outflow from domestic residents as *capital flight*, a sharp reduction in capital outflow from domestic residents as *capital retrenchment*, a sharp increase in capital inflows from foreign residents as *capital surge*, and a sharp decrease in capital inflow from foreign residents as *sudden stop* (Figure 1).

[1] The term "sudden stop" was first introduced by Dornbusch, Goldfajn, and Valde's (1995). This term refers to sudden and large drop in capital inflows and comes from a widely quoted adage among bankers that "it isn't speed that kills you, it's the sudden stop." Since the Mexican crisis in 1994, the term "sudden stop" has been widely cited by scholars (Dornbusch, Goldfajn, and Valde's, 1995; Eichengreen and Gupta, 2016).

[2] Efremidze, Schreyer, and Sula (2011) found that the highest correlation between two of the most common measures of sudden stops and the most widely used measure of currency crises was only 0.30 with the other correlation being 0.28.

[3] Sula (2010) showed that a characteristic of many of the emerging market currency crises is a preceding surge in capital inflows and their reversals or "sudden stops" during the crises.



Sources: Forbes and Warnock (2012) and author's compilation

Figure 1 Four types of large international capital flows: capital flight, capital retrenchment, capital surge, and sudden stop.

From the broad view, the sharp decreasing capital outflows can be viewed as one kind of large capital inflows (i.e., *capital retrenchment*), and the sharp decreasing capital inflows can be viewed as one kind of large capital outflows (i.e., *sudden stop*). Thus, to simplify the narrative, large capital inflows include *capital surge* and *capital retrenchment*, and large capital outflows include *capital flight* and *sudden stop*.

This study has two purposes. First, we explore the relationship between different types of large international capital flows and the occurrence of a currency crisis in a country. Different from past studies focusing on few capital flows (Rothenberg and Warnock, 2011), we consider four types of large capital flows proposed by Forbes and Warnock (2012), that is, *capital flight*, *capital retrenchment*, *capital surge*, and *sudden stop*. We also investigate which type of large capital flows tends to increase the probability of a currency crisis in a country. We argue that these different capital flows may represent different meanings and may have varying impacts on the crisis. For the two types of large capital outflows, *capital flight* and *sudden stop*, *capital flight* indicates the sharp increasing capital outflow from domestic residents when domestic residents purchase considerable foreign assets because they are optimistic about foreign economic conditions. This case results in domestic capital outflows but allows the country to own the foreign assets and share in the profits abroad. The *sudden stop* indicates the sharp decreasing capital inflow from foreigners when foreigners are pessimistic about the host country's economic situation and therefore stop buying or even selling the country's assets. This case returns the property rights to the host country but reduces the capital that promotes the economic development of the host country. Calderón and Kubota (2013) explored the reasons for large capital outflows and found that foreigners are likely to divest or stop affording further funds from countries

with poor economic performance. Moreover, domestic residents tend to invest abroad when they have significant excessive savings or high overseas earnings. Rothenberg and Warnock (2011) found that sudden stop is more likely to slow down GDP and induce sharper currency depreciation than a capital flight.

The two types of large capital inflows, *capital retrenchment* and *capital surge*, also have different meanings. *Capital retrenchment* indicates the sharp decreasing capital outflow from domestic residents when they are pessimistic about the economic conditions of foreign countries. Hence, they stop buying or even selling foreign assets, causing large capital back to the country, which is beneficial to the country's economic development. Then, *capital surge* indicates the sharp increasing capital inflow from foreigners when foreigners are optimistic about the economy of the host country and thus purchase assets in the host country. This case may result in a large capital inflow to the financial market in the host country, which may overflourish the host economy.

We investigate the lead–lag relationship between the four types of capital flows and currency crises to eliminate endogeneity. That is, which type of large capital flows occurs in the previous period (t-1 period) increases the probability of a currency crisis in the next period (t period) (Almahmood, Bird, and Willett, 2020; Furceri, Guichard, and Rusticelli, 2012; Kaminsky, Lizondo, and Reinhart, 1998). Using data from 56 countries from 1985 to 2017, we find that a country with a sudden stop of foreign capital in the previous stage (t-1 period) tends to experience a sharp depreciation of the exchange rate in the next periods (t period), thereby increasing the probability of a currency crisis. However, foreign capital surge, domestic capital flight, and domestic capital retrenchment in the previous period (t-1 period) do not significantly increase the probability of a currency crisis in the next stage (t period). This result echoes and complements Eichengreen and Gupta's (2016) findings on the impact of a sudden stop of foreign capital on exchange rate depreciation but is in contrast to the results of Efremidze, Schreyer, and Sula (2011).

Our second purpose is based on the significant results of the first purpose regarding sudden stops. We further investigate which type of large capital inflows combined with the sudden stop would increase the probability of a currency crisis. The literature argued that a large capital inflow can easily lead to economic overheating but trigger sudden stop and even massive capital outflow once the economy is adversely affected (Furceri, Guichard, and Rusticelli, 2012; Agosin and Huaita, 2012; Almahmood, Bird, and Willett, 2020), further increasing the probability of future currency crises (Catão, 2007; Yazdani and Tayebi, 2013). Anecdotal evidence also shows that the Southeast Asian financial crisis in 1997 to 1998 and the global financial crisis in 2008 to 2009 started with a large capital inflow, followed by a sudden stop, and then caused a severe currency crisis. However, the large capital inflows, including capital surge and capital retrenchment, are driven by different entities, which may affect the impact of sudden stop on currency crises. The occurrence of first capital retrenchment and then sudden stop represents that domestic residents stop investing in foreign countries and even sell foreign assets to largely return their capital to their home country (the host country). Then, foreigners stop inflowing capital into the host country. The occurrence of the first capital surge and then sudden stop indicates that foreigners first inflow substantial capital into the host country and then divest from the host country. We argue that the former case may have a better impact on the economy than the latter case because capital retrenchment allows some capital to remain in the host country after foreigners withdraw their capital. Moreover, the capital surge tends to lead to a capital boom in the host country and then easily increase the instability in the host country (Efremidze, Kim, Sula, and Willett, 2017).

Hence, we add two interaction terms to the empirical model, the interaction term of the capital retrenchment (t-2 period) and sudden stop (t-1 period) and the interaction term of capital surge (t-2 period) and sudden stop (t-1 period). We explore which case will increase the probability of a currency crisis (t period). Our empirical results show that a capital surge followed by a sudden stop increases the

probability of future currency crises. On the contrary, capital retrenchment followed by a sudden stop is less likely to increase the probability of a future currency crisis. The latter result may be because of the offsetting of capital retrenchment and sudden stop.

We have three robustness tests. First, we consider the levels of economic development. International capital flows have greater effects on emerging markets and developing economies than developed economies (Broner and Rigobon, 2004; Cowan, De Gregorio, Micco, and Neilson, 2008). We find that a capital retrenchment followed by a sudden stop will reduce the probability of future currency crises in developed economies. By contrast, a capital surge followed by a sudden stop will increase the probability of future currency crises in emerging markets and developing economies. Second, we consider different thresholds in calculating large capital flows. Past studies have various definitions of "large" international capital flows. Thus, in addition to the commonly used standard in the literature, we also adopt stringent criteria.[4] Third, we consider different thresholds in calculating currency crises. Past studies did not have unified criteria to define currency crises in terms of "substantial" exchange rate depreciation. Thus, in addition to Frankel and Rose's (1996) standard, we also follow Laeven and Valencia (2013) to adopt stringent criteria.[5]

This study has two contributions. First, this study is the first to simultaneously consider the impact of four types of large capital flows, including capital flight, capital retrenchment, capital surge, and sudden stop, on the probability of a currency crisis in a country, which is different from past studies that only focused on one type of large capital flow (Suh, 2019; Milesi-Ferretti, and Tille, 2011; Ghosh, Ostry, and Qureshi, 2016; Eichengreen and Gupta, 2016). When capital flows have similar flow directions but are driven by different entities, they would have different effects. Considering four types of large capital flows together provides a complete understanding of the impact of various capital flow types on the occurrence of currency crises. Second, this study is the first to investigate which kind of large capital inflows followed by sudden stop will increase or decrease the probability of a currency crisis in the country. Some past studies have explored the relationship between capital inflows and sudden stop (Agosin, Díaz, and Karnani, 2019; Broner, Didier, Erce, and Schmukler, 2013) or the relationship between sudden stop and currency crisis (Eichengreen and Gupta, 2016; Rothenberg and Warnock, 2011). However, few studies have investigated the effect of the capital reversals (Sula, 2010). However, they did not consider the driving entities behind the large capital inflow, and thus, we fill the gap in the literature.

The remainder of this study is organized as follows: Section 2 is the literature review, and Section 3 provides the definitions of four types of capital flows and currency crises. Then, Section 4 shows the empirical model, and Section 5 presents the sample, data sources, and basic statistics. Then, Section 6 is the empirical results, and Section 7 concludes the study.

2. Literature review

This study reviews the literature on large international capital flows and currency crises. First, we follow Forbes and Warnock (2012) to define four types of large international capital flows, namely, capital flight and capital retrenchment of domestic residents, and capital surge and sudden stop of foreigners. We also investigate which type of large international capital flows tends to increase the

[4] Following Forbes and Warnock (2012), we first calculate the average value and 2.0 times the standard deviation as "large" for the international capital flows. Then, we use an additional definition, which is the mean and a 2.5 times the standard deviation as an alternative measure for "large."

[5] Following Frankel and Rose's (1996) standard, we consider the threshold of exchange rate depreciation of at least greater than 25% and a decrease of more than 10% from the previous year to define "substantial." We also follow Laeven and Valencia (2013) to calculate the depreciation of exchange rate that is at least greater than 30% and an increase of more than 10% from the previous year's decline.

probability of a currency crisis in a country.

Some literature explored the relationship between large international capital flows and currency crises, but they did not obtain consistent results. In terms of large capital outflows, including capital flight and sudden stop. Suh (2019) showed that currency crises are positively associated with domestic capital flight. However, Suh (2022) used the generalized method of moments to estimate the causal effects of capital outflows and found that domestic capital flight will not depress GDP growth directly and, therefore, is harmless to domestic economies. In addition, Efremidze, Schreyer, and Sula (2011) used two common sudden stop variables and currency crisis to study their correlation coefficient. They found that the correlations between sudden stop variables and currency crisis are low. Rothenberg and Warnock (2011) noted that crisis events may be caused by the retreat of foreign investors or by the sudden flight of domestic investors. Their results show that a sudden stop (caused by the retreat of foreign investors) is associated with a more pronounced GDP slowdown and sharper currency depreciation than a sudden flight (caused by the sudden flight of domestic investors). In terms of large capital inflows, including capital retrenchment and capital surge. Sachs, Tornell, and Velasco (1996) found that excessive capital inflows did not have any significant impact on currency crises. In the model of Tille and Wincoop (2014), fundamental economic shocks leading to capital retrenchment by domestic investors contribute to investment in domestic assets because they have further information about domestic assets and are highly optimistic. Large capital inflows can bring considerable economic benefits (López-Mejía, 1999). Strong growth in global economic activity is associated with an increased probability of foreign capital surges (Forbes and Warnock, 2012). However, Furceri, Guichard, and Rusticelli (2012) found that large capital inflows easily lead to the probability of a currency crisis in the next two years. Ghosh, Ostry, and Qureshi (2016) confirmed that countries experiencing economic overheating are likely to have financial crises following the surge of foreign capital.

Second, we study which type of large capital inflows combined with the sudden stop would increase the probability of a currency crisis. The impact of capital reversal on currency crises has few focuses in past studies. Sula (2010) showed that a characteristic of many of the emerging market currency crises is a preceding surge in capital inflows and their reversals or “sudden stops” during the crises. Broner, Didier, Erce, and Schmukle (2013) studied the behavior of capital flows along the business cycles and showed that during crises, foreign investors flee, whereas domestic investors tend to retrench. Regarding the sudden stop after the capital retrenchment, Alberola, Erce, and Serena (2016) explored the role of international reserves as a stabilizer of international capital flows, particularly during periods of global financial stress. They found that during periods of financial stress, great international reserves make domestic residents highly willing to invest their savings domestically and repatriate capital invested overseas, thereby mitigating the lack of foreign financing. Milesi-Ferretti and Tille (2011) showed that compared with developed economies, emerging economies experience the retrenchment of domestic capital for a short period. Agosin, Díaz, and Karnani (2019) noted that a sudden stop of foreign capital inflows may be offset by domestic capital retrenchment, which is common in developed economies. Regarding the sudden stop after the capital surge, Efremidze, Kim, Sula, and Willett (2017) proposed that 70% of foreign capital surge ended with a sudden stop of foreign capital, and that large capital inflows may signal an increase in the risk of future instability. They also noted that, contrary to popular belief, approximately half of sudden stop of foreign capital was not preceded by a surge of foreign capital. Agosin, Díaz, and Karnani (2019) showed that countries that experienced a boom in foreign capital inflows a year ago are likely to experience a sudden stop in foreign capital inflows that year. Eichengreen and Gupta (2016) explored the sudden stop of foreign capital in emerging markets and found that when foreign capital suddenly stops, exchange rate depreciation and a reduction in the GDP growth rate will occur.

3. Definitions and measurement of four types of capital flows and currency crises

This section provides the definitions and measurement of four types of capital flows in Section 3.1 and the measurement of currency crises in Section 3.2.

3.1 Definition and measurement of large capital flows

Following Forbes and Warnock (2012), we have two steps for calculating *capital flight* (D_{FLIGHT}) and *capital retrenchment* ($D_{RETRENCH}$). Considering that *capital flight* is the increasing large capital outflow and *capital retrenchment* is the decreasing large capital outflow, we start by calculating the capital outflow (*OUTFLOW*) as the first step. Then, we calculate capital flight (D_{FLIGHT}) in Eq. (1) and capital retrenchment ($D_{RETRENCH}$) in Eq. (2) in the second step.

$$D_{FLIGHT_{i,t}} = \begin{cases} 1 \;\; if \;\; \Delta OUTFLOW_{i,t} > \mu + 2.0 \times \sigma_{\Delta OUTFLOW_i} \\ 0 \quad \text{otherwise} \end{cases} \tag{1}$$

$$D_{RETRENCH_{i,t}} = \begin{cases} 1 \;\; if \;\; \Delta OUTFLOW_{i,t} < \mu - 2.0 \times \sigma_{\Delta OUTFLOW_i} \\ 0 \quad \text{otherwise} \end{cases} \tag{2}$$

where i and t denote i^{th} country and t^{th} year, respectively. Capital outflow (*OUTFLOW*) is the net of domestic investors' purchase and sale of foreign assets. $\Delta OUTFLOW_{i,t}$ is the change in capital outflows. μ is the mean of change in capital outflows, and $\sigma_{\Delta OUTFLOW_i}$ is the standard deviation of the change in capital outflows. D_{FLIGHT} is the dummy for *capital flight* and equals 1 when the change in capital outflows ($\Delta OUTFLOW$) is higher than its historical mean plus 2.0 times the standard deviation, and 0 if otherwise. This case indicates a large increase in capital outflows. $D_{RETRENCH}$ is the dummy for *capital retrenchment* and equals 1 when the change in capital outflows ($\Delta OUTFLOW$) is less than its historical mean minus 2.0 times the standard deviation, and 0 if otherwise. This case indicates a large decrease in capital outflows. The historical average and standard deviation are calculated over the last 5 years.

Turning to the calculation of *capital surge* (D_{SURGE}) and *sudden stop* (D_{STOP}), we also have two calculation steps. Given that *capital surge* is the increasing large capital inflows and *sudden stop* is the decreasing large capital inflows, we start by calculating the capital inflow (*INFLOW*) as the first step. Then, we calculate *capital surge* (D_{SURGE}) in Eq. (3) and sudden stop (D_{STOP}) in Eq. (4) as the second step.

$$D_{SURGE_{i,t}} = \begin{cases} 1 \;\; if \;\; \Delta INFLOW_{i,t} > \mu + 2.0 \times \sigma_{\Delta INFLOW_i} \\ 0 \quad \text{otherwise} \end{cases} \tag{3}$$

$$D_{STOP_{i,t}} = \begin{cases} 1 \;\; if \;\; \Delta INFLOW_{i,t} < \mu - 2.0 \times \sigma_{\Delta INFLOW_i} \\ 0 \quad \text{otherwise} \end{cases} \tag{4}$$

where i and t denote i^{th} country and t^{th} year, respectively. Capital inflow (*INFLOW*) is the net of foreign investors' purchase and sale of domestic assets. $\Delta INFLOW_{i,t}$ is the change in capital inflows. μ is the mean of change in capital inflows, and $\sigma_{\Delta INFLOW_i}$ is the standard deviation of the change in capital inflows. D_{SURGE} is the dummy for *capital surge* and equals 1 when the change in capital inflows ($\Delta INFLOW$) is greater than its historical mean plus 2.0 times the standard deviation, and 0 if otherwise.

This case indicates a large increase in capital inflows. D_{STOP} is the dummy for *sudden stop* and equals 1 when the change in capital inflows (*ΔINFLOW*) is less than its historical mean minus 2.0 times the standard deviation, and 0 if otherwise. This case indicates a large decrease in capital inflows. The historical average and standard deviation are calculated over the last 5 years.

We also adopt a strict definition by using the historical average and a threshold of 2.5 times the standard deviation.

3.2 Definition and measurement of currency crisis

Following Frankel and Rose (1996), we define a currency crisis ($D_{CC1\ i,t}$) when the depreciation rate of the nominal exchange rate in the current year is greater than or equal to 25% and the difference in the depreciation rate between the current year and last year is greater than or equal to 10%.

$$D_{CC1_{i,t}} = \begin{cases} 1 & ,if\ \%\Delta e_{i,t} \geq 25\%\ \ and\ \ \%\Delta e_{i,t} - \%\Delta e_{i,t-1} \geq 10\% \\ 0, & \text{otherwise} \end{cases} \quad (5)$$

where $D_{CC1\ i,t}$ denotes the dummy of a currency crisis. $\%\Delta e_{i,t}$ denotes the depreciation rate of the nominal exchange rate.

We alternatively use a strict standard to define currency crisis. Following Laeven and Valencia (2013), we define a currency crisis ($D_{CC2\ i,t}$) when the depreciation rate of the nominal exchange rate in the current year is greater than or equal to 30% and the difference in the depreciation rate between the current year and last year is greater than or equal to 10%.

$$D_{CC2_{i,t}} = \begin{cases} 1 & ,if\ \%\Delta e_{i,t} \geq 30\%\ \ and\ \ \%\Delta e_{i,t} - \%\Delta e_{i,t-1} \geq 10\% \\ 0, & \text{otherwise} \end{cases} \quad (6)$$

where $D_{CC2\ i,t}$ denotes the dummy of a currency crisis. $\%\Delta e_{i,t}$ denotes the depreciation rate of the nominal exchange rate.

4. Empirical model

This section provides two models for our two investigations. We employ the logit method with robust and clustered standard errors within a country and year (White, 1980; Peterson, 2009) for both models to reduce the problem of correlated error terms across countries and over time in the panel regressions. We also consider the lead–lag relation to eliminate the endogeneity. The first model, shown in Eq. (7), investigates which type of large capital flows will increase or decrease the probability of future currency crises.

$$\begin{aligned} Pr\,(D_{cc\ i,t} = 1) = {} & \alpha_0 + \alpha_1 D_{FLIGHT\ i,t-1} + \alpha_2 D_{RETRENCH\ i,t-1} + \alpha_3 D_{SURGE\ i,t-1} \\ & + \alpha_4 D_{STOP\ i,t-1} + \alpha_5\ GOVER_{\ i,t-1} + \alpha_6\ POP_{\ i,t-1} + \alpha_7\ M2GDP_{\ i,t-1} \\ & + \alpha_8\ CAGDP_{\ i,t-1} + \alpha_9\ D_{KAOPEN\ i,t-1} + \alpha_{10}\ OPEN_{\ i,t-1} + \alpha_{11}\ RATE_{\ i,t-1} \\ & + \alpha_{12}\ GDPPER_{\ i,t-1} + \alpha_{13}\ RES_{\ i,t-1} + e_{\ i,t} \end{aligned} \quad (7)$$

where $i = 1, \ldots, N$, $t = 1, \ldots, T$, and $N = 56$ is the number of countries, and T is the sample period, ranging from 1985 to 2017. α is the parameter. e is the residual.

In Eq. (7), the dependent variable, D_{CC}, is the dummy variable for a currency crisis in the current year defined in Section 3.2. Our concerned independent variables are four types of large capital flows

in the previous year, namely, D_{FLIGHT}, $D_{RETRENCH}$, D_{SURGE}, and D_{STOP}, which are defined in Section 3.1. D_{FLIGHT}, $D_{RETRENCH}$, D_{SURGE}, and D_{STOP} denote the dummy variables for capital flight, capital retrenchment, capital surge, and sudden stop, respectively.

Controlled variables (**Control**) include nine macro variables, namely, the government consumption (*GOVER*), the population (*POP*), the ratio of M2 to GDP (*M2GDP*), the ratio of current account to GDP (*CAGDP*), capital account openness (D_{KAOPEN}), trade openness (*OPEN*), real interest rate (*RATE*), real GDP per capita (*GDPPER*), and total reserves (*RES*). These variables are also considered by Furceri, Guichard, and Rusticelli (2012); Agosin and Huaita (2012); Neanidis (2019); and Zhao, de Haan, Scholtens, and Yang (2014).

Table 1 presents the detailed definitions of variables.

Table 1 Variables description and sources.

Variable	Definition	Formula	Source
D_{CC}	Dummy for a currency crisis	Definition 1: D_{CC1} is a dummy variable that equals 1 when the depreciation rate of the nominal exchange rate this year is greater than or equal to 25%, and the difference in the depreciation rate between this year and last year is greater than or equal to 10%, and 0 if otherwise.	PACIFIC Exchange Rate Service
		Definition 2: D_{CC2} is a dummy variable that equals 1 when the depreciation rate of the nominal exchange rate this year is greater than or equal to 30%, and the difference in the depreciation rate between this year and last year is greater than or equal to 10%, and 0 if otherwise. Please see Section 3.2.	
D_{FLIGHT}	Dummy for capital flight	Definition 1: = 1 if the change in capital outflows is more than 2.0 standard deviation above the historic average, and 0 if otherwise.	IFS
		Definition 2: = 1 if the change in capital outflows is more than 2.5 standard deviation above the historic average, and 0 if otherwise. Please see the details in Section 3.1.	
$D_{RETRENCH}$	Dummy for capital retrenchment	Definition 1: = 1 if the change in capital outflows is more than 2.0 standard deviation below the historic average, and 0 if otherwise.	IFS
		Definition 2: = 1 if the change in capital outflows is more than 2.5 standard deviation below the historic average, and 0 if otherwise. Please see the details in Section 3.1.	
D_{SURGE}	Dummy for capital surge	Definition 1: = 1 if the change in capital inflows is more than 2.0 standard deviation above the historic average, and 0 if otherwise.	IFS
		Definition 2: = 1 if the change in capital inflows is more than 2.5 standard deviation above the historic average, and 0 if otherwise. Please see the details in Section 3.1.	

D_{STOP}	Dummy for sudden stop	Definition 1: = 1 if the change in capital inflows is more than 2.0 standard deviation below the historic average, and 0 if otherwise. Definition 2: = 1 if the change in capital inflows is more than 2.5 standard deviation below the historic average, and 0 if otherwise. Please see the details in Section 3.1.	IFS
GOVER	Government consumption	General government final consumption expenditure (% of GDP).	WDI
POP	Population	*POP* = log (Total population).	WDI
M2GDP	M2 to GDP	M2 as a percentage of GDP	WDI
CAGDP	Current account to GDP	Current account balance as percent of GDP.	IFS
D_{KAOPEN}	Capital account openness	D_{KAOPEN} is an index measuring a country's degree of capital account openness (range between 0 and 1).	Chinn and Ito (2006). This update is based on IMF's AREAER 2021.
OPEN	Trade openness	Trade openness is the sum of imports and exports divided by GDP.	IFS
RATE	Real interest rate	Real interest rate = Nominal interest rate − Contemporaneous inflation rate. The nominal interest rate is represented by treasury bill rate, or by discount/bank rate or deposit rate if not available. Inflation is measured by the annual growth rate of the GDP implicit deflator.	IFS and WDI.
GDPPER	Real GDP per capita	GDP per capita is real GDP divided by midyear population.	WDI
RES	Total reserves	Total reserves include gold (log).	WDI

Notes: WDI: World Development Indicators, IFS: International Financial Statistics, IMF's AREAER: International Monetary Fund Annual Report on Exchange Arrangements and Exchange Restrictions

Based on our second purpose, we set the second model as Eqs. (8) and (9). The model investigates which type of large capital inflows followed by a sudden stop increases the probability of a currency crisis in a country. Eq. (8) proxies the large capital inflow by the capital retrenchment, and Eq. (9) proxies the large capital inflows by a capital surge.

$$\begin{aligned} Pr\,(D_{cc\,i,t} = 1) = {} & \alpha_0 + \alpha_1 D_{RETRENCH\,i,t-2} \times D_{STOP\,i,t-1} + \alpha_2 D_{RETRENCH\,i,t-2} + \alpha_3 D_{FLIGHT\,i,t-1} \\ & + \alpha_4 D_{SURGE\,i,t-1} + \alpha_5 D_{STOP\,i,t-1} + \alpha_6 GOVER_{i,t-1} + \alpha_7 POP_{i,t-1} + \alpha_8 M2GDP_{i,t-1} \\ & + \alpha_9 CAGDP_{i,t-1} + \alpha_{10} D_{KAOPEN\,i,t-1} + \alpha_{11} OPEN_{i,t-1} + \alpha_{12} RATE_{i,t-1} \\ & + \alpha_{13} GDPPER_{i,t-1} + \alpha_{14} RES_{i,t-1} + e_{i,t} \end{aligned} \quad (8)$$

$$Pr\,(D_{cc\,i,t}=1)=\alpha_0+\alpha_1 D_{SURGE\,i,t-2}\times D_{STOP\,i,t-1}+\alpha_2 D_{SURGE\,i,t-2}+\alpha_3 D_{FLIGHT\,i,t-1}$$
$$+\alpha_4 D_{RETRENCH\,i,t-1}+\alpha_5 D_{STOP\,i,t-1}+\alpha_6 GOVER_{i,t-1}+\alpha_7 POP_{i,t-1}+\alpha_8 M2GDP_{i,t-1}$$
$$+\alpha_9 CAGDP_{i,t-1}+\alpha_{10} D_{KAOPEN\,i,t-1}+\alpha_{11} OPEN_{i,t-1}+\alpha_{12} RATE_{i,t-1}$$
$$+\alpha_{13} GDPPER_{i,t-1}+\alpha_{14} RES_{i,t-1}+e_{i,t} \quad (9)$$

where i = 1, …, N, t = 1, …, T, and N = 56 is the number of countries, and T is the sample period, ranging from 1985 to 2017. α is the parameter. e is the residual.

In Eqs. (8) and (9), the dependent variable, D_{CC}, is a dummy variable for a currency crisis in the current period defined in Section 3.2. Our concerned independent variables are the interactions of $D_{RETRENCH}$ in two lagged periods and D_{STOP} in the one lagged period ($D_{RETRENCH\ t-2}\times D_{STOP\ t-1}$) and the interactions of D_{SURGE} in two lagged periods and D_{STOP} in one lagged period ($D_{SURGE\ t-2}\times D_{STOP\ t-1}$). The first interaction measures whether the capital retrenchment followed by a sudden stop will increase or decrease the probability of a currency crisis. The second interaction measures whether a capital surge followed by a sudden stop will increase or decrease the probability of a currency crisis.

Controlled variables (Control) are the same as those in the first model.

5. Sample, data sources, and basic statistics

We employ a sample of 56 countries from 1985 to 2017, including 31 advanced economies and 25 emerging market and developing economies.[6] We collect the data from International Financial Statistics, World Development Indicators, PACIFIC Exchange Rate Service, and IMF's AREAER.[7]

Table 2 presents the basic statistics of variables in currency and non-currency crisis groups. Panel A presents the number and the percentage of observations in currency and non-currency crisis groups. Our sample has 186 currency crises and 1662 non-currency crises. The percentage of a currency crisis occurring after a sudden stop (15.59%) is significantly higher than that of no currency crisis occurring after a sudden stop (9.02%), indicating that sudden stop tends to lead to increase the percentage of a currency crisis.

Panel B presents the mean, standard deviation, minimum, and maximum of variables and the mean difference between currency and non-currency crisis groups. Only the mean differences are reported to save space. For the four types of large capital flows, only the difference between sudden stop ($D_{STOP\ t-1}$) in currency and non-currency crisis groups is significant (0.076). For the controlled variables, the population (POP_{t-1}) in the currency crisis group is significantly higher than the non-currency crisis group. Then, the ratio of M2 to GDP ($M2GDP_{t-1}$), the ratio of current account to GDP ($CAGDP_{t-1}$), capital account openness ($D_{KAOPEN\ t-1}$), trade openness ($OPEN_{t-1}$), real GDP per capita ($GDPPER_{t-1}$), and Total reserves (RES_{t-1}) in the currency crisis group are significantly lower than those in the non-currency crisis group.

Table 2 Basic statistics: currency and non-currency crisis groups (56 countries from 1985–2017).

	Currency crisis $_t$	Non-currency crisis $_t$	Total
Panel A	Obs (percentage)	Obs (percentage)	

[6] Argentina, Australia, Austria, Belgium, Brazil, Brunei Darussalam, Cambodia, Canada, Chile, China, Colombia, Czech Republic, Egypt, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Lao, Luxembourg, Malaysia, Mexico, Myanmar, Netherlands, New Zealand, Nigeria, Norway, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, United Kingdom, United States, Venezuela, Vietnam.

[7] IMF's AREAER: International Monetary Fund Annual Report on Exchange Arrangements and Exchange Restrictions.

			186				1662		1848
$D_{FLIGHT\ t-1}$			19(10.21%)				176(10.58%)		195
$D_{RETRENCH\ t-1}$			19(10.21%)				160(9.62%)		179
$D_{SURGE\ t-1}$			18(9.67%)				194(11.67%)		212
$D_{STOP\ t-1}$			29(15.59%)				150(9.02%)		179
Panel B	Mean	Std.	Min	Max	Mean	Std.	Min	Max	Diff
$D_{FLIGHT\ t-1}$	0.115	0.321	0.000	1.000	0.117	0.322	0.000	1.000	-0.002
$D_{RETRENCH\ t-1}$	0.115	0.321	0.000	1.000	0.107	0.309	0.000	1.000	0.008
$D_{SURGE\ t-1}$	0.109	0.313	0.000	1.000	0.129	0.336	0.000	1.000	-0.020
$D_{STOP\ t-1}$	0.176	0.382	0.000	1.000	0.100	0.300	0.000	1.000	0.076^{+}
$GOVER_{t-1}$	14.172	5.742	1.220	27.052	16.261	5.276	0.911	30.323	-2.089***
POP_{t-1}	17.296	1.456	12.472	20.944	16.800	1.741	12.321	21.044	0.496***
$M2GDP_{t-1}$	47.378	31.607	10.476	199.255	76.218	56.035	4.894	375.038	-28.840***
$CAGDP_{t-1}$	-0.807	16.177	-13.880	203.719	4.430	34.678	-24.593	486.347	-5.237***
$D_{KAOPEN\ t-1}$	0.388	0.373	0.000	1.000	0.657	0.363	0.000	1.000	-0.269***
$OPEN_{t-1}$	55.446	45.731	0.200	392.804	85.832	69.434	0.167	442.620	-30.386***
$RATE_{t-1}$	176.848	1342.093	-1706.712	14189.723	-1.906	173.506	-5971.641	2872.399	178.754
$GDPPER_{t-1}$	12849	16837	403	105583	23298	20753	181	112417	-10449***
RES_{t-1}	23.015	1.813	13.370	26.957	23.684	1.879	15.931	28.992	-0.669***

Notes:
1. All variables are defined in Table 1.
2. ∗, ∗∗ and ∗∗∗ denote significances of the differences of variable means between bad boom and non-bad boom groups at the 10%, 5%, and 1% level, respectively.
3. + denote significance of Fisher's exact test for the difference in means between the two subsamples at the 1% level.
4. D_{FLIGHT}, $D_{RETRENCH}$, D_{SURGE}, and D_{STOP} denote the dummy of capital flight, capital retrenchment, capital surge, and sudden stop based on their first definition, respectively.

6. Empirical results

We have two results based on our two purposes. Tables 3 and 4 present the results of the first and second purposes, respectively. We have three robustness tests in Tables 5–7. Tables 5–7 consider different levels of economic development, the large capital flows with a strict standard, and currency crises with a strict standard, respectively.

6.1 Effect of four types of large capital flows on currency crisis

Table 3 reports the regression results of our first purpose that which type of four large capital flows increases the probability of a currency crisis. The four large capital flows are capital flight, capital retrenchment, capital surge, and sudden stop. We only report the fifth regression that includes all variables. The coefficients of the previous capital flight ($D_{FLIGHT\ t-1}$), the previous capital retrenchment ($D_{RETRENCH\ t-1}$), and the previous capital surge ($D_{SURGE\ t-1}$) are insignificantly negative, but only the coefficient of the previous sudden stop ($D_{STOP\ t-1}$) is significantly positive. Thus, the previous capital flight, the previous capital retrenchment, and the previous capital surge do not lead to a currency crisis, but the previous sudden stop drives a currency crisis.

For controlled variables, the low ratio of current account to GDP ($CAGDP_{t-1}$), low capital account openness ($D_{KAOPEN\ t-1}$), low total reserves (RES_{t-1}), and high real interest rate ($RATE_{t-1}$) would drive the

probability of a currency crisis.

Therefore, currency crises are more likely to be triggered by a sudden stop in the previous year rather than by capital flight, capital retrenchment, and capital surge. This case may imply that divestment by foreigners has a more severe effect on the crisis than that by domestic residents.

Table 3 Effect of four types of large capital flows on currency crisis.

Dep.Var = D_{CCI}	(1)	(2)	(3)	(4)	(5)
Constant	2.38627	2.27915	2.31498	2.53348	2.54779
	(0.88709)	(0.85314)	(0.86149)	(0.92929)	(0.92959)
$D_{FLIGHT\ t-1}$	-0.30791				-0.16124
	(-0.95466)				(-0.51436)
$D_{RETRENCH\ t-1}$		0.29354			-0.02837
		(0.92211)			(-0.10376)
$D_{SURGE\ t-1}$			-0.36220		-0.18533
			(-0.95984)		(-0.48037)
$D_{STOP\ t-1}$				0.93975***	0.90886***
				(2.88943)	(2.90664)
$GOVER_{t-1}$	0.00526	0.00656	0.00683	0.00667	0.00754
	(0.15011)	(0.18420)	(0.19664)	(0.18511)	(0.20913)
POP_{t-1}	0.06942	0.06921	0.07644	0.06923	0.07642
	(0.39823)	(0.39444)	(0.43729)	(0.37268)	(0.41777)
$M2GDP_{t-1}$	-0.00179	-0.00178	-0.00198	-0.00188	-0.00203
	(-0.44410)	(-0.43692)	(-0.49647)	(-0.45460)	(-0.50006)
$CAGDP_{t-1}$	-0.07898***	-0.07785***	-0.07999***	-0.07659***	-0.07720***
	(-2.79132)	(-2.73036)	(-2.74743)	(-2.74857)	(-2.73246)
$D_{KAOPEN\ t-1}$	-0.96457*	-0.95145*	-0.93614*	-0.94975*	-0.94153*
	(-1.89059)	(-1.85300)	(-1.85257)	(-1.81906)	(-1.82608)
$OPEN_{t-1}$	-0.01133	-0.01154	-0.01134	-0.01207	-0.01183
	(-1.45204)	(-1.46414)	(-1.43361)	(-1.45410)	(-1.42759)
$RATE_{t-1}$	0.00054***	0.00055***	0.00055***	0.00057**	0.00056**
	(2.66635)	(2.71074)	(2.72013)	(2.48997)	(2.55115)
$GDPPER_{t-1}$	-0.00001	-0.00001	-0.00001	-0.00001	-0.00001
	(-0.57397)	(-0.62757)	(-0.59861)	(-0.66473)	(-0.64126)
RES_{t-1}	-0.18988	-0.18825	-0.19271	-0.20152	-0.20664*
	(-1.56806)	(-1.55721)	(-1.61275)	(-1.60576)	(-1.66112)
Number of observations	995	995	995	995	995
Pseudo- R^2	0.09256	0.09261	0.09289	0.10196	0.10257

Notes:
1. The dependent variable, D_{CCI}, is the dummy variable for a currency crisis.
2. The sample covers 56 countries from 1985 to 2017.
3. Regressions are estimated using the logit model with robust and clustered standard errors within a country and year.
4. The numbers in parentheses are t-values. *, ** , and *** denote significance at the 10%, 5%, and 1% level, respectively.
5. All variables are defined in Table 1.
6. D_{FLIGHT}, $D_{RETRENCH}$, D_{SURGE}, and D_{STOP} denote the dummy of capital flight, capital retrenchment, capital surge, and sudden stop based on their first definition, respectively.

6.2 Effect of capital retrenchment/capital surge followed by a sudden stop on the probability of currency crisis

Table 4 reports the results of our second purpose that which type of large capital inflows followed by a sudden stop tends to lead to a currency crisis. We estimate these effects by considering the interaction terms of a large capital inflow and a sudden stop. In the first regression, we proxy the large capital inflows by a capital retrenchment. We find that the coefficient of the interaction term ($D_{RETRENCH\ t-2} \times D_{STOP\ t-1}$) is insignificantly positive, which indicates that the occurrence of a capital retrenchment and then a sudden stop does not increase the probability of a currency crisis. In the second regression, we proxy the large capital inflows by a capital surge. We find that the coefficient of the interaction term ($D_{SURGE\ t-2} \times D_{STOP\ t-1}$) is significantly positive, which indicates that a capital surge followed by a sudden stop will increase the probability of a currency crisis.

For controlled variables, the low ratio of the current account to GDP ($CAGDP_{t-1}$), low capital account openness ($D_{KAOPEN\ t-1}$), low trade openness ($OPEN_{t-1}$) high real interest rate ($RATE_{t-1}$), and low total reserves (RES_{t-1}) would drive the probability of a currency crisis.

Therefore, the capital surge followed by a sudden stop will increase the probability of a currency crisis, but capital retrenchment followed by a sudden stop does not. This case indicates that the foreigners' investment and divestment have a great impact on currency crisis in the host country. Despite the withdrawal of foreign capital, previous capital retrenchment of domestic residents can maintain financial stability in the host country.

Table 4 Effect of capital retrenchment/capital surge followed by a sudden stop on the probability of currency crisis.

$Dep.Var = D_{CCI}$	(1)	(2)
Constant	2.89798	3.49502
	(1.05122)	(1.25687)
$D_{SURGE\ t-2} \times D_{STOP\ t-1}$		1.35788**
		(2.13890)
$D_{RETRENCH\ t-2} \times D_{STOP\ t-1}$	0.67570	
	(0.69177)	
$D_{SURGE\ t-2}$		0.37367
		(1.17814)
$D_{RETRENCH\ t-2}$	0.43444	
	(1.43941)	
$D_{FLIGHT\ t-1}$	-0.24643	-0.31881
	(-0.72593)	(-0.95815)
$D_{RETRENCH\ t-1}$		-0.07900
		(-0.28629)
$D_{SURGE\ t-1}$	-0.26213	
	(-0.72074)	
$D_{STOP\ t-1}$	0.86264**	0.63432**
	(2.47019)	(2.08705)
$GOVER_{t-1}$	0.01016	0.00389
	(0.28164)	(0.10812)
POP_{t-1}	0.05699	0.01177
	(0.31936)	(0.06897)
$M2GDP_{t-1}$	-0.00142	-0.00069
	(-0.33523)	(-0.16032)
$CAGDP_{t-1}$	-0.07852***	-0.07426***
	(-2.89538)	(-2.79306)
$D_{KAOPEN\ t-1}$	-1.06314**	-1.10193**
	(-2.07660)	(-2.08213)

$OPEN_{t-1}$	-0.01168	-0.01395*
	(-1.40609)	(-1.67961)
$RATE_{t-1}$	0.00055***	0.00055**
	(2.61684)	(2.51647)
$GDPPER_{t-1}$	-0.00001	-0.00001
	(-0.61044)	(-0.78707)
RES_{t-1}	-0.20985*	-0.19330
	(-1.66453)	(-1.56106)
Number of observations	971	971
Pseudo- R^2	0.10596	0.11191

Notes:
1. The dependent variable, D_{CCI}, is the dummy variable for a currency crisis.
2. The sample covers 56 countries from 1985 to 2017.
3. Regressions are estimated using the logit model with robust and clustered standard errors within a country and year.
4. The numbers in parentheses are t-values. *, ** , and *** denote significance at the 10%, 5%, and 1% level, respectively.
5. All variables are defined in Table 1.
6. D_{FLIGHT}, $D_{RETRENCH}$, D_{SURGE}, and D_{STOP} denote the dummy of capital flight, capital retrenchment, capital surge, and sudden stop based on their first definition, respectively.

6.3 Robustness test

6.3.1 Considering different levels of economic development

Table 5 reports the results in different levels of economic development by three regressions. The first regression estimates our first purpose of the effects of four types of large capital flows on a currency crisis. The second and third regressions estimate our second purpose of the effects of the large capital inflow followed by a sudden stop on the currency crisis.

Panel A employs samples of developed economies. In the first regression, the coefficients of $D_{FLIGHT\ t-1}$, $D_{RETRENCH\ t-1}$, $D_{SURGE\ t-1}$, and $D_{STOP\ t-1}$ do not reach a significant level. The second regression considers the interaction term, $D_{RETRENCH\ t-2} \times D_{STOP\ t-1}$, and its coefficient is significantly negative. The third regression considers the interaction term, $D_{SURGE\ t-2} \times D_{STOP\ t-1}$, and its coefficient is insignificantly positive. Panel B uses samples of emerging markets and developing economies. In the first regression, only the coefficient of $D_{STOP\ t-1}$ is significantly positive. The coefficient of the interaction term ($D_{RETRENCH\ t-2} \times D_{STOP\ t-1}$) in the second regression is insignificantly positive, whereas that of the interaction term ($D_{SURGE\ t-2} \times D_{STOP\ t-1}$) in the third regression is significantly positive.

In sum, the four types of large capital flows would not lead to a currency crisis in developed economies, and a sudden stop would cause a currency crisis in emerging markets and developing economies. Moreover, a capital retrenchment followed by a sudden stop would reduce the probability of currency crises in developed economies, and a capital surge followed by a sudden stop will increase the probability of currency crises in emerging markets and developing economies.

6.3.2 Considering different criteria for the calculation of large capital flows

Table 6 reports the results that adopt the large capital flows by an alternative threshold of 2.5 standard deviations. This criterion is stricter than that used for the large capital flows in the benchmark model.

Three regressions are proposed. In the first regression, only the coefficient of $D_{STOP\ t-1}$ is significantly positive. The coefficient of the interaction term ($D_{RETRENCH\ t-2} \times D_{STOP\ t-1}$) in the second regression is insignificantly positive, whereas that of the interaction term ($D_{SURGE\ t-2} \times D_{STOP\ t-1}$) in the third regression is significantly positive.

In sum, the results using the alternative criteria to define the large capital flows are robust to those in Tables 3 and 4.

Table 5 Robustness test I: considering different levels of economic development.

Dep.Var = D_{CCI}	(1)	(2)	(3)
Panel A: Advanced economies			
Constant	-9.0080	-8.75093	-9.41941
	(-1.46460)	(-1.48598)	(-1.33151)
$D_{SURGE\ t-2} \times D_{STOP\ t-1}$			0.34155
			(0.57839)
$D_{RETRENCH\ t-2} \times D_{STOP\ t-1}$		-30.25485***	
		(-18.37176)	
$D_{SURGE\ t-2}$			0.89602
			(1.21083)
$D_{RETRENCH\ t-2}$		0.12132	
		(0.17160)	
$D_{FLIGHT\ t-1}$	0.60115	0.50934	-0.11119
	(0.74919)	(0.63376)	(-0.13550)
$D_{RETRENCH\ t-1}$	0.18351		0.25762
	(0.22900)		(0.39253)
$D_{SURGE\ t-1}$	-1.19789	-1.15422	
	(-1.25047)	(-1.12514)	
$D_{STOP\ t-1}$	0.40025	0.57905	0.23009
	(0.30560)	(0.46715)	(0.18638)
Includes control variables in set X			
Number of observations	393	383	383
Pseudo- R^2	0.03458	0.03612	0.03881
Panel B: Emerging market and developing economies			
Constant	4.73398	5.52314	7.07550*
	(1.31883)	(1.44647)	(1.90122)
$D_{SURGE\ t-2} \times D_{STOP\ t-1}$			2.11637**
			(2.24061)
$D_{RETRENCH\ t-2} \times D_{STOP\ t-1}$		0.93782	
		(0.94142)	
$D_{SURGE\ t-2}$			0.33512
			(1.01060)
$D_{RETRENCH\ t-2}$		0.47315	
		(1.37959)	
$D_{FLIGHT\ t-1}$	-0.13022	-0.23589	-0.24340
	(-0.41593)	(-0.65244)	(-0.65839)
$D_{RETRENCH\ t-1}$	0.01046		-0.10284
	(0.03618)		(-0.36611)
$D_{SURGE\ t-1}$	0.06284	-0.05838	
	(0.15197)	(-0.14985)	
$D_{STOP\ t-1}$	1.16621***	1.10639***	0.78766**
	(3.67505)	(3.41925)	(2.52523)
Includes control variables in set X			
Number of observations	602	588	588
Pseudo- R^2	0.14770	0.15683	0.16884

Notes:

1. The dependent variable, D_{CCI}, is the dummy variable for a currency crisis.
2. The sample covers 56 countries from 1985 to 2017.
3. Regressions are estimated using the logit model with robust and clustered standard errors within a country and year.

4. The numbers in parentheses are t-values. *, ** and *** denote significance at the 10%, 5%, and 1% level, respectively.
5. All variables are defined in Table 1.
6. D_{FLIGHT}, $D_{RETRENCH}$, D_{SURGE}, and D_{STOP} denote the dummy of capital flight, capital retrenchment, capital surge, and sudden stop based on their first definition, respectively.

Table 6 Robustness test II:
considering different criteria for the calculation of large capital flows.

Dep.Var = D_{CC1}	(1)	(2)	(3)
Constant	2.37644	2.68250	3.39903
	(0.89371)	(1.01786)	(1.25858)
$D_{SURGE\ t-2} \times D_{STOP\ t-1}$			1.70077*
			(1.94124)
$D_{RETRENCH\ t-2} \times D_{STOP\ t-1}$		0.12253	
		(0.09104)	
$D_{SURGE\ t-2}$			0.31572
			(0.81774)
$D_{RETRENCH\ t-2}$		0.21770	
		(0.53028)	
$D_{FLIGHT\ t-1}$	-0.14143	-0.24740	-0.24181
	(-0.37556)	(-0.57902)	(-0.60080)
$D_{RETRENCH\ t-1}$	0.04134		-0.11601
	(0.12391)		(-0.31806)
$D_{SURGE\ t-1}$	0.21054	0.11672	
	(0.50194)	(0.29037)	
$D_{STOP\ t-1}$	1.00810***	0.99657**	0.74826**
	(2.89333)	(2.49827)	(2.05035)
Includes control variables in set X			
Number of observations	995	971	971
Pseudo- R^2	0.10056	0.10086	0.10725

Notes:
1. The dependent variable, D_{CC1}, is the dummy variable for a currency crisis.
2. The sample covers 56 countries from 1985 to 2017.
3. Regressions are estimated using the logit model with robust and clustered standard errors within a country and year.
4. The numbers in parentheses are t-values. *, ** , and *** denote significance at the 10%, 5%, and 1% level, respectively.
5. All variables are defined in Table 1
6. D_{FLIGHT}, $D_{RETRENCH}$, D_{SURGE}, and D_{STOP} denote the dummy of capital flight, capital retrenchment, capital surge, and sudden stop based on their second definition, respectively.

6.3.3 Considering different thresholds for the calculation of currency crisis

Table 7 reports the results using 30% as an alternative threshold for the depreciation rate of the exchange rate. This criterion is stricter than that used for the currency crisis in the benchmark model.

Three regressions are proposed. In the first regression, only the coefficient of $D_{STOP\ t-1}$ is significantly positive. The coefficient of the interaction term ($D_{RETRENCH\ t-2} \times D_{STOP\ t-1}$) in the second regression is insignificantly positive, whereas that of the interaction term ($D_{SURGE\ t-2} \times D_{STOP\ t-1}$) in the third regression is significantly positive.

In sum, the results using an alternative criterion to define the currency crisis are robust to those in Tables 3 and 4.

Table 7 Robustness test III:
considering different thresholds for the calculation of currency crisis.

Dep.Var = D_{CC2}	(1)	(2)	(3)
Constant	2.87879	3.15921	3.86872
	(0.78966)	(0.84446)	(1.03474)
$D_{SURGE\ t-2} \times D_{STOP\ t-1}$			1.72741**
			(2.35829)
$D_{RETRENCH\ t-2} \times D_{STOP\ t-1}$		1.47122	
		(1.45254)	
$D_{SURGE\ t-2}$			0.41507
			(1.22210)
$D_{RETRENCH\ t-2}$		-0.09781	
		(-0.23233)	
$D_{FLIGHT\ t-1}$	-0.09316	-0.19599	-0.28722
	(-0.27241)	(-0.52017)	(-0.77534)
$D_{RETRENCH\ t-1}$	-0.22717		-0.19275
	(-0.93422)		(-0.74276)
$D_{SURGE\ t-1}$	-0.26296	-0.18054	
	(-0.67979)	(-0.46492)	
$D_{STOP\ t-1}$	1.20608***	1.03606***	0.83107**
	(3.61458)	(2.89332)	(2.49545)
Includes control variables in set X			
Number of observations	995	971	971
Pseudo- R^2	0.11641	0.12081	0.13139

Notes:
1. The dependent variable, D_{CC2}, is the dummy variable for a currency crisis.
2. The sample covers 56 countries from 1985 to 2017.
3. Regressions are estimated using the logit model with robust and clustered standard errors within a country and year.
4. The numbers in parentheses are t-values. *, ** , and *** denote significance at the 10%, 5%, and 1% level, respectively.
5. All variables are defined in Table 1.
6. D_{FLIGHT}, $D_{RETRENCH}$, D_{SURGE}, and D_{STOP} denote the dummy of capital flight, capital retrenchment, capital surge, and sudden stop based on their first definition, respectively.

7. Conclusion

This study considers different types of international capital flows and further explores the relationship between these large international capital flows and currency crises. We argue that the large capital flows with different driving entities, such as domestic or foreign residents, may have different effects on the probability of a currency crisis. Thus, we follow Forbes and Warnock (2012) to define four large capital flows, namely, capital flight and capital retrenchment of domestic residents, and capital surge and sudden stop of foreigners. Using data from 56 countries from 1985 to 2017, we find that only sudden stop would likely increase the probability of a currency crisis.

Then, based on the significant results of the sudden stops, we further investigate which type of large capital inflows combined with the sudden stop would increase the probability of a currency crisis, which is not investigated in the literature. We argue that the large capital inflows, including capital surges and capital retrenchments, are driven by different entities, which may affect the impact of

sudden stop on currency crises. We find that a capital surge followed by a sudden stop would increase the probability of a currency crisis, but the capital retrenchment followed by a sudden stop does not. The reason may be that capital retrenchment offsets sudden stop.

We have three robustness tests by considering different economic developments, different thresholds in defining the large capital flows, and different thresholds in defining the currency crises. Most of the results are robust. This study provides a complete investigation of the relationship between large international capital flows and currency crises.

However, when conducting econometric empirical research, our research sample is limited by the data acquisition (because the IFS database does not provide early data), so our sample starts from 1985. This study has two contributions. First, this study is the first to simultaneously consider the impact of four types of large capital flows, including capital flight, capital retrenchment, capital surge, and sudden stop, on the probability of a currency crisis in a country, which is different from past studies that only focused on one type of large capital flow (Suh, 2019; Milesi-Ferretti, and Tille, 2011; Ghosh, Ostry, and Qureshi, 2016; Eichengreen and Gupta, 2016). Second, this study is the first to investigate which kind of large capital inflows followed by sudden stop will increase or decrease the probability of a currency crisis in the country. Some past studies have explored the relationship between capital inflows and sudden stop (Agosin, Díaz, and Karnani, 2019; Broner, Didier, Erce, and Schmukler, 2013) or the relationship between sudden stop and currency crisis (Eichengreen and Gupta, 2016; Rothenberg and Warnock, 2011). However, few studies have investigated the effect of the capital reversals (Sula, 2010). However, they did not consider the driving entities behind the large capital inflow, and thus, we fill the gap in the literature.

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