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FACING VOLATILE CAPITAL FLOWS: THE ROLE OF EXCHANGE RATE FLEXIBILITY AND FOREIGN ASSETS*

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Abstract

In this paper we study the role played by capital controls (CC), the flexibility of the exchange rate regime (FERR) and the stock of assets held abroad (AA) in reducing the volatility of capital flows. First, following Forbes and Warnok (2012), we study the impact of CC, FERR and AA on the probability of stops and surges of gross capital inflows. We find that FERR reduces the probability of a stop, but CC and AA have no impact. Second, we look at their role in facilitating an offsetting event on outflows (a retrenchment or a flight) to an event on inflows (a stop or a surge, respectively). We find that both FEER and AA increase significantly the probability of a retrenchment occurring when a stop has taken place; while lower CC increases the probability of a flight in the event of a surge. Finally, we look at the extent at which funds lost (gained) in a stop (surge) are compensated by funds gained (lost) in a retrenchment (flight). We find that FERR remain the most significant policy tool behind the compensation of stops, as well as CC is for the compensation of surges.

Resumen

En este trabajo estudiamos el rol que juegan los controles de capitales, la flexibilidad cambiaria y el stock de activos en el exterior sobre la volatilidad de los flujos de capitales. En primer lugar, estudiamos la probabilidad de caídas y aumentos repentinos en las entradas de capitales brutas. Encontramos que una mayor flexibilidad cambiaria reduce la probabilidad de caídas abruptas, mientras que los controles de capitales y el stock de activos en el exterior no son significativos. En segundo lugar, analizamos la probabilidad de que ocurran eventos compensatorios entre salidas y entradas abruptas de flujos brutos. Encontramos que, ante la ocurrencia de una caída repentina en las entradas, tanto la flexibilidad cambiaria como el stock de activos en el exterior aumentan la probabilidad de salidas que actúen como un evento compensatorio de las entradas. Por otra parte, ante la ocurrencia de un aumento abrupto en las entradas, la existencia de menores controles de capitales facilita el rol compensatorio de las salidas. Por último, analizamos la magnitud de estas compensaciones y encontramos que la flexibilidad cambiaria sigue siendo el principal instrumento de política que permite la compensación de caídas repentinas de las entradas de capitales; mientras que la apertura de la cuenta de capitales contribuye a la compensación de aumentos abruptos en las entradas.

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1 Introduction

In the last decades, international financial integration has increased substantially around the world. As a result, countries, in particular emerging market economies, are now more exposed to both the positive and the negative effects of capital inflows. While providing an alternative source of funding, sudden changes in capital flows can create important monetary policy and financial stability challenges.[1] On the former, a highly open capital account reduces monetary independence unless a flexible exchange rate regime is adopted. On the financial stability side, some of the challenges are associated to the volatility of capital flows. Boom-bust cycles in external financing may cause financial instability through currency mismatches. Also, if funds retrieved cannot be replaced, projects being financed may default. On the positive side, capital flows benefit growth, as they provide additional sources of funding for investment. Additionally, an easier access to credit improve consumption smoothing, reducing macroeconomic volatility.

The volatility that accompanied increased capital inflows in the nineties led to the adoption of controls to capital flows in some countries and to a debate on their effectiveness. Although evidence of the 1990s pointed towards the difficulty of administering controls effectively (Edwards, 1999; De Gregorio, Edwards and Valdés, 2000; Habermeier et al, 2011), in the sense of successfully controlling ways to circumvent them, they are revisited in the debate when episodes of increased volatility of flows take place (Ostry et al, 2010). Concerns involving capital controls have been focused in the role in avoiding transitory real exchange rate appreciation in the presence of a wave of capital inflows.

Another consequence of this increased volatility – one that affects particularly emerging market economies – has been the consolidation of certain macro policy frameworks. In particular, a framework that combines a somewhat flexible exchange rate and inflation targeting for monetary policy as a nominal anchor, has gained adepts among developing countries. Countries adopting an inflation targeting framework for monetary policy, consider that the first line of defense to volatile capital flows is the flexibility of the exchange rate (De Gregorio, 2010). In particular, exchange rate flexibility is expected to help to reduce the volatility of capital flows, and, in a way, act as a substitute for capital controls.

Exchange rate flexibility may reduce the volatility of capital flows in two ways. First, if sudden changes in flows cause a change in the level of the exchange rate, the threat

[1] For a comprehensive discussion about the monetary policy and financial stability challenges associated with capital inflows, see CGFS (2009) and Jara and Tovar (2008).

of a reversal of this change – provided by its flexible nature – should act as a deterrent to additional inflows. Second, in particular when the sudden change is related to global rather than to local factors, its impact on the exchange rate may provide a signal to domestic investors in order to change their position in foreign assets. This may tame the impact of the initial change in gross flows on the net flows. The overall question is whether the flexibility of the exchange rate and the possibility to repatriate or expatriate funds by residents, reduce the negative effect of volatile gross flows, obtaining *de facto* an effect similar to that expected for capital controls.[2]

In this paper, we investigate whether exchange rate flexibility helps dealing with volatile capital flows in the ways described above. In the first case, it should be true that, controlling for other factors– including the effect of capital controls– a more flexible exchange rate regime should be associated with a lower probability of extreme events in gross capital inflows (surges or stops, as they will be defined below). In the second case, we take two approaches. In the first we test for the likelihood of having an offsetting event on outflows provided an event on inflows has occurred. In the second approach, we focus on the magnitude of this offsetting behavior rather than just its likelihood. In both cases we search for the importance of the flexibility of the exchange rate regime, in the likelihood of an offsetting event given an event on inflows in the former, and in the size (magnitude) of the compensation in the latter.

This paper is organized as follows. Section 2 presents some stylized facts from the data: rate of occurrence of events and policy changes over the period (controls to capital flows and flexibility of regime). Section 3 studies the importance of the first channel by estimating the determinants of the probability of extreme events in gross capital flows. Section 4 studies the second potential channel by estimating: (1) the determinants of the probability of a contemporaneous extreme event in gross outflows when an extreme event in gross inflows occur (i.e. the probability of a flight given a surge and the probability of a retrenchment given a stop), and (2) determinants of the fraction of a surge that is compensated by a flight, and the fraction of a stop that is compensated by a retrenchment.

[2] For a similar discussion see IMF (2013) and Contreras and Pinto (2013), who show that countries with more stable net capital flows have, on average, a more flexible exchange rate.

2 Data issues

We start by identifying four types of extreme events associated to changes in gross capital flows.[3] The first two types of events are associated to changes in gross capital *inflows* (stops and surges); while the last two are associated to changes in gross capital *outflows* (flights and retrenchments).

In identifying extreme events of gross capital flows, we follow closely the methodology described in Forbes and Warnock (2012). More specifically, let us consider K_{it} to be the quarterly gross capital flows (inflows or outflows) in country i at time t, as presented in the Balance of Payments. Then, k_{it} represents the annualized version of K_{it}, equivalent to its four quarter moving sum.

In order to identify extreme events of gross capital flows, we need to compute the annual change of k_{it} (Δk_{it}), its mean and standard deviation ($\overline{x}_{\Delta k_{it}}$ and $\sigma_{\Delta k_{it}}$), such that:[4]

$$\Delta k_{it} = k_{it} - k_{i(t-4)} \tag{1}$$

$$\overline{x}_{\Delta k_{it}} = \sum_{m=1}^{20} \frac{\Delta k_{i(t-m)}}{20} \tag{2}$$

$$\sigma_{\Delta k_{it}} = \sqrt{\sum_{m=1}^{20} \frac{\left(\Delta k_{i(t-m)} - \overline{x}_{\Delta k_{i(t-m)}}\right)^2}{19}} \tag{3}$$

With these elements in hand, we define extreme event on capital flows $e_{k_{it}}$. For capital inflows, an extreme event on surges (stops) is declared when Δk_{ijt} is above (or below) its rolling average ($\overline{x}_{\Delta k_{it}}$) plus (minus) one standard deviation ($\sigma_{\Delta k_{it}}$) for one or more contiguous periods (what we call "wave"), *and* in at least one of them it is above (or below) its rolling deviation ($\overline{x}_{\Delta k_{it}}$) plus (minus) two standard deviation ($\sigma_{\Delta k_{it}}$).

[3] The focus on gross flows follows Forbes and Warnock (2012), Rothenberg and Warnock (2011) and Cowan et al (2008). All these authors emphasize that the factors underlying the behavior of gross inflows and outflows may differ from those of net flows. In that sense, this approach represents a departure from the empirical literature on capital flows that focuses mainly on net capital flows approximated by the current account deficit (e.g. Calvo et al, 1993).

[4] The means and standard deviations are computed using a 5 years moving window (i.e 20 observations). Therefore, the identification process of events takes into account the fact that capital flows grow over time, as is based on rolling estimations of means and standard deviations of capital flows by countries.

For capital outflows, an extreme event on retrenchments (flights) is declared when Δk_{ijt} is above (or below) its rolling average ($\overline{x}_{\Delta k_{it}}$) plus (minus) one standard deviation ($\sigma_{\Delta k_{it}}$) for one or more contiguous periods ("wave"), *and* in at least one of them it is above (or below) its rolling average ($\overline{x}_{\Delta k_{it}}$) plus (minus) two standard deviation ($\sigma_{\Delta k_{it}}$).

We also consider two additional adjustments to our data set of extreme events: (i) only those events that last more than one quarter are considered, and (ii) if a zero lies between two events, both events are considered to be the same, including the intermediate zero.

To clarify the definition of extreme events even more, Figure 1 shows the identification of stops, surges, flights and retrenchments for the case of Chile, when Δk_{it} of inflows and outflows are taken separately.

[insert Figure 1]

Our data set of gross capital inflows is constructed from quarterly data of 59 emerging and advanced countries for the $1990q1 - 2010q4$ period.[5]

2.1 Frequency of extreme events

In Table 1 we summarize the frequency of extreme events for advanced and emerging economies, over the period from 1990 to 2010. As can be seen, in advanced economies the frequency of extreme events of gross capital flows were the highest in the period $1990-94$, while the period $2005-10$ is the second most volatile according to this metric. Table 1 also allows verifying that periods of high frequency of surges are associated with periods of high frequency of flights. A similar phenomenon occurs between stops and retrenchments. In emerging economies, all kinds of extreme events reach their highest in the period $2005-10$. Finally, note that the frequency of events in advanced and emerging economies is similar.

[5] We include 34 emerging economies and 25 advanced economies. The emerging economies are: 10 from Latin America (Argentina, Brazil, Colombia, Costa Rica, Chile, Ecuador, Mexico, Peru, Uruguay, Venezuela), 13 from Eastern Europe (Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovak Republic, Turkey, Ukraine), 7 from Emerging Asia (Indonesia, India, Korea, Malaysia, Pakistan, Philippines, Thailand), and 4 from MENA (Israel, Jordan, Morocco, South Africa). The advanced economies are: 12 from the Euro Zone (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Slovenia), 10 from non-Euro zone (Australia, Canada, Denmark, Japan, New Zealand, Norway, Sweden, Switzerland, UK, USA), and 3 from countries that act as off-shore centers (Hong Kong, Panama, Singapore).

[insert Table 1]

The occurrence of surges-flights and stops-retrenchments tend to be related, as we will discuss later, suggesting that portfolio decisions of foreign investors may complement the decision of domestic investors in times when capital inflows experience a sudden change.

2.2 Capital account openness and the exchange rate regime

Two of the key variables that we test for significance in the section below are the Chinn and Ito (2008) *de facto* measure of capital account openness and the Reinhart and Rogoff (2004) measure of the exchange rate flexibility.

Regarding the capital account openness, the upper panel of Figure 2 shows the average, median and interdecile range measure of capital account openness for emerging and advanced economies separately. As can be seen, capital accounts have shown an increasing degree of openness in the period $1990 - 2010$. The average level of openness in general is higher for advanced economies than for emerging economies. In emerging economies, a trend towards decreasing openness can be observed towards the end of the sample period. In addition, it should be noted that trajectories of specific countries are by no means monotonic along this period.[6]

[Insert Figure 2]

As for the exchange rate flexibility, the bottom panel of Figure 2 shows that on average, emerging economies showed a reduction from mid-nineties towards the end of the last century.[7] Also, the maximum level of observed flexibility receded. Towards the end of the period of observation, median flexibility returned to mid-nineties levels, although its average remained unchanged. In advanced economies the main development is the formation of the monetary union of the Euro, which enters into full form at the end of the nineties.

[6] We obtain similar conclusions when using alternative measures of capital account openness, such as the one developed by Quinn (2003).

[7] For this purpose, we use the coarse classification of exchange rate flexibility presented in Reinhart and Rogoff (2004). In this index, countries are ranked from 1 (including, among other, pre announced peg, currency board and the facto peg) to 4 (freely floating). We exclude those observations when the index is equal to 5 (a period of "free falling" or hyperinflation) and when it is equal to 6 (a period of dual market in which parallel market data is missing) as commonly suggested in the literature (see Kaminsky, Reinhart and Végh, 2004).

3 Probability of extreme events in gross inflows

In this section we search for the determinants of the probability of occurrence of events in gross capital inflows (stops and surges), as defined in the previous section. In particular, we are interested on the extent to which these events are affected by policies of recipient economies related to the exchange rate regime and the degree of capital controls. We also test for the significance of the level of assets held abroad as a determinant of the probability of experiencing a extreme event in gross capital inflows.

Therefore, we estimate the following equation:

$$Pr(event_{it} = 1) = \alpha + \beta X_t + \gamma Z_{it} + \mu_i + \epsilon_{it} \tag{4}$$

where $event_{it}$ represents a dummy variable that is equal to one when the event occurs (a surge or a stop) and zero otherwise, in country i at time t, X_t represents the traditional set of *push* variables, which vary over time but are constant across countries, and Z_{it} includes a set of *pull* factors that are idiosyncratic from the perspective of each country.

In Tables 2 and 3, we consider four *push* variables in all estimations: (1) an index of global risk aversion, measured by the VIX, (2) the weighted average of real GDP growth in G3 countries (US, UK and Japan), and (3) the cyclical component of a commodity price index,[8] and (4) an ex-post real short term interest rate in G3 countries.[9] This set of *push* factors are always included, both for the probability of stops (Table 2) and that of surges (Table 3).

Regarding *pull* factors, we consider the level of GDP percapita, the annual real GDP growth, and the level of assets held abroad over GDP as part of our baseline estimations; while the lagged occurrence of surges only in the probability of stops.[10] Finally, we also include the level of GDP per capita as a control.

[8] This index is measured by the Hoddrik-Prescott (H-P) detrended real non-oil commodity price index, assuming the H-P parameter $\lambda = 1600$.

[9] The latter captures conditions in global liquidity. We also try growth in monetary aggregates in order to better measure liquidity conditions in a context of interest rates at minimum levels and liquidity being provided through policies focused on quantities. Results are similar.

[10] Since there is limited availability on data on stock of assets abroad, we construct a proxy. In particular, our measure of the stock is equal to the accumulated sum of total outflows since early 1970s. A robustness check was implemented using the annual measure of assets held abroad constructed by Lane and Milesi-Ferretti (2007). Results do not differ.

With these elements in hand, we study the importance of the flexibility of exchange rate regimes and the significance of capital controls. We estimate the equations for surges and stops using a panel probit procedure with random effects.

Table 2 shows the results for the determinants of the probability of stops. As can be seen, stops in gross capital inflows are more likely to occur when global uncertainty (as measured by the VIX) is higher, GDP growth in the three main economic areas (US, Europe and Japan) is lower, short-term interest rate in these areas is higher (proxying more tightened liquidity conditions), and when the GDP growth of the recipient country is lower. Also, the probability of a stop is higher if a surge existed in the previous year. The commodity price index is not significant. The level of GDP per capita is significant, indicating that, controlling for all other variables, the level of development of a country does matter for a stop occurring.

[Insert Table 2]

When looking at the role played by the level of assets held abroad, the degree of openness of the capital account and the flexibility of the exchange rate regime, the sign of the parameter of the three variables indicate that more assets, higher openness and higher flexibility reduce the probability of stops, but only the flexibility of the exchange rate is statistically significant.

We also study the possibility of a differential impact in advanced vis-à-vis emerging market economies of the variables under study (stock of assets abroad, openness of the capital account and the flexibility of the exchange rate). We take these results with caution, in particular for the case in which a variable losses significance for a given group of countries. If this happens, we cannot identify whether that reduction in significance is a solid fact or an effect of having separated the sample in segments. These segments, aside from being smaller in size, may cluster data in a way that dilutes a relation that is strong in the whole population.

Having said that, we find that the flexibility of the exchange rate regime significantly (at $p < 5\%$ level) reduces the probability of stops, both for emerging and advanced economies.[11]

With regards to the probability of surges, Table 3 shows that variables significant in explaining stops are also significant here (with the opposite sign), plus some additional

[11] All results related to the differentiation between emerging and advanced economies are available upon request.

variables. Among the former, growth in advanced economic areas and growth in the recipient country increase the probability of a surge, while global uncertainty and short term interest rates in main economic areas reduce it. In addition, the level of GDP per capita and commodity prices are positively related with the probability of a surge.

[Insert Table 3]

Moving to our variables of interest, namely, assets abroad (this time as proxy of assets susceptible of being sent overseas), flexibility of the exchange rate regime and openness of the capital account are not significant. When a distinction between advanced and emerging economies is introduced, evidence is found in advanced economies for an impact of higher flexibility of the exchange rate regime in reducing the probability of surge (at $p < 10\%$). However, this result is sensitive to the specification, i.e. to the inclusion of other variables.

Tables 2 and 3 therefore summarize our first set of results, namely, that the stock of assets held abroad and the level of capital account openness play no role in determining the likelihood of stops and surges in gross capital inflows. While the flexibility of the exchange rate regime mainly reduces the probability of a stop. When a distinction is made between advanced and emerging countries, some evidence is found for a role of flexibility of the exchange rate regime in reducing the probability of stops and surges. These results have a confidence level of 5%, and 10% respectively.

4 Determinants of conditional events of inflows and outflows

In this section, we explore the relevance of the exchange rate flexibility, capital account openness, and the level of assets held abroad, in prompting compensatory events of gross capital inflows and outflows (Figure 3).

[Insert Figure 3]

In particular, we follow two approaches. First we study the determinants of the conditional probability of experiencing an event in gross capital outflows (flights and retrenchments), given the occurrence of an event in gross capital inflows (surges and stops). Second, we look at the size of these compensations (magnitude), i.e the extent at which an extreme event in gross capital inflows can be compensated by and event in gross capital outflows.

4.1 Probability of conditional joint events

In what follows, we study the determinants of the conditional probability of experiencing an event in gross capital outflows (retrenchment or flight), given the occurrence of an event in gross capital inflows (surges or stops). In other words, we look at the probability of flights given surges, and the probability of retrenchments given stops. In particular, we look at all periods of a surge (stop) event (wave) and ask whether a flight (retrenchment) takes place in at least one of those periods. If that happens, we consider that a surge (stop) event was accompanied by a flight (retrenchment). Therefore, the conditional surge (stop) is equal to one if it is accompanied by a flight (retrenchment) and zero when it is not accompanied by an event in gross outflows.

$$\text{flight given surge}_{it} = \begin{cases} 1 & \text{when} \quad \text{surge=1 and flight=1} \\ 0 & \text{when} \quad \text{surge=1 and flight=0} \end{cases} \tag{5}$$

$$\text{retrenchment given stop}_{it} = \begin{cases} 1 & \text{when} \quad \text{stop=1 and retrenchment=1} \\ 0 & \text{when} \quad \text{stop=1 and retrenchment=0} \end{cases} \tag{6}$$

Considering the whole sample, a flight occurs in 46% of surge episodes, while retrenchments take place on 57% of stop events (Table 4). The frequency of both pairs of joint events is higher in advanced economies. We presume that this is a sign of financial markets that are more integrated with the rest of the world. In that way, an event that occurs in, say, gross capital inflows, generates an impact on market prices that would lead domestic investors to adjust their portfolios. Everything else equal, it is expected that this adjustment goes in the direction of compensating the initial shock.

[Insert Table 4]

Looking at country level for Latin-America and Emerging Asia, we see that Chile and South Korea have the highest probability of having a retrenchment conditional on facing a stop (86% and 75% respectively) (Table 5). On the other hand, the countries with the highest probabilities of having a flight when facing a surge are Malaysia and South Korea (71% and 67% respectively).[12]

[12]The capacity of some emerging economies to compensate gross capital inflows with gross capital outflows has also been emphasizes recently by IMF (2013), Contreras and Pinto (2013) and Adler et al (2014).

[Insert Table 5]

The complementary set of conditional joint events (retrenchments conditional on surges, and a flights conditional on a stops) show a substantial lower frequency of occurrence, in particular for advanced economies (Table 4). The first case refers to episodes of both foreign and local investors adjusting their portfolios towards an increased presence in the domestic market (a 'mania'), while the second, a generalized 'run' on the country (i.e. by residents and non-residents). In emerging market economies the probability of both pairs of events is higher, in particular in emerging Asia and Latin America.

4.1.1 Determinants of retrenchments given a stop

To study the determinants of having a retrenchment given a stop we run a panel probit with random effects. In these estimations we control by the level of GDP per capita as a proxy of the level of financial development. Then, we control by two variables that try to capture the nature of the shock faced by the economy when the event on gross capital inflows occur. In particular, we test whether the probability of experiencing a retrenchment given a stop is higher when the shock faced by the economy is external or internal. We expected that a stop related to an external shock may be more likely to be accompanied by a retrenchment (home bias operating in both sides). On the other hand, if the stop is related to a domestic shock, the probability of a retrenchment should be lower.The internal shock is proxied by the deviations in the GDP growth from its trend. We call this variable GDP shock. External shocks are proxied by the log of the VIX.

In addition, we control by the stock of assets abroad as share of GDP, and test for the significance of capital controls and the exchange rate flexibility, as in Tables 2 and 3.

Table 6 summarize our results. Economies with higher GDP per capita are more likely to experience retrenchments following a stop. Similarly, retrenchments depends on the existence and size of assets held abroad. The higher the assets held abroad, the higher the probability that a retrenchment occurs alongside a stop. However, the nature of the shock does not seem to play a role. Regarding the exchange rate, a more flexible exchange rate regime increases the probability of experiencing a retrenchment given a stop. The higher the flexibility of the exchange rate, the higher the likelihood that the initial shock (stop) affects the exchange rate, giving a signal to other investors to adjust their portfolios. The degree of capital openness does not affect the likelihood of this conditional event.

[Insert Table 6]

As in previous analysis, we investigate the possibility of a differential impact in advanced versus emerging economies in our variables of interest. Assets abroad continue showing high significance both in advanced and emerging economies, while openness is not significant in either of them. Exchange rate flexibility maintains high significance in emerging economies while losing it in advanced ones. Openness of the capital account remains not significant in both of them.

Therefore, we find evidence of the importance of both the flexibility of the exchange rate regime and the holdings of assets abroad in the occurrence of a retrenchment when a stop occurs.

4.1.2 Determinants of flights given surges

Despite the fact that the occurrence of flights given a surge is of a frequency similar to that of a retrenchment given a stop, they are harder to pin-down, as reflected in both the lower number of significant variables found and a lower R-square.

During flights, domestic assets are sent abroad. Therefore, the relevant stock of assets to be considered in the equation is that of assets susceptible of being moved overseas. This is certainly a difficult variable to measure. We consider instead the amount of assets already overseas, which we think may proxy for the capacity or easiness for moving assets abroad. However, the variable is not significant.[13] Neither is the flexibility of the exchange rate regime.

[Insert Table 7]

However, openness of the capital account is significant (at 5%), indicating that a more open capital account increases the probability of flights when surges occur. When looking at the differential impact between advanced versus emerging economies, we observe that

[13] Alternatively, we consider M2 over GDP as a proxy of financial assets susceptible of being sent abroad. The variable becomes significant with the appropriate sign in some specifications. However, data is available for a limited number of countries for which reason we maintain the presentation of results with the largest possible sample.

the relation does not show up in emerging economies, while it does in advanced ones with the same sign and significance as before.

Overall, we have found that the flexibility of the exchange rate regime has a role in determining the occurrence of retrenchments when a stop occurs. However, it does not seem to have one in explaining the occurrence of flights given surges. This asymmetry may point out to a different dynamic response of the financial system to appreciating (associated with surges) versus depreciating (associated with stops) local currencies. We leave this question for future work.

4.2 Determinants of the magnitude of compensation

In this section we take a deeper look at the issue of compensating events. In particular, we measure the extent of compensations to surges and stops in magnitudes. While in the previous sub-section we focused on the probability of a compensating event taking place at the same time, here we focus on the determinants of the effective size of the compensation occurred. In particular, we look at the relationship between the accumulated changes in net capital flows during the duration of an event, and the accumulated fall (increase) on gross inflows during the episode of a stop (surge). We consider all events in inflows (surges and stops), not only those accompanied by a compensatory event in outflows (flights and retrenchments, respectively).

More specifically, when looking at stops events, we construct the ratio between the accumulated changes in net capital flows as percentage of GDP, and the accumulated fall in gross inflows as percentage of GDP, both measured during the entire event of a stop (since events can last for more than one quarter). Similarly, for surges events, the accumulated changes in net capital flows as percentage of GDP are compared to the accumulated increase in gross flows during the event. Assuming that an event (stop or surge) has a duration of k-quarters, our measure is equivalent to:

$$I_{it} = \frac{\sum_{j=1}^{k} \Delta NetFlows_{ij}}{\sum_{j=1}^{k} \Delta GrossFlows_{ij}}, \text{at the time of a stop(surge) event} \tag{7}$$

Therefore, when I_{it} is equal to 1, it means that the fall (increase) in gross inflows that occurs during the stop (surge) impacted net flows in full. If this relation is equal to 0, it means that the initial impact on gross inflows was totally compensated by a movement

on the opposite direction on gross outflows. I_{it} can take values above 1 or below 0 if movements in gross outflows reinforce or overcompensate respectively, movements in gross inflows. Therefore, the lower I_{it} the higher is the compensation of gross outflows after a event in gross inflows.

We focus on the role of assets abroad on the impact that an abrupt change on gross inflows may have on net flows to the country. Also, we analyses the role of the flexibility of the exchange rate regime in facilitating this adjustment.

[insert Figure 4]

There is an ample variation in the relation between gross and net flows. The top graph of Figure 4 shows the case of stops. Points close to the 45 degree line show cases where there was no compensation to events in gross inflows (stop in this case), so the impact translates fully into observed net flows. Points below the 45 degree line indicate cases where movements in outflows (exit or flights) reinforced the stop. On the other hand, points above the 45 degree line indicate cases where movements in outflows (retrenchments) compensated in some degree the stop in inflows. Points close to the horizontal zero level indicate a full compensation, while points above this level indicate cases where the retrenchment of outflows was bigger than the stop in inflows.

The bottom graph in Figure 4 shows the analogous comparison of gross and net flows in the case of surges. Points in the 45 degree line indicate the absence of compensation, while points close to the horizontal zero level indicates close to full compensation.

4.2.1 The magnitude of compensation of stops

Table 8 shows what factors make compensation of stops stronger. In particular, we look at the 379 episodes of stops and ask whether the variables presented in previous sections have any explanatory power in explaining the magnitude of compensation. We do this estimating the determinants of I_{it} in a panel regression with fixed effects.

Our results show that the degree of compensation of stops is higher (a lower value of the dependent variable) for countries with higher income per capita and higher amount of assets abroad. However, the significance of this last variable is sensitive to the specification.[14]

[14]It should be noted that instead of scaling assets abroad by GDP, we do so by the size of the stop suffered. This gives us a metric of assets directly linked to the phenomenon we are measuring.

Flexibility of the exchange rate regime is significant (at 1%) indicating a higher degree of compensation in more flexible regimes, while capital account openness is only significant at 10%. When we differentiate between advanced and emerging economies, assets abroad is only significant for advanced ones. Flexibility of the exchange rate regime, in turn, remains highly significant in both, emerging and advanced countries. While capital account openness is significant only for emerging countries. As argued before, this separation should be read with caution.

[Insert Table 8]

Comparing these results with the determinants of the likelihood of an offsetting event occurring (subsection 4.1.1, Table 6), we find that results are similar for the most part. Differences are that capital account openness does not seem relevant for triggering an event of retrenchment given a stop, but it does matter for the extent of compensation (the more open, the higher the extent of compensation), although only at 10% of significance. Also, significance of our variables of interest (assets abroad and flexibility of the exchange rate regime) is reduced, but they are still relevant.

4.2.2 The magnitude of compensation of surges

Table 9 shows results for determinants of compensation of surges. Here, we look at what factors make the degree of compensation – via exit of capital owned by residents – stronger when a surge occurs. In this section we use the term "exit" generically. A flight is a particular case of an exit – an extreme event – that fulfills the conditions specified previously.

In order to capture the possibilities of domestic agents to compensate a surge, a measure of domestic assets susceptible of being sent abroad should be the relevant. As previously argued, we use the stock of assets abroad as a proxy for the easiness of local assets to go abroad.

[Insert Table 9]

Our results show that countries with higher income compensate surges to a lesser extent. Also, that a stronger exit occurs during a surge if external conditions are benign, as would be

indicated by a relatively low VIX. Conversely, when world uncertainty is high (a higher VIX) surges are less compensated by an exit, pointing to the fact that the country experiencing the surge may be considered a haven in that juncture. A result pointing in the same direction was verified in terms of probability of occurrence of a flight given a surge, i.e. that a higher VIX reduced that probability.

Table 9 also shows that a more open capital account increases the magnitude of compensation. This goes in line with the previous result regarding the likelihood of flights given surges. Also, the level of assets held abroad (which proxy for assets that could go abroad) does not play any role in determining the magnitude of compensation, just as they did not play a role in the likelihood of flights given surges (Table 7). As for the flexibility of the exchange rate regime, a higher compensation is found in countries with higher flexibility.

Finally, when we differentiate between advanced and emerging economies we find that the importance of openness of the capital account in determining a larger degree of compensation increases its significance for advanced economies. Significance of the same parameter for emerging economies is less significant, but still at 10%. Regarding flexibility of the exchange, this is more significant for emerging than for advanced countries.

5 Conclusions

In this paper we have found that a flexible exchange rate regime and the holdings of international assets reduce the impact of the volatility in capital inflows. We find this by departing from the analysis of determinants of events in inflows and outflows separately but instead considering the behavior of outflows when events on inflows have occurred. Our findings confirm the importance of analyzing gross flows, but also that of looking inflows and outflows in a comprehensive way.

Results are robust for the case of stops to capital inflows. A flexible exchange rate regime and the holdings of assets abroad allow an offsetting movement in outflows that stabilize net flows when a stop on inflows occurs. However, in the case of surges, these variables are not significant in determining an analogous offsetting movement. Instead, the presence of such an offsetting movement is related to a more open capital account. The robustness of this relation is not as strong as the one found for stops.

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Table 1: Frequency of events by type of economy

	Advanced				Emerging			
	1990-1994	1995-1999	2000-2004	2005- 2010	1990- 1994	1995- 1999	2000- 2004	2005- 2010
Surges	9.4%	5.7%	6.1%	8.0%	7.9%	6.3%	8.9%	14.0%
Flights	11.4%	6.3%	6.2%	5.0%	8.7%	5.1%	7.8%	10.1%
Stops	14.1%	4.3%	5.2%	8.7%	3.5%	9.5%	2.8%	10.8%
Retrenchments	11.2%	4.7%	6.4%	9.7%	6.0%	5.8%	2.8%	9.8%

Note: Number of events over the number of observations during each period.
Source: Authors' calculations.

Table 2: Probability of stops. All countries

variables	(1)	(2)	(3)	(4)
VIX (in logs)	0.7283***	0.7230***	0.7823***	0.7775***
	(0.1095)	(0.1097)	(0.1115)	(0.1118)
GDP growth G3	-14.9953***	-14.8623***	-14.8938***	-14.6897***
	(2.0356)	(2.0508)	(2.0365)	(2.0522)
Commodity price index	0.0097	0.0077	-0.0148	-0.0208
	(0.2364)	(0.2369)	(0.2365)	(0.2371)
Short term real interest rate G3	18.9288***	19.2034***	18.0312***	18.3714***
	(3.1838)	(3.2023)	(3.2153)	(3.2307)
GDP per capita	0.0979*	0.1157*	0.1509***	0.1782***
	(0.0536)	(0.0610)	(0.0568)	(0.0648)
GDP growth	-8.2726***	-8.3308***	-8.1286***	-8.1961***
	(1.1471)	(1.1509)	(1.1452)	(1.1493)
Surges (-4)	0.5493***	0.5460***	0.5491***	0.5449***
	(0.0875)	(0.0875)	(0.0879)	(0.0880)
Stock of foreign assets (% of GDP)	-0.1433	-0.1460	-0.1361	-0.1386
	(0.0993)	(0.1002)	(0.0981)	(0.0991)
Capital account openness (difference w.r.t. mean)		-0.0273		-0.0390
		(0.0393)		(0.0397)
Exchange rate regime (difference w.r.t mean)			-0.1675***	-0.1735***
			(0.0523)	(0.0529)
Constant	-3.9543***	-4.1029***	-4.5763***	-4.8151***
	(0.6207)	(0.6772)	(0.6595)	(0.7220)
Log likelihood	-834.33	-833.70	-829.01	-828.09
Pseudo R-squared	0.2207	0.2207	0.2257	0.2260
Observations	2,454	2,450	2,454	2,450
Number of countries	40	40	40	40

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: Includes non-Eurozone advanced economies and emerging market economies.
Source: Authors' calculations.

Table 3: Probability of surges. All countries

variables	(1)	(2)	(3)	(4)
VIX (in logs)	-0.4314***	-0.4387***	-0.4201***	-0.4255***
	(0.0991)	(0.0997)	(0.0996)	(0.1002)
GDP growth G3	10.6022***	10.5267***	11.0860***	11.0750***
	(3.0841)	(3.0680)	(3.1259)	(3.1085)
Commodity price index	0.7615***	0.7625***	0.7498***	0.7462***
	(0.2657)	(0.2649)	(0.2666)	(0.2658)
Short term real interest rate G3	-8.0573***	-7.5060***	-8.6443***	-8.0987***
	(2.6637)	(2.6895)	(2.7138)	(2.7292)
GDP per capita	0.2846***	0.3027***	0.3156***	0.3443***
	(0.0846)	(0.0863)	(0.0900)	(0.0928)
GDP growth	12.8341***	12.6359***	12.7432***	12.5303***
	(1.3938)	(1.4047)	(1.3928)	(1.4036)
Stock of foreign assets (% of GDP)	-0.0105	-0.0097	-0.0045	-0.0035
	(0.1061)	(0.1059)	(0.1069)	(0.1068)
Capital account openness (difference w.r.t. mean)		-0.0478		-0.0571
		(0.0393)		(0.0400)
Exchange rate regime (difference w.r.t mean)			-0.0686	-0.0804
			(0.0540)	(0.0546)
Constant	-2.8718***	-3.0149***	-3.1758***	-3.4190***
	(0.8730)	(0.8922)	(0.9243)	(0.9527)
Log likelihood	-1119.71	-1113.79	-1118.89	-1112.69
Pseudo R-squared	0.1098	0.1093	0.1104	0.1102
Observations	2,585	2,569	2,585	2,569
Number of countries	40	40	40	40

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: Includes non-Eurozone advanced economies and merging market economies.
Source: Authors' own calculations.

Table 4: Ocurrence of join events: 1990-2010

Region	Flight given surge	Retrenchment given surge	Retrenchment given stop	Flight given stop
Africa	43%	9%	49%	3%
Emerging Asia	45%	10%	35%	11%
Eastern Europe	38%	5%	42%	5%
Euro Zone	61%	2%	82%	1%
Latin America	27%	11%	20%	15%
Other Developed	56%	0%	54%	0%
Offshore	35%	0%	100%	0%
Advanced	59%	1%	74%	1%
Emerging	37%	8%	35%	9%
Total	46%	5%	57%	4%

Note: Number of events over the number of observations during each period.
Source: Authors' calculations.

Table 5: Ocurrence of join events in Latin America and Asia: 1990-2010

Country	# of events of surges	Flights given surge	# events of stops	Retrenchments given stop
Argentina	11	55%	16	13%
Brazil	21	33%	12	25%
Chile	10	50%	7	86%
Colombia	11	55%	0	
Costa Rica	16	0%	6	0%
Ecuador	6	0%	11	0%
India	25	50%	14	0%
Indonesia	15	33%	9	33%
Korea	12	67%	12	75%
Malaysia	5	0%	8	50%
Mexico	12	0%	5	0%
Pakistan	15	36%	16	0%
Peru	13	0%	11	0%
Philippines	16	25%	14	57%
Thailand	14	71%	21	24%
Uruguay	0		0	
Venezuela	7	57%	3	33%
Total	209	35%	165	29%

Note: Number of events in the sample period and number of events over the number of observations in the sample period.
Source: Authors' calculations.

Table 6: Probability of retrenchments given stops

variables	(1)	(2)	(3)	(4)
GDP per capita	0.5554***	0.6156***	0.4330**	0.4826**
	(0.1834)	(0.1863)	(0.1917)	(0.1960)
VIX (in logs)	0.2350	0.2290	-0.0119	-0.0100
	(0.2418)	(0.2418)	(0.2608)	(0.2604)
GDP growth shock	-2.7291	-2.7085	-2.8140	-2.8335
	(2.7086)	(2.7230)	(2.7393)	(2.7481)
Stock of foreign assets (% of GDP)	1.2920***	1.2727***	1.3336***	1.3195***
	(0.3463)	(0.3407)	(0.3620)	(0.3568)
Capital account openness (difference w.r.t. mean)		-0.1132		-0.0887
		(0.0959)		(0.0998)
Exchange rate regime (difference w.r.t mean)			0.4537***	0.4368***
			(0.1632)	(0.1622)
Constant	-6.6022***	-7.1389***	-4.7724**	-5.2357***
	(1.8074)	(1.8399)	(1.9104)	(1.9601)
Log likelihood	-178.21	-177.52	-173.77	-173.37
Pseudo R-squared	0.1758	0.1790	0.1963	0.1981
Observations	379	379	379	379
Number of countries	37	37	37	37

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: Includes all countries that have experienced join events during the sample period.
Source: Authors' calculations.

Table 7: Probability of flights given surges

variables	(1)	(2)	(3)	(4)
GDP per capita	0.0856	-0.1048	0.0617	-0.1515
	(0.1020)	(0.1471)	(0.1080)	(0.1576)
VIX (in logs)	-1.3152***	-1.3369***	-1.3226***	-1.3487***
	(0.2260)	(0.2313)	(0.2263)	(0.2320)
GDP growth shock	-3.5766	-2.6440	-3.2697	-2.1547
	(3.8777)	(4.0243)	(3.9008)	(4.0632)
Stock of foreign assets (% of GDP)	0.0792	0.1085	0.0734	0.0965
	(0.1698)	(0.1831)	(0.1699)	(0.1839)
Capital account openness (difference w.r.t. mean)		0.2124**		0.2241**
		(0.1019)		(0.1040)
Exchange rate regime (difference w.r.t mean)			0.0692	0.1045
			(0.1016)	(0.1111)
Constant	2.8219***	4.6155***	3.0493***	5.0587***
	(1.0901)	(1.4857)	(1.1427)	(1.5822)
Log likelihood	-285.12	-282.54	-284.89	-282.09
Pseudo R-squared	0.0667	0.0751	0.0674	0.0766
Observations	457	457	457	457
Number of countries	39	39	39	39

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: includes all countries that have experienced join events during the sample period.
Source: Authors' calculations.

Table 8: Determinants of the magnitud of compensation of stops

variables	(1)	(2)	(3)	(4)
GDP per capita	-0.3711***	-0.3798***	-0.3169***	-0.3252***
	(0.0577)	(0.0582)	(0.0593)	(0.0594)
VIX (in logs)	-0.1142*	-0.1112*	-0.0580	-0.0491
	(0.0596)	(0.0596)	(0.0613)	(0.0613)
GDP growth shock	-0.7007	-0.7186	-0.8308	-0.8670
	(0.6558)	(0.6557)	(0.6481)	(0.6467)
Stock of foreign assets (% of GDP)	-0.0155**	-0.0145**	-0.0134**	-0.0117*
	(0.0065)	(0.0066)	(0.0065)	(0.0065)
Capital account openness (difference w.r.t. mean)		-0.0409		-0.0591*
		(0.0351)		(0.0349)
Exchange rate regime (difference w.r.t mean)			-0.1385***	-0.1495***
			(0.0429)	(0.0433)
Constant	4.4119***	4.4793***	3.7417***	3.7855***
	(0.4935)	(0.4966)	(0.5292)	(0.5284)
R-squared	0.171	0.174	0.196	0.203
Observations	379	379	379	379
Number of countries	37	37	37	37

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: Includes all countries that have experienced join events over the sample period.
Source: Authors' calculations.

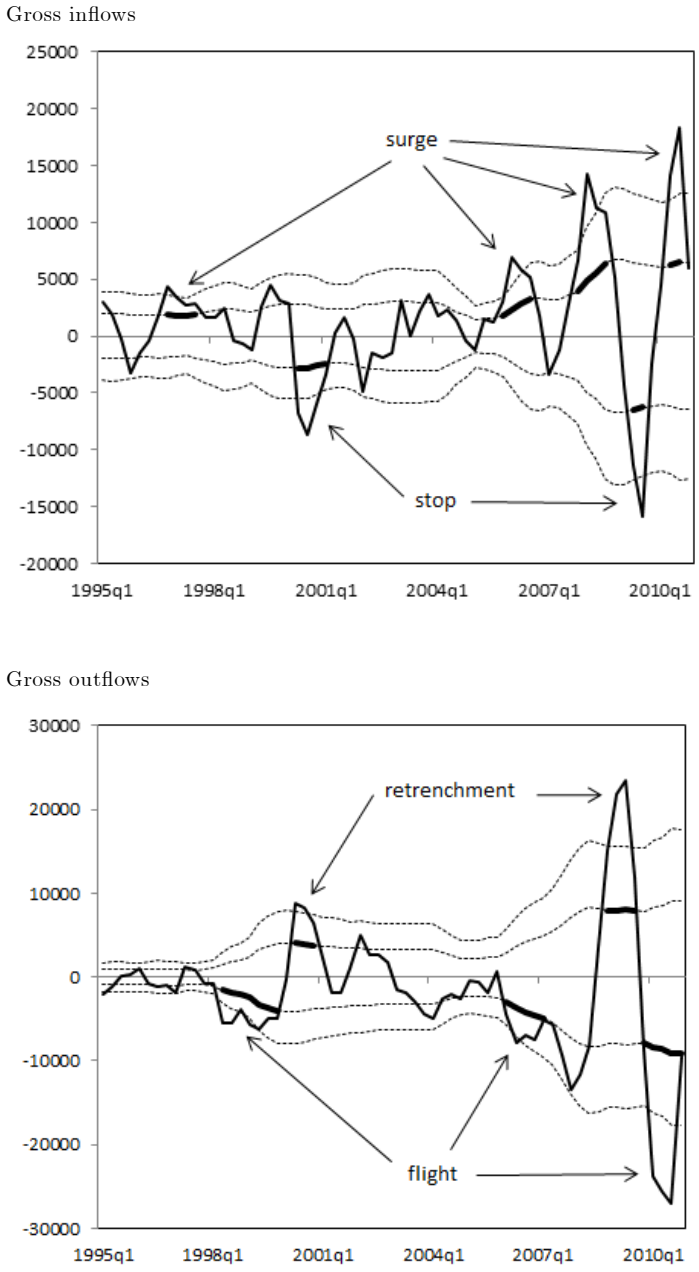
Table 9: Determinants of the magnitud of compensation of surges

variables	(1)	(2)	(3)	(4)
GDP per capita	0.1659***	0.1920***	0.2087***	0.2486***
	(0.0633)	(0.0637)	(0.0662)	(0.0671)
VIX (in logs)	0.3437***	0.3350***	0.3500***	0.3414***
	(0.0608)	(0.0605)	(0.0606)	(0.0601)
GDP growth shock	-0.7027	-0.6867	-1.0765	-1.1414
	(1.1875)	(1.1801)	(1.1961)	(1.1858)
Stock of foreign assets (% of GDP)	-0.0661	-0.1035	-0.0342	-0.0707
	(0.0734)	(0.0745)	(0.0747)	(0.0751)
Capital account openness (difference w.r.t. mean)		-0.0900**		-0.1050***
		(0.0361)		(0.0363)
Exchange rate regime (difference w.r.t mean)			-0.0851**	-0.1041**
			(0.0406)	(0.0408)
Constant	-1.9263***	-2.1363***	-2.3275***	-2.6620***
	(0.5887)	(0.5910)	(0.6167)	(0.6222)
R-squared	0.085	0.099	0.095	0.113
Observations	457	457	457	457
Number of ifs_code	39	39	39	39

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

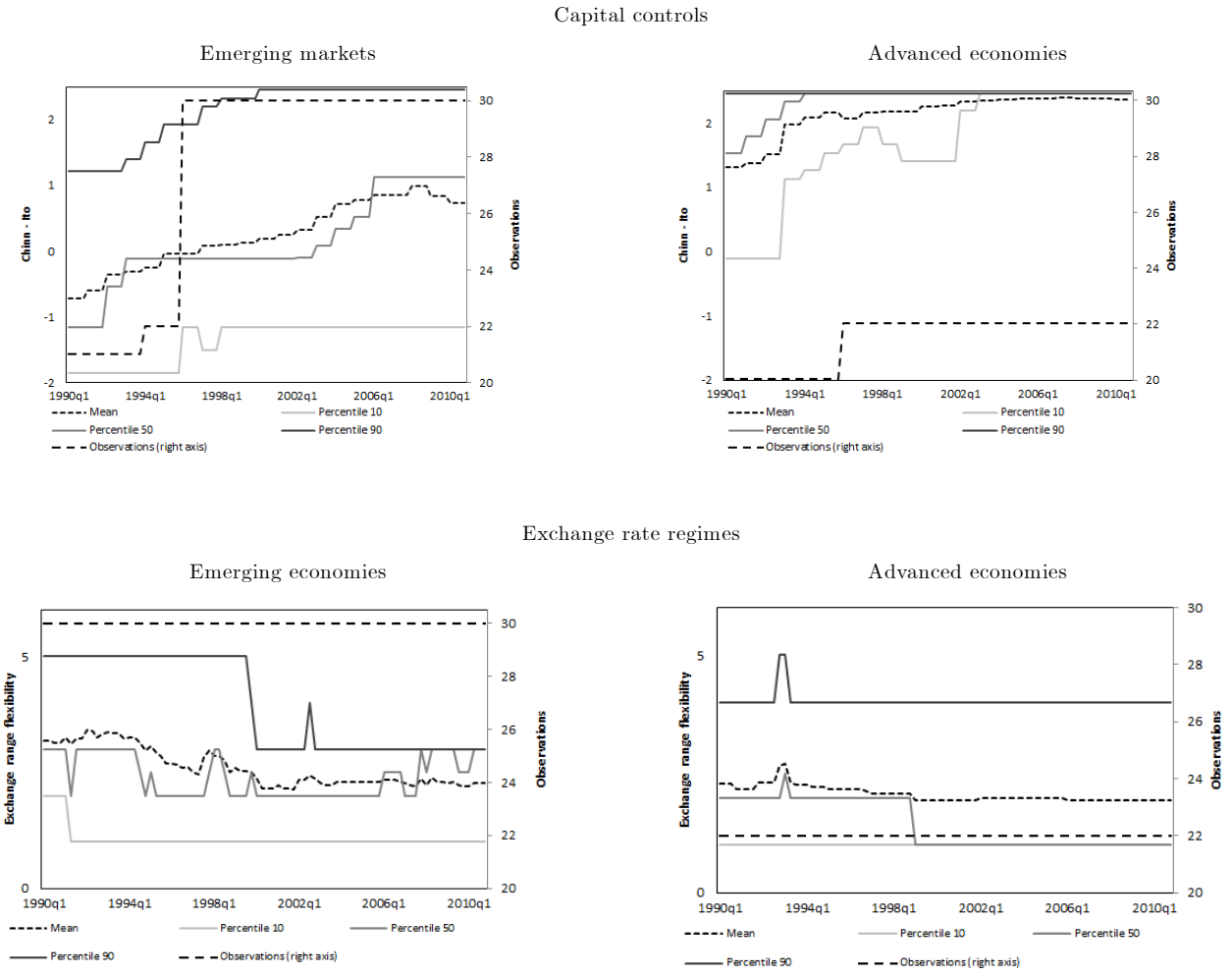
Note: Includes all countries that have experienced join events over the sample period.
Source: Authors' calculations.

Figure 1: Chile: extreme events in gross capital inflows and outflows



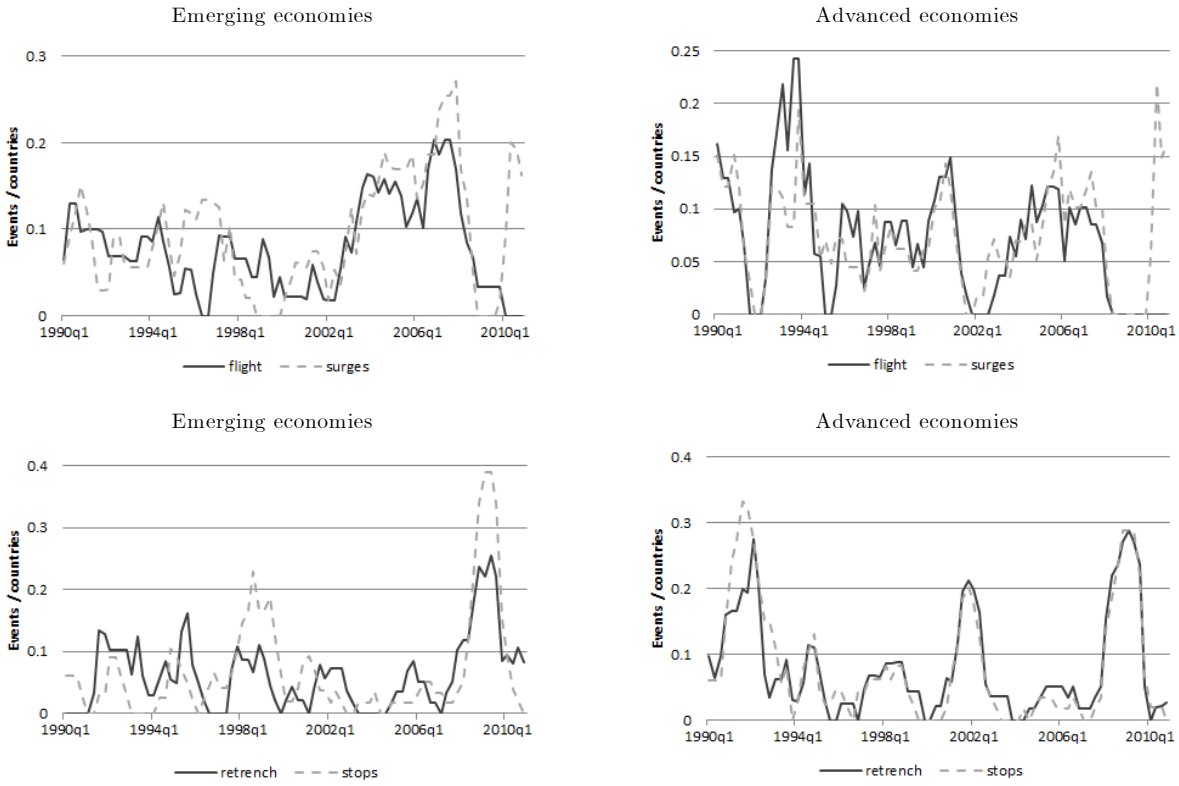
Note: Solid lines represent the four quarter change of annualized gross inflows and gross outflows, while dash lines represent one and two standard deviations of the five-years rolling window of these changes. Finally, the darker lines identify different waves of successive events (surge, stops, retrenchments, and flights). For more details see the definition of events in the text.
Source: Authors' calculations.

Figure 2: Capital account openness and exchange rate regimes by type of economy



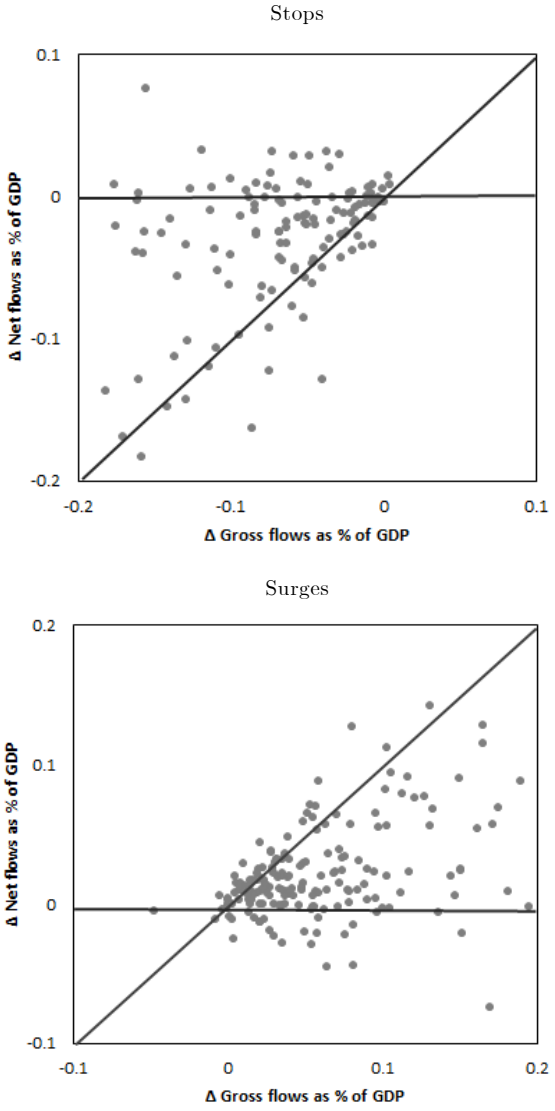
Source: Authors' calculations based on Chinn and Ito (2008) and Reinhart and Rogoff (2004).

Figure 3: Frequency of events by type of countries



Note: Number of events over the number of observations during the sample period.
Source: Authors' calculations.

Figure 4: Net flows versus gross inflows: stops and surges



Note: Each graph shows the level of net flows and gross inflows as percentage of GDP when a country experience a gross a stop and a surge in gross inflows respectively.
Source: Authors' calculations.

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