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Mouhamadou Sy. Exchange Rate Regimes, Capital Controls and the Pattern of Speculative Capital Flows. 2012. halshs-00684591

**HAL Id: halshs-00684591**

**<https://shs.hal.science/halshs-00684591>**

Preprint submitted on 2 Apr 2012

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**PARIS SCHOOL OF ECONOMICS**  
ÉCOLE D'ÉCONOMIE DE PARIS

**WORKING PAPER N° 2012 – 15**

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**JEL Codes: F31, F32, F41**

**Keywords: Short-term Capital Flows ; Exchange Rate Regimes ; Financial  
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# Exchange Rate Regimes, Capital Controls and the Pattern of Speculative Capital Flows \*

Mouhamadou Sy <sup>†</sup>

April 2012

## Abstract

*This paper proposes theoretical and empirical analysis of the effect of capital controls and alternative exchange rate regimes on the patterns of speculative capital. I argue that the exchange rate regime and its interaction with the monetary regime can explain the patterns of speculative capital around the world. I show that speculative capitals are more likely to flow into countries in which there is a contradiction between the monetary and the exchange regimes, e.g. more likely in countries with managed exchange rates. I model exchange-rate as a jump process in a stochastic dynamic portfolio optimization. Through this approach, the influence of the frequency and the size of “jumps” in the exchange rate on the allocation of speculative capital can be determined. It will also allow inflows to be endogenous. By linking the jumps to the frequency of exchange rate movements, this paper determines the effectiveness of different exchange rate regimes in fending off “hot money” for a given monetary regime. On the empirical side, I use a newly constructed data set to verify the theoretical predictions of the determinants and the patterns of speculative capital. Capital controls do not affect speculative capital.*

**JEL classification:** F31, F32, F41

**Keywords:** Short-Term Capital Flows, Exchange Rate Regimes, Financial Openness

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\*I wish to thank Daniel Cohen, Salifou Issoufou, Mathias Lé, Richard Portes, Romain Rancière, and Hamidreza Tabarraei for helpful comments. Special thanks to Gian Maria Milesi-Ferretti for his helpful advices on the construction of the data and to Gregor Schwerhoff for helpful discussions. The usual disclaimer applies.

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# 1 Introduction

*"Since the adoption of this regime, the nature of capital flows to Mexico has shifted from mainly short-term to long-term in nature. To give you an idea, before the crisis of 1990 to 1994, foreigners had over \$34 billion in short-term investments in Mexico. As of today, they have less than \$2 billion. That reduction can be attributed to the floating exchange-rate regime." Agustin G. Carstens (1998)<sup>a</sup>*

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<sup>a</sup>Governor of Central Bank of Mexico

The above quote highlights the fact that between 1994 and 1998, the amount of short-term capital inflows to Mexico was divided by seventeen because of the exchange rate flexibility. This paper tries to rationalize this theoretically, empirically and look beyond Mexico.

The 1990s is still generally called the lost decade for some emerging countries, particularly Asian countries. The financial turmoils in Mexico (1995), Korea, Indonesia, and Thailand (1997), Russia (1998), and Brazil (1999) were mainly due to foreign capital flight. As noted by [Rodrik and Velasco \(1999\)](#), all these countries had one thing in common: a *large level of short-term foreign debt*. [Komulainen and Lukkarila \(2003\)](#) and others found that foreign direct investment reduces the likelihood of financial crises, whereas short-term capital flows increase it. In retrospect the *"key question is therefore why do some economies at certain time receive much more short-term flows?"* [Hoggarth and Sterne \(1997\)](#). This paper attempts to provide the answers to this question by examining the role of capital controls and exchange rate regimes from a short term perspective on the distribution of speculative capital worldwide both theoretically and empirically. In this paper, I adopt the definition of speculative capital given by [Kant \(1996\)](#): *"Money that responds quickly to political or financial crisis, to expectations of tighter capital controls or the devaluation of the domestic currency, or to changes in after-tax real return"*. With this definition of speculative capital flows, I can approximate it by short-term capital flows.

The main characteristic of short-term capital inflows is their dependence on short-term interest rates, thus it also depends on monetary policy when it is used to fight inflation. In other words, short-term capital inflows must be a result of speculators' positions taking advantage of heterogeneity in monetary regimes across different countries. But, nowadays, many countries conduct *"active monetary policies"* which consist of fighting inflation through changes in their nominal interest rates, e.g. when inflation increases, countries choose to fight inflation by raising their nominal interest rates. This paper argues that even if monetary regimes become more and more homogeneous across countries, huge differences between their exchange rate regimes can explain the pattern of speculative capital inflows. I build

a portfolio balance model which takes into account these differences in the exchange rate regimes. In a stochastic dynamic optimization framework, inflation is a diffusion process and exchange rate adjustment a jump process. This framework focuses, in particular, on the uncovered interest rate parity condition (UIP). Since a violation of UIP allows for arbitrage profits, it is traditionally assumed to hold at all times. Empirical researches such as [Chinn \(2006\)](#) show, however, that deviations do occur. For reasons such as exchange rates forecasting errors ([Campbell-Pownall et al. \(2007\)](#)), UIP does not always hold in the short term. The model allows for temporary deviations from UIP and thus identifies, among other factors, the role of exchange rate regime and the frequency of exchange rate adjustments on speculative capital<sup>1</sup>.

The influence of monetary policy on exchange rates is an important pillar of this mechanism. This literature starts with [Dornbusch \(1976\)](#). [Obstfeld and Rogoff \(1984\)](#) finds that the Mussa and Barro-Grossman rules yield structurally equivalent exchange rate models. Unexpected currency depreciations are explained as a result of a surprise inflation policy by the central bank in [Penati and Pennacchi \(1989\)](#). Finally, there are more technical strands on portfolio management. The first consists of technical treatments for the solution of the stochastic dynamic optimization. The seminal contribution of this sort is [Merton \(1992\)](#). The second concerns the importance of skewness – unexpected jumps – in returns on asset prices such as [Harvey and Siddique \(2000\)](#) and [Martinez and Nava \(2010\)](#). I model the link between the monetary regime and the exchange rate regime in a simple way: by making the unexpected size of the currency depreciations endogenous to the inflation rate and to the frequency of devaluations.

The existing empirical literature, [Montiel and Reinhart \(1999\)](#), [Ariyoshi et al. \(2000\)](#), [Kamil and Clements \(2009\)](#), and others focused mainly on the role of capital controls. Most of the studies reached the conclusion that capital controls do not play an important role in fending off hot money and do not give another channel through which speculative capital inflows can be avoided. The empirical part of this paper is in line with this literature, it shows that capital controls do not affect short-term capital inflows. It also shows that managed exchange rates are more likely to attract these types of capitals compared to flexible exchange rates. The central message of this paper is that if the primary objective of policymakers is to fend off “hot money”, moving from a pegged exchange rate to a flexible exchange rate is more efficient than imposing controls on inflows.

This paper is also linked to [Levy-Yeyati and Sturzenegger \(2003\)](#). They studied the rela-

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<sup>1</sup>Throughout the paper, I will not consider sterilization operation in order to manage capital inflows since it requires widening the interest differential between the domestic and the international interest rates. This is more likely to attract more short-term capital inflows than to prevent them

tionship between exchange rate regimes and economic growth and showed that less flexible exchange rate regimes are associated with slower growth. But [Levy-Yeyati and Sturzenegger \(2003\)](#) did not give the insights – the channels – through which countries with a more flexible exchange rate regimes grow faster than countries with less flexible exchange rate regimes <sup>1</sup>. This paper shows that short-term capital are more likely to flow in countries with pegged exchange rate regimes which implicitly means that countries with flexible exchange rate regimes attract long-term capital inflows which can affect economic growth positively (see [Eichengreen et al. \(2011\)](#)). In other words, this paper may give the channel between exchange rate regimes, long-term capital inflows and economic growth.

To my limited knowledge, this is the first paper which investigates the geography of speculative capital flows. [Rodrik and Velasco \(1999\)](#) studied the determinants of short-term capital flows but focused on one form of capital: short-term external debt. Moreover, they did not distinguish the difference between gross and net capital flows and they did not consider the role of capital controls or the nature of the exchange rate regimes in their analysis. They identified the share of money supply over gross domestic product as the main determinant of short-term external debt. In this paper, I focus on gross rather than net capital inflows. The reason is that recent literature ([Gourinchas and Rey \(2007a\)](#) and [Forbes and Warnock \(2011\)](#)) highlights the importance of gross capital inflows that measure positions. This may help us to better understand the abrupt movements in capital inflows. Recently [Gourinchas \(2012\)](#) highlights that to understand vulnerabilities it is necessary to focus on gross capital inflows. He also highlights that the measure of short-term liabilities should be more broader than the standard measure of short-term external debt as in [Rodrik and Velasco \(1999\)](#) and should include bank lending and money funds.

Empirically, I use an innovative data set on speculative capital to take into account these issues and to determine the influence of the theoretically identified factors on speculative capital.

The remainder of this paper is organized as follows. Section 2.2 describes the data and gives descriptive statistics on the pattern of short-term capital inflows. The third section shows a simple model which describes the mechanism, while section 4 examines the determinants and the pattern of short-term capital using a new dataset. The last section 5 concludes.

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<sup>1</sup>As [Levy-Yeyati and Sturzenegger \(2003\)](#) acknowledge, their “*paper opens more questions than it answers.*”

## 2 Data and Stylized Facts

### 2.1 Description of the Data

To document worldwide patterns of speculative capital flows, I have gathered a comprehensive data set on capital flows by distinguishing short-term from long-term inflows, and gross inflows from net inflows. The sample covers annual observations of 70 countries from 1980 to 2009. The sample is mainly dictated by the availability of the variable of interest: short-term capital inflows. Except for this variable, the remaining variables mainly stem from the World Development Indicators (WDI, World Bank). They are commonly used variables and are well described in macroeconomic literature. Therefore, I devote more time describing the short-term capital inflows.

**Capital inflows:** There is no data on international gross capital flows by maturities. In order to document the pattern of short term capital flows, several choices were made while gathering data. To distinguish between short-term capital flows and long-term capital flows, I use the Balance of Payments Statistics (BOPS) of the International Monetary Fund (IMF). The BOPS is divided into the three categories: Foreign direct investment (FDI), Portfolio investment, and the Other investments. Each category is divided between *assets* and *liabilities*. I consider FDI as a long term investment since it is “an investment involving a long-term relationship and reflecting a lasting interest and control of a resident entity in one economy” according to the United Nations *World Investment Report* (UNCAD, 1999). In the BOPS, FDI assets are called “foreign direct investment abroad” and liabilities are called “foreign direct investment in reporting economy”. Even if Portfolio investment could be considered as short-term investment, some Portfolio investments can have long term motive. Therefore, for this study, I did not consider Portfolio investments<sup>1</sup>. The third category which is Other investments, is mainly composed by trade credit, loans and, currency and deposits. The BOPS provides information on their maturities. Short-term investments are characterized by maturities less than one year while the others are long-term investment. In this paper, long-term capital flows are Foreign direct investment plus long-term flows from the category “Other investment” in the BOPS while short-term capital flows are short-term flows in the category “Other investment”. In the BOPS, all these categories, including assets and liabilities, are not aggregated. Consequently, all these categories result from an aggregation of sub-categories.

For the reasons highlighted in the introduction, I am interested in gross capital inflows by

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<sup>1</sup>As a supplement of this study, the reader can see [Lane and Milesi-Ferretti \(2008\)](#) “International Investment Patterns” which focused exclusively on portfolio equity holdings across countries

foreigners in this paper. But the balance of payments statistics report assets and liabilities in net terms so they can be negative or positive, which is a challenge when trying to give gross capital inflows a value. For example, an increase on the liabilities side vis-à-vis non-residents is entered as positive value while a decrease is a negative value. Therefore, the negative values of liabilities can be considered as capital outflows while negative values of assets can be considered as capital inflows. Thus, I compute gross capital inflows – short and long – using the following methodology:

$$\text{Gross Capital Inflows} = \max(\text{Liabilities}, 0) - \min(\text{Assets}, 0)$$

I compile datasets from 1980 to 2009 for 160 countries using this methodology. I follow [Broner et al. \(2010\)](#) by dropping very small or very poor countries. Small countries are deleted because “they might display an artificially high volume of financial transactions due to their role as offshore financial centers or tax havens” and poor countries are deleted because they “generally depend heavily on official aid flows that behave differently than private capital flows”. Small countries had a gross national income (GNI) in 2005 that was less than four billion U.S. dollars PPP adjusted, while poor countries had a GNI per capita smaller than 2,000 U.S. dollars PPP adjusted. I ended up with 90 countries after applying this elimination method.

There are some countries with large amount of missing data in the BOPS. All countries that do not have at least 20 consecutive observations for capital inflows are dropped. This eliminates another 20 countries and we are finally left with a sample of 70 countries that have useful annual data. See table 7 for the list of countries included in the final sample.

**Capital controls:** The measure of capital controls is based on [Chinn and Ito \(2002\)](#). The index depends on four variables: restrictions on the current account, restrictions on the financial account, if the country has multiple exchange rates or not, and if there is a requirement to surrender export receipts. The index is the principal component analysis factor of these three variables.

**Exchange rate regimes:** The exchange rate regime classification is based on [Levy-Yeyati and Sturzenegger \(2003\)](#). They use a *de facto* classification of exchange rate regimes based on cluster analysis techniques. Countries are sorted according to three variables: (i) Exchange rate volatility, (ii) Volatility of exchange rate changes, and (iii) Volatility of reserves. They are classified into three categories: 1 = float; 2 = intermediate and 3 = fixed.



**Quality of institutions:** The Political Rights Index of the NGO Freedom House is used as a proxy for the quality of institutions. A country with the highest score adheres to political rights that are close to certain ideals (free and fair elections, competitive parties, minorities have reasonable self government, etc.). I transform this index via a logistic transformation to the interval between zero and one, where one is the best possible score for quality of institutions.

**Other variables:** The remaining variables are taken from the World Development Indicators (WDI) of the World Bank for September 2010. The inflation rate is in the form of annual log differences of the consumer price index. Money and quasi money is the total money supply. Real GDP growth and population size are also taken from the WDI. The nominal interest, defined as the average of the deposit interest rate and the lending interest rate come from also to the WDI.

## 2.2 Stylized Facts

Prior to a formal model or a formal econometric analysis, let us compute some basic descriptive statistics. Table 1 shows, in billions of dollars, the average amount of short-term capital inflows across exchange rate regimes during the last three decades. For each decade, I compute the average amount of short-term capital inflows conditional on the nature of the exchange rate regimes, e.g. peg, intermediate, or flexible. Note that for calculating the average speculative capital, each country is weighted by the country's GDP, PPP adjusted. A simple comparison of the values in the table across line anticipates the main results of the paper. These figures clearly show that there is a lot of heterogeneity in short-term capital across exchange rate regimes and the message is very clear: the more the exchange rate is flexible, the lower the amount of short-term capital inflows.

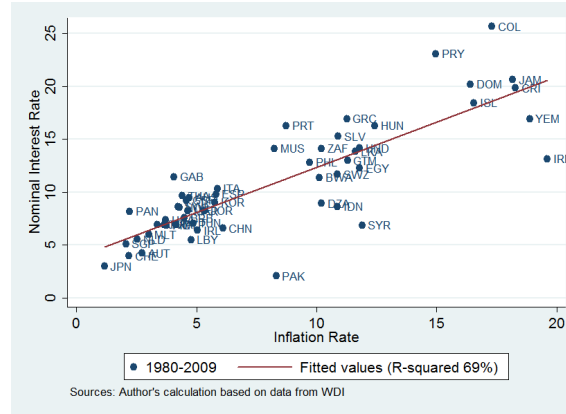
Table 1: Short-Term Capital Inflows across Exchange Rate Regimes

Short-Term Capital Inflows in billions of \$	Exchange Rate Regimes		
	Hard Peg	Intermediate	Flexible
1980s	15.78	14.01	1.30
1990s	62.65	30.48	22.72
2000s	93.07	49.20	14.21

Sources: Balance Of Payments Statistics (BOPS) and author's calculation. 1980-2009

How can these differences across exchange rate regimes be explained? As I highlighted

in the introduction, the main characteristic of short-term capital inflows is their dependence on nominal short-term interest rates set by monetary policies. However, diverging nominal short-term interest rates across countries reflects only diverging inflation rates across countries since countries with constantly higher long-term inflation rates have steadily higher nominal interest rates, e.g. inflation differentials explain most of the nominal interest rate differentials, see figure 1. The correlation between the two variables is equal to 83% in the sample.



**Figure 1: Nominal Interest Rate vs Inflation Rate**

*Notes:* The y-axis is the average between the lending and the deposit rates between 1980 and 2009. The x-axis is inflation rate between 1980 and 2009. The variables are defined in section 2.1.  
*Sources:* World Development Indicators (WDI) and author's calculation.

In other words, short-term capital inflows are driven mainly by inflation rates. Why then, are these differences between exchange rate regimes as shown in table 1? The answer is that the higher level of inflation attracts short-term capital inflows only in the absence of exchange rate risk, e.g. only if the exchange rate is pegged. In this case, the value of the exchange rate is stable and foreign investors lower the risk of potential losses because there are rare adjustments. Indeed, this is what I found in the data, see figure 2.



as given the monetary policy<sup>1</sup>, I model the fact that speculative capital inflows is possible only if the government moves from a pure to a hybrid monetary regime, which can help to explain table 1 and figure 2.

The model that takes into account capital controls, the monetary regime, and the frequency of the exchange rate adjustment is a little technical because it uses a stochastic calculus. Before I present it, I will show a simple two period model which provides insights for the general and more realistic model.

### 3.1 A Model in Two Periods

Before considering a fully dynamic model in section 3.2, I first illustrate the main mechanism in a very simple two period model. The main research question remains the same: why do some countries receive much more speculative capital inflows than others? The objective is to determine the international distribution of speculative capital. I therefore consider an investor with two different investment alternatives, one of them being a speculative investment. Even in this simple framework, we can see how policy choices such as the exchange rate regime, capital controls and macroeconomic characteristics such as inflation, influence a country's attractiveness to speculators. In this case, I use a portfolio balance approach to model speculative capital flows since they are easily reversible compared to foreign direct investment. I use long-term capital flows as a given in this model because I'm only focusing on short-term capital inflows.

#### 3.1.1 Wealth and Utility

I model an international investor with initial wealth  $W_0$  who maximizes expected utility from wealth in period 1. He has two investment projects to distribute his wealth. A long-term project ( $L$ ) and a short-term project ( $S$ ).

$$W_0 = S + L \quad (1)$$

The share invested in the two projects are noted by

$$\omega = \frac{L}{W_0} \quad \text{and} \quad (1 - \omega) = \frac{S}{W_0} \quad (2)$$

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<sup>1</sup>Contrary to a currency board or a dollarization, there is room for monetary policy under an adjustable peg. For example, China raised its interest rates for the fifth time by 25 basis points basis on July 7, 2011 in order to fight inflation. While having a pegged exchange rate vis-à-vis United States.

The long term project is not risky and pays a return  $r_{rf}$ . The return on the speculative project is noted  $r_{spec}$  and will be detailed in section 3.1.2. Wealth in the next period will therefore be

$$\begin{aligned} W_1 &= r_{rf}L + r_{spec}S \\ &= r_{rf}\omega W_0 + r_{spec}(1 - \omega)W_0 \\ &= (\omega r_{rf} + (1 - \omega)r_{spec})W_0 . \end{aligned} \tag{3}$$

The investor thus maximizes

$$\max_{\omega} E(U(W_1)) \tag{4}$$

in which utility is assumed to be logarithmic.

### 3.1.2 Return on Speculation in Two Periods

I start with a short illustration using two periods and later generalize in the continuous case. A speculator living in home country  $H$  and investing in the foreign country  $F$  gets the following return  $r_{spec}$  from investing a dollar abroad:

$$r_{spec} = R_F + g_s - \pi_H. \tag{5}$$

$R_F$  is the foreign nominal interest rate.  $g_s$  is the change in the exchange rate that the investor has to take into account since he has to convert his own currency into the foreign currency in period 0 and back in period 1. Due to home inflation, the home investor loses  $\pi_H$ .

For a quick experiment, I plug  $g_s$  in two extreme scenarios: fully fixed and fully flexible exchange rates in the foreign country (the home country is assumed to have flexible exchange rates in both cases). I then return to the general scenario, which uses the extreme scenarios as limiting cases.

If the currency and the good markets could function as a perfect market, the change in the exchange rate would equals the difference between home inflation  $\pi_H$  and foreign inflation  $\pi_F$ . This is the relative purchasing power parity (RPPP):

$$g_s^{flex} = \pi_H - \pi_F. \tag{6}$$

in which I denote the variables under a perfectly flexible exchange rate with the index  $^{flex}$ .

Substituting this into (5) we see that the speculator investing abroad earns exactly the *real*

interest rate of the foreign country:

$$\begin{aligned} r_{spec}^{flex} &= R_F + (\pi_H - \pi_F) - \pi_H \\ &= R_F - \pi_F = r_F \end{aligned} \quad (7)$$

This means that foreign investors simply earn the real interest rate of the foreign country, because the perfectly flexible exchange rate takes away all exchange rate risk. This case is illustrated in figure 2b: under a pure flexible exchange rate regime, equation (7) says that there is no relationship between short-term capital inflows ( $r_{spec}^{flex}$ ) and foreign inflation ( $\pi_F$ ), e.g.  $\text{correlation}(r_{spec}^{flex}, \pi_F) = 0$ . Indeed in the data, see figure 2b, this correlation is equal to zero.

Now, let us assume that the foreign country fully pegs its currency to that of the home country, a scenario we denote with  $^{peg}$ . Then the exchange rate remains constant

$$g_s^{peg} = 0. \quad (8)$$

Substituting this into (5) we obtain

$$\begin{aligned} r_{spec}^{peg} &= R_F - \pi_H \\ &= r_F + (\pi_F - \pi_H) \end{aligned} \quad (9)$$

In this case the investor earns a nominal interest rate from abroad minus home inflation and therefore benefits from a high inflation abroad. In other words, under a pegged exchange rate, any positive inflation differential with respect to the anchor country is beneficial to investors. This case is illustrated by the figure 2a: under a hard peg exchange rate regime, equation (9) says that there is a positive relationship between short-term capital inflows ( $r_{spec}^{peg}$ ) and foreign inflation ( $\pi_F$ ), e.g.  $\text{correlation}(r_{spec}^{peg}, \pi_F) > 0$ . Indeed in the data, see figure 2a, this correlation is equal to 44.35%. <sup>1</sup>.

Let's assume that the foreign country in principle wants to keep the exchange rate pegged. But once in a while it is forced to adjust the exchange rate by the difference in inflation rates. The speculator knows that eventually the exchange rate will adjust, but cannot anticipate exactly when the government chooses to do so. He therefore attaches a probability  $\rho$  to the event of an adjustment occurring. This feature of occasional exchange rate adjustments is based on the empirical literature concerning the uncovered interest rate parity (cf. [Alexius](#)

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<sup>1</sup>But if the peg is *credible* then  $\pi_F = \pi_H$  and so  $r_{spec}^{flex} = r_{spec}^{peg} = r_F$ , see [Barro and Gordon \(1983\)](#).

(2001), Chinn (2006), and Campbell-Pownall et al. (2007) ), which says that there are deviations from UIP in the short run, but that it holds in the long run.

In this scenario, the expected return to speculation becomes a weighted average of the two limiting cases in (7) and (9):

$$\begin{aligned} r_{spec} &= (1 - \rho)r_{spec}^{peg} + \rho r_{spec}^{flex} \\ &= R_F - \pi_H + \rho(\pi_H - \pi_F) \end{aligned}$$

$\rho$  can also be interpreted as the exchange rate regime of the foreign government. A flexible exchange rate is indicated by  $\rho = 1$ . As adjustments become every more rare,  $\rho$  decreases and finally reaches a fixed exchange rate with  $\rho = 0$ . The link between  $\rho$  and the expected return to speculation can be summarized as follow:

$$\{\rho, r_{spec}\} \begin{cases} \rho = 1 & \text{if fully flexible exchange rate} & \Rightarrow r_{spec} = r_F \\ \rho = 0 & \text{if fully pegged exchange rate} & \Rightarrow r_{spec} = r_F + (\pi_F - \pi_H) \\ 0 < \rho < 1 & \text{if adjustable peg exchange rate} & \Rightarrow r_{spec} = r_F + (\pi_F - \pi_H)(1 - \rho) \end{cases}$$

Wealth in period 1 is with probability  $1 - \rho$  equal to

$$W_1^{peg} = \omega r_{rf} + (1 - \omega)(R_F - \pi_H)$$

and with probability  $\rho$ :

$$W_1^{flex} = \omega r_{rf} + (1 - \omega)(R_F - \pi_F) .$$

Normalizing  $W_0 = 1$  and substituting (7) and (9) into (3) we obtain for expected utility:

$$\begin{aligned} E[U(W_1)] &= (1 - \rho) \log(W_1^{peg}) + \rho \log(W_1^{flex}) \\ &= (1 - \rho) \log(\omega r_{rf} + (1 - \omega)(R_F - \pi_H)) + \rho \log(\omega r_{rf} + (1 - \omega)(R_F - \pi_F)) \end{aligned} \quad (10)$$

### 3.1.3 Results in Two Periods

By maximizing the expected utility, it is possible to determine how the parameters affect the allocation of international investors between short-term and long-term capital flows:

**Proposition 1 (Discrete time)** *If inflation in the foreign country is higher than inflation in the home country and that the real foreign interest rate is lower than the safe asset then:*

*The share of wealth invested in short-term capital  $(1 - \omega)$  will depend*

(i) positively on foreign inflation  $\pi_F$

(ii) negatively on the degree on the exchange rate flexibility  $\rho$

**Proof** See appendix 1' □

A higher foreign inflation increases the profits of the speculator in fear of no devaluation. This increases the overall attractiveness for the speculator. Since a devaluation decreases the speculator's profits, an increase in the probability of this event reduces speculative investments. A very flexible exchange rate is characterized by a large probability for a devaluation, so  $\rho$  is close to 1. In this case, arbitrage profits are minimal. However, a peg that is certain of not experiencing a devaluation, that is,  $\rho = 0$ , allows speculators to earn arbitrage profits from high foreign inflation since it *drives up* the nominal interest rate abroad and the profits made abroad can be converted back using the same exchange rate used when the investment was made.

### 3.2 The Continuous Time Model

A continuous time framework is necessary since in practice all these variables are dynamic. The continuous time allows also to introduce more “ingredients” in the previous model. This section extends the analysis from section 3.1 and includes it in a dynamic framework. Based on the work from the two periods already studied, we can analyze to what degree it is affected by the dynamic structure.

In order to theoretically find the determinants for the distribution of speculative capital across countries, I use the point of view of an individual international investor. In the most basic form considered here, the investor can choose between a speculative investment abroad and a long-term investment project, which I call long-term capital flows (LCF). The speculative investment is subject to exchange rate changes since it must be moved twice across currency borders between countries with potentially very different inflation rates. The LCF project has a long-term horizon and its return is therefore less affected by inflation and exchange rates risks.

The profitability of speculation crucially depends on the interplay between the exchange rate and relative purchasing power parity (RPPP). If RPPP holds at all times (the exchange rate is perfectly flexible or the peg is perfectly credible<sup>1</sup>) then speculators could make no arbitrage profits between different currency zones and could ignore inflation differentials because they will not be able to exploit exchange rate regime heterogeneity across different countries. Motivated by empirical results, I modeled skewed deviations of the exchange rate by introducing

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<sup>1</sup>Or prices are not sticky (Dornbusch (1976)) but I abstract here from this last consideration



a jump process for the exchange rate in the target country of the investor. This also allows us to model the importance of skewness on the returns of portfolio choices.

The model is solved using stochastic dynamic optimization based on [Merton \(1969\)](#) and similar treatments of portfolio theory.

### 3.2.1 Wealth and Utility

I model an international investor with initial wealth  $W_0$  and utility function

$$U(W_t) = \log(W_t) \quad (11)$$

The objective function is thus

$$V_0 = E \left[ \int_0^\infty \log(W_t) e^{-\beta t} | I_0 \right] \quad (12)$$

where  $I_0$  is all available information at  $t = 0$  and  $\beta$  is the discount rate. He maximizes utility by allocating optimally between a speculative investment  $S_t$  and long term investment,  $L_t$ :

$$W_t = S_t + L_t \quad (13)$$

The investment shares into the two projects are noted by

$$\omega_t = \frac{L_t}{W_t} \quad (14)$$

$$(1 - \omega_t) = \frac{S_t}{W_t} \quad (15)$$

The return of the LCF project is noted  $\alpha$ :

$$\frac{d(lcf_t)}{lcf_t} = \alpha dt \quad (16)$$

In this basic form, the LCF project is equivalent to a risk-free rate<sup>1</sup>. It is modeled to be independent of inflation and exchange rates, so we can think of it as an investment in the home country of the investor, another member country of a currency union or another country

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<sup>1</sup>This paper focuses on the determinant of short-term capital inflows and abstract from the determinant of long-term flows so the process of the last capital is simply modeled. Another rationale of this hypothesis is that foreign direct investment is the main component of long-term capital inflows in the data presented earlier and the main determinants of FDI are the levels of financial development, the quality of institutions, property rights, productivity, etc. See [Antras et al. \(2009\)](#). These determinants make long-term capital more independent to short-term monetary policy. The long-term capital can include a broader type of assets. For this, the reader can see [Kraay et al. \(2005\)](#), [Alfaro et al. \(2007\)](#), [Gourinchas and Rey \(2007b\)](#) and [Lane and Milesi-Ferretti \(2007\)](#) which focused on long-term capital flows

with similarly low inflation.

In order to determine the return to the speculative investment, I calculate its profitability depending on the frequency of exchange rate adjustments:

### 3.2.2 Return to Speculation in Continuous Time

I generalize the previous illustration for a continuous time and I also introduce taxes on speculation. Without loss of generality, let us assume that the inflation rate in the home country is zero,  $\pi_H = 0$ . Second, assume that the foreign country uses the following exchange rate policy: it pegs the exchange rate for long times, but at random points devaluates the currency very quickly. Then, speculators will benefit from the foreign inflation as long as the exchange rate stays constant and also experience a sudden loss at times when the currency devaluates.

Given these two assumptions, the continuous time can be written the same as in equation (5) and individual terms specified as:

$$\frac{dR_t}{R_t} = \frac{dr_{Ft}}{r_{Ft}} + \pi_{Ft} + g_{st} \quad (17)$$

$$\frac{dr_{Ft}}{r_{Ft}} = (1 - \tau)r_0 dt + \sigma_0 dx_t \quad (18)$$

$$\pi_{Ft} = \varepsilon dt + \sigma dz_t \quad (19)$$

$$g_{st} = v dq_t. \quad (20)$$

The foreign real interest rate  $r_F$  is modeled as a deterministic interest rate  $r_0$  plus a random part.  $\sigma_0$  is the instantaneous volatility of the expected rate of return and  $x_t$  is a standard Wiener process. The deterministic rate can be reduced by the foreign government through a tax  $\tau \in [0, 1]$  on speculation in order to maintain an autonomy on monetary policy. The tax  $\tau$  on speculative investments represents the possibility of the foreign government to introduce capital controls. For  $\tau = 0$  speculative capital is unrestricted, while for  $\tau = 1$  it is effectively banned. This allows the foreign government to keep a fixed exchange rate, an autonomous monetary policy and yet restrict speculative capital, thus respecting the “impossible trinity” introduced by [Mundell \(1962\)](#) and [Mundell \(1963\)](#).

Similarly, inflation is given as a deterministic trend  $\varepsilon$  and zero-mean noise, where  $\sigma$  is volatility and  $z_t$  is a Wiener process. Without loss of generality, let normalize inflation in the home country to zero. In this case,  $\varepsilon$  is equivalent to the inflation differential in the two periods model ( $\pi_F - \pi_H$ ).  $dx_t$  and  $dz_t$  are temporally independent normally distributed random variables with  $E[dx_t] = E[dz_t] = 0$  and  $Var[dx_t] = Var[dz_t] = dt$ . The linear relationship

between the trend in the inflation process ( $\varepsilon$ ) and the nominal return ( $dR_t/R_t$ ) is clear thanks to figure 1. Furthermore, the relationship can be rationalized by using the standard linear Taylor rule in which the central bank focused only on inflation and not on output<sup>1</sup>.

Finally, the random devaluations by the foreign government are modeled as a Poisson process  $q_t$  with intensity  $\lambda$  and amplitude  $\nu$ . This type of modeling allows for the exchange rate to be endogenous and for investment strategies in speculative capital to be risky. The endogenous characteristics and the uncertainty of the exchange rate are a result of the random devaluations. The number of devaluations per unit of time is

$$Pr\{\text{one unit jump during } dt\} = Pr\{dq_t\} = \lambda dt + o(dt)$$

Combining equations (17) to (20), I obtain the following profit from speculation

$$\frac{dR_t}{R_t} = (1 - \tau)r_0 dt + \sigma_0 dx_t + \varepsilon dt + \sigma dz_t + \nu dq_t \quad (21)$$

The interest rate process and the exchange rate process will be linked through the uncovered interest parity condition. Concerning the size of the exchange rate adjustments, I can take guidance in the empirical literature on the uncovered interest rate parity (cf. [Alexius \(2001\)](#), [Chinn \(2006\)](#), and [Campbell-Pownall et al. \(2007\)](#)), which says that there are deviations from the UIP in the short run, but that it holds in the long run. More interestingly, [Campbell-Pownall et al. \(2007\)](#) provide the reasons for why the UIP condition does not hold in the short run but is validated in the long run. First, they show that deviations from the uncovered interest parity condition are mainly explained by exchange rates forecasting errors and not by the risk premium factor. They also found that in the long run, exchange rate forecasting errors decrease progressively. In other words, in the short run, deviations from the UIP condition are mainly driven by the exchange rate forecasting errors<sup>2</sup>. I formulate the long run condition as:

$$E\left(\frac{dR_t}{R_t}\right) = E\left(\frac{dr_F}{r_F}\right) \quad (22)$$

The expected return on a speculative investment equals the expected real interest rate in the target country. Using the property of the Poisson process with intensity  $\lambda$ ,  $E(dq_t) = \lambda$  and

<sup>1</sup>In the new Keynesian framework, this allow also to stabilize output. In other words, central banks can only focus on inflation management. This property is called *divine coincidence* by [Blanchard and Gali \(2007\)](#). But this is beyond the scope of this paper.

<sup>2</sup>This is why this paper abstracts from risk premia considerations since deviations from UIP are almost explained by forecasting errors of the exchange rates rather than the risk premia. In this model, I do not model these errors of forecasting but in the model the only sources of uncertainty are the "jump" and the "frequency" of the exchange rates adjustment. So we may think that the forecasting errors of the exchange rate come from these two sources of uncertainty.

the fact that the relative purchasing power parity holds when the change in the exchange rate equals the difference between home inflation (normalized to zero) and foreign inflation ( $\epsilon$ ), I can solve (22) for  $v$ :

$$v = \frac{\epsilon}{\lambda} \quad (23)$$

I define the size of the exchange rate adjustments as  $|v|$ , e.g. the absolute amount of the jump. Equation (23) makes the depreciations of the foreign currency endogenous since it depends (positively) on the inflation rate and (negatively) to the frequency of devaluations, which is consistent intuitively. This is a simple way to model the interaction between the exchange rate policy and the monetary policy. With this we can write the return to speculation as

$$\frac{dR_t}{R_t} = ((1 - \tau)r_0 + \epsilon)dt + \sigma_0 dx_t + \sigma dz_t + \frac{\epsilon}{\lambda} dq_t \quad (24)$$

This equation shows that as long as the government keeps its exchange rate fixed, speculators will make arbitrage profits and “earn the inflation rate” as an additional profit. But whenever the exchange rate adjusts to restore long-run equilibrium, speculators will experience sudden losses. See figures 2 and 3.

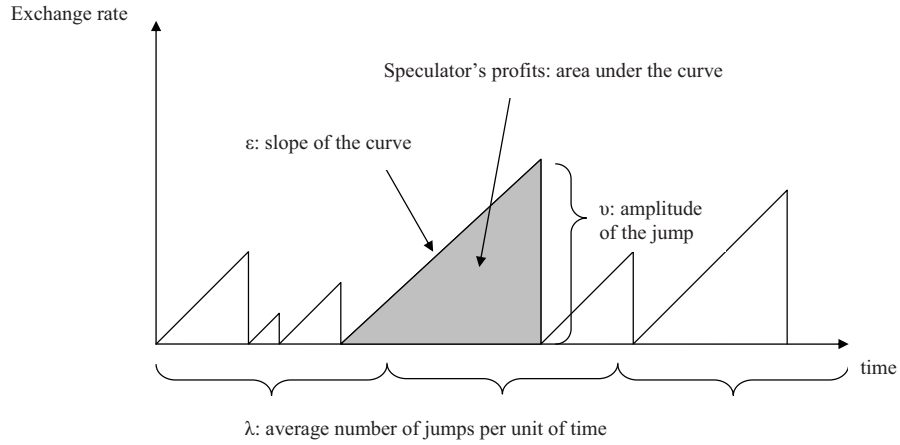


Figure 3: Illustration of the parameters describing speculative profits

Using (16) and (24), the evolution of wealth can be written as:

$$\begin{aligned} dW_t &= \omega_t \frac{dlc f_t}{f_t} W_t + (1 - \omega_t) \frac{dR_t}{R_t} W_t \Leftrightarrow \\ \frac{dW_t}{W_t} &= \omega_t \alpha dt + (1 - \omega_t) ((\epsilon + (1 - \tau)r_0)dt + \sigma dz_t + \sigma_0 dx_t + \frac{\epsilon}{\lambda} dq_t) \\ &= (\omega_t \alpha + (1 - \omega_t)(\epsilon + (1 - \tau)r_0))dt + (1 - \omega_t)(\sigma dz_t + \sigma_0 dx_t) + (1 - \omega_t) \frac{\epsilon}{\lambda} dq_t \end{aligned} \quad (25)$$

### 3.2.3 Results from Continuous Time

The first results concern the determinants of the investment shares. To obtain them, I solve the model with a Hamilton-Jacobi-Bellman equation. Since this is standard procedure and rather technical, the solution for this can be found as the proof of proposition 1' in the appendix.

**Proposition 1' (Continuous time)** *The share of capital invested in short-term capital  $(1 - \omega)$  depends:*

- (i) *positively on the average level of inflation  $\varepsilon$  in the target country*
- (ii) *negatively on the frequency of exchange rate adjustments  $\lambda$*

**Proof** See appendix 1' □

Part (i) means that since countries with steady higher long-term inflation rates have steadily higher nominal interest rates, a high level of inflation attracts speculator's capital even though the exchange rate is adjusted occasionally. In this model, this is the case because inflation pressures require a tighter monetary policy which for a given exchange rate, requires higher interest rates that in turn attract more short-term capital inflows.

Part (ii) links the number of exchange rate adjustments to inflows of speculative capital. Recall from equation (23) that the size of devaluating jumps  $\nu$  is *endogenously* determined. But the frequency of these jumps,  $\lambda$  is a *free choice* parameter belonging to the foreign government (cf. equation (20)). This policy instrument allows the government to control the amount of speculative capital without requiring restrictions on inflows. In the continuous time,  $\lambda$  *can be interpreted as the exchange rate regime of the foreign government*, so  $\lambda$  is equivalent to  $\rho$  in the discrete time. In the presence of short-term capital inflows, an increase in  $\lambda$  means a more flexible exchange rate which increases the risk for investors and therefore eliminates the "one-sided bet" that a less flexible exchange rate would provide, see figures 2a and 2b for empirical evidences.

From the perspective of the exchange rate regime, proposition 1' (ii) can be expressed as:

**Lemma 1** *The amount of short-term capital inflows is minimized by*

$$\operatorname{argmin}_{\lambda}(1 - \omega) = \infty$$

*maximized by*

$$\operatorname{argmax}_{\lambda}(1 - \omega) = 0 \quad .$$

In economic terms, a fully flexible exchange rate regime minimizes the inflow of speculative capital. A fully pegged exchange rate triggers large inflows of speculative capital. In between the amount of speculative capital inflows increases as the exchange rate regime becomes less flexible. A very flexible exchange rate is characterized by a large number of exchange rate adjustments ( $\lambda$  big), each adjustment being small ( $\nu$  small). In this case, arbitrage profits are minimal. In the limiting case ( $\lambda \rightarrow \infty$ ), there is a permanent adjustment and no arbitrage profits. However, peg that has rare and large exchange rate corrections ( $\lambda$  small,  $\nu$  big), allows speculators to earn arbitrage profits from high foreign inflation since it drives the foreign nominal interest rate up. This theoretical reasoning is empirically illustrated in figure 4. Australia and Malaysia's exchange rates with respect to the U.S. dollar are illustrated. Australia is characterized by continuous devaluations and therefore, the frequency of its exchange rate adjustments is high and as figure 4a shows, the size of each jump is small. For Malaysia, which has a pegged exchange rate, exchange rate adjustments are rare but when they do occur, they are large in size compared to continuous devaluations, see figure 4b. This is consistent with the peso problem hypothesis. Large nominal interest rate differentials are possible even though there is an absence of exchange rate changes. However, when these changes occur, they tend to be large because of the uncovered parity condition, equation 22.

Since it is a given that the exchange rate regime is a parameter choice for the government, why would the government want to choose anything other than a fully flexible exchange rate regime? The reason for this, is that governments' profit from fixed exchange rate because it could increase exports. This can potentially lead to a positive net profit since tax revenues from exporters exceed losses to foreign speculators. The details of this trade-off are however beyond the scope of the current model, so government policy will remain exogenous.

The exchange rate regime is not the only option for controlling speculative capital inflows, at least theoretically. Established by the theory of the "impossible trinity", a second option is of course capital controls. The following proposition highlights another government policy instrument. The tighter capital controls are, the lower the share invested.

**Proposition 2** *The share of capital invested in speculative investments ( $1 - \omega$ ) depends negatively on the tax on speculative capital ( $\tau$ )*

**Proof** See appendix 2 □

Speculative capital inflows imply a loss for the foreign government since it is the source for the speculator's arbitrage profits. In other words, taxing capital inflows allows the foreign government to reduce the share of speculative capital flows, e.g. to increase the share of long-term capital flows. In other words, capital inflows can affect the composition of aggregate

capital. This is really not a new idea. It was first proposed by [Tobin \(1978\)](#) in order to “throw sand in the wheels” of speculative capital. [Magud et al. \(2011\)](#) find similar theoretical results.

Similarly, we can identify the determinants of long-term investment, LCF:

**Lemma 2** *The share of capital invested in a long-term project ( $\omega$ ) depends positively on the return in the LCF target country ( $\alpha$ )*

Next, we consider the difference between a fully flexible exchange rate and a completely pegged exchange rate. The difference is characterized by  $\lambda$ , the frequency of jumps occurring in the Poisson process  $dq_t$ . If  $\lambda \rightarrow 0$ , the jump occurs more and more rarely and the size of the jump becomes bigger and bigger (recall that the size of the jump is  $\frac{\varepsilon}{\lambda}$ ). In the case of  $\lambda = 0$ , jumps never occur and the UIP never holds. If  $\lambda \rightarrow \infty$ , the jumps occur very frequently, but each jump is very small. For  $\lambda = \infty$ , the UIP will always hold. In all the intermediate cases  $- 0 < \lambda < \infty$  – the UIP will only hold at the moment of a jump but never in between. [Flood and Rose \(2002\)](#) empirically found that the UIP functions poorly in countries with a fixed rate regime. This model rationalizes Flood and Rose’s finding. The link between  $\lambda$ ,  $\nu$  and the UIP condition can be summarized as follow:

$$\{\lambda, \nu\} \begin{cases} \lambda = 0 & \Rightarrow \nu = \infty & \text{UIP never holds} \\ 0 < \lambda < \infty & \Rightarrow \nu = \frac{\varepsilon}{\lambda} & \text{UIP holds only at the moment of a jump} \\ \lambda = \infty & \Rightarrow \nu = 0 & \text{UIP will always hold} \end{cases}$$

**Proposition 3** *A country that keeps its exchange rate perfectly pegged ( $\lambda \rightarrow 0$ ) gives a speculative investor a premium equal to the inflation differential ( $\varepsilon$ ), compared to a country with a fully flexible exchange rate ( $\lambda \rightarrow \infty$ ).*

**Proof** See appendix 3 □

By formulating proposition 3 less technically, we can conclude that a country with a pegged exchange rate pays an extra interest rate to the speculators’ capital that is equal to its inflation rate. If the peg is fully credible, the inflation differential is zero and there is no premium for foreign investors. Proposition 3 highlights the difference between pure monetary regimes and hybrid monetary regimes. Under a pure monetary regime, speculators only earn the real interest rate. Under a hybrid monetary regime, speculators benefit from a real interest rate and from inflation differentials since the exchange rate is not flexible enough to offset this difference. In other words, since both regimes suppose that there is a one-to-one relationship between the nominal interest rates and the inflation rates of countries, *ceteris paribus*, cross-country differences in the exchange rate regimes can explain the differences in the pattern

of speculative capital inflows. Proposition 3 therefore rationalizes the findings in section 2.2: table 1 and figure 2. The empirical part seeks to test if the results hold under statistical inferences.

## 4 Estimation and Methodology

### 4.1 Predictions derived from the theoretical model

Through the different propositions and lemmas, this paper has shown that the main determinants of short-term capital inflows are: controls on inflows, nominal interest rate differentials between countries because of inflation differentials, and the nature of the exchange rate regimes. In return I have also shown that profits from inflation differentials depend on the exchange rate regimes. In other words, the model predicts that *ceteris paribus*, capital controls, inflation rates and exchange rate regimes should be the main determinant of short-term capital inflows. The dependent variable is defined as in the theoretical part:  $(1 - w_t) = S_t / W_t$  i.e. the share of short-term capital inflows over total capital inflows.

$$\frac{\text{Short-Term Capital}_{i,t}}{\text{Total Capital Inflows}_{i,t}} = \beta_0 + \beta_1 \text{Inflation}_{i,t} + \beta_2 \text{ERR}_{i,t} + \beta_3 \text{Capital Controls}_{i,t} + \beta' X_{i,t} + \mu_t + U_{i,t}$$

where  $i = 1, \dots, 70$  indexes for countries and  $t = 1, \dots, 28$  indexes the years (from 1980 to 2009). The dependent variable, the share of short term capital over total capital inflows is regressed on the inflation rate, capital account openness, and exchange rate dummies for hard peg and intermediate peg. The flexible regime is thus the reference. I intend to compare pegged and flexible exchange rate regimes. Another control variable is money supply, which allows me to take into account liquidity. Rodrik and Velasco (1999) and Komulainen and Lukkarila (2003) have shown that this variable is among the main determinants of short-term debt.

The above equation is estimated using different regression techniques to address the various short-comings of standard OLS. For example, to control for the potential endogeneity of inflation, this variable is instrumented by using its lagged values.

Since the goal of this paper is first and foremost to explain the geography of speculative capital inflows, I include the year fixed effect instead of the country fixed effects: the identification strategy relies on differences across countries within each year. The model predicts that  $\beta_1 > 0$ ,  $\beta_2 > 0$ , and  $\beta_3 < 0$ . In other words, speculative capital are more likely to flow into countries with high inflation, managed exchange rate regimes, and open financial account.



## 4.2 Estimation Results

Tables 2 and 3 are my baseline results and are presented in the following paragraph. Additional control variables and robustness checks follow in the following paragraph.

### 4.2.1 Main Results

Table 2 is the benchmark regression in which pegged and flexible exchange rate regimes are compared. The first column is an ordinary least square with the year fixed effect, while the third column presents general method of moment to deal with endogeneity. The regressions are performed for the full sample, and for both developed and developing countries. All variables have expected signs. Money supply which is the proxy of liquidity is positively linked to short term capital inflows. We now arrive at the variables of interest for our proposed model on the pattern of speculative capital inflows. As predicted by the model, higher inflation is associated to higher short-term capital inflows. Crucial for our theory, the regression for the full sample shows that countries with pegged exchange rate regimes received significantly higher short-term capital inflows than countries with flexible exchange rate regimes. A deeper analysis shows that this conclusion is valid for both developing and developed countries.

The former literature focused mainly on the role of capital controls on speculative capital. Of course, having a direct measure of capital controls is difficult. But we may get an idea of the countries' financial account restrictions by using the Chinn-Ito's index. We expected countries with more capital controls to receive less speculative capital inflows. By including this index (see table 3), it is found that it is indeed the case, but that the coefficient is not significant, which means that capital controls seem to play an insignificant role in fending off "hot money". The former literature reached the same conclusion <sup>1</sup>. Our novelty is to show that the nature of the exchange rate regimes is more effective. This conclusion does not depend on the choice of the sample. By comparing table 2 and table 3 we see that these results are valid for both developing and developed countries. The ineffectiveness of capital controls is theoretically documented by Gros (1987). Capital controls are ineffective because financial operators always find a way to get round controls in order to make the same transactions.

### 4.2.2 Robustness Check and Extension

**Robustness Check:** The results discussed above are broadly consistent with the main thesis of this paper, the fact that the nature of the exchange rate regimes is more important than

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<sup>1</sup>The exception is Magud et al. (2011). They showed theoretically conditions under which capital controls can work or not, their effectiveness depending mainly on country-specific characteristics

capital controls on the allocation of speculative capital inflows. This section seeks to check how robust this conclusion is and its level of sensitivity by adding more controls.

Table 4 and table 5 add more macroeconomic controls. The first variable is the quality of institutions. Alfaro et al. (2007) documented that the main determinant of long term capital flows is the quality of institutions. The regressions confirm this result. Speculative capital inflows and the quality of institutions are negatively correlated. The GDP growth rate is also added to take into account economic perspectives. Higher growth is associated with good/long-term perspectives that attract more long-term capital. As expected, speculative capital inflows and GDP growth are negatively correlated. Population is also added as a control for size. Countries with fixed exchange rate regimes are mainly small countries and hence attract more speculative capital. Indeed, the correlation between speculative capital inflows and population is negative.

If we compare table 4 and table 5 with table 2 and table 3, we see that even though the new variables carry the signs expected and have significance, they do not strongly affect the results of the benchmark regression. Quantitatively, they remain significant and carry the signs expected, and qualitatively the main conclusion holds: the nature of the exchange rate regime plays a role on the allocation of speculative capital inflows. Capital controls do not affect this allocation.

**Extension:** Through the theoretical and the empirical parts of this paper, I demonstrated that it is possible to explain the pattern of speculative capital inflows across the world. The main conclusion is that: speculative capital inflows are more likely to flow into countries with managed exchange rates, higher inflation rates, higher ratio of money supply over gross domestic product, poor quality of institutions, low gross domestic product growth, and low population size through its link with the nature of exchange rate regimes. In line with former literature, I also showed that capital controls do not affect speculative capital. To explain the geography of speculative capital, I did not exploit the time variation of the series. It is possible to move beyond cross country comparison by investigating *within-country variation*: is a country more likely to receive less speculative capital inflows when its exchange rate regime becomes relatively less pegged? This can be achieved only by introducing country fixed effect and year fixed effect. I began by creating a new classification of the exchange rate regime that combines the pegged dummy, the intermediate dummy, and the flexible dummy in one index. This new index takes a value of zero if for a given year in a given country, the exchange rate is pegged. It takes a value of one if for a given year in a given country, the exchange rate is an intermediated pegged. And it takes a value of two if for a given year in a given country,

the exchange rate is fully flexible. In other words, an increase in this index means that the exchange rate is becoming more flexible. The index is called “Exchange regime”.

The results are displayed in table 6. As we can see, all variables carry expected signs. When the within-country variation is exploited, all the variables continue to behave as predicted. The variable of interest, that is, the exchange rate regime index is negative and significant across all the specifications. This means that when a country moves relatively from a pegged to an intermediate regime, or from an intermediate to a flexible regime, this country will receive less speculative capital inflows.

## 5 Conclusion and Policy Implication

A large body of literature studied the causes and the consequences of the Asian financial crisis. As noted by [Rodrik and Velasco \(1999\)](#) all these countries had on thing in common: *large level of short-term foreign debt*. This paper studied a broader type of short-term capital inflows and focused on gross capital inflows rather than net capital inflows. I show that it is possible to explain the geography of short-term capital inflows. Although the previous literature had focused on capital controls, I demonstrated how important the nature of exchange rate regimes is and the link between the monetary regime and the exchange rate regime. The main policy implication of this paper is the following: if the only goal is to fend off “hot money”, as in Mexico in 1994, moving from a pegged exchange rate to a flexible exchange rate is more efficient than imposing controls on inflows. But adopting a flexible exchange rate can induce other costs and trade-offs between a pegged and a flexible exchange rate when fending off “hot money” is not the primary objective of the policy makers is open to future research.

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## A Appendix

### A.1 Proofs of the Different Propositions

#### Proof of Proposition 1'

The first order condition of (4) using (12) is

$$0 = (1 - \rho) \frac{r_{rf} - (R_F - \pi_H)}{(\omega r_{rf} + (1 - \omega)(R_F - \pi_H))} + \rho \frac{r_{rf} - (R_F - \pi_F)}{(\omega r_{rf} + (1 - \omega)(R_F - \pi_F))}$$

This is equivalent to  $M = 0$  with

$$M = (1 - \rho)[r_{rf} - (R_F - \pi_H)][\omega r_{rf} + (1 - \omega)(R_F - \pi_F)] + \rho[r_{rf} - (R_F - \pi_F)][\omega r_{rf} + (1 - \omega)(R_F - \pi_H)]$$

From this I get

$$\begin{aligned} \frac{\partial M}{\partial \omega} &= (1 - \rho)[r_{rf} - (R_F - \pi_H)][r_{rf} - (R_F - \pi_F)] + \rho[r_{rf} - (R_F - \pi_F)][r_{rf} - (R_F - \pi_H)] < 0 \\ \frac{\partial M}{\partial \rho} &= -[r_{rf} - (R_F - \pi_H)][\omega r_{rf} + (1 - \omega)(R_F - \pi_F)] + [r_{rf} - (R_F - \pi_F)][\omega r_{rf} + (1 - \omega)(R_F - \pi_H)] < 0 \\ \frac{\partial M}{\partial \pi_F} &= (1 - \rho)[r_{rf} - (R_F - \pi_H)][-(1 - \omega)] + \rho[(\omega r_{rf} + (1 - \omega)(R_F - \pi_H))] > 0 \end{aligned}$$

Applying the implicit function theorem we obtain

$$\frac{\partial \omega}{\partial \rho} = -\frac{\frac{\partial M}{\partial \omega}}{\frac{\partial M}{\partial \rho}} > 0 \quad \text{and} \quad \frac{\partial \omega}{\partial \pi_F} = -\frac{\frac{\partial M}{\partial \pi_F}}{\frac{\partial M}{\partial \rho}} < 0$$

□

#### Proof of Proposition 1'

I start out with the general solution of the model. In order to maximize (12) subject to (26)

I need to maximize the Hamilton-Jacobi-Bellman equation  $H$  with respect to  $\omega_t$  (cf. Merton (1992), equation (4.17a) for example):

$$\max_{\omega_t} H \tag{27}$$

where

$$\begin{aligned} H &= \log(W_t)e^{-\rho t} + I_W(W_t, t)W_t(\omega_t\alpha + (1 - \omega_t)(\varepsilon + (1 - \tau)r_0)) + I_t(W_t, t) \\ &\quad + \frac{1}{2}I_{WW}(W_t, t)W_t^2[(1 - \omega_t)^2(\sigma^2 + \sigma_0^2 + \text{Cov}(dx_t, dz_t))] + \lambda[I(W_t(\frac{\varepsilon}{\lambda}(1 - \omega_t) + 1), t) - I(W_t, t)] \end{aligned} \tag{28}$$

where

$$I(W_t, t) = \max_{\omega_t} E_t \int_t^\infty \log(W_t) e^{-\rho s} ds. \quad (29)$$

The first-order condition for an interior solution is:  $H_{\omega_t} = 0$ . I postulate  $I(W_t, t)$  in a time-separable form as

$$I(W_t, t) = e^{-\rho t} [\delta_1 \log(W_t) + \delta_0] \quad (30)$$

where  $\delta_0$  and  $\delta_1$  are to be determined from (29). Substituting (30) into (29) and simplifying yields

$$\begin{aligned} H = & e^{-\rho t} [\log(W_t) + \delta_1(\omega_t \alpha + (1 - \omega_t)(\varepsilon + (1 - \tau)r_0)) - \rho(\delta_1 \log(W_t) + \delta_0) \\ & - \frac{1}{2} \delta_1 [(1 - \omega_t)^2 (\sigma^2 + \sigma_0^2 + \text{Cov}(dx_t, dz_t))] + \lambda(\delta_1 \log(\frac{\varepsilon}{\lambda}(1 - \omega_t) + 1) - \delta_0)] \end{aligned} \quad (31)$$

Abbreviating the variance term as

$$X = (\sigma^2 + \sigma_0^2 + \text{Cov}(dx_t, dz_t)) \quad (32)$$

we can now write the FOC as

$$0 = H_{\omega_t} = e^{-\rho t} [\delta_1(\alpha - \varepsilon - (1 - \tau)r_0) + \delta_1(1 - \omega_t)X - \delta_1 \lambda \frac{\varepsilon}{\lambda + \varepsilon(1 - \omega_t)}]$$

In order to compute the effect of  $\varepsilon$  and  $\lambda$  on  $\omega_t$  we define

$$M = (\alpha - \varepsilon - (1 - \tau)r_0) + (1 - \omega_t)X - \lambda \frac{\varepsilon}{\lambda + \varepsilon(1 - \omega_t)} \quad (33)$$

and use the implicit function theorem:

$$\frac{\partial M}{\partial \omega} = -X - \frac{\lambda \varepsilon^2}{(\lambda + \varepsilon(1 - \omega_t))^2} < 0; \frac{\partial M}{\partial \varepsilon} = -1 - \frac{\lambda^2}{(\lambda + \varepsilon(1 - \omega_t))^2} < 0; \frac{\partial M}{\partial \lambda} = \frac{\varepsilon^2(1 - \omega)}{(\lambda + \varepsilon(1 - \omega_t))^2} > 0.$$

$$\text{which implies: } \frac{\partial \omega}{\partial \varepsilon} = -\frac{\partial M / \partial \varepsilon}{\partial M / \partial \omega} < 0 \quad \text{and} \quad \frac{\partial \omega}{\partial \lambda} = -\frac{\partial M / \partial \lambda}{\partial M / \partial \omega} > 0 \quad \square$$

### Proof of Proposition 2

Using the proof for proposition 1' and  $\frac{\partial M}{\partial \tau} = r_0 > 0$  we obtain  $\frac{\partial \omega}{\partial \tau} = -\frac{\partial M / \partial \tau}{\partial M / \partial \omega} > 0$ .  $\square$

### Proof of Proposition 2

Using the proof for proposition 1' and  $\frac{\partial M}{\partial \alpha} = 1$  we obtain  $\frac{\partial \omega}{\partial \alpha} = -\frac{\partial M / \partial \alpha}{\partial M / \partial \omega} > 0$   $\square$



### Proof of Proposition 3

I determine the difference between the two limiting cases for  $\lambda$  in the function  $M$  from equation (33):

$$\lim_{\lambda \rightarrow 0} M(\lambda) = (\alpha - \varepsilon - r_0) - (1 - \omega_t)X \quad (34)$$

$$\lim_{\lambda \rightarrow \infty} M(\lambda) = (\alpha - \varepsilon - r_0) - (1 - \omega_t)X - \varepsilon \quad (35)$$

Consequently:  $\lim_{\lambda \rightarrow 0} M(\lambda) - \lim_{\lambda \rightarrow \infty} M(\lambda) = \varepsilon$  □

Table 2: Benchmark regression: Short-term inflows regressions across ERR

	OLS		GMM	
	$\beta$	t-stat	$\beta$	t-stat
<i>Full sample</i>				
<b>Hard peg</b>	0.0568**	2.2918	0.0852**	2.3203
Intermediate peg	0.0422*	1.7879	0.0847**	2.6021
Inflation	0.0029***	3.6213	0.0031***	2.8572
Money supply/GDP	0.0183**	2.2480	0.0089	0.5565
Constant	0.1962***	6.5951	0.1662***	5.1478
Observations	1430		1430	
Time Fixed Effects	Yes			
Number of countries	69		69	
R-squared (Between)	0.128			
<i>Developed countries</i>				
<b>Hard peg</b>	0.0626**	2.2791	0.0779*	1.8392
Intermediate peg	0.1042***	2.9387	0.0720	0.8990
Inflation	0.0044**	2.0075	0.0036	1.5736
Money supply/GDP	0.0236***	9.6080	0.0244***	9.4372
Constant	0.2181***	4.9720	0.2281***	4.8381
Observations	305		305	
Time Fixed Effects	Yes			
Number of countries	20		20	
R-squared (Between)	0.595			
<i>Developing countries</i>				
<b>Hard peg</b>	0.0654**	2.3716	0.1060**	2.2935
Intermediate peg	0.0343	1.0368	0.0874**	2.1936
Inflation	0.0024***	2.8555	0.0028**	2.3726
Money supply/GDP	0.0089	0.6316	0.0011	0.0376
Constant	0.2135***	4.8675	0.1636***	3.8037
Observations	1125		1125	
Time Fixed Effects	Yes			
Number of countries	49		49	
R-squared (Between)	0.100			

Notes: The dependent variable is the share of short term capital inflows over total capital inflows (short + long). White's heteroskedasticity-consistent t-statistic are given in brackets; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. The columns GMM deal with the fact that some variable (e.g. inflation) can be endogenous. Developed countries refer to OECD countries. For the exchange rate classification, the omitted category is flexible exchange rate regimes.

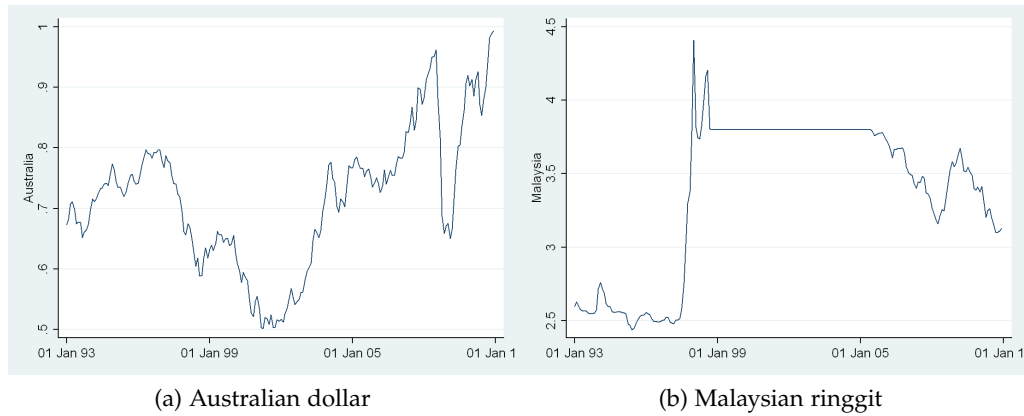


Figure 4: Continuous vs Discrete Devaluations

Table 3: Benchmark regression: adding capital control using Chinn-Ito Index

	OLS		GMM	
	$\beta$	t-stat	$\beta$	t-stat
<i>Full sample</i>				
Hard peg	0.0582**	1.9673	0.1018***	2.9284
Intermediate peg	0.0402	1.5935	0.0879**	2.5058
Inflation	0.0031***	3.8093	0.0034***	2.9836
Money supply/GDP	0.0184**	2.1973	0.0123	0.8134
<b>Capital controls</b>	-0.0054	-0.5236	-0.0283	-1.4403
<i>Chinn-Ito index</i>				
Constant	0.2023***	5.9808	0.1848***	4.9739
Observations	1413		1413	
Time Fixed Effects	Yes			
Number of countries	69		69	
R-squared (Between)	0.112			
<i>Developed countries</i>				
Hard peg	0.0470**	1.9829	0.0626	1.3584
Intermediate peg	0.0979***	3.1146	0.0857	1.4201
Inflation	0.0047**	2.2843	0.0036	1.5724
Money supply/GDP	0.0252***	14.8333	0.0260***	10.7450
<b>Capital controls</b>	-0.0163	-1.1384	-0.0107	-0.6280
<i>Chinn-Ito index</i>				
Constant	0.2426***	4.9478	0.2409***	4.6935
Observations	297		297	
Time Fixed Effects	Yes			
Number of countries	20		20	
R-squared (Between)	0.646			
<i>Developing countries</i>				
Hard peg	0.0770**	1.9962	0.1305***	3.0150
Intermediate peg	0.0329	0.9349	0.0931**	2.2160
Inflation	0.0026***	3.1081	0.0031**	2.4565
Money supply/GDP	0.0081	0.5395	0.0034	0.1286
<b>Capital controls</b>	0.0066	0.4800	-0.0164	-0.7309
<i>Chinn-Ito index</i>				
Constant	0.2076***	4.5583	0.1607***	3.5563
Observations	1116		1116	
Time Fixed Effects	Yes			
Number of countries	49		49	
R-squared (Between)	0.0741			

Notes: The dependent variable is the share of short term capital inflows over total capital inflows (short + long). White's heteroskedasticity-consistent t-statistic are given in brackets; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. The columns GMM deal with the fact that some variable (e.g. inflation) can be endogenous. Developed countries refer to OECD countries. For the exchange rate classification, the omitted category is flexible exchange rate regimes.

Table 4: More Covariates: OLS Regression of Short-Term Inflows

	(1)	(2)	(3)
Hard peg	0.0548** [1.9673]	0.0598** [1.9816]	0.0601** [1.9926]
Intermediate peg	0.0290 [1.0836]	0.0408 [1.6080]	0.0390 [1.5410]
Inflation	0.0034*** [4.4317]	0.0030*** [3.7488]	0.0031*** [3.7404]
Liquidity	0.0115 [1.3939]	0.0179** [2.1533]	0.0192** [2.3649]
Money supply/GDP			
Capital controls	-0.0042 [-0.3640]	-0.0061 [-0.5745]	-0.0072 [-0.6972]
Chinn-Ito Index			
Quality of institutions	-0.0014** [-2.0287]	- -	- -
Freedom house index			
Business Cycle	- -	-0.0006 [-0.3931]	- -
GDP growth			
Population	- -	- -	-0.1370** [-2.1190]
Constant	0.2063*** [5.6987]	0.2052*** [6.0652]	0.2126*** [6.2237]
Observations	1218	1393	1410
Time Fixed Effects	Yes	Yes	Yes
Number of countries	66	69	69
R-squared (Between)	0.218	0.126	0.142

Notes: The dependent variable is the share of short term capital inflows over total capital inflows (short + long). White's heteroskedasticity-consistent t-statistic are given in brackets; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. For the exchange rate classification, the omitted category is flexible exchange rate regimes.

Table 5: More Covariates: GMM Regression of Short-Term Inflows

	(1)	(2)	(3)
Hard peg	0.0886** [2.0867]	0.1052*** [3.0205]	0.0970*** [2.8219]
Intermediate peg	0.0523 [1.5810]	0.0956*** [2.8190]	0.0890** [2.4956]
Inflation	0.0035*** [2.6678]	0.0032*** [2.9428]	0.0034*** [2.9764]
Liquidity	0.0047 [0.3237]	0.0121 [0.8088]	0.0152 [1.0637]
Money supply/GDP			
Capital controls	-0.0282 [-1.3943]	-0.0310 [-1.5839]	-0.0352* [-1.7924]
Chinn-Ito Index			
Business cycle	- -	-0.0014 [-0.9622]	- -
GDP growth			
Quality of institutions	-0.0017** [-2.1063]	- -	- -
Freedom house index			
Population	- -	- -	-0.1973*** [-3.2407]
Constant	0.2109*** [6.5051]	0.1897*** [4.9559]	0.2062*** [5.4432]
Observations	1218	1393	1410
Number of countries	66	69	69

Notes: The dependent variable is the share of short term capital inflows over total capital inflows (short + long). White's heteroskedasticity-consistent t-statistic are given in brackets; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. For the exchange rate classification, the omitted category is flexible exchange rate regimes.

Table 6: Within country estimate: OLS Regression of Short-Term Inflows

	(1)	(2)	(3)	(4)
<b>Exchange regime</b>	-0.0348*	-0.0302**	-0.0348**	-0.0335*
	[-1.8748]	[-1.9788]	[-1.9791]	[-1.7979]
<b>Inflation</b>	0.0022**	0.0025***	0.0022**	0.0023**
	[2.5916]	[3.0228]	[2.5330]	[2.5875]
<b>Liquidity</b>	0.0146	0.0040	0.0145	0.0166
<i>Money supply/GDP</i>	[1.3137]	[0.3034]	[1.2945]	[1.5601]
<b>Capital controls</b>	-0.0149	-0.0138	-0.0149	-0.0142
<i>Chinn-Ito index</i>	[-1.3389]	[-1.0476]	[-1.3427]	[-1.2647]
<i>Quality of institutions</i>		-0.0011*		
<i>Freedom house index</i>		[-1.7600]		
<i>Business cycle</i>			-0.0004	
<i>GDP growth</i>			[-0.2680]	
<i>Population</i>				-0.5220**
				[-2.1501]
<b>Constant</b>	0.3104***	0.3189***	0.3136***	0.3412***
	[19.0570]	[19.6043]	[18.4978]	[16.3495]
<b>Observations</b>	1413	1218	1393	1410
<b>Country fixed effect</b>	Yes	Yes	Yes	Yes
<b>Year fixed effect</b>	Yes	Yes	Yes	Yes
<b>Number of countries</b>	69	66	69	69

*Notes:* The dependent variable is the share of short term capital inflows over total capital inflows (short + long). White's heteroskedasticity-consistent t-statistic are given in brackets; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. For the exchange rate classification, the omitted category is flexible exchange rate regimes.

Algeria Angola Argentina Australia Austria Barbados Bolivia Botswana Brazil Bulgaria China Colombia Costa-Rica Croatia Cyprus Dominican-Republic Ecuador Egypt El-Salvador Finland France Gabon Ghana Greece Guatemala Honduras Hungary Iceland India Indonesia Iran Ireland Israel Italy Jamaica Japan Jordan Korea Kuwait Libya Malta Mauritius Mexico Morocco Netherlands Norway Pakistan Panama Paraguay Peru Philippines Poland Portugal Singapore South Africa Spain Sri-Lanka Swaziland Sweden Switzerland Syria Thailand Tunisia Turkey United-Kingdom United-States Uruguay Venezuela Yemen

Table 7: List of countries