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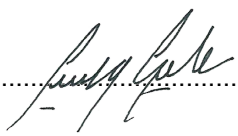
Student's signature:  Date: 27/04/2015

Essays on Exchange Rate Determination and International Capital Flows in Emerging Economies

A thesis submitted in partial fulfilment of
the requirements for the degree of
Doctor of Philosophy in Economics

by

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April 2015

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Declaration

I submit this thesis to the University of Warwick in support of my application for the degree of Doctor of Philosophy. I declare that this thesis has been composed by myself and has not been submitted in any previous application for any degree.

Fredy Alejandro Gamboa Estrada

April 2015

Abstract

This thesis consists of three self-contained chapters. The first two chapters are concerned with the same overall topic though, namely exchange rate determination in Emerging Economies (EMEs), while the third chapter is related to the dynamics of capital flows in EMEs.

The *first* chapter studies the impact of monetary policy announcements on the exchange rate behaviour in EMEs under Inflation Targeting (IT), focusing on the case of Colombia, Chile and Brazil. I address two specific issues. First, I analyze if the pattern of exchange rate returns and its volatility behave differently on days when the Central Bank makes interest rate announcements. Second, I investigate whether the adoption of IT has produced a systematic change in the effect of these announcements on the exchange rate. Using daily data, the results provide evidence that there are significant differences in the conditional volatility of exchange rate returns on days when interest rate announcements surprise the market. The results indicate that the effects of surprise announcements on the exchange rate volatility have been diminished due to the adoption of IT and is related to the systematic change in market expectations.

The *second* chapter studies the effectiveness of foreign exchange intervention in Brazil, Chile, Colombia, Mexico, and Peru. I use the coordination channel approach of exchange rate behaviour where exchange rates are determined in an environment of order flow from informed and uninformed traders. The empirical approach of this theoretical model is based on a Smooth Transition Regression GARCH-M (STR-GARCH-M) model where the confidence of traders in the fundamentals depends on exchange rate misalignments and central bank intervention that increases traders' confidence and strengthen the degree of exchange rate mean reversion. Unlike the existent literature on this channel of intervention, I include a measure of risk premium in the conditional mean equation of exchange rate returns that is consistent with the idea that the rejection of the risk-neutral efficient market hypothesis may be the

result of a time-varying risk premia. Using daily data from 2000 to 2013, the results suggest that foreign exchange intervention has been effective via the coordination channel, and the risk premia decreases the pace of depreciation as risk averse investors demand a higher rate of return from holding the domestic currency.

The recent literature on capital flows has tried to find evidence regarding the post-crisis increase of capital inflows in EMEs due to Fed Unconventional Monetary Policies (UMP). In the *third* chapter, I address this open question analyzing if the effect of these policies on capital flows in EMEs depends on the degree of financial exposure of each country to the US. This approach could be the smoking gun in this debate as I attempt to find evidence of a specific mechanism by which these policies could affect the pattern of capital flows. I estimate a dynamic panel data model with country fixed effects using quarterly data on gross private capital inflows for 46 EMEs from 2000:Q1 to 2013:Q2. The results suggest that UMP have a significant effect on capital flows that depends on the type of unconventional measure examined and it is bigger if countries have a higher financial exposure to the US.

Chapter 1

Exchange Rate Determination under Inflation Targeting: A Microstructural Approach for Emerging Economies

1.1 Introduction

During the last two decades, Central Banks in some developing and developed countries have implemented Inflation Targeting (IT) as a framework for monetary policy in order to control inflation. In 1990, New Zealand was the first country that adopted this regime followed by Canada and United Kingdom. As Roger (2010) notes, today there are 26 countries using IT and about half are developing countries. The principal goal of monetary policy in countries under IT is price stability. However, in some emerging countries such as Colombia, Chile and Brazil, the monitoring of the exchange rate behaviour and the implementation of intervention policies with the purpose of defending the exchange rate remain important in Central Bank policies,

as the external situation of each country affects directly monetary conditions.

This paper studies the pattern of exchange rate returns and its volatility on Central Bank meeting days when interest rates are announced to the public. The aim is to investigate the role of the information incorporated in interest rate announcements and its impact on the exchange rate behaviour before and after the adoption of IT. The hypothesis is that the pattern of transmission of surprise interest rate announcements on the exchange rate dynamics has changed after the adoption of IT, and is related to the systematic change in market expectations.

If after the adoption of IT, surprise announcements are not powerful in explaining the exchange rate returns and its volatility on Central Bank meeting days, there are two possible explanations. There are less surprises in the market due to the adoption of IT or there is a greater range of acceptable surprises which reduces the impact of surprise announcements on the exchange rate dynamics. Although less surprises in the market could be related to the degree of transparency or credibility of Central Banks, this paper only focuses on IT effects and cannot isolate the exact channel which drives this result.

The adoption of IT could change the mechanisms through which the information incorporated into interest announcements affects agents expectations. The role of this information is associated with the degree of independence, transparency and credibility of Central Banks; therefore it is necessary to study the exchange rate dynamics from a microeconomic perspective, analyzing the relationship between agents in the foreign exchange market rather than the determinants of the exchange rate under conventional macroeconomic models. This is one of the main contributions of this paper to the recent literature of exchange rate determination in Emerging Economies (EMEs) and it contrasts with the traditional macroeconomic approach used in these countries.[1]

[1]The debate between monetary authorities in developing economies has been focused on studying the determinants of the exchange rate from a macroeconomic perspective. For instance, the litera-

This paper is an extension of similar studies developed in industrialized economies (Melvin et al. 2004 and 2010) to emerging countries focusing on the case of Colombia, Chile and Brazil. They analyze the pattern of the exchange rate on Monetary Policy Committee days in the UK using the traditional event-study framework but explicitly modelling the conditional variance as time-varying. They find a notable change in exchange rate volatility on days when the interest rate announcement is a surprise. However, they do not analyze if the adoption of IT has changed the mechanisms of transmission of interest rate announcements on exchange rate behaviour, especially if they surprise the market. This analysis is developed in this paper and is another contribution to the literature on exchange rate determination in developing countries.

After studying exchange rate arrangements (Reinhart and Rogoff 2002) and the date of adoption of IT across countries (Roger 2010), there are two reasons for selecting Colombia, Chile and Brazil in this paper. First, they adopted IT in 1999 under similar economic conditions. Second, there is a high degree of association between their foreign exchange markets. In order to assess the effects of interest rate announcements on the exchange rate dynamics, I use daily data that covers two periods. First, the pre-IT scheme from 1995 in Colombia and Chile, and from 1996 in Brazil to the date of adoption of IT in each country in 1999. Secondly, the IT regime running from its adoption date to December 2011. The main reason to start the pre-IT scheme analysis in 1995 is that between 1995 and 1996, Colombia, Chile and Brazil implemented new monetary mechanisms in order to reduce the interbank interest rate volatility, and in 2000 all of them were under a managed floating exchange rate regime and an IT monetary framework.

ture in EMEs has specialized in analyzing the exchange rate dynamics under conventional models, Taylor rule models, and the New Open Macroeconomics. This research is purely a microstructural approach of exchange rate determination. As Sarno and Taylor (2002) note, the microstructural approach does not suppose that there is homogeneity between foreign exchange market agents and assumes that public and non public information are relevant to exchange rates. In addition, the microstructural approach analyses the mechanism of foreign exchange trading instead of imposing different macroeconomic relationships such as the purchasing power parity and a particular money demand function (Ibid).

As in Melvin et al. (2004), I test the equality of means and variances on daily exchange rate returns to assess if there are differences between days when the Board of Directors (BOD) announces its policy rate decision and the other days. In addition, GARCH effects are modelled in order to test if on BOD meeting days and after the adoption of IT, there are significant differences in nominal exchange rate volatility when policy rate announcements surprise the market. Finally, a Logit model is used to examine the role of surprise announcements and inflation targeting in explaining extreme exchange returns. The tests of equality of means and variances do not report any differences between the BOD meeting days and other days in Colombia, Chile, and Brazil either before or after the adoption of IT. EGARCH models provide evidence of significant differences in exchange rate volatility on interest rate announcement days, especially when they surprise the market. The results indicate that the effects of surprise announcements on exchange rate volatility have been diminished due to the adoption of IT and is related to the systematic change in market expectations.

The next section reviews the literature about exchange rate determination and how this paper relates to the existing literature. Section 1.3 discusses the current monetary and exchange rate policies and their objectives in Colombia, Chile, and Brazil. Section 1.4 describes the data set and the empirical methodology. Section 1.5 discusses the empirical results. Section 1.6 covers the conclusions, policy implications and future research.

1.2 Exchange Rate Determination: Related Literature

There are two different approaches to study the exchange rate behaviour. The macroeconomic approach based on fundamental relationships, and the microstruc-

tural approach which analyses the impact of the information contained in macroeconomic announcements on the exchange rate.

In Colombia, Chile and Brazil there is some literature analyzing the determinants of the exchange rate under a macroeconomic perspective. These studies focus on long term relationships between the exchange rate and its fundamentals. For instance, Gamboa (2011) uses conventional and Taylor rule models for Colombia and finds that the Flexible Price Monetary Model outperforms the random walk model of the exchange rate in forecasting at long horizons. In Chile, Calderón (2004) finds a cointegration relationship between the exchange rate and its fundamentals. In Brazil, Moura et al. (2008) find that Behavioral Equilibrium Models and Taylor Rule models have superior forecasting performance in contrast with the random walk benchmark.

There is no extensive literature in these countries studying the exchange rate from a microeconomic approach. However, it is important to note the most relevant studies. In Colombia, Kamil (2008) finds evidence that exchange rate intervention is ineffective when is incompatible with the main objective of the Central Bank, the achievement of the inflation target. Toro and Julio (2005) study the effectiveness of exchange rate intervention using ten-minutes return data. They note that exchange rate intervention is only effective if is credible and the amount of intervention is significant. Toro and Rincon (2010) evaluate the effectiveness of intervention and capital controls for depreciating the exchange rate and reducing its volatility. Using high frequency data and a GARCH model for the exchange rate, they find that exchange rate intervention and capital controls increased exchange rate volatility. Similarly, in Chile some studies have been focused on the effectiveness of the official intervention using daily and intraday analysis. For instance, Tapia and Tokman (2004) note the importance of the credibility of intervention policy announcements to impact the pattern of the exchange rate.

Zettelmeyer (2003), Goncalves and Guimaraes (2007) and Kohlscheen (2011) are

the closest studies to this paper. For instance, Zettelmeyer (2003) analyses the impact of monetary policy on the foreign exchange market in Chile. He uses an event study approach covering only four years after the adoption of a floating exchange rate regime. He finds that the reaction of the bilateral exchange rate to monetary policy decisions adopted in Chile is lower than the response found to the monetary policy in the US. Goncalves and Guimaraes (2007) analyze the impact of monetary policy decisions on the exchange rate in Brazil from 2000 to 2006. They examine the direct effect of 1-year interest rate changes on exchange rate returns around Central Bank meeting days and find that unexpected increases in Brazilian policy rates tend to depreciate the domestic currency. Kohlscheen (2011) employs an event study to analyze the impact of monetary policy shocks on bilateral exchange rates in Chile, Brazil and Mexico. He finds a lack of evidence of the uncovered interest parity in these economies that makes it necessary to understand other factors such as global risk aversion and the dynamics of international capital flows. All these studies analyze the relationship between exchange rates and policy rates under the standard uncovered interest parity condition with rational expectations. One of the main differences of my approach is to consider that the conditional variance of exchange rate returns is time-varying, and although I focus on monetary policy meeting days, I use all daily observations of exchange rate returns to model GARCH effects. Additionally, I analyze if the transmission mechanisms of unanticipated monetary policy decisions on the exchange rate behaviour have changed after the adoption of IT. This has important policy implications and makes a notable contribution to the exchange rate literature in EMEs.

The literature analyzing the impact of monetary policy shocks on exchange rates in developed countries is extensive. For instance, Faust et al. (2003) use high frequency data and employ a SVAR to identify the effects of monetary policy shocks on variables such as the foreign interest rate and the exchange rate. The main

conclusion is the significant effect of U.S. monetary shocks on the exchange rate using an intraday analysis. Furthermore, they find that large uncovered interest parity deviations are generated for this type of shocks in the economy. Andersen et al. (2003) use data consisting of macroeconomics expectations, macroeconomics announcements and real time quotations of exchange rates. Their main conclusion is that news, especially surprising announcements affect the conditional mean of U.S. dollar spot exchange rates. Thus, the exchange rate dynamics are linked to the announcement timing and the market reaction to news called the sign effects, which is the recognition that good news has less impact than bad news.

Kuttner (2001) studies the impact of monetary policy on asset prices. He uses a decomposition of the Federal funds rate into anticipated and unanticipated components, finding a significant effect of unanticipated changes in the policy rate on bond rates. Zettelmeyer (2004) evaluates the impact of monetary policy shocks on the exchange rate for three similar countries, Australia, New Zealand and Canada. The study is developed during the 1990s. At that time all of them had common characteristics such as high degree of openness, the use of inflation targeting frameworks and floating exchange regimes. The main result is that the mechanisms of transmission between monetary policy and exchange rates go according to the economic theory. For instance, estimations for these countries suggest an appreciation of the exchange rate by 2-3 percent when there is an increase in the short interest rates by 1 percent. In addition, they find that changes in monetary policy in order to reduce the turbulence in the foreign exchange rate are not effective if these decisions are taken on the same day that the exchange rate volatility is greater than in average.

Melvin et al. (2004 and 2010) examine the Dollar-sterling foreign exchange market pattern around the Monetary Policy Committee (MPC) days of the Bank of England. They evaluate if surprise interest rate announcements days contain important information that changes the dynamic of the exchange rate. They perform a

daily and intraday analysis. In the daily analysis they find that announcement days have more exchange rate volatility than all other days. Finally, the intraday analysis is based on a Markov switching model. The evidence shows that the probability of remaining in the high volatility state or in the low volatility state differs around the announcement time and that prior to the announcements there is limited evidence of market positioning.

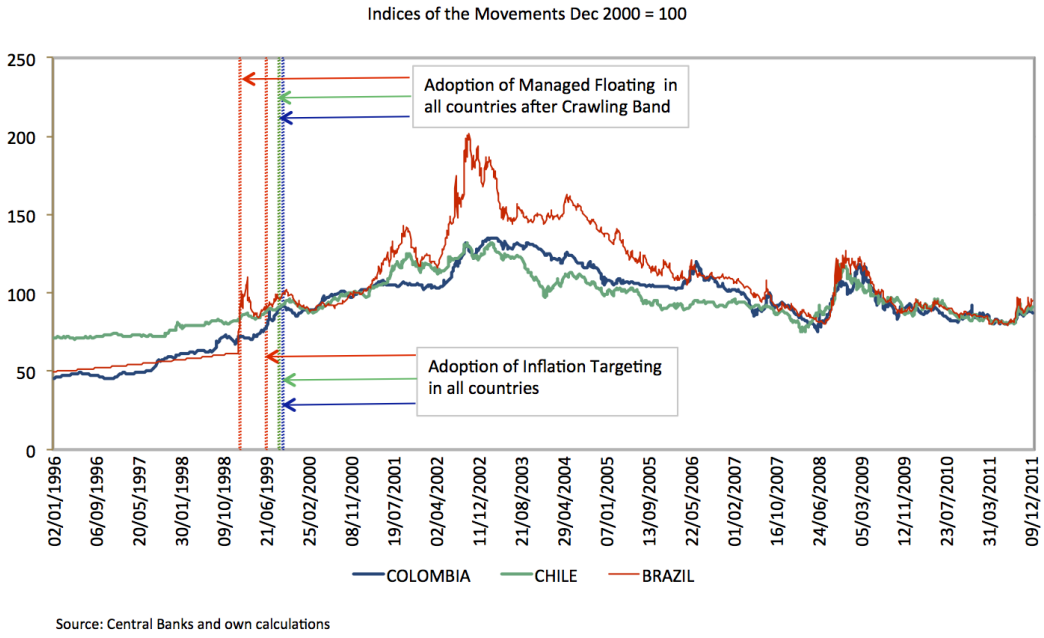
This paper relies on the literature developed in industrialized countries, mainly on Melvin et al. (2004 and 2010), and confirms their empirical findings that there is useful information on announcement days that produce significant differences in exchange rate volatility, especially if those announcements are unexpected. This paper combines the event study framework with a conditional time-varying variance where the signaling channel of interest rate announcements is important in explaining the exchange rate behaviour.

1.3 Monetary Policy and Exchange Rate Policy in Colombia, Chile, and Brazil

Colombia, Chile and Brazil implemented IT as a monetary framework and a flexible exchange rate scheme at the end of the 1990s. These events were motivated by the economic slowdown in 1999 associated partially to the international economic crisis and the unsustainable fixed exchange rate system.

Figure 1.1 shows the exchange rate dynamics in these countries. The higher degree of association between their foreign exchange markets reflected in the exchange rate dynamics before and after the adoption of IT is evident. This is the main reason to study these countries in order to find if they have any similar pattern in the transmission of monetary policy shocks on exchange rate returns and its volatility.

Figure 1.1: Nominal Exchange Rates in Colombia, Chile and Brazil



Source: Central Banks and own calculations

1.3.1 The case of Colombia

The main objective of monetary policy in Colombia since 1991 has been the gradual reduction in inflation. M1 as the most narrowly measure of the money supply was initially used as the intermediate target of the monetary regime. However, the monetary base was chosen as intermediate target in 1996 as it was more accurate in predicting the price level dynamics. Monetary policy was conducted within the framework of an hybrid between monetary and exchange rate anchor as Colombia adopted a crawling band system around the dollar on January 24 1994 (Figure A.1). The Central Bank intervened more actively in the foreign exchange market when the exchange rate approached the upper and lower limits of the band and there were four realignments since its adoption. As Bernal (2003) notes, the monetary authority had the opportunity to make independent movements in the policy rate when the nominal exchange rate was not precisely at either limit of the band. In addition, the crawling band system was a framework between a fixed exchange rate system and a floating

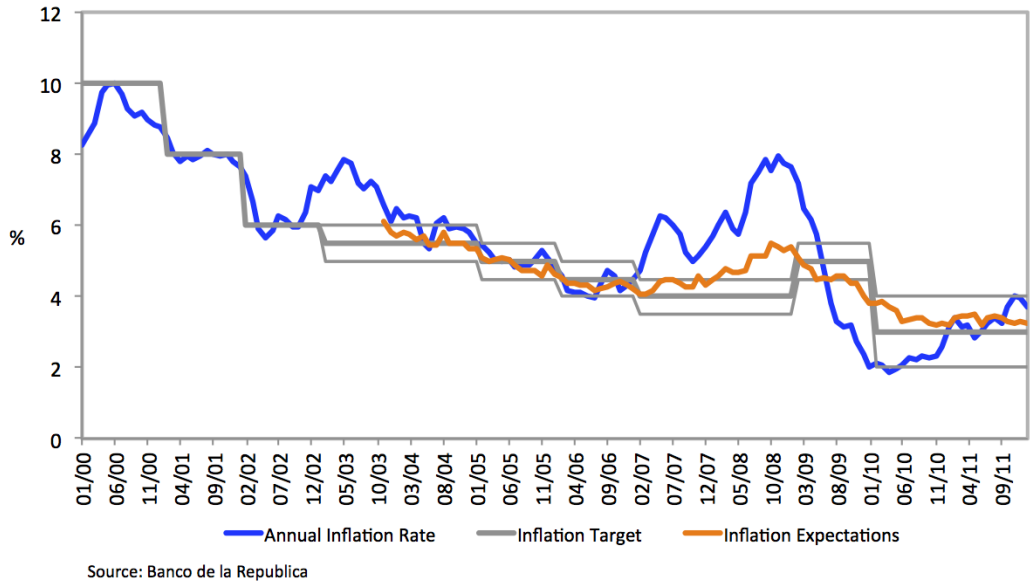
exchange rate regime that according to Villar (1998) was sending clear messages to the market about the equilibrium exchange rate level in the medium and long-run. This scheme was trying to avoid excessive fluctuations of the exchange rate that were compromising the inflation objective. According to Vargas (2005), the abandonment of the exchange rate band on September 25 1999 was mainly caused by the terms of trade shocks and the sudden stop of 1998-99 originated in the Russian crisis (1998) in an scenario of large external imbalances, a declining GDP growth and a domestic banking crisis.

After the adoption of a flexible exchange rate regime, Colombia converged to a completely IT framework despite the difficult economic situation that was experiencing. The primary objective of monetary policy under IT in Colombia is to achieve and maintain a stable and low inflation rate and reach a long run GDP growth trend. At the end of each year, the Board of Directors (BOD) sets quantitative inflation targets defined as the annual variation of the Consumer Price Index (CPI). The monetary policy is implemented by changing interest rates with the purpose of withdraw or provide liquidity to the economy. These interventions rates are the monetary policy tool and through them the other interest rates are affected in the economy.

Figure 1.2 describes the dynamic of inflation relative to the target and the pattern of inflation expectations since the adoption of IT. There is evidence that inflation was close to the target at the beginning of the IT period, specifically in 2001, 2002, 2005 and 2006. In addition, inflation was above the target in 2003, 2007 and 2008 and below the target in 2009 and 2010. The central bank describes in the quarterly inflation report the possible factors that account for failure to achieve the inflation target. Supply shocks such as climate change, a stronger demand or changes in inflation expectations could be the main causes of failure to meet the inflation target. For instance, food inflation attributable in part to weather conditions, strong demand

from Venezuela and increasing world commodity prices were the main causes of failure to meet the inflation target in 2007. Although there is no information of inflation expectations since the beginning of the IT period, inflationary expectations adjusted quickly to this new monetary regime.

Figure 1.2: Observed Inflation, Targets and Expectations in Colombia



Every month the BOD meets to set the interest rate. These decisions are based on the extensive monthly briefing on the economy received from the Banco de la República Staff. There are three important meeting days after the adoption of IT. In the first day, which usually takes place four working days before the interest rate announcement meeting, the BOD revises the Inflation Report. That document evaluates the evolution of variables such as the consumer and producer price indexes, measures related to basic inflation, production and costs indicators, price series on money, credit, interest rates, asset prices and international economic indicators. In addition, the medium and long-run prospects of inflation are analyzed. Although the Inflation Report is only made public quarterly, the brief review of the economy previous to the announcement day is fundamental in the final decision made by the BOD.

Based on this report, there is a second meeting day which usually takes place two working days before the BOD interest rate setting meeting. During this day, the Banco de la República Staff makes policy recommendations and analyses the main conclusions that resulted from the first meeting. Based on these policy recommendations, during the third day, the Board sets its position about the policy interest rate for the next month. These meetings are usually held on Friday on the third week of each month at predetermined dates. The information analyzed during the first two meeting days is not public before the announcement day, and the final decision is released to the public on the third day at no specific time. Before the adoption of IT, between 1995 and 1999, there was a brief report on the economy analyzed before the announcement day. However, this report was not public, and therefore the interest rate decision day is the only day included in this analysis.

There is a strong link between monetary and exchange rate policies in Colombia. The IT regime was implemented under a flexible exchange rate framework. This exchange rate scheme classified as managed floating according to Reinhart and Rogoff (2002) is governed by intervention rules. Its main objective is to limit the exchange rate volatility and maintain an optimal level of international reserves in order to reduce the vulnerability to external shocks. The Banco de la República has different intervention mechanisms in the foreign exchange market. It can intervene in the foreign exchange market through option auctions, selling or purchasing foreign exchange directly at its own discretion, and purchasing foreign exchange through competitive auctions in the foreign exchange market.

According to the IT regime, there should be consistency between monetary policy and exchange rate policy. However, given the importance that the Banco de la República gives to the exchange rate reflected in its constant monitoring and the use of intervention tools, there is risk of inconsistency. This is the concern of the last years reflected in some working papers such as Kamil (2008) that finds official

intervention ineffective in the first half of 2007 which resulted in the conflict between diminishing the appreciation and achieving the inflation target.

1.3.2 The case of Chile

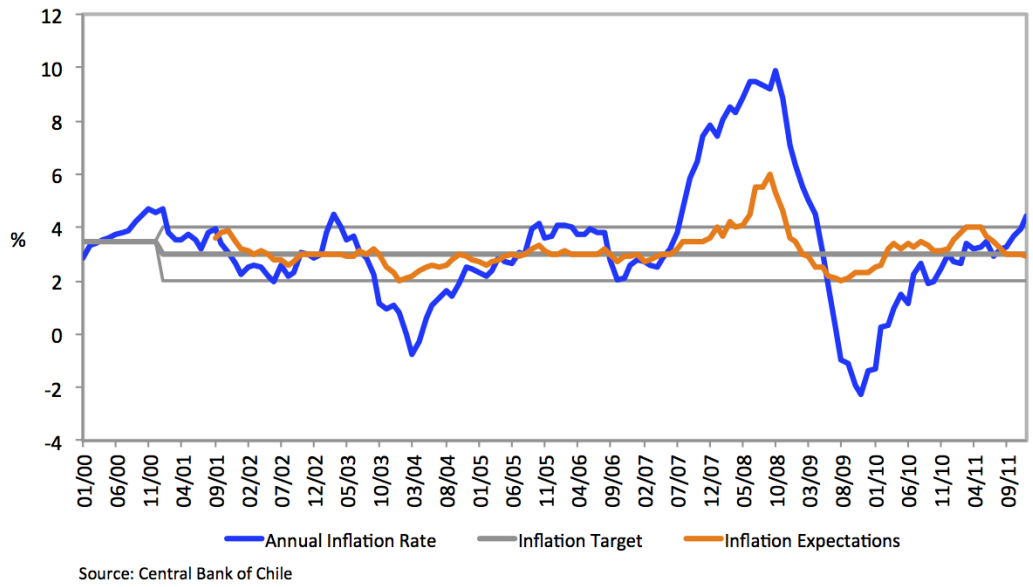
Chile was the first country in Latin America that adopted IT as monetary framework. The transition to this monetary regime was developed in two stages. During the 1990s, the Central Bank of Chile set inflation targets and used different instruments such as interest rates to control inflation levels. In addition, the development of monetary policy was conditioned to the high degree of indexation. Unlike Colombia, monetary policy did not use any monetary aggregate as intermediate target. An exchange rate band and an annual inflation target were used as nominal anchors. There was a permanent conflict between achieving the inflation target and maintaining the exchange rate within the corridor, and the crawling band was defended by intervention in the foreign exchange market (Figure A.2). Given the high degree of indexation, real interest rates were used as the main policy tool. However, there was an implicit nominal anchor as the real interest rate was adjusted according to the inflation target. Although the monetary authority defined punctual or inflation target ranges during that decade, other characteristics such as transparency and communication were absent. After September 1 1999, IT was fully adopted along with the adoption of a fully free floating exchange regime. However, it was not until May 2000 that the Central Bank published the first inflation report, and thereby improved substantially the level of transparency and credibility of the institution.

The main objective of monetary policy is to preserve price stability defined in terms of the consumer price index (CPI) targets set each year. Monetary policy is implemented by defining monthly targets for the interbank interest rate known as the monetary policy rate (tasa de política monetaria TPM). Although during the 1990s there was a high degree of indexation of the Chilean Economy, the monetary

policy rate was nominalised in August 2001. In addition, the Central Bank regulates the liquidity of the financial system through different instruments in order to assure that the interbank rate falls in the target previously defined.

Figure 1.3 shows the dynamic of inflation relative to the target and the behaviour of inflation expectations during IT. Although inflation expectations adjusted quickly to IT, there were some periods where the central bank failed to achieve the inflation target. For instance, in 2004 and 2009 the annual inflation was considerably lower than the inflation target, while in 2007 and 2008 was notably above as in Colombia. For instance, food price increases, specifically prices of perishable food, and soaring prices of fuel and electricity were the main causes of the annual inflation acceleration at the end of 2007 and the failure to meet the inflation target. In addition, the pattern of international prices of some commodities such as wheat and corn by-products were determinant in driving the domestic price behaviour.

Figure 1.3: Observed Inflation, Targets and Expectations in Chile



The TPM is determined by the Board of Directors (BOD) every month. There are two important days in the process of interest rate setting before and after the

fully adoption of IT. During the first day, that usually is held two working days before the interest rate announcement day, the staff from the Central Bank gives an economic outlook to the BOD. The brief economic review is made public on the previous day of the interest rate announcement day, and this is the basis of the interest rate decisions. During the second day, that usually is held on Thursdays, the Board makes the decision about the monetary policy interest rate with the posterior publication of the resolution to the public in the evening of that day.

The current foreign exchange policy is based on a fully flexible exchange rate regime. However, as in Colombia, this flexibility does not avoid the use of foreign exchange intervention mechanisms in order to control the exchange rate volatility. The Central Bank of Chile only intervenes under exceptional circumstances when the exchange rate deviates notably from its fundamentals. These interventions are fully transparent and announced to the public in advance along with the reasons involved in these actions.

1.3.3 The case of Brazil

The Real Plan was introduced in 1994 to stabilize the Brazilian economy. These set of measures brought about a continuous reduction in inflation. In 1994, the central bank introduced quarterly targets for the monetary base, M1 and M4. Monetary policy was more flexible after the adoption of a floating exchange rate regime in July 1994. However, aftermath of the Mexican crisis, a crawling band system was formally adopted on March 5 1995 (Figure A.3). The central bank intervened in the foreign exchange market in order to maintain the exchange rate within the band limits and preserve the stability in the market. In 1996, an interest rate corridor was introduced and the effective interest rate on federal securities transactions or Selic rate was the operational target of monetary policy. Brazil floated its currency, the Real, on January 18 1999. Its attempt to control deviations of the exchange

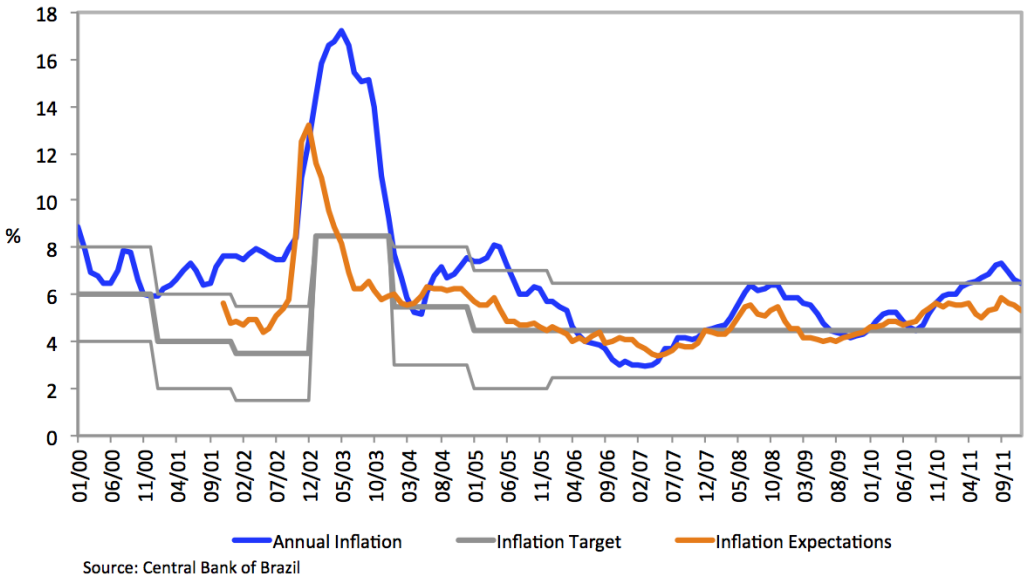
rate through reserves accumulation has not affected the functioning of the floating exchange rate scheme, especially during the recent financial turmoil. The current exchange rate arrangement is classified as managed floating where the central bank buys or sell foreign currency through publicly announcements and this process is transparent to the market. On June 21 1999, Brazil converged to a new monetary policy system, inflation targeting. This new monetary regime was chosen in order to try to achieve price stability considering that the economy was under a floating exchange rate regime and there was uncertainty about the effects of the Brazilian real devaluation on inflation. After the adoption of IT, monetary policy could be described as a rule where the central bank modifies the effective Selic rate to maintain it close to the pre-established monthly target. This target is set according to the annual inflation target range established by the central bank. The Selic rate is known as the primary instrument of monetary policy and is the basic rate in the economy as is used on overnight operations in the financial sector and balances the market of bank reserves. In addition, changes in the effective Selic rate respond to one year ahead inflation expectations that are available from the daily survey conducted by the central bank.

The inflation target is defined in terms of the Broad National Consumer Price Index and instead of setting punctual inflation targets, the Central Bank sets an inflation target band in order to make the monetary policy less restrictive. The Monetary Policy Committee (COPOM) was established in 1996. The COPOM could set bias to its decisions in order to change the SELIC target between meetings.

There is evidence that the central bank failed to meet the inflation target during the first four years of the adoption of IT, in part due to the economic instability of the Brazilian economy (Figure 1.4). In 2004, 2005, 2008 and 2010, the annual inflation rate was above the midpoint of the target range but within the upper limit of the tolerance range, while it was below the midpoint of the target range in 2006

and 2007. According to the Central Bank of Brazil, anchoring market expectations is one of the main objectives of the IT regime. After the adoption of the Real Plan in 2004, monetary policy decisions become more predictable as inflation expectations were more accurately formed and closer to the actual inflation rate as it can be observed in Figure 1.4.

Figure 1.4: Observed Inflation, Targets and Expectations in Brazil



Between 1999 and 2000, the COPOM defined the SELIC target rate every month. However, since 2006 the Committee meetings have been held eight times per year and the dates are publicly announced before. There are two important meeting days in the process of interest rate setting after the adoption of IT. In the first day, that usually is held on Tuesdays, the Central Bank Staff provides an economic outlook to the Committee. The schedule of this meeting is made public in advance. However, the briefing of the economy is not made public before the decision day. During the second day, usually on Wednesdays, the COPOM makes the interest rate decision and it is announced to the public in the evening. Before IT, the interest rate setting process was only taken in one day.

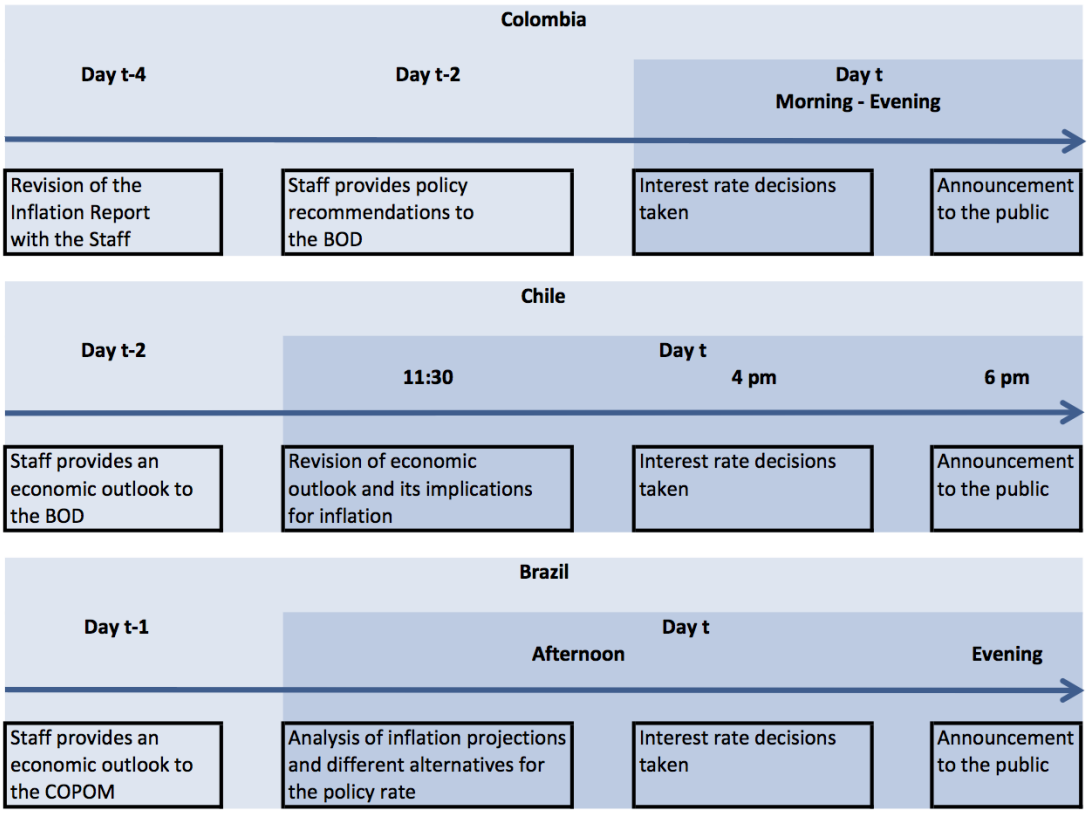
1.4 Empirical Methodology and the Data Set

This paper focuses on the impact of interest rate announcements on exchange rate behaviour on monetary policy meeting days. There are different days involved in the interest rate setting process. Figure 1.5 shows the timeline of this process in each country after the adoption of IT. In Chile and Brazil the interest rate decision is released to the public after the market has closed. In Colombia, there is not a scheduled time for the policy decision to be announced. [2]However, as the monetary meetings are pre-scheduled in advance after the adoption of IT, it is unlikely that the policy decisions made by the Central Bank of Colombia respond to other macroeconomic events on the same day. In light of these facts and as it is only on the decision day that new information is released to the market, this paper focuses on the day after the policy announcement is made as this is the day when markets take into account the decision.

The information used covers two periods. First, the period before the adoption of IT and, second the period after the adoption of this monetary regime. I consider as the initial observation the first available data of monetary policy meetings in each country. This date coincides with structural changes in the monetary policy strategy as I described in the previous section. In addition, I exclude all extraordinary policy meeting days as they could bias the results because an announcement could be classified as a surprise when the market was not forming expectations about it.

[2]A couple of times, the Central Bank of Colombia has announced the policy rate in the evening of the decision day when markets have closed. For instance, on June 15 2007, June 20 2008, and November 23 2009 the policy rate decision was released to the public at 17:20, 20:25 and 19:22 respectively.

Figure 1.5: Interest Rate Decision Process after the Adoption of Inflation Targeting



Source: Central Banks of Colombia, Chile, and Brazil.

1.4.1 Data

The empirical analysis of the effects of interest rate announcements in the foreign exchange market uses daily data of nominal exchange rates returns against the US Dollar in Colombia, Chile, and Brazil. This information is obtained from each Central Bank. The exchange rate returns Δe_t are calculated as the first difference of the log of the nominal exchange rate against the US Dollar multiplied by 100. The daily variation of the log exchange rate is calculated as the difference between day $t+1$ and day t. The notation used for the Colombian Peso against the US Dollar is COP, for the Chilean Peso CLP, and for the Real in Brazil BRL.

This paper examines different aspects of the exchange rates. First, descriptive

statistics for the level of exchange rates and their returns are reported in Tables B.1 and B.2. Table B.1 shows that the mean of the nominal exchange rate for Colombia, Chile, and Brazil before the adoption of IT are 1238.1 COP/USD, 434.9 CLP/USD, and 1.2 BRL/USD, respectively. Table B.2 shows that the mean for the same countries during IT are 2244.9 COP/USD, 569.9 CLP/USD, and 2.2 BRL/USD. The standard deviation in Colombia and Chile before the adoption of IT is 277 and 35.7 respectively, considerably higher than in Brazil with a value of 0.2. The same pattern is described in Table B.2 during IT. The p-value of zero from the Jarque-Bera statistic suggests evidence of non normality for the level of exchange rates and their returns in all countries for both periods. In addition, the Augmented Dickey-Fuller test does not reject the hypothesis of non-stationarity in the level of exchange rates for both periods, while exchange rate returns are found to be stationary before and after the adoption of IT.

The literature on monetary policy shocks employs different methodologies to estimate monetary surprises. I use the change of short-term money market rates as a proxy for unexpected monetary decisions. As in Zettelmeyer (2004), I select money market interest rates in each country that are short enough to reflect the policy targets established by the monetary authorities for the short-run, and at the same time long enough to capture any unanticipated change in the policy rate as they are able to respond exclusively to the extent that changes in the monetary policy rate were unexpected. [3]

For Colombia and Chile, I use three month money market interest rates. The TBS3M (Tasa Basica de la Superintendencia) in Colombia and the TIP3M (Tasa de Interes Promedio) in Chile are calculated as the weighted average of all financial

[3]I use short term interest rates to construct monetary surprises due to the limited data availability before the adoption of IT of variables such as Bloomberg survey on interest rate expectations, yields on government securities and future rates. For instance, the Bloomberg survey is only available after 1999 for Brazil, 2001 for Chile, and 2002 for Colombia. This information clearly is not appropriate for this paper as I want to use data that includes before and after the adoption of IT.

institution deposit rates. This is similar to Zettelmeyer (2004) that uses three month interest rates to estimate the unanticipated content of monetary policy actions. For Brazil, I use the one-day interbank deposit futures contract rates (DI1) where the underlying asset is the interest rate of interbank deposits. Brazil has a developed futures market and according to BM&FBOVESPA, the largest stock exchange in Brazil and one of the largest in the world, the DI1 interest rate is one of the main benchmarks in the Brazilian interbank market. This is the main reason of selecting this reference rate instead of three month money market rates in order to construct accurate surprise measures. [4]For instance, Kuttner (2001) and De Oliveira et. al (2011) use data from futures markets in the US and Brazil respectively to calculate the unanticipated component of monetary policy announcements. As De Oliveira et. al (2011) state, markets experience changes after any unexpected monetary shock, especially money market rates.

The actual policy rate change $\triangle i$ is equal to the expected policy rate change $\triangle i^e$ plus the unexpected change in the policy rate $\triangle i^u$. The change of the money market interest rates selected between period t+1 and t represents a surprise or the unexpected change in the policy rate. Why this is an appropriate measure of continuous surprises? For Colombia, and Chile, at period t, the three month interest rate agreed in the interbank market (t+90) includes the policy rate expectation for the next three months, while at period t+1, the three month interest rate agreed (t+91) incorporates the actual policy rate change. Then, if I calculate the change in each of the three month interest rates between $r_{t+1} = f(\triangle i^e + \triangle i^u)$ and $r_t = f(\triangle i^e)$, I will get a measure of the unexpected component of the monetary announcement or surprise $f(\triangle i^u)$. For Brazil the change between period t+1 and t of the one-day interbank deposit futures contract rates captures surprises because on day t the agents in the financial system agree the rate at which they will negotiate in the

[4]90 day swap rates in Brazil are only available from 1999.

interbank market at day t+1. Given that the future contract is an efficient instrument for hedging against fluctuations in the average one day interbank deposit rate, this will incorporate the expected value of the policy rate announcement $\triangle i^e$. At day t+1 the future contract rate will incorporate the actual change in the policy rate $(\triangle i^e + \triangle i^u)$, and thus the difference between t+1 and t represents the monetary surprise. It is important to note that these measures could represent changes in expected future changes, and they still represent a surprise.

The properties of the surprise measures chosen can be described within the context of the efficient-markets theory that states that prices fully reflect all available and relevant information. The main characteristic of the efficient-market hypothesis is the assumption of rational expectations as agents update their expectations accordingly when new important information appears. If agents in the market use appropriately all the available information to form their expectations, the surprise measures chosen should be orthogonal to lagged information available at the moment they form those expectations. The null hypothesis of orthogonality can be tested using a regression of the following form:

$$Surp_t = \beta X_{t-1} + \nu_t \tag{1.4.1}$$

where $Surp_t$ is the surprise measure calculated as the change in the short term interest rates chosen, X_{t-1} is a vector of variables that belongs to the information set known Ω_{t-1} at time $t-1$, and ν_t is a random error term. If the assumption of rationality or orthogonality is valid, then $E(Surp_t \mid \Omega_{t-1}) = 0$ which implies that the coefficient $\beta = 0$ in equation (1.4.1). As for variables from the information set Ω_{t-1}, I choose the most recent change in the policy rate $\triangle i_{t-1}$, changes in US monetary conditions, risk premia and international commodity prices that are captured by

the lagged daily change of the 3 month T-Bill rate, the VIX and the Commodity Research Bureau index (CRB), respectively. It would be recommendable to use other set of variables such as forecasts for growth rate of domestic real GDP and domestic inflation to evaluate if surprise measures are unexplained by the central bank response to the economic conditions. However, there is limited data availability before the adoption of IT that makes impossible the inclusion of these variables in these tests of orthogonality. I use F-statistics to test the null hypothesis that all the coefficients (excluding the constant) from the regression (1.4.1) are equal to zero.

Table 1.1 shows the results of the orthogonality tests for the surprise measures chosen in each country. Orthogonality of the chosen surprise measures to the set of variables included in X_{t-1} is not rejected at the 1% significance level. There is evidence that the surprise measures appear to be rational as they are orthogonal to lagged information which implies that all the information available at the time agents form expectations is incorporated efficiently into this measures.

Table 1.1: Orthogonality Tests of Surprises

	Colombia	Chile	Brazil
Constant	-0.0072	-0.0017	-0.0026
	(0.0084)	(0.0059)	(0.0122)
Δ(Policy Rate)t-1	-0.0363	0.0371	-0.0222
	(0.0788)	(0.0302)	(0.0166)
Δ(T-Bill Rate)t-1	0.3225	0.0671	-0.1537
	(0.1918)	(0.1112)	(0.1304)
Δ(VIX)t-1	0.0053	0.0067	0.0099
	(0.0055)	(0.0034)	(0.0108)
Δ(CRB Index)t-1	-0.0030	0.0015	0.0029
	(0.0030)	(0.0018)	(0.0022)
R2	0.002	0.001	0.001
F-statistic	1.260	1.620	1.050
	(0.285)	(0.167)	(0.379)

Notes: Robust standard errors in parenthesis. F-statistics for testing that all the coefficients (excluding the constant) are equal to zero with associated p-values (in parenthesis). CRB index is the Commodity Research Bureau index.

Although the orthogonality hypothesis is not rejected for any of the surprise measures chosen, and policy rate changes during IT are usually announced after the market has closed, these surprises could be still contaminated. As I explained previously, there is limited data availability before the adoption of IT that makes impossible to include some variables in the orthogonality tests. As money market interest rates changes could respond to other macroeconomic announcements apart from the effects of the policy rate, I check if the release dates for GDP, inflation and global economic news coincide with any of the announcement days or the day after the decision is released to the market. In addition, I examine if central banks intervened in the foreign exchange market during any of these days, especially during the period of the crawling band where the exchange rate was the intermediate target of monetary policy. As Zettelmeyer (2004) notes, policy rate decisions could have been correlated with the dynamics in the foreign exchange market. I only consider as meeting days the days that are not contaminated by other events apart from the monetary policy decision. [5]

Monetary surprises might represent good or bad news in an IT regime. For instance, if the central bank increases (decreases) the policy rate more than market expectations in an scenario where actual inflation rate is considerably above (below) the inflation target, this move could be taken as good news by the market as it

[5]I examine central banks press releases, announcements from institutes of statistics in each country (e.g. IBGE in Brazil, INE in Chile and DANE in Colombia), Bloomberg and Factiva where I can have access to premium news from the main newspapers and magazines. For instance, Factiva provides news from Dinheiro, Folha de Sao Paulo and Primeira Pagina in Brazil; el Mercurio, La Nacion and Diario Financiero in Chile, and El Tiempo in Colombia. Central bank foreign exchange intervention and data on the exchange rate band is collected from central bank websites. It is important to note that foreign exchange intervention data is not available in Colombia and Chile before the adoption of IT. However, I check the dynamics of the nominal exchange rate within the band defended during that period. I classify interest rate announcement days as other days if the independence of the monetary policy decision was affected when the exchange rate was exactly at either of the edges of the exchange rate band. In addition, only announcement days when central banks intervene actively in the foreign exchange market are classified as other days after the adoption of IT. The main reason is that monetary policy under IT is more independent of the exchange rate dynamics even if the central bank has a managed floating framework. Then, it is more likely that interventions are correlated to monetary policy decisions during the band period.

sends clear messages to the agents about the central bank commitment of achieving price stability. However, if the central bank changes the policy rate more than market expectations when the inflation rate is close to its target, this move could be taken as bad news as it will raise inflation uncertainty. One clear example is the Bank of Japan that although has not adopted an IT regime, it sets an annual price stability target in terms of the year-on-year rate of change in the consumer price index. On October 31 2014, the Bank of Japan surprised the markets by accelerating the increase in the monetary base at an annual pace of JPY80trn. In addition, it decided to increase its purchases of Japanese government bonds at an annual pace of JPY80trn and extending the average remaining maturity of these bonds purchases to 7-10 years. These unexpected decisions were taken in an scenario of lowering of the BOJ's inflation and growth forecasts and were taken as very good news by global markets.

It is important to note that the main objective of this paper is to study the impact of interest rate announcements on the exchange behaviour, and if the effect of these announcements has changed after the adoption of IT, especially if they surprise the market. However, it is fundamental to understand if there is any direct relation between IT and surprises and thereby analyze their impact on exchange rate returns and its volatility. To confirm this conjecture I estimate a simple equation of the relation between the continuous surprise measures and IT. Using OLS, I evaluate if IT has reduced the absolute size of surprises in the sample of the countries analyzed. I include a dummy for IT as explanatory variable as follows:

$$Abs(Surp_t) = \alpha + \beta IT_t + \varepsilon_t \tag{1.4.2}$$

where $Abs(Surp_t)$ is the absolute value of the interest rate change or surprises as

explained earlier in this section; and the variable IT_t is equal to 1 after the adoption of IT and equal to 0 otherwise. In Table 1.2 and Figure A.4, I show that IT has reduced the absolute surprise size in all countries, confirming my previous conjecture. In order to improve the power of explanation of this model, I could include control variables. For instance, including a dummy variable equal to one when the central bank announces the interest rate decision and zero otherwise captures the differential effect that may have announcement days on the absolute size of surprises. In addition, deviations of the observed inflation from the target set by the central bank may have differential effects on the size of surprises as agents will be more accurate in their interest rate expectations if inflation is closer to the target. Nevertheless, I only want to explain briefly if there is any relation between IT and the absolute size of surprises.

Table 1.2: Impact of Inflation Targeting on Surprises

	Colombia	Chile	Brazil
Constant	0.5852	0.3792	0.5527
	(0.0189)	(0.0166)	(0.0592)
IT	-0.3383	-0.2439	-0.4859
	(0.0195)	(0.0168)	(0.0592)
R2	0.1240	0.1056	0.0635

Notes: Robust standard errors in parenthesis. All the estimates are significant at the 1% level.

Figure A.5 shows the stepwise nature of interest rate decisions respectively in all countries before and after IT. I exclude atypical changes in policy rates before the adoption of IT. From Figure A.5, it is evident that at least in 40% of BOD meetings the policy rate was not changed and changes have been made in 25 bp steps after the adoption of IT. It is important to note that no changes in the policy rate can be a surprise in the market.

In order to check the accuracy of the continuous surprise measures, I calculate their correlation on announcement days with the surprises derived from the Bloomberg survey to analyze if I am capturing a similar pattern. A monetary announcement is classified as a surprise using the Bloomberg survey if there is any difference between the actual change of the policy rate and the survey median. For instance, Melvin et. al (2004 and 2010) use the Bloomberg survey to study the impact of monetary announcements in the UK. Table 1.3 and Figure A.6 compare my continuous surprise measures based on short term interest rates and the Bloomberg surprises in Colombia, Chile, and Brazil. It is evident the strong correlation between these two measures in Chile and Brazil. For Chile the correlation is 70% while for Brazil is 47%. For Colombia the correlation is only 10%. This could be explained by other factors in the interbank market such as periods of liquidity stress difficult to disentangle from my measures.

Table 1.3: Correlation Between Surprise Measures and Bloomberg Survey Surprises

Country	Date	Meetings	Measure	Correlation
Colombia	15/03/2002 - 30/12/2011	118	TBS3M	10%
Chile	09/08/2001 - 30/12/2011	125	TIP3M	70%
Brazil	28/07/1999 - 30/12/2011	128	DI1	47%

Notes: All measures are evaluated from the first date available of the Bloomberg Survey. On August 9 2001, the monetary policy rate was nominalised in Chile.
Source: Own calculations and Bloomberg.

Table 1.4 shows the specific dates for each period by country, the number of BOD meeting days and the corresponding absolute size of the continuous surprise measures based on short term rates changes. From Table 1.4, I could infer that the average absolute size of surprises has been reduced after the adoption of IT.

Table 1.4: Board of Directors Meetings and Surprise Measures

Country	Period	Date	Exchange Rate Arrangement	Meetings	Surprise Size*
Colombia	Before IT	01/04/1995 - 25/09/1999	De facto crawling band around US Dollar	45	0.6%
	After IT	26/09/1999 - 30/12/2011	Managed Floating	147	0.3%
Chile	Before IT	2/05/1995 - 1/09/1999	Pre-announced crawling band to US Dollar	30	0.4%
	After IT	02/09/1999 - 30/12/2011	Managed Floating	147	0.2%
Brazil**	Before IT	03/06/1996 - 20/06/1999	Pre-announced crawling band to US Dollar	39	0.6%
	After IT	21/06/1999 - 30/12/2011	Managed Floating	129	0.1%

*Correspond to the average absolute size of surprises on central bank meeting days.
**Brazil floated its currency on Januray 18, 1999.
Sourse: Own calculations, central banks, and Reinhart and Rogoff (2002) for the Exchange Rate Arrangements.

A caveat in this analysis is that the sample size used before the adoption of IT is smaller than after IT because the period analyzed starts when Central Banks introduced new mechanisms to give more stability to the interest rates, and in some cases the only information available corresponds to the date of the announcement when it was an effective change in the policy rate. This could affect the frequency and size of surprises in the sample.

Figure A.7 shows the degree of association between short term interest rate changes or continuous surprises and exchange rate returns on announcement days before and after the adoption of IT. The data with label Pre and Post corresponds to the pre-IT period and post-IT period, respectively. I could infer from the scatter plots that in Brazil there is more acceptable range of surprises and a smaller surprise size after the adoption of IT. This is reflected in the concentration of the data around zero which implies that surprise announcements have reduced their effect on exchange rate returns. There is not a clear relationship between monetary policy shocks and exchange rate returns in Colombia and Chile. However, I only could give evidence that IT has changed the mechanism through which surprise announcements impact the exchange rate pattern until I analyze the econometric results in the next section.

1.4.2 Methodology

Following the same methodology employed by Melvin et. al (2004 and 2010), the questions to be examined are:

1. Are exchange rate returns different on days when the BOD meets?

2. Have surprise monetary announcements diminished their effect on daily exchange rate returns after the adoption of IT?

3. Is information contained in surprise monetary announcements useful in explaining extreme exchange rate returns?

I shall now examine each question in turn:

1. Are exchange rate returns different on days when the BOD meets?

To answer this question, I test the equality of means and variances across different days. I compare exchange rate returns on BOD announcement days with exchange rate returns on days outside the interest rate decision process. I only use the days when the BOD announces the new policy rate as the information from these days is the only made public in these countries, with the exception of Chile where the report from the briefing day is made public before the final decision.

A one way analysis of variance (ANOVA) for unbalanced data is used in order to test if there is equality of means in exchange rate returns between the announcement days and the other no meeting days. Given that the groups sizes are different, and I want to compare the difference in means between the BOD announcement days with all the other days, called the control group, I use the Dunnett´s test using the GLM (General Linear Model) procedure. I assume three groups of days. The days when the BOD announces the policy rate Day_a, the days when there is a change in the policy rate Day_{ach}, and the other no meeting days or control group called $Others$.

The null hypothesis considering two groups of BOD meeting days and one control group is described as follows:

$$H_0 : u_i = u_0 \quad vs \quad H_1 : u_i \neq u_0 \; for \; i = 1, 2 \tag{1.4.3}$$

where u_i is the mean of the ith experimental group (Day_a or Day_{ach}) and u_0 is the mean of the control group ($Others$). Assuming that the variance for $\overline{x_i} - \overline{x_0}$ is equal to σ_i^2, the test computed has a t-distribution $t_i = \frac{\overline{x_i} - \overline{x_o}}{\hat{\sigma_i}}$

Under the GLM procedure, $\hat{\sigma}_i = \sqrt{s^2 * (\frac{1}{N_i} + \frac{1}{N_o})}$ where N_i and N_0 are the sample size of the ith experimental group and the control group respectively, and s^2 is the pooled variance. The significance level for the equality of means test is the p-value for the F-test on the dependent variable that in this case is the exchange rate returns.

Within the GLM procedure, I use the Levene´s Test for Homogeneity of Variances to confirm if there is any substantial difference in the variance between groups of days. This test is more robust under distributions that seem non normal and derives a dispersion variable from the original values of the dependent variable in order to perform an analysis of variance. According to Levene (1960) the tests based on any of the following dispersion variables are satisfactory. The first one equal to $z_{ij}^2 = (y_{ij} - \overline{y_i})^2$, and the second one equal to $z_{ij} = |y_{ij} - \overline{y_i}|$. Although both measures report similar results, only the estimations based on the first dispersion variable are discussed in this study. The null hypothesis tested is:

$$H_0 : \sigma_1^2 = \sigma_2^2 = ... = \sigma_k^2 \quad vs \quad H_1 : \sigma_i^2 \neq \sigma_j^2 \; for \; at \; least \; one \; pair(i, j) \tag{1.4.4}$$

where σ_i^2 is the variance of the ith experimental group. In addition, the significance level for this test is the p-value for the F-test.

2. Have surprise monetary announcements diminished their effect on daily exchange

rate returns after the adoption of IT?

As in Melvin et al. (2004 and 2010), I estimate a model of exchange rate returns by OLS where the independent variables are dummy variables equal to 1 on days where the BOD meets and announce the new policy rate, and equal to 0 in other case (Day_{at}). In addition, I include a continuous surprise measure $Surp_t$ based on changes in short term interbank rates as I explained in the previous section and as controls $\triangle X_t$ the daily variation of the Chicago Board Options Exchange Market Volatility Index (VIX) and the Thomson/Reuters Core Commodity Research Bureau index (CRB) obtained from Datastream. To analyze how the effect of surprise measures have changed after the adoption of IT, I include a dummy variable IT_t equal to 1 after the adoption of IT and equal to 0 otherwise. This implies the inclusion of interaction terms described in the following model:

$$\begin{aligned} \triangle e_t = \mu + c_1 \triangle e_{t-1} + ... + c_n \triangle e_{t-n} \\ + \eta_0 Day_{at} + \eta_1 Surp_t + \eta_2 IT_t \\ + \phi_0 Day_{at} IT_t + \phi_1 Surp_t IT_t + \gamma \triangle X_t + \varepsilon_t \end{aligned} \tag{1.4.5}$$

If there is evidence of GARCH effects, I use Melvin et al. (2004 and 2010) specification of the conditional variance. As I focus on the effects of surprise announcements on meeting days after the adoption of IT, I include these variables multiplicatively into the conditional variance. The reason as in Melvin et al. (2010) is that the impact of announcements have only a transitory effect on the conditional variance. [6] The AR(p)-GARCH (1,1) regression model estimated is described as follows:

[6] This methodology follows Jones et al. (1998).

$$
\begin{aligned}
\triangle e_t &= \mu + c_1 \triangle e_{t-1} + ... + c_n \triangle e_{t-n} \\
&\quad + \eta_0 Day_{at} + \eta_1 Surp_t + \eta_2 IT_t \\
&\quad + \phi_0 Day_{at} IT_t + \phi_1 Surp_t IT_t + \gamma \triangle X_t + \sqrt{s_t}\varepsilon_t \\
\varepsilon_t \mid \Omega_{t-1} &\sim N(0, h_t) \\
s_t &= (1 + \delta_0 Day_{at} + \delta_1 Surp_t + \delta_2 IT_t + \delta_3 Day_{at} IT_t + \delta_4 Surp_t IT_t) \\
h_t &= \omega + \alpha \epsilon_{t-1}^2 + \beta h_{t-1}
\end{aligned}
\tag{1.4.6}
$$

where $\omega \geqslant 0$, $\alpha \geqslant 0$, $\beta \geqslant 0$ and the condition $\alpha + \beta < 1$ implies that the GARCH process is weakly stationary. This specification indicates that the conditional variance on any day t is equal to $s_t h_t$ and any of the coefficients of s_t represents the percentage increase in the exchange rate volatility associated to any of the variables included into the conditional variance. For instance, $(1 + \delta_0)h_t$ represents the conditional variance on any announcement day.

Nelson and Cao (1992) argue that the linear GARCH model has limitations due to the non-negativity constraints on the parameters. Modelling the logarithm of the variance guarantee its non-negativity, especially when some explanatory variables have negative values. As mentioned before, monetary shocks could represent good or bad news in an IT regime and this suggests that the behavior of exchange rate volatility in response to shocks should be asymmetric. In this sense, the EGARCH specification seems appropriate to model asymmetric effects as negative and positive shocks might have differential effects on exchange rate volatility. I evaluate if the GARCH specification or the EGARCH model is more appropriate to study the effects of interest rate announcements on the exchange rate behaviour. Following Nelson (1991) that proposed an Exponential GARCH (EGARCH), the AR(p)-EGARCH(1,1) regression model estimated is described as follows:

$$
\begin{aligned}
\triangle e_t &= \mu + c_1 \triangle e_{t-1} + ... + c_n \triangle e_{t-n} \\
&\quad + \eta_0 Day_{at} + \eta_1 Surp_t + \eta_2 IT_t \\
&\quad + \phi_0 Day_{at} IT_t + \phi_1 Surp_t IT_t + \gamma \triangle X_t + \varepsilon_t \\
\varepsilon_t \mid \Omega_{t-1} &\sim N(0, h_t) \\
ln(h_t) &= \omega + \alpha g(z_{t-1}) + \beta ln(h_{t-1}) + \delta_0 Day_{at} + \delta_1 Surp_t \\
&\quad + \delta_2 IT_t + \delta_3 Day_{at} IT_t + \delta_4 Surp_t IT_t
\end{aligned}
\tag{1.4.7}
$$

where $g(z_t) = \theta z_t + \varphi[|z_t| - E|z_t|]$, $z_t = \varepsilon_t / \sqrt{h_t}$ and w, α, β, θ and φ are real numbers. θ and φ are the asymmetric and symmetric effects, respectively. If z_t is a standard Gaussian random variable, $E|z_t| = \sqrt{2/\pi}$. There is multiplicative heteroskedasticity in the EGARCH model as in the GARCH specification because the conditional variance is specified in logs.

3. Is information contained in surprise monetary announcements useful in explaining extreme exchange rate returns?

I use a logistic model of extreme exchange rate events to answer this final question. As in Melvin et al. (2004), if at any day the absolute value of exchange rate returns exceeds 2.5 standard deviation of the entire exchange rate returns sample, this day is called an extreme exchange rate event. In this analysis, a response binary variable is created which is equal to 1 on days when there is an extreme exchange rate event and equal to 0 otherwise. In addition, I calculate the marginal effects to explain how a change in the probability of having an extreme exchange rate event is related to a change in a regressor. The regression equation of this logit model is equal to the following expression:

$$
\begin{aligned}
Logit(\pi) &= log(\frac{\pi}{1-\pi}) \\
&= Intercept + \gamma_0 Day_{at} + \gamma_1 Surp_t \\
&\quad + \gamma_2 IT_t + \gamma_3 Day_{at} IT_t + \gamma_4 Surp_t IT_t
\end{aligned}
\tag{1.4.8}
$$

In order to convert logit to probabilities the following formula is used:

$$
\hat{\pi} = \frac{e^{\hat{logit}}}{1 + e^{\hat{logit}}} \tag{1.4.9}
$$

1.5 Empirical Results

As in Melvin et al. (2004), the first question to be addressed is:

1. Are exchange rate returns different on days when the BOD meets?

The results are reported in Table 1.5. In Colombia, Chile and Brazil there are no significant differences in means of exchange rate returns between the different groups of days, and there is homogeneity of variances in both periods. The only exception is Brazil before the adoption of IT where the hypothesis of no significant differences in means is rejected at the 5% significance level and Chile where the hypothesis of homogeneity of variances is rejected at the 1% significance level. The hypothesis of equality of means is not rejected for Colombia given the p-values of 0.58 and 0.81 for pre-IT and IT periods, respectively. Additionally, the hypothesis of homogeneity of variances of daily exchange returns using the Levene's Test is not rejected according to the p-values of 0.86 and 0.82 in the same periods for Colombia. Similar results are obtained for Brazil and Chile. These results imply that in overall it is not possible to conclude that exchange rate returns behave different between announcement days

and other days. However, GARCH and Logit models are estimated as in Melvin et al. (2004 and 2010) to confirm the impact of surprise policy rate announcements on the exchange rate behaviour.

Table 1.5: Test of Equality of Means and Variances of Exchange Rate Returns

	Before Inflation Targeting			Inflation Targeting		
	Colombia	Chile	Brazil	Colombia	Chile	Brazil
			Dunnett's t Tests			
F	0.53	0.96	2.97	0.20	2.66	1.43
(p-value)	(0.58)	(0.38)	(0.05)	(0.81)	(0.07)	(0.23)
Difference Btw Means						
Daya-Others	-0.063	0.065	-0.252	-0.029	-0.063	-0.094
Dayach-Others	-0.060	0.079	-0.276	0.028	-0.165	-0.155
			Levene's Tests			
F	0.14	8.38	0.08	0.19	1.5	0.61
(p-value)	(0.86)	(0.00)	(0.92)	(0.82)	(0.21)	(0.54)
Standard Deviation						
Daya	0.395	0.586	1.009	0.676	0.513	0.942
Dayach	0.443	0.662	1.064	0.566	0.555	0.754
Others	0.477	0.352	0.872	0.653	0.642	0.999

Notes: Dunnett's test for unbalanced data. Levene's test for homogeneity of variances using ANOVA of squared deviations from group means.

2. Have surprise monetary announcements on BOD meeting days diminished their effect on daily exchange rate returns after the adoption of IT?

I initially estimated the model of equation (1.4.5) by OLS, and the results indicate that the variables related to the BOD meeting days are not powerful in explaining exchange rate returns. However, as in Melvin et al. (2004 and 2010), GARCH effects are found in the estimations and I estimate the GARCH specification represented by equation (1.4.6) but with the mean equation equal to:

$$\triangle e_t = \mu + c_1 \triangle e_{t-1} + ... + c_n \triangle e_{t-n} + \gamma \triangle X_t + \sqrt{s_t}\varepsilon_t \qquad (1.5.1)$$

As I find strong persistence in the parameters estimated of the conditional variance that could lead to an integrated GARCH (IGARCH) model, I choose an EGARCH model as my preferred specification due to the reasons explained in the previous section. I estimate an EGARCH model for each country under the assumption that errors follow a generalized error distribution (GED) as the shape parameter of that distribution results significant and less than 2. This indicates that the distribution of the residuals appear to have fatter tails than the residuals of the normal distribution. [7]As in the GARCH case, the mean equation does not include the variables related to announcement days and surprises as they are not significant. The reached specification for each country corresponds to an AR(2)-EGARCH(1,1) model as follows:

$$\begin{aligned} &\triangle e_t = \mu + c_1 \triangle e_{t-1} + c_2 \triangle e_{t-2} + \gamma \triangle X_t + \varepsilon_t \\ &\varepsilon_t \mid \Omega_{t-1} \sim N(0, h_t) \\ &ln(h_t) = \omega + \alpha g(z_{t-1}) + \beta ln(h_{t-1}) + \delta_0 Day_{at} + \delta_1 Surp_t \\ &\qquad + \delta_2 IT_t + \delta_3 Day_{at} IT_t + \delta_4 Surp_t IT_t \end{aligned} \tag{1.5.2}$$

Table 1.6 shows the estimations of the EGARCH model in each country. In order to control for the recent financial crisis, I include a dummy *Crisis* equal to one for the period January 2 2008 to June 30 2009 and zero otherwise. [8]The results indicate that the effect of inflation targeting on exchange rate volatility is positive and statistically significant at 1% level in all countries. In addition, the estimates of the interaction terms between inflation and announcement days and surprise measures attain the expected sign indicating a decrease in volatility after the adoption of IT. The asymmetric coefficients captured by θ are positive and significant at the 1% significance level, implying that positive shocks are more destabilizing than negative

[7]The shape parameter is equal to 2 when the residuals are distributed normal.

[8]The crisis period is selected according to the business cycle reference dates announced by the National Bureau of Economic Research (NBER).

Table 1.6: EGARCH Models for Exchange Rate Returns

	Colombia	Chile	Brazil
		Mean Equation	
Constant	0.0045	0.0028	0.0276***
	(0.0052)	(0.0055)	(0.0018)
AR(1)	0.2215***	0.1462***	0.1023***
	(0.0164)	(0.0157)	(0.0164)
AR(2)	-0.0882***	-0.0379***	-0.0392***
	(0.0157)	(0.0155)	(0.0158)
		Variance Equation	
Daya	0.7426***	0.2114	0.4082**
	(0.0816)	(0.1742)	(0.1710)
Surp	-0.0200	0.0922***	0.3295***
	(0.0376)	(0.0256)	(0.0081)
IT	0.0248***	0.0733***	0.1547***
	(0.0091)	(0.0154)	(0.0178)
Crisis	0.0817***	0.0579***	0.0297*
	(0.0191)	(0.0163)	(0.0201)
Daya*IT	-0.6014***	-0.1346	-0.3663*
	(0.1113)	(0.2034)	(0.2164)
Surp*IT	-0.0339	-0.2854***	-0.2367***
	(0.0739)	(0.0849)	(0.0857)
Constant	-0.0871***	-0.1261***	-0.1546***
	(0.0106)	(0.0220)	(0.0182)
EARCH(1)	0.3963***	0.2803***	0.3910***
	(0.0169)	(0.0202)	(0.0193)
EGARCH(1)	0.9577***	0.9522***	0.9657***
	(0.0035)	(0.0070)	(0.0036)
Asymmetric Effect	0.0283***	0.0445***	0.0920***
	(0.0086)	(0.0118)	(0.0125)
GED Shape	1.2668***	1.3547***	1.3066***
	(0.0334)	(0.0253)	(0.0299)
Chi-Square	206.66	88.13	111.10
p-value	0.0000	0.0000	0.0000
Log-Likelihood	-2423.286	-2596.94	-2883.14
Obs	4089	4159	3882

Notes: Robust standard errors in parenthesis. ***, **, * denotes significance at the 1%, 5%, and 10% level. Test GED shape parameter with Ho: GED shape=2 equivalent to a normal distribution. The VIX and the CRB index are included as controls but not reported here.

shocks of equal magnitude. Although the asymmetric effect is smaller than the symmetric effect in each country, this result does not imply that there is no a differential

effect of good news and bad news as θ is significant in all the estimations.

I use a difference-in-differences analysis with the EGARCH estimates before and after the adoption of IT to examine the overall effects in volatility of announcement days and days when the interest rate announcement surprises the market. The coefficients in Table 1.7 are the result of linear combinations of the estimates from the EGARCH model. For instance, the coefficient Day_a before the adoption of IT corresponds to the coefficient Day_a in the EGARCH estimations. The coefficient Day_a after the adoption of IT is the sum of the coefficient Day_a plus the interaction term $Day_a * IT$ as I want to measure the effect of announcement days after the adoption of IT. The coefficients in the second row correspond to the impact of surprise announcements on interest rate decision days. For instance, the coefficient $Surp$ before the adoption of IT corresponds to the coefficient of the announcement day Day_a plus the coefficient of surprises $Surp$. In addition, the coefficient $Surp$ after the adoption of IT corresponds to the coefficient of the announcement day Day_a plus the coefficient of surprises $Surp$, plus the interaction terms $Day_a * IT$ and $Surp * IT$.

The results reported in Table 1.7 indicate that the exchange rate volatility in Colombia behaves different on announcement days Day_a and even more when the announcement is a surprise $Surp$. Exchange rate volatility increases by 72% before IT and by 9% after IT on days when the interest rate announcement is a surprise. However, if I consider the effect of IT, exchange rate volatility is about 64% lower after the adoption of IT. This confirm my previous conjecture that IT has diminished the impact of surprise interest rate announcements on exchange rate volatility and it may be related to the systematic change in market expectations. It is important to note that these results could be affected by the pre-IT period because at that time was introduced an interest rate band to reduce the interest rate volatility. This implies when an interest rate decision was made before the adoption of IT to maintain the exchange rate within the band, the market thought it was going to be profitable,

and this does not happen under a flexible regime.

Table 1.7: The Effect of Interest Rate Announcements on Exchange Rate Volatility

Colombia			
	Pre-IT	Post-IT	Difference
Daya	0.7426***	0.1411**	-0.6014***
	(0.0816)	(0.0731)	(0.1113)
Surp	0.7226***	0.0872	-0.6354***
	(0.0946)	(0.1008)	(0.1398)
Difference	-0.0200	-0.0539	-0.0339
	(0.0376)	(0.0637)	(0.0739)
Chile			
	Pre-IT	Post-IT	Difference
Daya	0.2114	0.0768	-0.1346
	(0.1742)	(0.1031)	(0.2034)
Surp	0.3037*	-0.1163	-0.4200*
	(0.1783)	(0.1348)	(0.2244)
Difference	0.0922***	-0.1931***	-0.2854***
	(0.0256)	(0.0805)	(0.0849)
Brazil			
	Pre-IT	Post-IT	Difference
Daya	0.4082**	0.0419	-0.3663*
	(0.1710)	(0.1306)	(0.2164)
Surp	0.7377***	0.1347	-0.6030***
	(0.1729)	(0.1564)	(0.2346)
Difference	0.3295***	0.0928	-0.2367***
	(0.0081)	(0.0854)	(0.0857)

Notes: Robust standard errors in parenthesis. ***, **, * denotes significance at the 1%, 5%, and 10% level. This table shows the estimates of the conditional variance for announcement days (Daya) and announcement days when the interest rate decision is a surprise (Surp) before the adoption of IT (Pre-IT) and during IT (Post-IT). The last row shows the difference between surprise announcement days(Surp) and announcement days(Daya). The last column shows the difference between Post-IT and Pre-IT for Daya and Surp, and the difference-in-differences (bottom right cell) that corresponds to the overall effect of surprises on exchange rate volatility after the adoption of IT (estimate Surp*IT from the EGARCH model).

I find that in Chile exchange rate volatility has decreased about 42% after the adoption of IT on days when the Central Bank surprise the market. The results for Brazil are similar to those in Colombia as volatility on surprise announcement days increases about 74% and 13% pre-IT and post-IT respectively. This implies a

reduction in volatility of about 60% after the adoption of IT and confirms that IT has changed the relationship between monetary policy announcements and exchange rate volatility. The results for Chile may be more moderate as during the 1990s the Central Bank adopted an implicit IT regime.

Table 1.8 consolidates the results by country. The estimations indicate that the relationship of surprise announcements with exchange rate volatility is affected by the monetary regime adopted, in this case IT. There is evidence for Colombia, Chile and Brazil that exchange rate volatility on surprise announcement days is lower after the adoption of IT. It is important to note that is not possible to disentangle if the overall effect comes from the adoption of IT or the adoption of a flexible exchange rate regime as in Colombia and Chile both were adopted simultaneously, and in Brazil there is only a time gap of five months. However, the literature on exchange rate determination advocates for an increase in exchange rate volatility after the elimination of a fixed exchange rate regime. For instance, Taylor (1995) notes that the literature has found evidence of higher variability in the nominal exchange rate during floating exchange rate regimes than fixed exchange rate frameworks. In addition, he explains that a number of papers evidence lower variability of macroeconomic fundamentals than nominal exchange rates during flexible exchange rate regimes that have enhanced the study of other factors not reflected in the traditional macroeconomic fundamentals. Following this evidence, it is likely that in this paper IT and not the adoption of a flexible exchange rate regime explains the notable reduction in exchange rate volatility on announcement days due to higher transparency and credibility in central bank policies.

Table 1.8: Overall Effects of Interest Rate Announcements on Exchange Rate Volatility after the Adoption of IT

	Colombia	Chile	Brazil
Daya	-0.6014***	-0.1346	-0.3663*
	(0.1113)	(0.2034)	(0.2164)
Surp	-0.6354***	-0.4200*	-0.6030***
	(0.1398)	(0.2244)	(0.2346)
Difference	-0.0339	-0.2854***	-0.2367***
	(0.0739)	(0.0849)	(0.0857)

Notes: Robust standard errors in parenthesis. ***, **, * denotes significance at the 1%, 5%, and 10% level.

3. Is information contained in surprise monetary announcements on BOD meeting days useful in explaining extreme exchange rate returns?

The coefficients on announcement days Day_a and continuous surprises $Surp$ are not significant in explaining extreme exchange rate returns in Colombia, Chile, and Brazil. However, the coefficients on inflation IT and the recent financial crisis $Crisis$ are significant in all countries. The results are reported in Table 1.9 and I only show the fitted models with significant variables. The probability of evidence an extreme exchange rate return event increases by about 2.7% in Colombia, 2.7% in Chile, and 2.6% in Brazil. Then, I analyze the marginal effect of each variable on the dependent variable. The predicted probability of having an extreme exchange rate return in Colombia is 2.1% lower after the adoption of IT and 6.6% greater during the recent financial crisis. In Chile and Brazil, the probability of having an extreme exchange rate return is 2.5% and 5.4% lower after the adoption of IT respectively, and 5.3% and 3.7% greater during the financial crisis. In general, there is no evidence that information on announcement days has changed the probability of evidence an extreme exchange rate return in the country sample, while IT and the recent financial crisis have affected that probability.

Table 1.9: Logit Models for Extreme Exchange Rate Returns

	Colombia	Chile	Brazil
Constant	-3.5667***	-3.3123***	-5.3875***
	(0.1851)	(0.1652)	(0.5787)
IT	-0.8641***	-0.9933***	-2.2820***
	(0.2587)	(0.2354)	(0.3070)
Crisis	2.6198***	2.0964***	1.5444***
	(0.2355)	(0.2411)	(0.2379)
Estimated Probability	0.0273	0.0266	0.0255
Marginal Effects			
IT	-0.0218	-0.0252	-0.0547
Crisis	0.0663	0.0531	0.0370
Chi-Squared			
LR	120.23***	70.44***	85.59***
Score	198.51***	96.74***	131.23***
Wald	133.40***	75.59***	90.61***

Notes: The probability modeled is having an extreme exchange rate event. Standard errors in parenthesis. ***, **, * denotes significance at the 1%, 5%, and 10% level.

1.6 Conclusions and Future Research

The exchange rate determination analysis in EMEs has usually been developed from a macroeconomic perspective using conventional and Taylor Rule models. This paper studies the exchange rate dynamics from a microeconomic perspective in EMEs. This study is of interest to economic policymakers because helps to understand the impact of interest rate announcements on exchange rate returns and its volatility in EMEs under IT. In addition, it is helpful in the formulation of appropriate policies in the exchange rate market without generating more disturbances.

I examine if the exchange rate returns and its volatility behave differently on surprise announcement days and if IT has changed the mechanisms through which these surprises impact the foreign exchange market using daily data. I include Colombia,

Chile and Brazil in the study. This analysis has not been studied before in industrialized and developing countries as I consider the pre-IT and post-IT periods.

Firstly, I tests the equality of means of returns and homogeneity of variances. The results for all countries indicate that there are no significant differences in means returns between announcement days and the other days. In addition, there is evidence of homogeneity of variances between policy rate announcement days and the other days. Secondly, I find that information on announcement days does not affect the exchange rate returns. However, I model the conditional volatility using EGARCH models, including dummy variables associated to announcement days and continuous surprise measures. The results for all countries show evidence that exchange rate volatility increases on BOD meeting days when the announcements represent a surprise for the market. However, the exchange rate volatility on announcement days and days when the market is surprised is lower after the adoption of IT in Colombia, Brazil and Chile.

It is important to note that the results indicate significant differences in exchange rate volatility on surprise announcements days and IT has changed the relationship between monetary policy announcements and exchange rate volatility. Although it is not possible to disentangle the overall effect from the adoption of IT and the adoption of a flexible exchange rate regime as both were adopted simultaneously in these countries, the literature advocates for an increasing volatility after the adoption of a flexible exchange rate regime that may indicate that IT is the factor driving my results.

Finally, I use Logit models to explain if the information on surprise announcement days explain extreme exchange rate returns. There is no evidence that information on surprise announcement days has changed the probability of evidence an extreme exchange rate return in the country sample, while IT and the recent financial crisis have affected that probability. The probability of having an extreme exchange rate

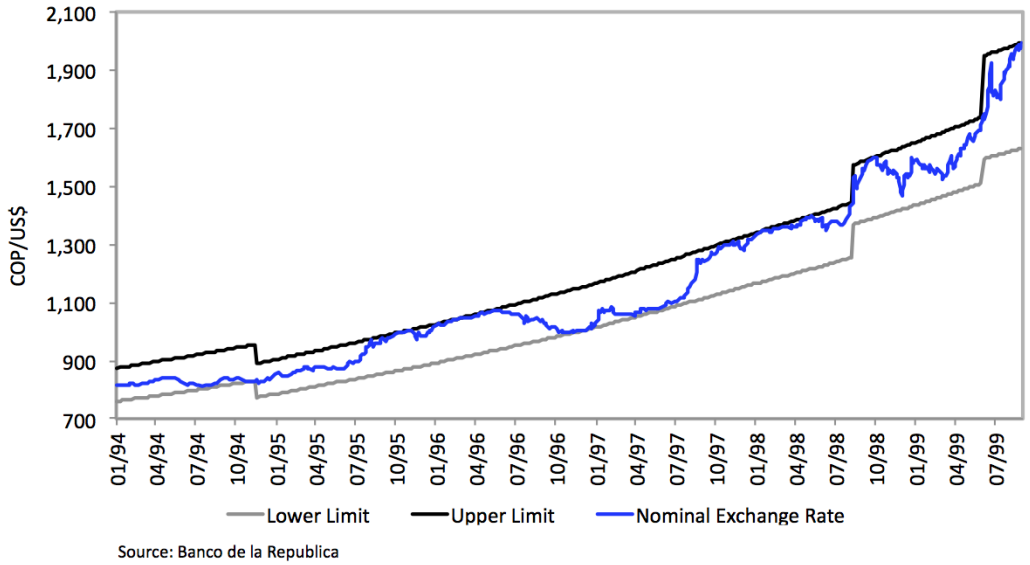
return is lower after the adoption of IT and expectedly higher during the recent financial crisis in all countries.

As an agenda for future research is interesting to use techniques such as the wild bootstrap in order to specify more accurately the mean equation irrespective of the variance equation. This method is different from the residual bootstrap in that allows for heteroskedasticity of unknown form by conditioning on the transformed residuals. The main idea of the wild bootstrap technique is to leave the explanatory variables at their sample value and to resample the dependent variable based on the transformed residuals that are multiplied by a random variable with mean 0 and variance 1. The most common choice for the random variable is Mammen's two-point distribution which involves two different probabilities and the Rademacher distribution where the bootstrap residuals are positive with probability one-half. An alternative to these distributions is the standard normal distribution. However, it has sometimes the problem that imposes symmetry as the Rademacher distribution. In addition, it would be interesting to use different procedures to detect structural breaks in order to evaluate if the break in the data was really precisely at the time of the adoption of IT, or if it occurred before or after. For instance, the Chow test (1960) would be useful to evaluate structural changes at a known break date that in this case corresponds to the date of the adoption of IT. Furthermore, the test of Bai and Perron (1998, 2003) evaluates structural changes at unknown break dates to see if there is econometric evidence that there are multiple unknown breakpoints.

Appendix

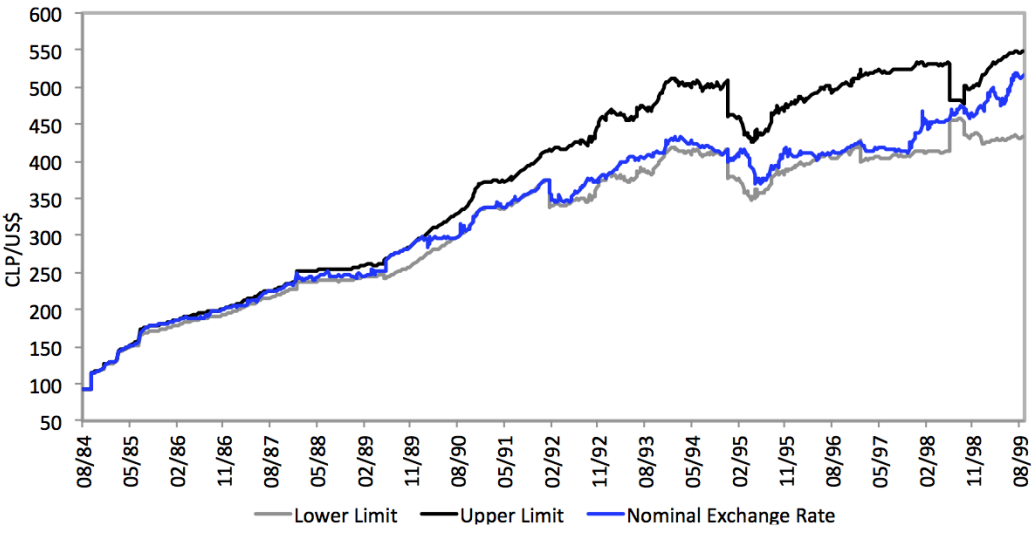
A. Figures

Figure A.1: Exchange Rate Band in Colombia



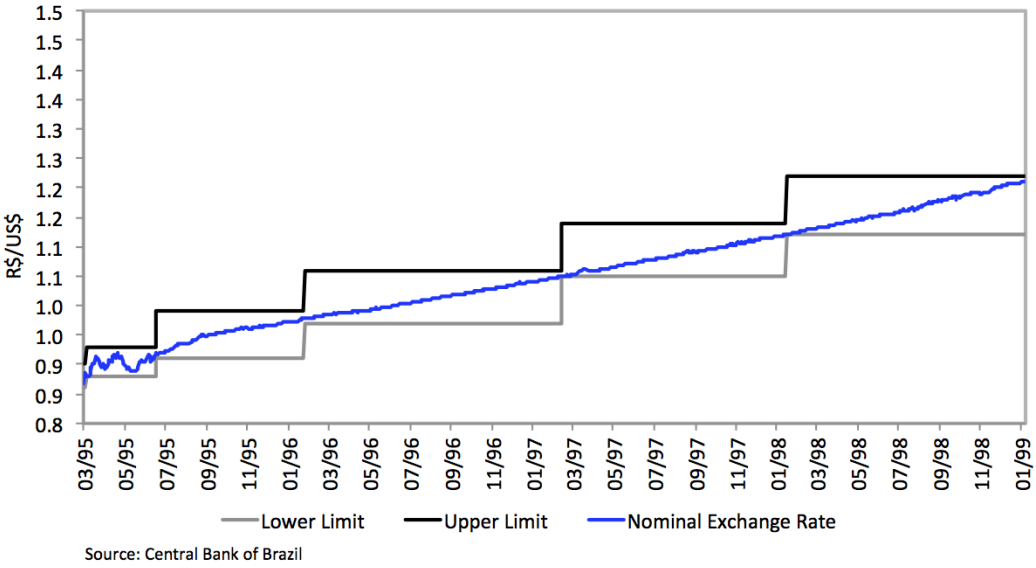
Source: Banco de la Republica

Figure A.2: Exchange Rate Band in Chile



Source: Central Bank of Chile

Figure A.3: Exchange Rate Band in Brazil



Source: Central Bank of Brazil

Figure A.4: Continuous Surprises Measures Before and After the Adoption of Inflation Targeting

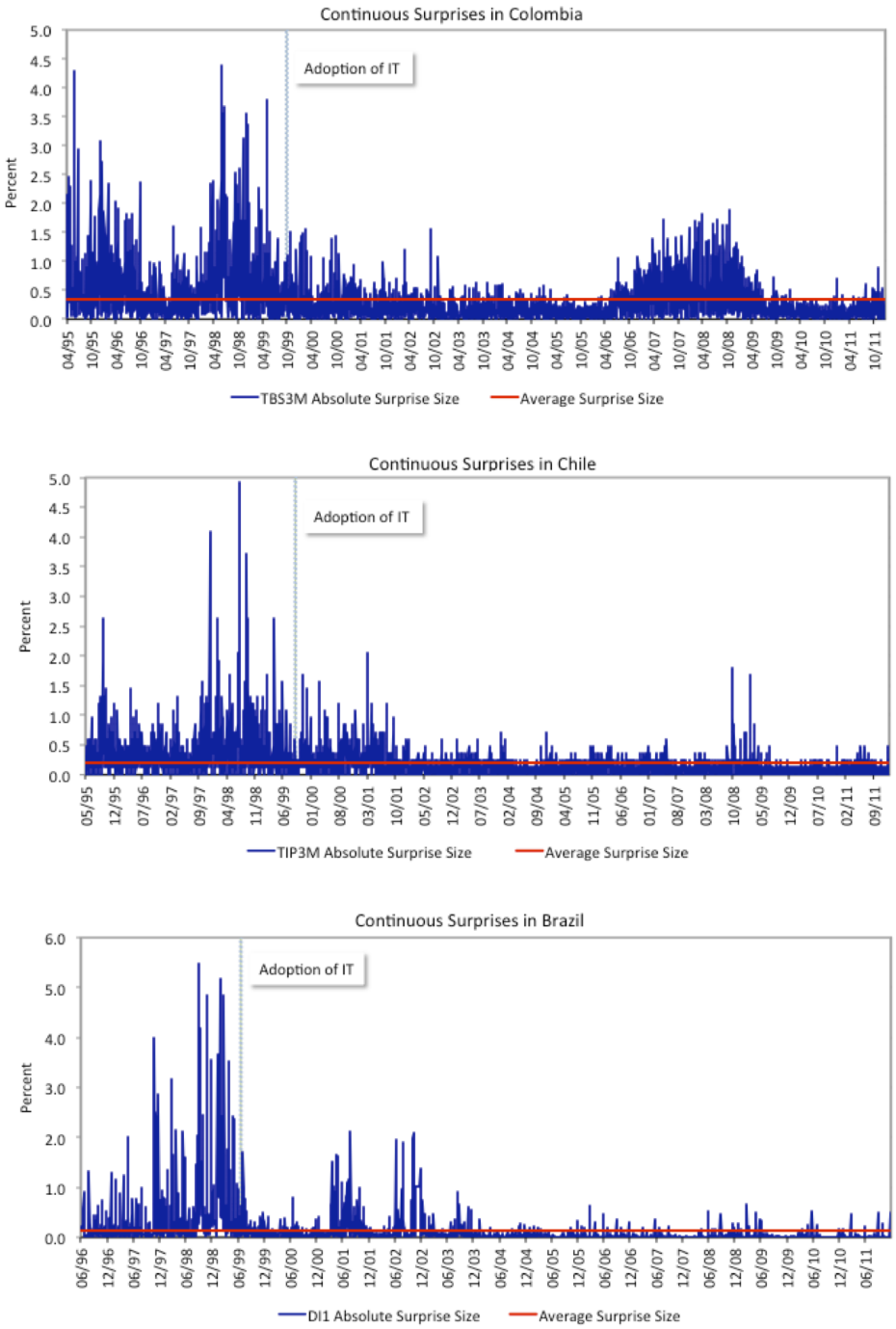
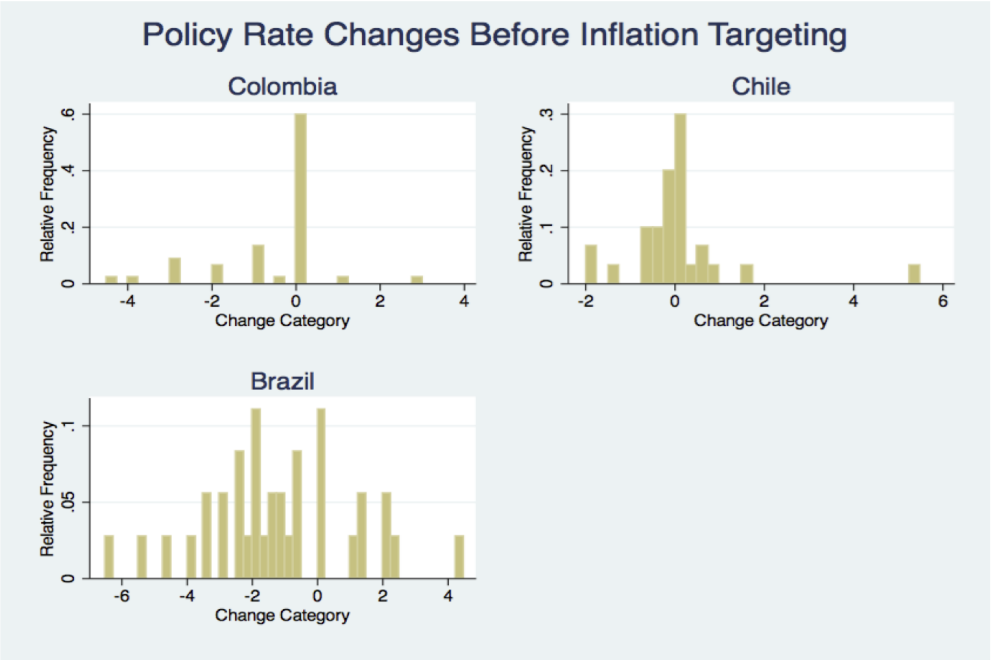
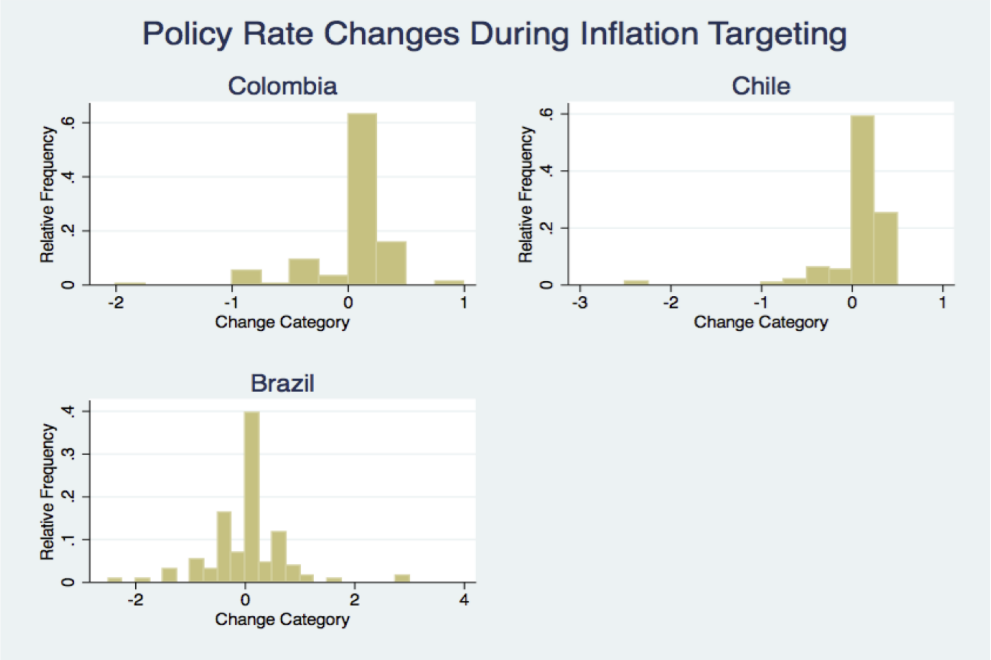


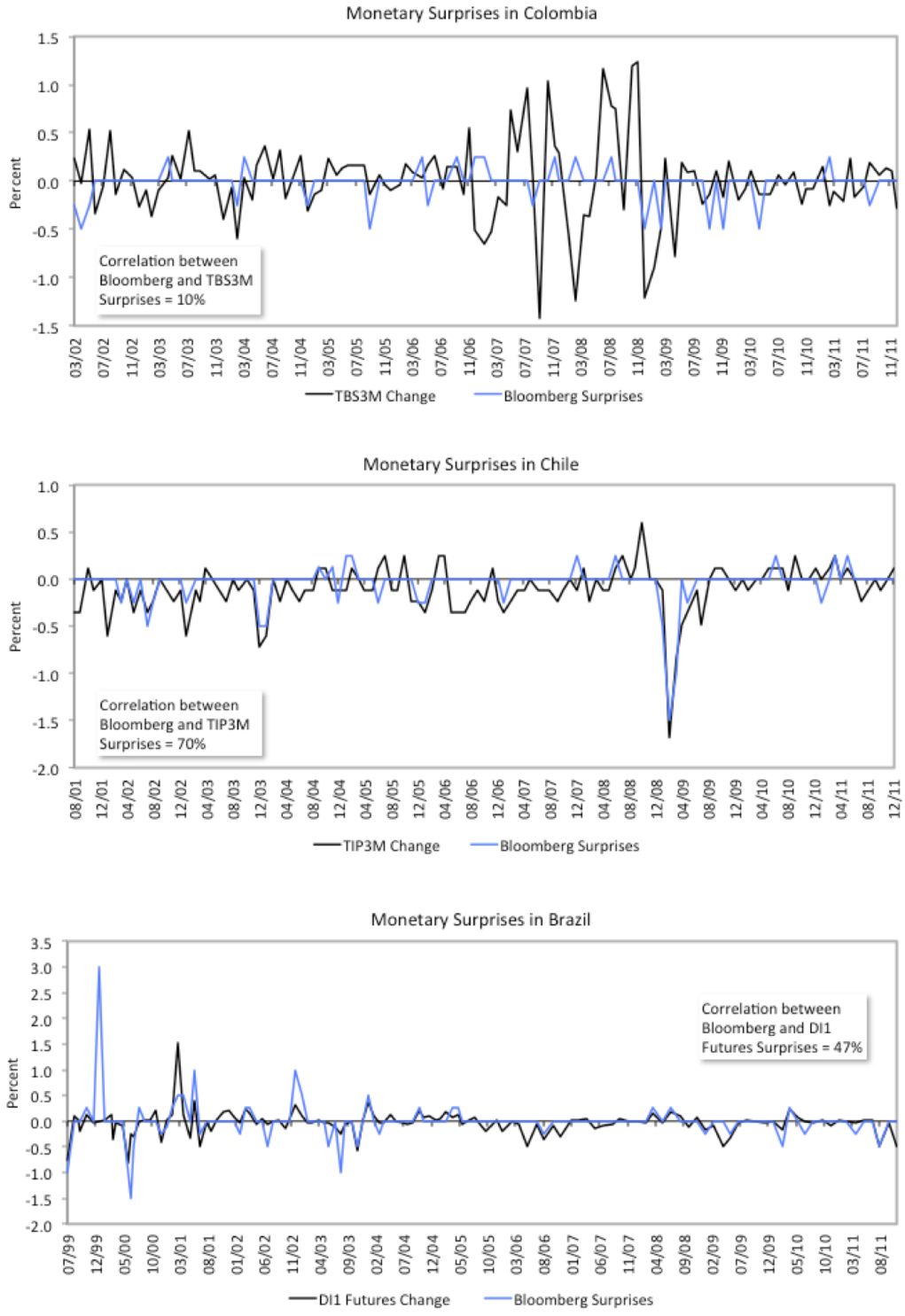
Figure A.5: Histograms of Policy Interest Rate Changes





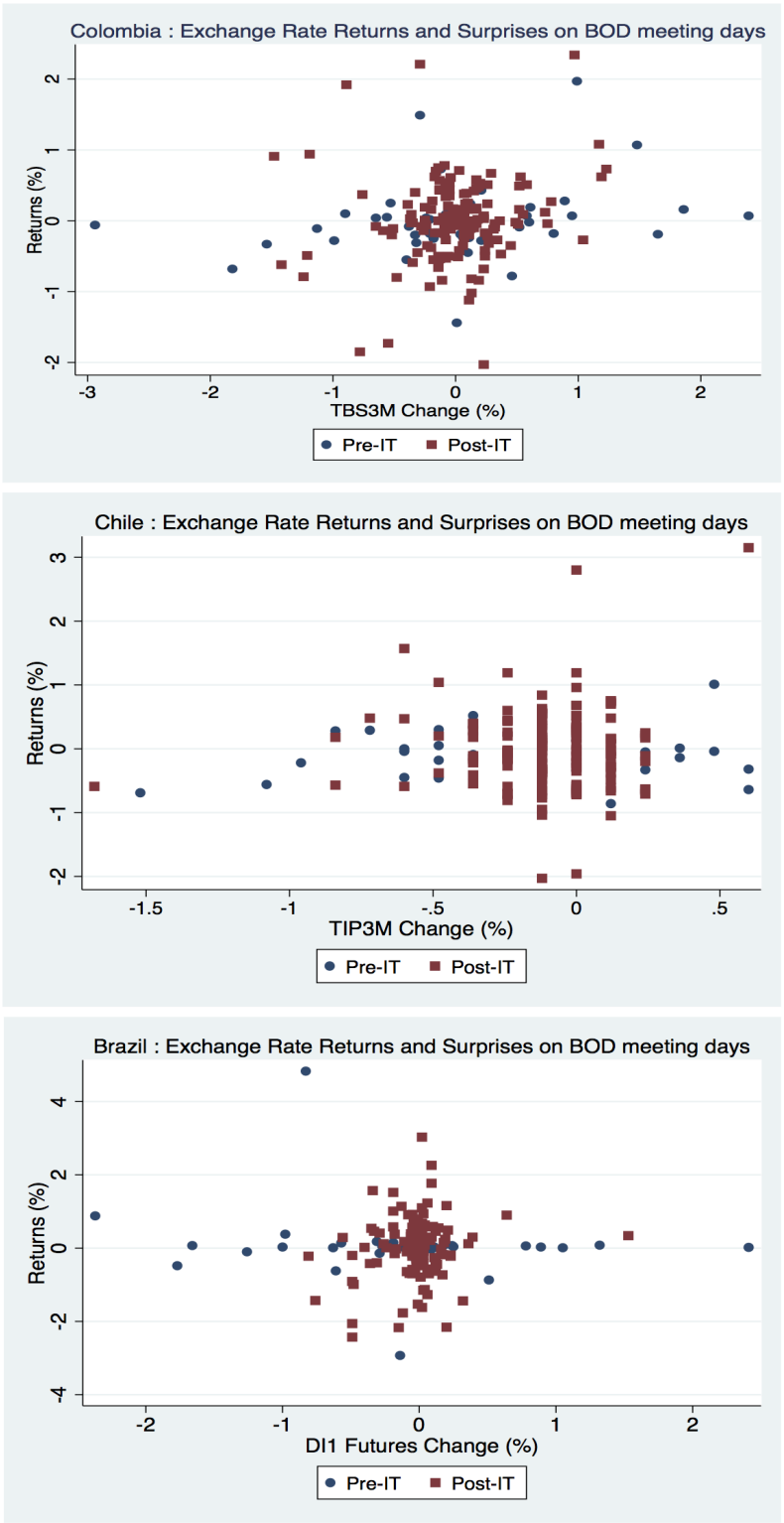
Source: Central Banks and own calculations.

Figure A.6: Monetary Surprises Based on Short Term Interest Rates and Bloomberg Expectations



Source: Own calculations and Bloomberg.

Figure A.7: Exchange Rate Returns and Continuous Surprises on Central Bank Meeting Days



B. Tables

Table B.1: Descriptive Statistics of Exchange Rates before Inflation Targeting

	Colombia		Chile		Brazil	
Statistic	Exchange Rate	Returns	Exchange Rate	Returns	Exchange Rate	Returns
Mean	1238.1	0.1	434.9	0.0	1.2	0.1
Median	1095.6	0.1	418.6	0.0	1.1	0.0
Maximum	1994.9	5.1	519.9	2.5	2.1	10.5
Minimum	866.3	-3.1	368.8	-2.4	0.9	-8.8
Standard Deviation	277.0	0.5	35.7	0.4	0.2	0.8
Skewness	0.7	1.4	0.6	0.6	2.0	3.1
Kurtosis	2.6	19.8	2.5	10.9	6.0	63.0
Jarque-Bera (p-value)	0.0	0.0	0.0	0.0	0.0	0.0
ADF test statistic	2.6	-22.4	0.3	-30.0	-0.5	-5.7

Table B.2: Descriptive Statistics of Exchange Rates during Inflation Targeting

	Colombia		Chile		Brazil	
Statistic	Exchange Rate	Returns	Exchange Rate	Returns	Exchange Rate	Returns
Mean	2244.9	0.0	569.9	0.0	2.2	0.0
Median	2257.7	0.0	544.9	0.0	2.1	0.0
Maximum	2968.9	4.8	758.2	4.4	3.9	8.9
Minimum	1652.4	-5.6	431.2	-3.7	1.5	-9.3
Standard Deviation	322.3	0.6	74.5	0.6	0.5	0.9
Skewness	0.5	0.02	0.6	0.5	0.9	0.08
Kurtosis	2.4	12.3	2.5	8.6	3.1	14.4
Jarque-Bera (p-value)	0.0	0.0	0.0	0.0	0.0	0.0
ADF test statistic	-1.4	-47.3	-1.5	-47.9	-1.4	-52.3

Chapter 2

The Effectiveness of Foreign Exchange Intervention in Latin America: A Nonlinear Approach of the Coordination Channel

2.1 Introduction

The literature on the effectiveness of exchange rate intervention in Emerging Economies (EMEs) has grown up during the last decade. However, as Menkhoff (2013) explains in his survey of empirical studies on foreign exchange rate intervention in EMEs, empirical research in this area is still focused in advanced economies. Studying the effectiveness of foreign exchange rate intervention is of crucial importance for policy-makers, especially in Latin America where exchange rate intervention is an important part of Central Bank policies.

The main objective of this paper is to find empirical evidence that exchange rate misalignments in Brazil, Chile, Colombia, Mexico and Peru may be caused

by nonlinear factors that force fundamentals-based traders to exit the market and this is the result of a coordination failure in the market. Following Reitz and Taylor (2008), the hypothesis is that foreign exchange intervention may act as a coordinating instrument that encourage traders to re-enter the market and revert the path of the exchange rate into a stable regime.

Empirical studies in Latin America have analyzed foreign exchange intervention effectiveness under the portfolio and signaling channels. The importance of the coordination channel and the existence of nonlinearities in deviations of the exchange rate from its fundamental value have been neglected in Latin America and this is reflected in the lack of research in this area. I want to fill this gap using a microstructural model based on heterogeneous agents where exchange rates are determined by the process of order flow trading in a market with uninformed and informed traders that is consistent with the coordination channel approach. The theoretical model is an extension of Reitz and Taylor (2008) to EMEs in Latin America. In addition, I include a measure of time-varying risk that is crucial in models that analyze the impact of foreign exchange intervention on exchange rate returns in these economies. This measure captures the behaviour of risk averse foreign exchange market participants and supports the idea that the rejection of the risk-neutral efficient markets hypothesis may be the result of a time-varying risk premia.

I use a Smooth Transition Regression GARCH-M (STR-GARCH-M) model to examine the empirical evidence of this microstructural approach in terms of the effectiveness of foreign exchange interventions conducted in Brazil, Chile, Colombia, Mexico and Peru. I include these countries in my analysis due to different reasons. First, the data availability at daily basis within all the emerging economies that intervene actively in the foreign exchange market. Second, these economies have inflation targeting and a managed floating exchange rate regime as a framework of monetary policy and foreign exchange policy, respectively. In addition, they exhibit

large exchange rate dependencies as noted by Gomez et al. (2012). Using daily data from 2000 and 2013, the results provide evidence of a nonlinear mean reverting process of exchange rates with the exception of Chile. In addition, I find that foreign exchange intervention has increased traders confidence in exchange rate fundamentals and has been effective in increasing the degree of mean reversion of exchange rates to a stable regime under a coordination channel perspective. Furthermore, the risk premia measured by the standard deviation of the conditional variance reduces the pace of domestic depreciation as risk averse investors require a higher rate of return from holding the domestic currency.

In Chapter 1, I model the exchange rate behaviour in similar countries (i.e. Brazil, Chile, and Colombia). However, I use different specifications between chapters due to two main reasons. First, the data sample in Chapter 1 considers two different periods. The period where the exchange rate band was a nominal anchor and the period after the adoption of inflation targeting. In Chapter 2, I only focus on the period under inflation targeting as the data on foreign exchange intervention is only available after 2000 in all countries. Different samples between chapters may result in different specifications of the autoregressive part of the mean. For instance, in Chapter 1, I reach a specification of the mean equation for exchange rate returns of order AR(2), while in this chapter the specification of the mean equation is of order AR(1). Second, I analyse in this chapter the coordination channel of foreign exchange intervention that usually employs non linear models relying on the assumption that non linear factors affect the dynamic of exchange rates.

The model used in this paper is part of the incipient literature on foreign exchange market microstructure in Latin America. The microstructure approach of exchange rate determination differs from the conventional macroeconomic approach in that not all information is publicly available and there is heterogeneity between market participants. Lyons (2001) explains that order flow as a fundamental variable in

this approach is a signed transaction volume that contains relevant information to exchange rates because contains the dealer's interpretation of fundamentals that is priced in the trading process. The empirical evidence on exchange rate determination in advanced economies finds that order flow has a higher degree of explanatory power of exchange rate behaviour than traditional macroeconomic fundamentals. As Sarno and Taylor (2002) explain, order flow capability to explain the pattern of exchange rates relies on its predictability of macroeconomic fundamentals expectations, poorly measured by the traditional macroeconomic approach.

Lyons (2001) notes that if central banks attempt to maintain a fixed exchange rate, they learn from order flow if fundamentals are consistent with the peg. There is such consistency when the private net order flow or the difference between buyer-initiated and seller-initiated orders is close to zero. This is not the case of a flexible exchange rate regime when the central bank does not intervene in the foreign exchange market. When the exchange rate regime is managed floating as in the case of the countries analyzed in this paper, central banks still learn from order flow if exchange rate is deviating from its fundamental value. From this learning process, central bank intervention may act as a coordinating tool that encourage informed dealers to re-enter the market and revert the exchange rate pattern to an stable path consistent with fundamentals.

This paper focuses on the effects of sterilized intervention on the exchange rate dynamics as non sterilized intervention may affect the exchange rate by a similar mechanism of transmission to conventional monetary policy. As Sarno and Taylor (2001) explain, there are two reference channels in the literature that address the question of how sterilized exchange rate intervention may affect the exchange rate: the portfolio and the signaling channel. Sterilized foreign exchange intervention works under the portfolio channel if there is imperfect substitution between domestic and foreign assets as purchases or sales of foreign currency change portfolio

assets composition and has a direct impact on the spot exchange rate. As Sarno and Taylor (2001) note, imperfect substitutability is unlikely to hold in highly integrated markets, especially in developed economies and that is the main reason that the empirical evidence on this channel is mixed. Through the signaling channel monetary authorities could send clear messages about the future stance of monetary policy and affect the level of the exchange rate through changes in expectations. Neely (2008) notes that central bankers in emerging markets report that both channels of intervention work but the signaling channel is stronger in terms of the effectiveness of intervention. From the signaling channel perspective, foreign exchange intervention effectiveness in Latin America may rely on the consistency between monetary and foreign exchange policies. Consistency between policies do not put in risk the commitment to an inflation target and avoid unclear messages to the market about the future stance of monetary policy that may affect the effectiveness of foreign exchange intervention through expectations. Taylor (1994, 2004, 2005) and Sarno and Taylor (2001) discuss a third channel called the coordination channel. Persistent deviations of the exchange rate from its fundamental value may be caused by the lack of coordination between traders when they form their expectations. As Sarno and Taylor (2001) note foreign exchange rate intervention may work as a coordinating tool that encourage fundamentals-based speculators to trade actively in the market and increase the degree of mean reversion of the exchange rate to a stable path.

Although this paper focuses on the coordination channel of foreign exchange intervention, it is noteworthy to mention the relevant literature on the effectiveness of foreign exchange intervention in Latin America. For instance, Nascimento and Ribeiro (2011) analyzes the effectiveness of foreign exchange intervention in Brazil between 1999 and 2006. They note that the impact of central bank intervention on the exchange rate conditional volatility depends on the type of intervention analyzed such as spot market auctions. Tapia and Tokman (2004) use daily data for

Chile covering the period 1998 to 2003 and find that the effect of foreign exchange intervention is small but public announcements or oral interventions during that period influenced the level and trend of the exchange rate. Kamil (2008) studies the effectiveness of central bank intervention in Colombia between 2004 and 2007. During that period, foreign exchange intervention was effective when foreign currency purchases were consistent with an easing monetary policy and ineffective when the central bank had a conflict between achieving the inflation target and fighting against currency appreciation. Mundaca (2011) uses intraday data for Peru between 2004 and 2009 and finds evidence that foreign exchange intervention moves the exchange rate to the desired level during the time frame at which the Central Bank is active intervening in the foreign exchange market. As Menkhoff (2013) states this result support the portfolio channel rather than the signaling channel as outside the intervention window intervention has a diminished effect on market expectations. In addition, there is empirical evidence that the Peruvian Sol has been less volatile when the Central Bank has intervened in the market. Finally, Guimaraes and Karacadag (2004) find evidence in Mexico that the effect of foreign exchange intervention is different for both the level and volatility of exchange rate. While the impact on the level is limited, sales of foreign currency increase short-term volatility.

The remainder of this paper is organized as follows. Section 2.2 explains the theoretical microstructural approach of the coordination channel used in this paper. Section 2.3 describes the empirical methodology. Section 2.4 describes the data set. Section 2.5 discusses the empirical results. In section 2.6, I include the results of robustness checks of the baseline model. Section 2.7 covers the conclusions and discusses future research.

2.2 A Microstructural Approach of the Coordination Channel

The framework used in this paper combines the coordination channel model developed by Reitz and Taylor (2008) with the theory on foreign exchange market efficiency, where the uncovered interest rate parity (UIP) condition may be adjusted by a risk premium component. Reitz and Taylor (2008) and Reitz et al. (2010) focus their approach on developed economies and include the interest rate differential as an unbiased predictor of the spot exchange rate change according to the UIP condition. However, due to the higher degree of foreign exchange risk perceived by foreign exchange market participants in EMEs, I include a risk premia component in this model. The assumption of non-risk neutrality of market participants modelled by a time-varying risk premium component does not rule out other possible explanations of the UIP condition failure such as the rejection of the rational expectations hypothesis. Modelling risk premium is still a matter of research as there are different factors that may affect its dynamics and there is still no common consensus on which measure is the most appropriate. As Fama (1984) notes if there is correlation between the forward premium and a time-varying measure of risk, this could produce biased results when testing the market efficient hypothesis. Nevertheless, the aim of this paper is to study the coordination role of central bank intervention in a framework where risk premia plays an important role in explaining the exchange rate behaviour.

The main assumption of this model is that order flow conveys relevant information in exchange rate determination and the foreign exchange market is composed by uninformed and informed traders with heterogeneous beliefs. The variation in the exchange rate is assumed to be a function of net order flow from these agents:

$$s_{t+1} = s_t + a^M(OF_t^U + OF_t^I) + \varepsilon_{t+1} \tag{2.2.1}$$

where s_{t+1} and s_t is the logarithm of the spot exchange rate at time $t+1$ and at time t, respectively. OF_t^U and OF_t^I are the net order flow from uninformed or chartists traders, and informed or fundamentalists-based traders, respectively. The exchange rate is the units of domestic currency per one unit of foreign currency that in this case is the US Dollar. As Reitz and Taylor (2008) note, exchange rates are determined by two main factors. First, the available public information captured by ε_{t+1}, and second, by order flow that may or may not be related to public macroeconomic news captured by $OF_t^U + OF_t^I$. The market maker determines the future path of the exchange rate depending on the number of orders filled and this is captured by the reaction coefficient a^M expected to be positive.

According to the UIP condition if the risk-neutral foreign exchange market efficiency hypothesis holds, the expected exchange rate depreciation should be equal to the interest rate differential between the domestic and the foreign nominal interest rates on similar securities. However, if market participants are risk averse, as I assume in this model, the interest rate differential is equal to the expected spot exchange rate depreciation plus a risk premium ρ_t as follows:

$$i_t - i_t^* = E_t s_{t+1} - s_t + \rho_t \tag{2.2.2}$$

As the failure of the efficient market hypothesis may be due to the rejection of the risk neutrality condition or the rejection of the rational expectations hypothesis, or both, I assume that rational expectations hold ($s_{t+1} = E_t s_{t+1} + \eta_{t+1}$) in order to model the existence of a time-varying risk premia that in my approach I assume as

exogenous. The UIP adjusted by a risk premium is defined as:

$$i_t - i_t^* = s_{t+1} - s_t + \rho_t - \eta_{t+1} \tag{2.2.3}$$

$$s_{t+1} - s_t = i_t - i_t^* - \rho_t + \eta_{t+1} \tag{2.2.4}$$

Domowitz and Hakkio (1985) study the existence of a time-varying risk premia in the foreign exchange market of some developed countries. Following their formulation, the risk premium p_t is composed by a constant term δ and a time-varying term σ_t equal to the conditional part of the standard deviation of the rational expectations forecast error term η_{t+1} as follows:

$$\rho_t = \delta + \sigma_t \tag{2.2.5}$$

As Sarno and Taylor (2002) note, chartists analyze patterns, trends and relevant information from statistical indicators in order to predict short term exchange rate movements. Chartist analysis has become important in foreign exchange trading and it plays a crucial role in an order flow-driven foreign exchange market. This model assumes that net order flow from chartists or uninformed traders is a function of the recent exchange rate return and the expected change of the exchange rate. Under rational expectations and the existence of a time-varying risk premia, the expected exchange rate depreciation is equal to the actual change of the exchange rate adjusted by a risk premium and a rational expectations error according to equations (2.2.2) to (2.2.4). The uninformed traders' orders is defined as:

$$OF_t^U = a^U(s_t - s_{t-1}) + b^U(i_t - i_t^*) - \rho_t^U + \eta_{t+1}^U \tag{2.2.6}$$

$$\rho_t^U = \delta^U + d^U\sigma_t \tag{2.2.7}$$

where i_t and i_t^* represent the overnight interest rates of domestic and foreign currency deposits, respectively. As chartists determine the exchange rate behaviour according to past patterns and trends, a^U is expected to be positive. The sign of $b^U$is ambiguous according to the forward premium puzzle found in the literature. If the covered interest parity holds, the UIP implies that the forward premium should be an unbiased predictor of the expected exchange rate depreciation, suggesting a positive sign for b^U. However, Sarno and Taylor (2002) explain that the empirical evidence on the foreign exchange market efficiency hypothesis using the UIP condition have found the existence of a forward rate bias that would suggest a negative sign for b^U. If $\delta^U$and d^U are equal to zero there is no risk aversion, while if they are different than zero there is evidence of a time-varying risk premia.

Fundamentalists or informed traders analyze exchange rate fundamentals to predict the future change of exchange rates. Their analysis relies on their perception about the long-run exchange rate fundamental equilibrium value f_t. The exchange rate is expected to reach this equilibrium level over time. According to Reitz and Taylor (2008), exchange rate deviations from its equilibrium level are important in determining net order flow for informed traders. The weight imposed to exchange rate misalignments w_t may not be constant over time as the confidence of traders in exchange rate fundamentals varies over time. Net order flow for informed traders depends on the deviation of the exchange rate from its long-run equilibrium value, and the interest rate differential plus a risk premium factor as in the uninformed traders case:

$$OF_t^I = a^I w_t(f_t - s_t) + b^I(i_t - i_t^*) - \rho_t^I + \eta^I{}_{t+1} \tag{2.2.8}$$

$$\rho_t^I = \delta^I + d^I \sigma_t \tag{2.2.9}$$

where a^I is a reaction coefficient expected to be positive; w_t takes values between zero and unity; the sign of b^I is ambiguous as in the chartists case; and d^I is expected to be different than zero. Reitz and Taylor (2008) note that a higher weight w_t reflects an increasing confidence c_t of informed traders in exchange rate fundamentals and it is modelled as follows:

$$w_t = \frac{exp(c_t)}{1 + exp(c_t)} \tag{2.2.10}$$

$$c_t = -(\phi_1 - \phi_2 D_t INT_t)\frac{|f_t - s_t|}{\sigma_t^s} \tag{2.2.11}$$

where w_t is a logistic function varying between zero and one; $D_t INT_t$ is a measure of central bank foreign exchange intervention; $f_t - s_t$ measures the degree of exchange rate misalignment; and σ_t^s is the conditional standard deviation of exchange rate changes. w_t is a function expressed in line with the study of De Grauwe and Grimaldi (2006) that evaluate the relative profitability of heterogeneous agents forecasting rules and the probability to switch to the better one.

If the degree of exchange rate misalignment increases, informed traders lose confidence in their predictions based on exchange rate fundamentals and it is more difficult to predict exchange rate behaviour. As Reitz et al. (2010) explain, informed traders are forced to exit the market because the exchange rate fundamental value is unobservable and the only option left for them is to derive information from the recent exchange rate realizations. When the degree of misalignment decreases, traders con-

fidence increases encouraging them to trade more actively in the market submitting more orders. Reitz and Taylor (2008) note that the degree of misalignment conveys more or less information in low or high volatility periods, respectively and it is reasonable to define traders confidence as a function of the standardized absolute exchange rate misalignment. In addition, central bank intervention influences fundamental-based traders confidence. From the coordination channel approach, central banks have more privileged information in the foreign exchange market and traders confidence is increased through foreign exchange intervention which send signals to the market to stabilize speculation. These signals incorporated in orders from informed traders stabilize the path of the exchange rate reverting it to its equilibrium level f_t. As Taylor (2004 and 2005) note, the effectiveness of intervention will depend on the degree of exchange rate misalignment. For instance, if there is a large gap between the equilibrium value of the exchange rate and the spot exchange rate, intervention is more effective, while is there is a small misalignment traders believe that this event is temporal reducing the positive effects of foreign exchange intervention on their confidence.

Reitz and Taylor (2008) explain that selling an undervalued currency or buying an overvalued currency may force informed traders to exit the market as these central bank actions send wrong signals to the market. In order to avoid this problem, they propose an indicator of intervention that not only considers the amount of intervention but includes the direction of intervention. This indicator of intervention is composed by an indicator variable D_t multiplied by the amount of intervention INT_t. As the exchange rate used in this paper is equal to the domestic value of one unit of foreign currency (i.e. US dollar), the indicator variable D_t is equal to -1 when the US dollar is overvalued with respect to the domestic currency $s_t > f_t$ and equal to +1 when the US dollar is undervalued with respect to the domestic currency $s_t < f_t$. The central bank acts in the right direction if the product $D_t INT_t$

is positive as sells of US dollars are consistent with an overvalued foreign currency and purchases of US dollars are consistent with an undervalued foreign currency.

The pattern of the exchange rate is derived after combining equations (2.2.1) to (2.2.11):

$$s_{t+1} = s_t + \varphi(s_t - s_{t-1}) + \psi w_t(f_t - s_t) + \gamma(i_t - i_t^*) - (\delta + \kappa\sigma_t) + u_{t+1} \qquad (2.2.12)$$

where $\varphi = a^M a^U > 0$, $\psi = a^M a^I > 0$, $\gamma = a^M(b^U + b^I)$ is ambiguous, $\delta = a^M(\delta^U + \delta^I) > 0$, $\kappa = a^M(d^U + d^I)$ is different than zero and u_{t+1} is a composite of ε_{t+1}, η_{t+1}^U and η_{t+1}^I. Under the presence of misalignments, the weight factor w_t determines a nonlinear mean reverting process of the exchange rate towards its fundamental value. If w_t is close to one the gap between the fundamental value of the exchange rate and the spot exchange rate is small. If this gap increases informed traders are forced to exit the market and in that case is when the central bank through foreign exchange intervention fixes the lack of market coordination increasing the level of confidence of fundamentalists-based traders.

2.3 Empirical Methodology

2.3.1 The STR-GARCH-M Model

There is an extensive literature on nonlinearities in real exchange rate adjustment that could arise from different factors such as transaction costs. Drawing on earlier work on these theoretical models, some studies model real exchange rate adjustment as discontinuous with two different regimes, the mean reverting and non-mean reverting states, modelled as a two-threshold model. Recent works have developed theoretical models where the mean reverting behaviour of real exchange rates is

smooth between a given number of regimes. Overall, all these models suggest that if the real exchange rate is more further away from the equilibrium level, the process will become increasingly mean-reverting.

In order to find empirical evidence of the microstructural model described in the previous section, I use a Smooth Transition Regression GARCH in mean (STR-GARCH-M) framework that models nonlinearities in the conditional mean of exchange rate returns and a time-varying conditional variance. This empirical approach belongs to the group of models developed by Terasvirta (1994), Terasvirta (1998) and Lundbergh and Terasvirta (1998). The STR-GARCH-M model applied in this paper allows a nonlinear pattern of exchange rate returns with switches smoothly between a non-mean reverting to a mean reverting regime that depends on the degree of exchange rate misalignment and the role played by foreign exchange intervention. Although the class of nonlinear models is extensive, I choose an STR-GARCH model as benchmark model because allows a smooth transition behaviour between regimes due to the properties of the transition function chosen. As suggested by Terasvirta (1994) and Dumas (1992), under the presence of heterogeneous agents is more likely that the adjustment between regimes follows a smooth rather than discrete process. Then, a smooth adjustment goes in line with the theoretical model described in the previous section. However, alternative models might be considered. For instance, the threshold autoregressive (TAR) model (Tong, 1990) and the floor and ceiling Pesaran and Poter (1997) model with discrete switching between regimes. In addition, a Markov-switching model with endogenous transition probabilities following Taylor (1994). Although these models are useful to model non linearities, they imply a sharp regime switch that is too restrictive in a world with heterogeneous informed and uninformed traders.

Following Terasvirta (1998) and Lundbergh and Terasvirta (1998), the standard STR-GARCH model has a conditional mean with the following structure:

$$y_t = \boldsymbol{\varphi}'\mathbf{x_t} + f(\mathbf{x_t};\boldsymbol{\theta}) + \varepsilon_t \tag{2.3.1}$$

where $\boldsymbol{\varphi} = (\varphi_0, \varphi_1, ..., \varphi_m)'$ is the vector of parameters of the linear part of the model and $\mathbf{x_t} = (1, y_{t-1}, ..., y_{t-m}; u_{1t}, ..., u_{kt})'$ is the vector of explanatory variables composed by the lag vector of the dependent variable y_t and a vector of exogenous variables $\mathbf{u_t}'$. Function $f(\mathbf{x_t};\boldsymbol{\theta})$ is nonlinear and is equal to the product of a transition function $w_n(s_t;\phi,\mathbf{c})$ of order n and a linear combination of explanatory variables $\mathbf{x_t}$. The transition function is parametrized as:

$$w_n(s_t;\phi,\mathbf{c}) = \left(1 + exp(-\phi\prod_{l=1}^{n}(s_t - c_l))\right)^{-1} \qquad ,\phi > 0, c_1 \leq .... \leq c_n \tag{2.3.2}$$

where the transition variable s_t can be part of $\mathbf{x_t}$ and usually is equal to $s_t = y_{t-d}$ but other variables such as $s_t = t$ may be used; ϕ is a slope parameter; d is a delay parameter; and $\mathbf{c} = (c_1, ..., c_n)'$ is a location vector. This transition function is bounded between a and 1, with $0 \leq a \leq 1/2$ which allows the dependent variable y_t to switch between regimes in a smooth and continuous pattern depending on the transition variable s_t. Function $f(\mathbf{x_t};\boldsymbol{\theta})$ with $\boldsymbol{\theta} = (\boldsymbol{\psi'}, \phi, \mathbf{c}')'$ is equal to:

$$f(\mathbf{x_t};\boldsymbol{\theta}) = \boldsymbol{\psi}'\mathbf{x_t}w_n(s_t;\phi,\mathbf{c}) = \boldsymbol{\psi}'\mathbf{x_t}\left(1+\exp(-\phi\prod_{l=1}^{n}(s_t - c_l))\right)^{-1} \tag{2.3.3}$$

The error process ε_t is described as:

$$\varepsilon_t = v_t\sqrt{h(\mathbf{x_t}, \boldsymbol{\varphi}, \boldsymbol{\theta}, \boldsymbol{\eta})} \tag{2.3.4}$$

where $v_t \sim nid(0,1)$, $h_t = h(\mathbf{x_t}, \boldsymbol{\varphi}, \boldsymbol{\theta}, \boldsymbol{\eta}) = \boldsymbol{\eta}'\mathbf{z_t}$ does not depend on v_t, $\boldsymbol{\eta} = (\alpha_0, \alpha_1, ...\alpha_q, \beta_1, ..., \beta_p)'$, $\mathbf{z_t} = (1, \varepsilon_{t-1}^2, ..., \varepsilon_{t-q}^2, h_{t-1}, ..., h_{t-p})'$ where $h_t > 0$, makes the model described in equation (2.3.1) a STR-GARCH(p,q) model. In order to avoid a negative variance, the parameters of vector $\boldsymbol{\eta}$ should follow the following restrictions $\alpha_0 > 0, \alpha_j \geq 0$, $j = 1, ..., q-1, \alpha_q > 0, \beta_j \geq 0, j = 1, ..., p$. The errors are assumed to be normal only for inference purposes as in Lundbergh and Terasvirta (1998). An important prerequisite of the STR part of the model is the stationarity of the dependent variable, and specifically of the transition variable. The STR model is built under the assumption of weak stationarity of the underlying process. In order that this assumption holds, it is necessary that the model is stable which is possible when there is convergence of the different paths of realizations to a stationary point captured by the dynamic of the transition variable. The assumption of stationarity is necessary to maintain the standard asymptotic distributions of LM-type linearity tests. For instance, applying linearity tests under the presence of a unit root in the dependent variable and the transition variable may lead to incorrect inferences using standard χ^2 critical values.

Following this general description of STR-GARCH models type, the empirical model of the microstructural approach developed in the previous section consist of a STR-GARCH-M model as follows:

$$\begin{aligned}
\triangle s_t &= \delta + \varphi \triangle s_{t-1} + \psi w_t(f_{t-d} - s_{t-d}; int_{t-1}; \phi; h_{t-d})(f_{t-1} - s_{t-1}) \\
&\quad + \gamma(i_{t-1} - i_{t-1}^*) + \kappa\sqrt{h_t} + \varepsilon_t \\
w(f_{t-d} - s_{t-d}; int_{t-1}; \phi; h_{t-d}) &= \frac{exp(-(\phi_1 - \phi_2 int_{t-1})(\mid f_{t-d} - s_{t-d} \mid / \sqrt{h_{t-d}}))}{1 + exp(-(\phi_1 - \phi_2 int_{t-1})(\mid f_{t-d} - s_{t-d} \mid / \sqrt{h_{t-d}}))} \\
h_t &= \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1}
\end{aligned} \tag{2.3.5}$$

where $\triangle s_t$ is the change in the logarithm of the spot exchange rate; w_t is the transition function that depends on the level of intervention and the absolute standardized level of misalignment; int_t is a measure of intervention calculated as the product of an indicator variable D_t and the amount of intervention INT_t; ϕ_1 and ϕ_2 are the transition parameters that govern the rate of transition between the non-mean reverting and mean reverting regimes; $\sqrt{h_t}$ captures the time-varying risk; and h_t is the conditional variance. Unlike Reitz and Taylor (2008), I include the conditional variance directly into the conditional mean to obtain the STR-GARCH-M model. The conditional volatility h_t for each of the exchange rates vis-a-vis the US dollar is modeled as a GARCH(1,1) according to the Box-Jenkins approach. The first-order GARCH model is commonly found in the literature of exchange rate determination, and as Lundbergh and Terasvirta (1998) explain, that lag is modeled as greater than one only if necessary. The form of the logistic transition function w_t is chosen according to De Grauwe and Grimaldi (2005, 2006) that model a similar transition function for uninformed and informed traders. In addition, the transition variable chosen is a linear combination of the fundamental and current value of the exchange rate $\mid f_{t-d} - s_{t-d} \mid$ given the impact of exchange rate misalignments on the level of traders confidence.

2.3.2 Specification, Estimation and Evaluation

Following Lundbergh and Terasvirta (1998) that proposed a procedure to estimate the STAR-GARCH class model, this paper uses a two-stage estimation strategy which specifies the conditional mean first, and then the conditional variance. I carry out the estimations as a series of single country regressions. The general rule of estimation consists of initially choosing the maximum lag length to specify a linear autoregressive model. There are two general approaches for determining the appropriate autoregressive order. First, the partial autocorrelation function (PACF), and

second the Akaike information criterion (AIC) and the Schwarz Bayesian information criterion (SBIC). In addition to these criteria, I use a residual autocorrelation test to avoid omitted autocorrelation according to Terasvirta (1994). This test is based on the Ljung Box-Q statistic for the estimated residuals of the selected autoregressive model. Second, I test the null hypothesis of linearity of the conditional mean $\phi = 0$ in equation (2.3.1) against the alternative of a nonlinear STR model according to Granger and Terasvirta (1993) and Lundbergh and Terasvirta (1998). I use a LM-type test according to Terasvirta (1994) where the null hypothesis is a linear AR model and the alternative is a logistic STR model of order n. As the transition function is not identified, I approximate equation (2.3.3) using a Taylor expansion around $\phi = 0$. Assuming $d \leq m$ without loss of generality and setting the transition variable equal to $\mid f_{t-d} - s_{t-d} \mid$, I apply the linearity test for different d values, and for each value I test the hypothesis $\phi = 0$. This test assumes constant conditional variance with an asymptotic χ^2 distribution. However, I use the F-version of the test according to Granger and Terasvirta (1993) as it has better small sample properties. If the null hypothesis of linearity is rejected, I select the delay parameter d for the STR model with the rule of minimum p-value of the F linearity test. Initially, I assume that the transition function is not identified to perform the linearity test. However, I do not test if the model adjust better to the logistic or exponential STR model as I choose the transition function specified in (2.2.10) according to De Grauwe and Grimaldi (2006).

I estimate the conditional mean assuming that the conditional variance is not time-varying and then test the hypothesis of ARCH effects in the error process using the Engle (1982) LM-test or the McLeod and Li (1983) test. The Engle Lagrange multiplier test is based on the autocorrelation of the squared residuals and it is asymptotically distributed as χ^2_q when the null hypothesis of no ARCH effects is true. The McLeod and Li test is asymptotically equivalent to the Engle LM-test an

it is commonly used as a diagnostic on the standardised squared residuals to test ARCH effects. This test is based on the Ljung-Box test and evaluate if the first p autocorrelations for the squared residuals are small in magnitude. Under the null hypothesis of no ARCH effects, the test statistic is asymptotically distributed as χ^2_p. If there is evidence of heteroskedasticity, I assume that the conditional variance is parametrized as a standard GARCH model. Finally, I estimate the STR-GARCH model specification and run different misspecification tests to check the adequacy of the model. This involve testing against remaining serial dependence in the conditional mean and the conditional variance using a LM test for the residuals and the squared standardised errors, respectively.

In addition, I use the BDS statistic (Brock et al., 1996) to test the null hypothesis of independence and identically distributed standardised errors. The BDS test is nonparametric and is derived from the correlation integral which measures the spatial correlation of all possible pairs of m consecutive points. The BDS test statistic is asymptotically $N(0,1)$ under the null hypothesis. In this paper, I have used the procedure BDSTEST in RATS to compute the asymptotic values of the test statistic. One of the advantages of this test is that does not require the existence of high-order moments in contrast to most alternative tests. In addition, the BDS test has a high power against a vast class of alternative models if the sample is sufficiently large (i.e. sample sizes of 500 or more). However, one of the disadvantages is that the asymptotic distribution of the test is invariant under some specific conditions when a GARCH process is used to pre-filter the data (de Lima 1996). Moreover, considering the GARCH standardised errors tend to under-reject the null hypothesis due to nuisance parameter effects. De Lima (1996) addresses this issue using a log-transformation of the squared standardised residuals. In addition, this problem may be solved using techniques such as response surface analysis to mitigate the size bias. In this paper, I evaluate the test using the standardised errors. Finally, I use the

likelihood ratio test to evaluate restrictions in the parameters.

It is noteworthy to mention that as in Lundbergh and Terasvirta (1998), I estimate all parameters simultaneously. The advantage of using the two-stage estimation procedure is to get appropriate initial values to get convergence in the joint estimation of the conditional mean and variance. In addition, I impose the non-negativity constraints in the GARCH model to avoid a negative conditional variance. As in Reitz et al. (2010), I use robust standard errors in my estimations using the BFGS algorithm. This is because the transition function used is a linear transformation of the general transition function suggested by Terasvirta and Anderson (1992) and that affects the assumption of conditional normality in the residuals. Terasvirta (1994) explains the convergence problems derived from nonlinear optimization, and suggest to standardize the transition variable by dividing it by the sample standard deviation for LSTAR models. The STR-GARCH-M model suggested in this paper is consistent with that approach as I scale the transition variable in the logistic function by dividing it by the conditional standard deviation. This is useful for selecting appropriate starting values for the slope parameters ϕ_1 and ϕ_2 .

2.4 Data Description

I use daily data on bilateral spot exchange rates vis-a-vis the US dollar and daily foreign exchange intervention in Brazil (BRL), Chile (CLP), Colombia (COP), Mexico (MXN) and Peru (PEN) between January 3, 2000 and December 30, 2013. The exchange rate is the domestic price of one unit of foreign currency which means that an increase (decrease) in the bilateral exchange rate implies a depreciation (appreciation) of the domestic currency against the US dollar. Exchange rate returns are calculated as the first difference of the log of the bilateral spot exchange rate multiplied by 100. In addition, I use the overnight interest rate on deposits in each

country and the effective federal funds rate for the US to construct the interest rate differential.[1]Exchange rates, foreign exchange intervention and domestic overnight interest rates are taken from Central Bank sources while the US federal funds rate is taken from the Federal Reserve Economic Data (FRED). Figures B.1 and B.2 describe the pattern of bilateral exchange rates vis-a-vis the US dollar and exchange rate returns, respectively. Table C.1 provide descriptive statistics of daily exchange rate returns. Means are close to zero for all countries at daily frequency. There is evidence of right skewed distribution in all returns which suggests more episodes of currency appreciation with extreme values related to currency depreciation. In addition, there is evidence of excess kurtosis in all currencies suggesting non-normalities in the data. The Augmented Dickey-Fuller test to the log of the exchange rate do not reject the null hypothesis of non-stationarity while it does reject the null hypothesis of unit root in exchange rate returns in all countries.

The data analyzed in this paper corresponds to the flexible exchange rate regime period in these economies. According to the IMF (2013) report on de facto exchange rate arrangements, Brazil, Colombia, Mexico and Peru are under a floating exchange rate regime while Chile is under free floating. However, their exchange rate regimes can not be considered as purely floating as central banks in these emerging economies have actively intervened in the foreign exchange market during the last decade. Foreign exchange intervention has different motives but the main objective of foreign exchange policies in theses economies is to maintain an appropriate level of foreign reserves for precautionary or competitiveness reasons and to reduce the excessive exchange rate volatility in the short run. I study only the flexible exchange rate arrangement period for two reasons. First, the availability of information on foreign exchange intervention is limited before the adoption of a floating exchange rate framework. Second, the dynamic of central bank intervention is different un-

[1]The interest rate differential is divided by 360 as the information used is on a daily basis.

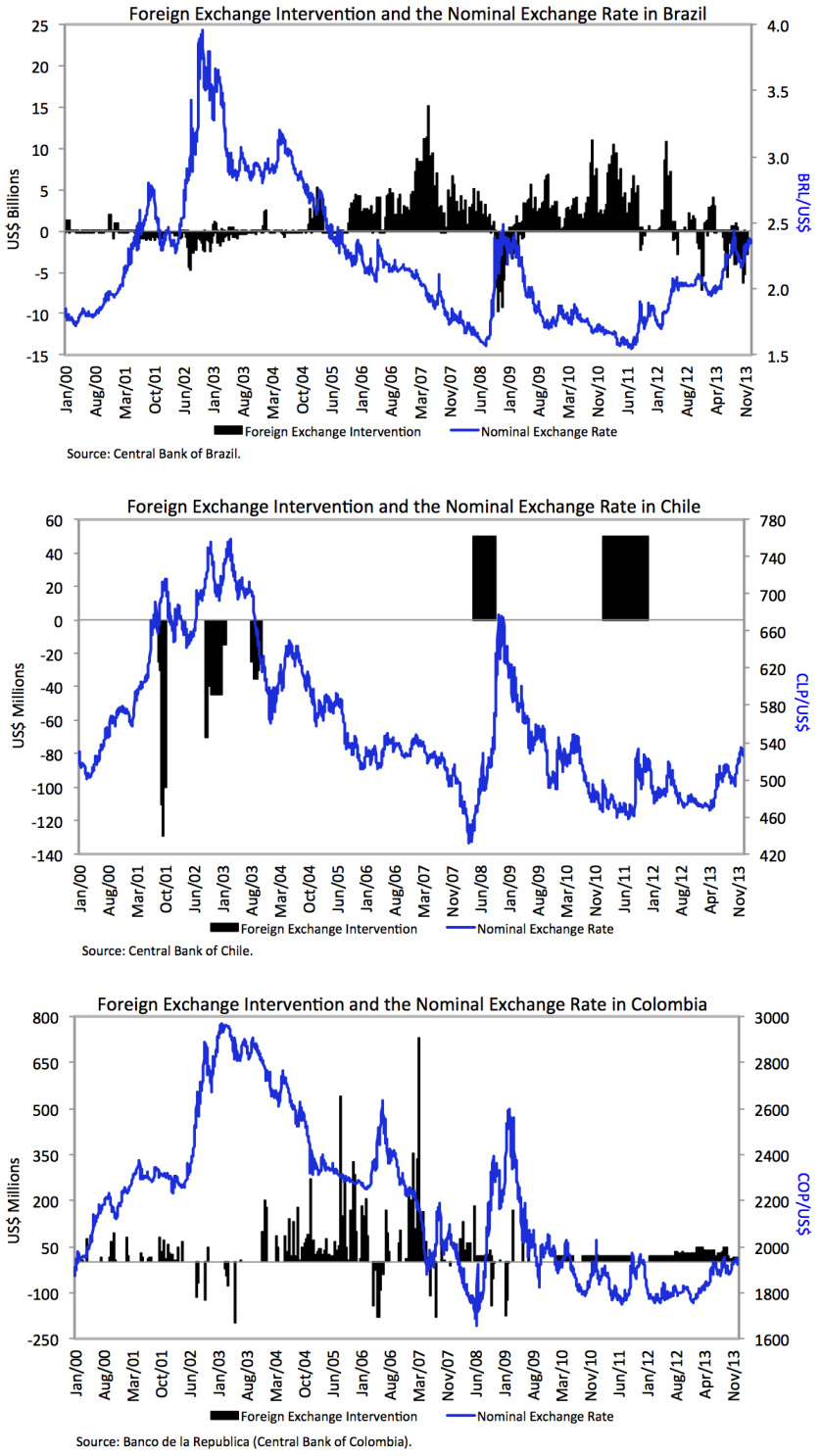
der a fixed exchange rate regime as the nominal anchor is the exchange rate and monetary policy and foreign exchange policy are aimed to achieve an exchange rate target range or value. For instance, during the late 1990's Brazil, Colombia and Chile adopted a crawling band system to the US dollar and when the exchange rate was approaching to the ceiling or the floor of the pre-announced band the Central Bank intervened actively in the foreign exchange market to revert the exchange rate to a pre-established exchange rate level or range.

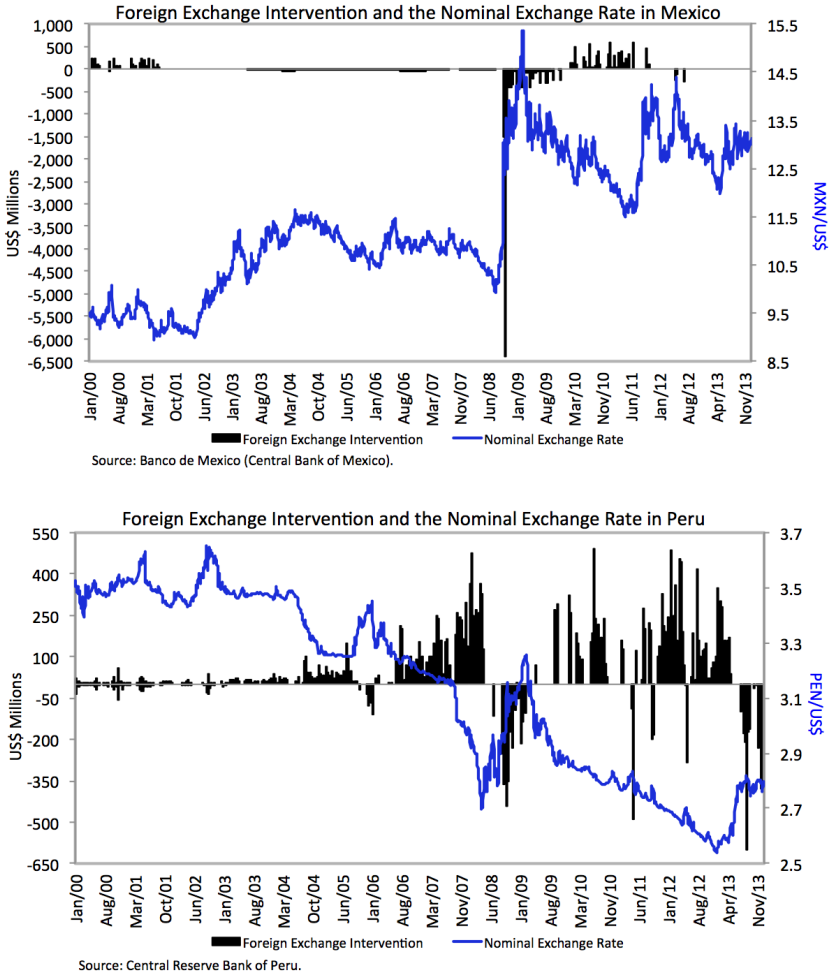
The current monetary policy in these economies is independent of foreign exchange policies as the main objective of central banks is to achieve the inflation target. However, monetary authorities intervene in the foreign exchange market using different mechanisms such as discretional intervention or pre-announced programs of purchases and/or sales of foreign exchange.[2]For instance, Colombia has used foreign exchange intervention based rules and discretional intervention, while Chile and Mexico have always relied on rules. Brazil and Peru have not used rules of intervention and when it is necessary, they intervene in the spot and forward exchange market. I aggregate all types of intervention in one measure by country assuming that each instrument has similar effects on exchange rates. This assumption takes into consideration the findings of the recent literature that the effectiveness of interventions does not depend on whether intervention is of the rule-based type or discretionary (IMF 2011a). The fact that publicly announced intervention operations are required under the coordination channel approach makes worth it to study if discretional intervention has any coordination role in the foreign exchange market. I select the case of Colombia in the robustness checks section and I leave for future research the analysis of the coordination role played by each type of intervention in the other countries. Figure 2.1 describes the pattern of intervention and bilateral exchange rates in each country, and Table C.2 provide descriptive statistics on central

[2]The appendix has a detailed description of the different mechanisms of intervention by country.

bank intervention.

Figure 2.1: Central Banks Foreign Exchange Intervention and Bilateral Nominal Exchange Rates





From Figure 2.1, I can infer that central bank foreign exchange intervention was of leaning against the wind type in different episodes of the period analyzed, especially during periods of exchange rate appreciation. Table C.2 shows that Chile has not intervened actively in the foreign exchange market between 2000 and 2013 with only 12% of central bank intervention of the total of trading days, while Brazil has intervened actively in the market with 99% of intervention of the total trading days. As the IMF (2011a) explains it is quite difficult to classify some operations used by the Central Bank of Mexico as foreign exchange intervention. This is due to the nature of the different mechanisms used. An important part of the information used for Mexico corresponds to option auctions. In addition, the size of intervention in Brazil is the result of an active and permanent presence not only in the spot

market. The intervention in the derivative market has been crucial in affecting the level of exchange rate as Kohlscheen and Andrade (2013) state.

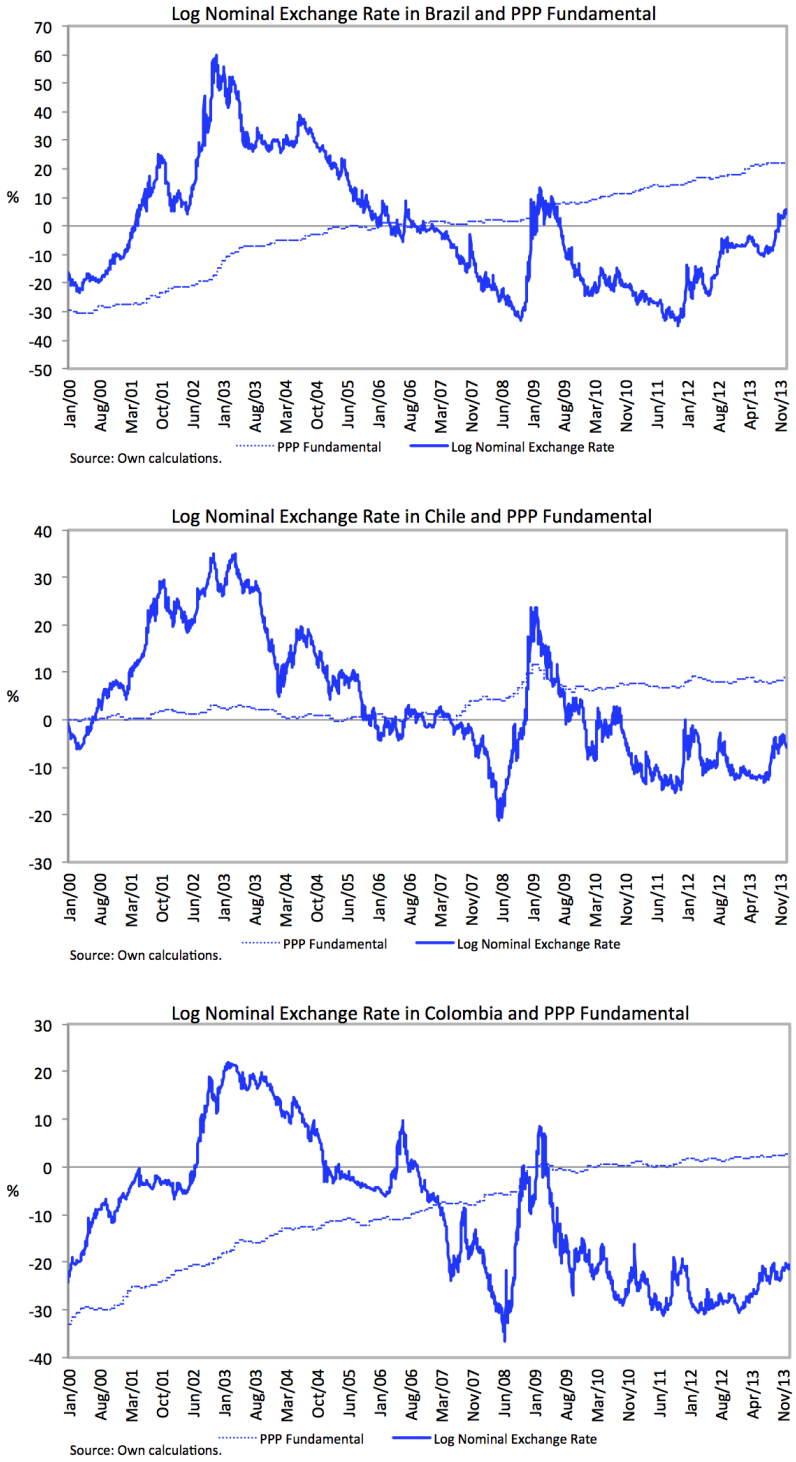
As Kamil (2008) notes, studying different episodes of intervention gives an indication of the stance of monetary policy and an ideal context in inflation targeting economies to study the interaction between monetary policy and exchange rate policy. Consistency between policies is one the requirements to have a credible inflation targeting regime. It is noteworthy to mention that the effectiveness of intervention may depend on the consistency between such policies. However, the aim of this paper is to analyze the coordinating role played by foreign exchange intervention and not the mechanism through which that intervention is more or less effective due to the consistency in policy decisions. Figure B.3 describes the pattern of central bank intervention and the monetary policy rate in each country. I can infer from Figure B.3 that these economies adopted a loose monetary policy after the recent financial crisis consistent with purchases of foreign currency. However, such consistency is less clear in the early 2000s.

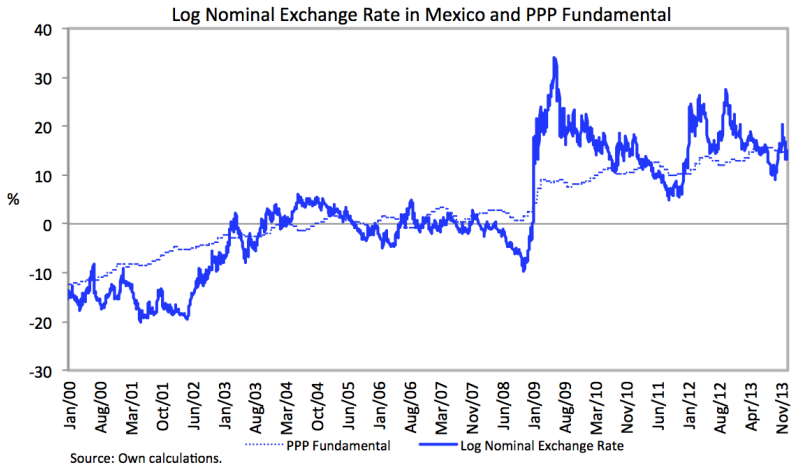
I use the purchasing power parity level based on relative consumer prices between the US and each country to measure the exchange rate equilibrium level f_t in the baseline model. This measure follows the methodology of Reitz and Taylor (2008) as it is broadly accepted by foreign exchange market participants as a correct long relationship. I assume that the PPP holds in Brazil, Chile, Colombia, Mexico and Peru. This may be a strong assumption but the main objective of this paper is to find evidence that foreign exchange intervention has a coordinating role rather than find evidence of the PPP validity. Nevertheless, assuming that PPP holds is not far from Central Banks projections of the long-run fundamental value. For instance, the Central Bank of Colombia use as a proxy for the fundamental value of the exchange rate the average of different models based on the PPP, the Hodrick-Prescott filter, and structural VEC methodologies.

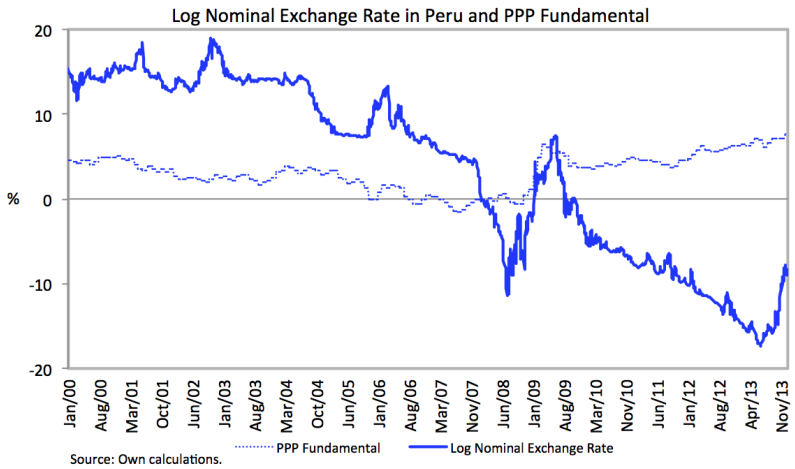
I use monthly observations of the consumer price indices for the US and each emerging economy to calculate the fundamental PPP value of the exchange rate as $f_t = log(CPI_t^d) - log(CPI_t^{US})$, where $log(CPI_t^d)$ and $log(CPI_t^{US})$ are the log of the CPI in the domestic economy (i.e. Brazil, Chile, Colombia, Mexico and Peru) and the log of the CPI in the US, respectively. This information is taken from the IMF International Financial Statistics database with 2005 as the base year. As Reitz and Taylor (2008) explain, one problem of this PPP fundamental measure is that consumer price indices are only available on a monthly basis while all the other variables used in the model are at a daily frequency. However, they explain that assuming that the PPP measure is valid for the whole month is compatible with market participants behaviour as their daily trading for the whole month is based on the latest published CPI. As the real exchange rate is assumed to be mean reverting, I normalize the log real exchange rate subtracting its mean value for the whole period. This implies that at some point in the sample the log real exchange rate is approximately equal to zero and there are no deviations from the PPP.

Figure 2.2 describes the pattern of the log nominal exchange rate and the PPP fundamental value in each country. The period analyzed in this paper includes important episodes that affected the dynamics of exchange rates and foreign exchange intervention. According to Figure 2.2, deviations from the PPP fundamental are characterized by two important periods in these economies. With the exception of Mexico, the first half of the 2000s is distinguished by an undervaluation of domestic currencies vis-a-vis the US dollar, while between late 2009 and 2013 there has been a domestic currency overvaluation. The first period coincides with the 9/11 attacks in 2001 that destabilized the US economy, and two important events in the region. The financial and the foreign exchange crisis in Argentina between 2000 and 2002, and then the currency crisis in Brazil in late 2002 due to political instability that increased exchange rate volatility with the Brazilian real (R$) reaching an historical

Figure 2.2: Log Nominal Exchange Rates and PPP Fundamental Value







level of R$4 per US$1. The period of overvaluation experienced between late 2009 and 2013 coincides with the stabilization of global markets and the recovery of capital flows between 2010 and 2012 to levels seen before the crisis. The literature on capital flows in emerging economies finds that one of the main factors driving the post-crisis foreign exchange appreciation is the recovery of capital inflows. However, as Nechio (2014) explains, it is worth noting that both Fed tapering news in early 2013 and country's domestic conditions have played an important role in slowing the pace of capital inflows in emerging economies. According to De Gregorio (2011), the post-crisis global economy adjustment has international effects in emerging economies, and the exchange rate is one of the variables that adjust in the process. The increase in capital inflows jointly with other global and domestic factors have affected the pace

of domestic currency appreciation. This makes necessary the adoption of additional policies such as foreign exchange intervention. De Gregorio (2011) explains that although foreign exchange intervention, either rule-based or discretionary has only temporary effects, it mitigates the exchange rate adjustment process. These motives for intervention under different episodes of exchange rate misalignment are reflected in figures 2.1, 2.2 and B.3, and I now turn to the empirical analysis of the coordination role played by this intervention to mitigate the adjustment process of the exchange rate.

2.5 Estimation Results

The AIC and SBIC accompanied by the Ljung Box-Q statistic suggest that the first lag is the appropriate order of the linear autoregressive model of exchange rate returns in Brazil, Chile and Colombia, while in Mexico and Peru the data adjusts to an autoregressive model of order two. Table C.3 reports the p-values of the F linearity test for different values of the delay parameter d. The null hypothesis tested is linearity of the conditional mean under the assumption of a constant conditional variance. I use the absolute exchange rate misalignment as the transition variable according to the theoretical model described in Section 2.2. The results indicate nonlinearities in the model and justify the formulation of a STR model as the p-values for all the different values of the delay parameter are smaller than the 1% significance level which implies a rejection of the null hypothesis of linearity. For instance, the transition variable selected for Brazil and Peru is $\mid f_{t-3} - s_{t-3} \mid$with a delay parameter of $d = 3$, while for Colombia and Mexico is $\mid f_{t-1} - s_{t-1} \mid$with a delay parameter $d = 1$. The null hypothesis of linearity is barely rejected for Chile at 10% significance level which is not conclusive about the evidence of nonlinearities

in exchange rate returns. [3]

I estimate the conditional mean of exchange rate returns assuming a constant conditional variance after determining the appropriate autoregressive lag and the appropriate delay parameter of the transition variable. After scaling the transition variable by the conditional variance, I fix the initial values of the slope parameters ϕ_1 and ϕ_2 equal to 1 and 0, respectively. This procedure follows Terasvirta (1994) and makes it easier to reach convergence in the nonlinear model. Table C.4 reports the results of the tests of no linear ARCH against ARCH effects in the residuals. The tests reported are asymptotically distributed $\chi^2$and are evaluated at different lags. As the calculated value of theχ^2statistic is greater than the critical value for all lags, the hypothesis of no ARCH is rejected in all cases using the Engle LM-Test and the McLeod and Li Test . This confirms the existence of heteroskedasticity in the residuals and suggests that it is appropriate to estimate a STR-GARCH model where the conditional variance follows a GARCH (1,1) process.

The parameter estimates of the STR-GARCH-M model are described in Table 2.1. The results are similar in Brazil, Colombia, Mexico and Peru. Although for Chile convergence is attained in the estimation of the STR-GARCH-M model, the slope parameters in the transition function are not even significant at the 10% level. It is plausible that the lack of evidence of a nonlinear influence of foreign exchange intervention through the coordination channel in Chile may be related to the fact that during the period analyzed the Central Bank of Chile did not actively intervene in the foreign exchange market, and the model is unable to capture the effectiveness of intervention via that channel. For instance, foreign exchange intervention in Chile

[3]As Taylor et al. (2001) note, economic intuition indicates small values of the delay parameter as it is unlikely that exchange rates will take long time to revert to the equilibrium. However, as in Reitz et al. (2010), I choose the appropriate delay parameter that gives the smallest p-value of the linearity test. Using a delay parameter equal to one does not change substantially the estimated coefficients and their significance.

Table 2.1: Parameter Estimates of the STR-GARCH-M Models

	Brazil	Chile	Colombia	Mexico	Peru
			Conditional Mean		
δ	0.020**	-0.053***	0.022***	0.033***	-0.0001
	(0.009)	(0.008)	(0.005)	(0.006)	(0.003)
φ_1	0.108***	0.135***	0.189***	0.095***	0.178***
	(0.015)	(0.017)	(0.018)	(0.014)	(0.028)
φ_2				-0.035***	-0.047**
				(0.011)	(0.021)
ψ	0.004***	0.010**	0.021***	-0.453***	0.179**
	(0.002)	(0.005)	(0.006)	(0.112)	(0.097)
γ	-0.956***	3.139***	-0.379	-0.666*	-1.291**
	(0.295)	(1.228)	(0.367)	(0.413)	(0.674)
κ	-0.029**	0.050***	-0.064***	-0.065***	-0.032
	(0.015)	(0.010)	(0.014)	(0.010)	(0.034)
ϕ_1	4.423***	1.730	0.193***	2.138***	0.380***
	(0.760)	(1.125)	(0.063)	(0.871)	(0.104)
ϕ_2	0.573***	0.029	0.002***	0.438***	0.0006
	(0.097)	(0.022)	(0.000)	(0.184)	(0.000)
			Conditional Variance		
α_0	0.013***	0.009***	0.005***	0.006***	0.001***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
α_1	0.170***	0.101***	0.218***	0.098***	0.231***
	(0.004)	(0.002)	(0.001)	(0.012)	(0.029)
α_2	0.822***	0.876***	0.782***	0.884***	0.768***
	(0.002)	(0.002)	(0.001)	(0.009)	(0.029)
			Specification Tests		
LRT	16.736***	8.729	14.128**	15.232**	64.209***
AR(1)	0.080	0.541	0.110	0.541	0.053
AR(5)	0.167	0.096	0.201	0.731	0.113
ARCH(1)	0.970	0.780	0.856	0.835	0.111
ARCH(5)	0.762	0.941	0.936	0.119	0.591
BDS	0.697	0.021	0.332	0.436	0.522
ADF (|f-s|)	-2.890	-2.955	-2.961	-4.574	-2.912

Notes: LRT is the log likelihood ratio test statistic with restrictions $\delta=\gamma=\kappa=\psi=\phi_1=\phi_2=0$. AR(p) and ARCH(q) corresponds to the p-value for the Ljung-Box statistics for serial correlation of the residuals and the standardised squared residuals, respectively. BDS denotes the p-value of the test of independence and identically distributed disturbances according to Brock et al. (1996). ADF denotes the Augmented Dickey-Fuller test of the transition variable. Robust standard errors in parentheses. ***, **, * denotes significance level at the 1%, 5%, and 10% level.

was only active for a short period between 2001 and 2003 through discretional interventions, and in 2008 and 2011 through pre-announced programs of foreign exchange purchases. [4]However, this result does not imply the absence of a coordination channel in Chile. It may indicate that the coordination role of central bank intervention could be seen as an extension of the signaling channel traditionally modeled using a linear framework.

I test restrictions on the parameters to check the validity of the introduction of chartist and fundamentalist trading analysis and the importance of intervention in increasing traders confidence in the market. The restrictions imposed on the coefficients are $\delta = \gamma = \kappa = \psi = \phi_1 = \phi_2 = 0$ which implies a restricted model equal to an AR(1)-GARCH(1,1) model. The results of the LRT test reported in Table 2.1 indicate that the constrained model is rejected in favor of the STR-GARCH-M model at the 1% significance level in Brazil and Peru, and at the 5% in Colombia and Mexico. There is no evidence for Chile that the STR-GARCH-M model is an appropriate representation of exchange rate returns.

The coefficients in all countries without considering Chile are significant and with the expected signs according to the description of the theoretical model. Unlike Reitz et al. (2010), the coefficient of the uninformed traders φ_1 is positive and significant which explains that chartist analysis plays an important role in exchange rate determination in these economies. The coefficient φ_2 is also significant in Mexico and Peru. However, the positive sign and significant coefficient ψ in Brazil, Colombia and Peru reveals the importance of fundamentalist trading that relies on the analysis of exchange rate deviations from its fundamental value. Although ψ is negative and significant at the 1% level in Mexico, intervention still has a coordination role. A negative reaction coefficient ψ may suggest that traders adopt contrarian strategies in the market. As this coefficient is assumed to be exogenous in the theoretical

[4]Details on the mechanisms of intervention in Chile are described in the Appendix.

model, I leave for future research the fact that this parameter may be endogenous to other factors that are not incorporated in this model. For instance, the Central Bank of Mexico adopted extraordinary auctions during 2008 due to the high turbulence in the foreign exchange market and it may be interesting to analyze if the market reaction coefficient could be affected by unexpected foreign exchange policies and periods of liquidity stress in the foreign exchange market.[5]

The coefficients of the interest rate differential are all negative and significant at 1% level in Brazil, 5% in Peru, and 10% in Mexico. This results suggests that an increase in the domestic interest rate relative to the interest rate in the US appreciates the domestic currency. As Reitz and Taylor (2008) and Reitz et al. (2010) note, this results may be consistent with the existence of carry trade. For instance, foreign investors in the last two years have noted that Colombia and Brazil are offering the best returns in the world to carry trade investors and the data may be capturing this fact.

The coefficients related to the constant part of the risk premium δ are significant and positive in Brazil, Colombia and Mexico, while κ is negative and significant in all countries except for Peru. This gives evidence of a time-varying risk premium in these countries. The negative coefficient implies that when risk increases, the rate of depreciation of the domestic currency decreases. This is consistent with the modern portfolio theory.[6]As investors usually get a higher return for riskier assets, an increase in risk that causes less depreciation of the domestic currency implies that investors demand a higher expected return of holding that currency.

The slope parameters ϕ_1 and ϕ_2 are significant at the 1% level in all countries with larger coefficients in Brazil and Mexico. As the parameter ϕ_1 conveys information about the speed of transition between the mean reverting and non-mean reverting

[5]Details on the mechanisms of intervention in Mexico are described in the Appendix.

[6]The modern portfolio theory explains how investment diversification in a pool of assets could maximize the expected return of that portfolio given a level of risk or minimizing its risk assuming that the level of the expected return is given.

regimes, a larger coefficient suggest that fundamentalists-based traders confidence is more susceptible to deviations of the exchange rate from its fundamental value. If the exchange rate is increasingly misaligned, its impact on confidence is more destabilizing in the foreign exchange markets of Brazil and Mexico than in Colombia and Peru, and traders are forced to exit the market more quickly in those economies. The significance and positive sign of ϕ_2 indicates that foreign exchange intervention through its coordination role fixes the lack of confidence present in the market due to the degree of exchange rate misalignment. The stabilizing role of intervention although is significant in Colombia, it is stronger in Brazil and Mexico and negligible in Peru.[7]

It is noteworthy to analyze the case of Peru as it is one of the most dollarized economies in Latin America. Although it has been under an on-going de-dollarization process there is still an important share of credit and deposits denominated in dollars in the banking sector. According to the Central Reserve Bank of Peru the degree of financial dollarization in the private sector reached 54 percent in 2006 that is considerably lower to the 2000 level of 72 percent. Inflation targeting adopted in 2002 has played an important role in reducing financial dollarization. The literature notes the relatively high stability of both the nominal and real exchange rates in Peru (i.e. Acosta and Coble, 2011). This may be related to the fact that monetary authorities have fear of floating as movements in the exchange rate have substantial effects in the economy, especially in the banking system where an important percentage of debtors receive income in domestic currency but have to pay their debt in foreign currency. Although exchange rate misalignments notably affect traders confidence in Peru, the limited effect of central bank intervention in terms of the coordination channel may be the result of the degree of dollarization. This makes difficult for the central bank to fix the lack of confidence in the market as traders may perceive that

[7]Different starting values were used in the estimations and all the results report a non significant coefficient ϕ_2 for Peru and close to zero.

the policy rate could be more effective in stabilizing exchange rate fluctuations than actual interventions. Although Peru is under an IT, the central bank uses the policy rate to control inflation through changes in the policy rate but indirectly controls fluctuations in the foreign exchange market to maintain a stable exchange rate in a dollarized economy.

There is no remaining serial autocorrelation and no remaining ARCH structure in the residuals. The hypothesis of independence and identically distributed errors is not rejected according to the BDS test as the p-values are greater than the 5% significance level, with the exception of Chile. Finally, I report unit root tests of the transition variable $\mid f_{t-d} - s_{t-d} \mid$ in order to check if this variable is effectively rendering the model balanced. The Augmented Dickey-Fuller test does reject the null hypothesis of unit root of the transition variable in all countries at the 5% significance level with a critical value of -2.862. As the degree of misalignment captured in the transition variable conveys more or less information in low or high volatility periods, respectively, scaling this variable by the sample standard deviation is useful to attain model convergence, and may reinforce the rejection of the null hypothesis of unit root of the transition variable.

2.6 Robustness Checks

An appropriate measure of intervention is fundamental in any type of model of exchange rate determination. The literature on the coordination channel approach usually considers the actual amount of intervention without analyzing the direction. As I outlined in the description of the theoretical model and according to Reitz and Taylor (2008), considering the direction of intervention is important as selling (buying) an undervalued (overvalued) currency may confuse informed traders. In order to distinguish between the effects of intervention under these two measures, I introduce

the amount of intervention regardless of the direction in the transition function of the benchmark model and compare the results with the estimations obtained in the previous section. Table C.5 reports the parameter estimates using the amount of intervention regardless of the direction. The results show that the slope parameters ϕ_1 and ϕ_2, although still significant are lower in magnitude in Brazil, Colombia and Mexico. In Chile, although these parameters are statistically significant, the coefficient on the transition function ψ is not significant which does not give conclusive evidence about the nonlinear influence of foreign exchange intervention. In general, the robustness estimations reveal that the benchmark model is more accurate in modelling traders behaviour as accounting for the direction of intervention avoid the loss of information in the trading process.

Foreign exchange intervention is effective under the coordination channel approach if agents in the market are well informed about the amount of intervention. As discretional intervention is not publicly disclosed on the day of the operations, I expect that it has a small effect on traders confidence when there are large exchange rate misalignments. If a central bank intervenes actively in a discretional form, traders may recognize its presence in the market through the electronic trading system that is frequently used by central banks. Although traders could inform to the market about central bank operations, the coordination role of intervention may be diminished as only a part of the information related to these operations would be immediately available. Thus, I select Colombia as a special case to study the effects of different types of intervention as it is the only country that has well-differentiated periods of intervention.[8]Table C.6 reports the results of the STR-GARCH-M model for Colombia differentiating by type of intervention. As the sub-sample periods estimated have few observations, I restrict the coefficients ψ and ϕ_1 to the values of the benchmark model in order to achieve convergence. The parameter estimate ϕ_2

[8]Details on the mechanisms of intervention in Colombia are described in the Appendix.

is significant for all types of intervention and it has the expected positive sign, with the exception of discretional intervention. As I expected, discretional intervention has not a positive impact on traders confidence on the day of intervention. However, the coordination channel could work after some days when the market learn all the information related to central bank operations.

2.7 Conclusions and Future Research

This paper analyses the coordination role of central bank foreign exchange rate intervention in Brazil, Chile, Colombia, Mexico and Peru. The literature in these countries has focused in the signaling and portfolio channels neglecting the existence of nonlinearities in the pattern of exchange rates. The theoretical framework used in this paper relies on a model of risk averse uninformed and informed traders that submit orders according to their believes of the recent trend of exchange rates and exchange rate misalignments, respectively. This model studies nonlinearities in exchange rate mean reversion where intervention increases traders confidence in order to conduct the exchange rate to a stable path. Unlike the existent literature, I include a time-varying risk premia as an important factor that explains exchange rate behaviour in emerging economies.

The empirical evidence from the STR-GARCH-M model reveals that foreign exchange intervention has a coordination role that fixes the lack of traders confidence in Brazil, Colombia, and Mexico. For instance, traders reduce their confidence in fundamentals if the exchange rate is largely misaligned but foreign exchange intervention increases their confidence encouraging them to re-enter the market. Although exchange rate misalignments in Peru affect traders confidence, the role of intervention is diminished due to the degree of financial dollarization. There is no evidence of nonlinearities of the exchange rate in Chile and a stabilizing role of foreign exchange

intervention that may be the result of the lack of central bank intervention during the period analyzed. However, the coordination role of foreign exchange intervention in Chile could be seen as an extension of the signaling channel extensively studied by the existing literature. In addition, there is evidence of a time-varying risk premia that reduces the pace of depreciation in all countries as investors demand a higher return of holding the domestic currency.

The magnitude and significance of the coefficient of intervention are diminished when the model is re-estimated using a measure of intervention regardless of the direction. The use of a measure that takes into consideration the direction of intervention sends more clear messages to the market about the objectives of intervention. In addition, discretional intervention does not have an impact on traders confidence on the day when operations are performed. However, the positive effect of intervention in stabilizing exchange rates may take some time until the market learn all the information related to central bank operations.

As the literature evidence the high degree of correlation between the foreign exchange markets in these countries, modelling spatial dependences or using a panel STR-GARCH model to exploit the heterogeneity in these markets may be a challenging but a promising topic for future research.

Appendix

A. Mechanisms of Intervention by Country

Brazil

There are different mechanisms of intervention in Brazil: spot market intervention, currency swap auctions, forward intervention, repurchase lines and foreign currency loans. As repurchase lines and foreign currency loans were used temporally during the foreign currency crisis in 2002 and the recent financial crisis between 2008 and 2009, I only include in this paper spot intervention and swap interventions through auctions as they are the most active mechanisms of intervention used by the central bank. Although currency swap auctions do not change the level of international reserves, Kohlscheen and Andrade (2013) has found that they have a direct impact in the level of exchange rate through the change in the supply of hedging instruments that affects the demand for USD dollars. This is the main reason to include this type of intervention in my analysis. Nascimento and Ribeiro (2011) explain that the central bank of Brazil intervenes depending on the characteristics and trends of the foreign exchange market. For instance, after the adoption of a flexible exchange rate regime in 1999, the central bank used more actively spot intervention, while foreign exchange swaps were more actively used during the foreign exchange crisis in late 2002. After 2005, the main objective of the foreign exchange policy was to increase international reserves and moderate the effects of the US dollar on the foreign exchange market through spot interventions. During the recent financial crisis and between 2011 and 2012 the central bank decided to intervene in the market using more actively currency swap auctions rather than spot intervention in order to limit the Brazilian Real depreciation experienced during these periods. As Brazil has a developed swap market, the central bank determined that was convenient to use these instruments to stabilize the pattern of the exchange rate.

Chile

After the adoption of a flexible exchange rate regime in September 1999, the central bank of Chile decided to intervene in the foreign exchange market only under exceptional circumstances. On August 16, 2001 the monetary authority announced an scheme of intervention through foreign exchange sales in the spot market and auctions of central bank bonds denominated in US dollars (BCD). This decision was due to the higher volatility of the Chilean Peso as a result of the difficult economic situation in some countries in the region such as Argentina, and the negative forecasts of the global economic performance. The amount of sterilized intervention had a limit of US$2 billion of the international reserves to finance foreign exchange sales in order to moderate the exchange rate volatility, but without targeting an exchange rate level. The period of intervention was extended until the end of 2001. The foreign currency crisis in Brazil in 2002 accelerated the pace of depreciation of the Chilean Peso forcing the central bank to announce in October 2002 the adoption of a similar scheme of intervention to the one adopted in 2001. This program would be extended until early 2003. However, spot intervention was not used during that period and only bonds denominated in US dollars were sold. Although transparency in the amount of intervention increased after the foreign exchange band was eliminated, the central bank did not announce the daily amount of intervention in 2001. The market only could know that there was spot intervention, the maximum amount of international reserves used for that purpose and the only proxy available for the amount of intervention were the movements of international reserves. On April 10, 2008 the central bank announced foreign exchange purchases for US$50 million between April 14 and September 29, 2008. In 2011, the central bank announced a program of foreign exchange purchases for US$12 billion performed with daily purchases of US$50 million between January and December 2011. The aim of this scheme was to increase the level of international reserves to a compatible level

of other similar emerging economies and to smooth the adjustment process of the exchange rate.

Colombia

The central bank of Colombia has three main mechanisms of intervention in the foreign exchange market: rule-based interventions based on options, discretionary intervention and pre-announced daily interventions through competitive auctions. In November 1999, the monetary authority adopted american put and call options as an instrument of intervention in order to accumulate or deaccumulate international reserves, and to control the exchange rate volatility. The central bank sets discretionally the amount to be auctioned and the option exercise condition is activated when the exchange rate is below or above its last 20 working days moving average for reserves accumulation and deaccumulation, respectively. To control the exchange rate volatility the central bank intervenes in the market through automatic put and call options when the exchange rate is 4% bellow or above its last 20 working days moving average, respectively. Discretionary intervention was actively used between 2004 and 2007 with the objective of depreciate the exchange rate. Finally, pre-announced constant daily interventions of US$20 million were announced in June 2008 in order to increase the pace of reserve accumulation. At the present time, this mechanism of intervention is the main instrument of the foreign exchange policy in Colombia. However, the amount of intervention was modified in September 2010 to be at least of US$20 million per day.

Mexico

The central Bank of Mexico has different mechanisms of intervention. After the peso crisis, the monetary authority adopted put options to increase the level of international reserves. This mechanism was introduced in August 1996 and suspended

in June 2001. Between February 1997 and June 2001, the central bank intervened discretionally through an auction mechanism selling US dollars with daily sales of up to US$200 million. This type of intervention was implemented as a result of the significant exchange rate volatility, and was possible due to a significant accumulation of reserves obtained through the put options mechanism. In May 2003 due to the significant increase in international reserves, the central bank decided to sell US dollars directly to the market and pre-announcing the amount to be sold based on the level of reserves in the preceding quarter. This mechanism was suspended in July 2008. On October 8, 10 and 16, 2008 the central bank implemented extraordinary auctions of US dollars due to the high volatility in the foreign exchange market. In addition to this mechanism, auctions with a minimum price were used to provide liquidity to the foreign exchange market between October 2008 and April 2010, and between November 2011 and April 2013. As a result of the adverse effects of the recent financial crisis in the foreign exchange market, put options were re-introduced in February 2010 in order to build an appropriate level of international reserves to moderate the vulnerability of the economy to external shocks. In November 2011 this mechanism was temporally suspended and replaced by auctions with a minimum price. As in Brazil, the Bank of Mexico used temporally a reciprocal currency agreement or swap line during the recent financial crisis. However, I do not include this measure in my estimations as it was adopted due to pressures of private institutions to obtain dollar funding.

Peru

The central reserve bank of Peru intervenes in the foreign exchange market through over the counter purchases or sales of USD dollars, swap operations and sales of foreign exchange to the public sector. However, I do not include in this analysis operations with the Treasury as they are aimed to fund external debt payments.

Peru does not have any rule-based instruments of intervention. The central bank intervenes actively in the market to moderate the excessive volatility of the exchange rate, as this economy is more vulnerable to external shocks due to the higher degree of financial dollarization. This intervention indirectly is contributing to strengthen the international liquidity of the economy accumulating international reserves. However, intervention in the foreign exchange market does not imply a commitment to any exchange rate target which supports the consistency of the foreign exchange policy with an inflation targeting framework.

B. Figures

Figure B.1: Bilateral Exchange Rates (January 2000=100)

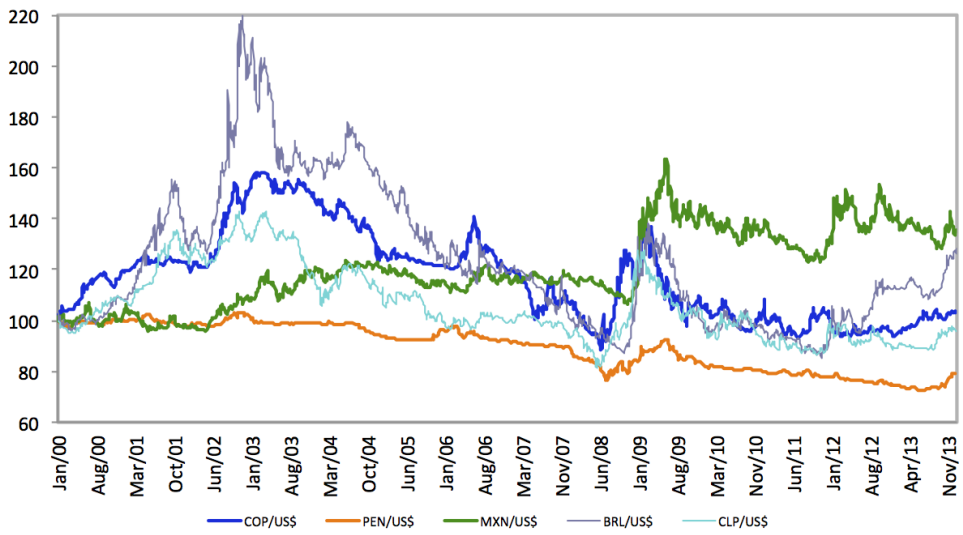
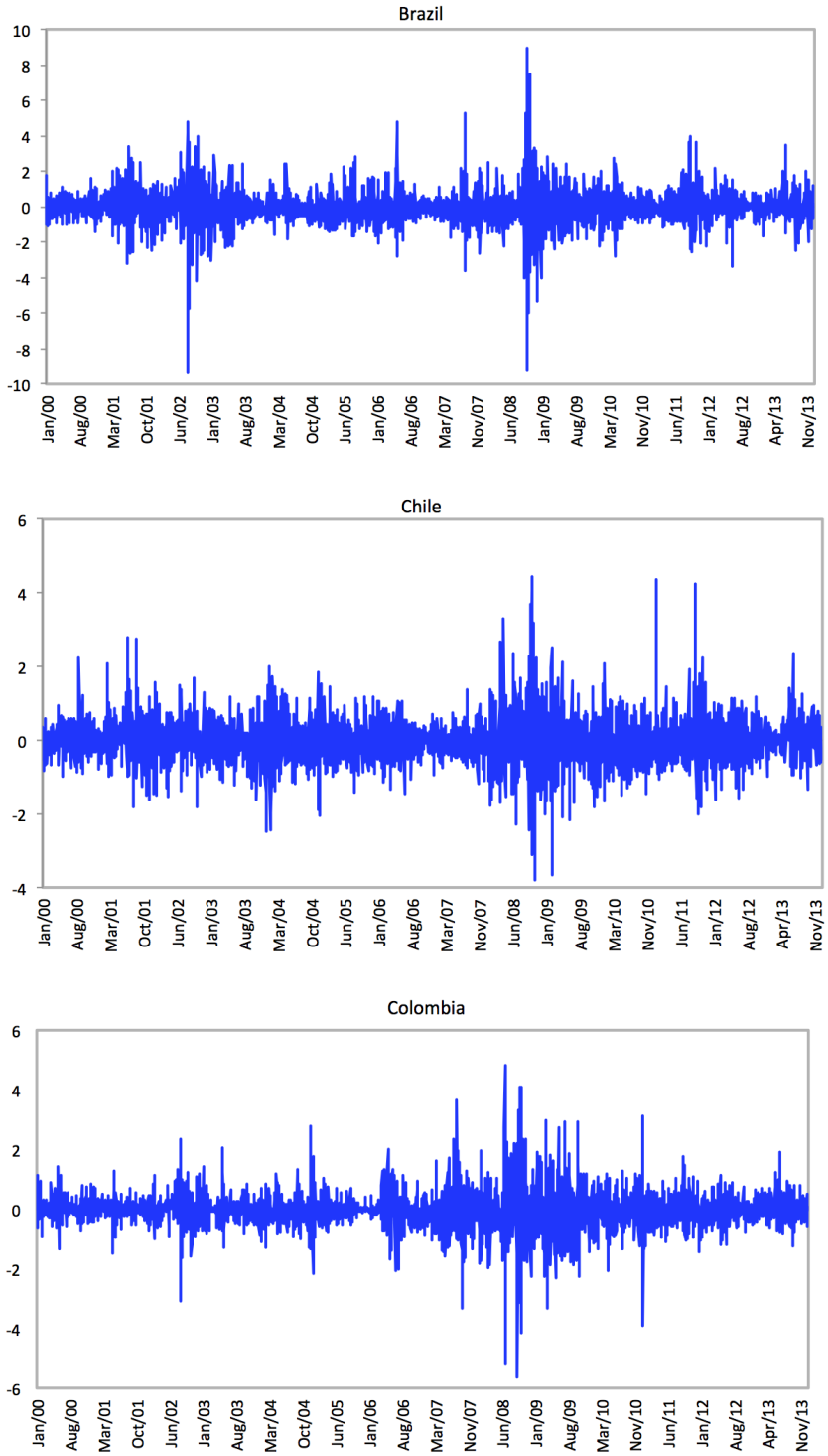
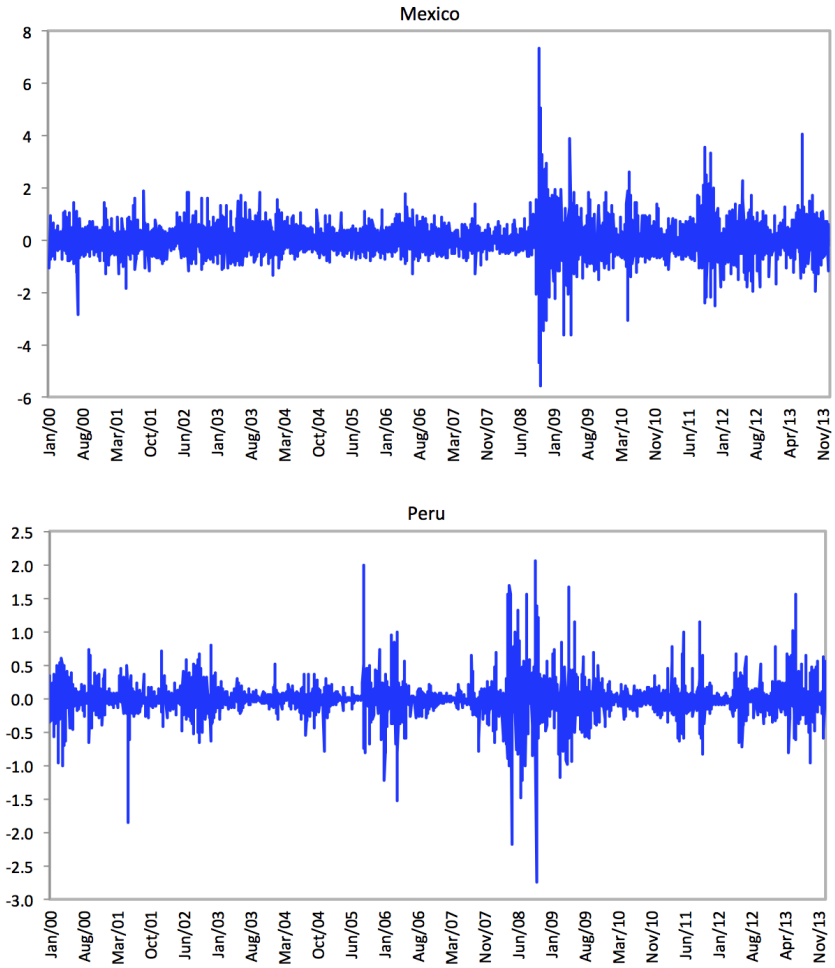


Figure B.2: Exchange Rate Returns




Mexico
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6
4
2
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-2
-4
-6
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Aug/00
Mar/01
Oct/01
Jun/02
Jan/03
Aug/03
Mar/04
Oct/04
Jun/05
Jan/06
Aug/06
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Mar/10
Nov/10
Jun/11
Jan/12
Aug/12
Apr/13
Nov/13

Peru
2.5
2.0
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1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
Jan/00
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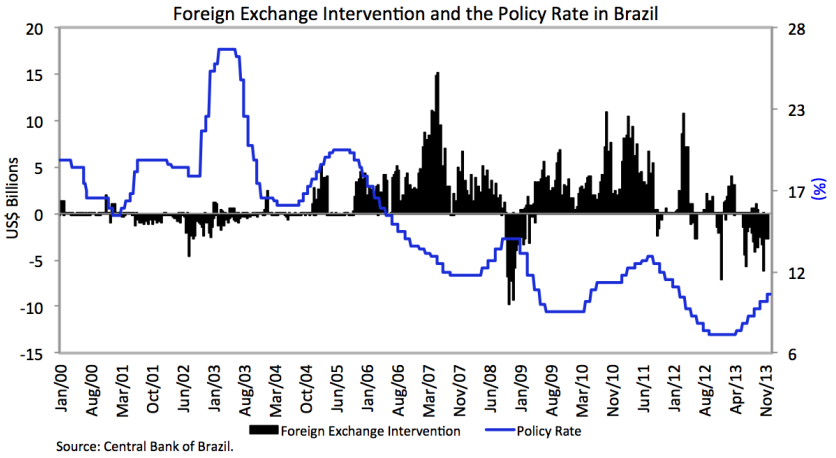
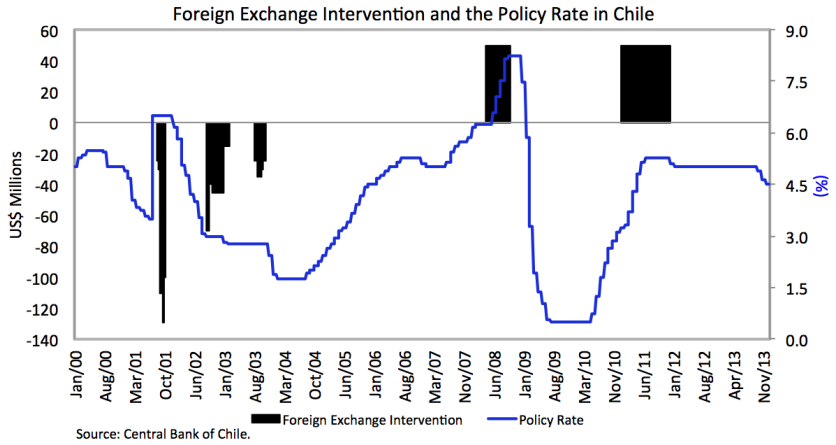
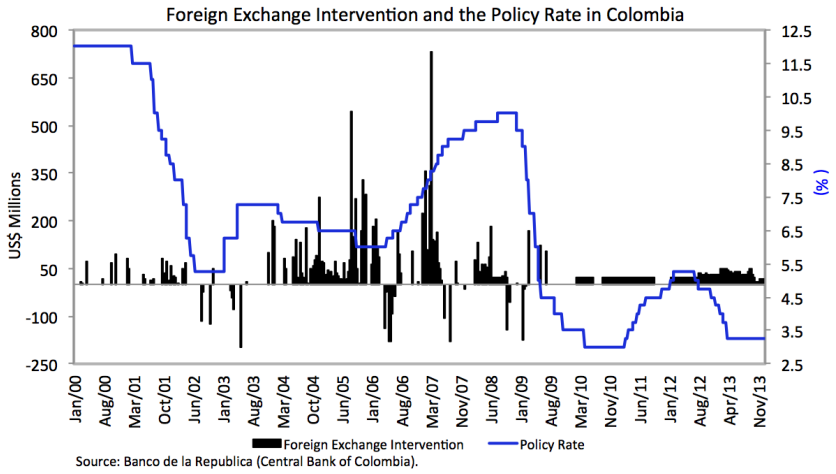
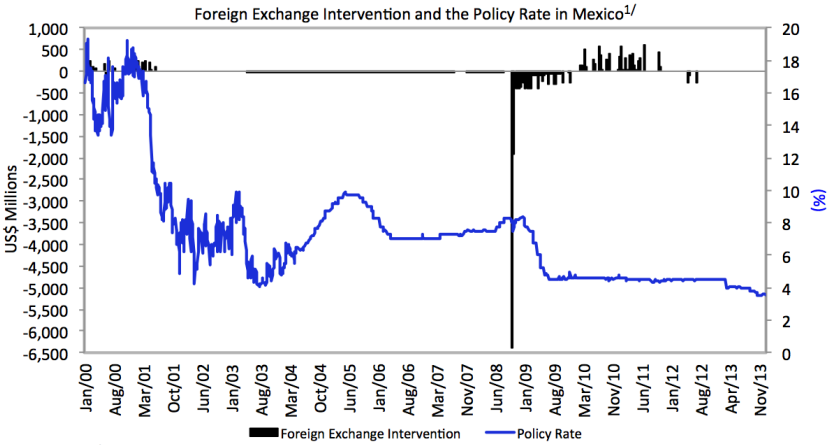
Figure B.3: Central Banks Foreign Exchange Intervention and Policy Rates

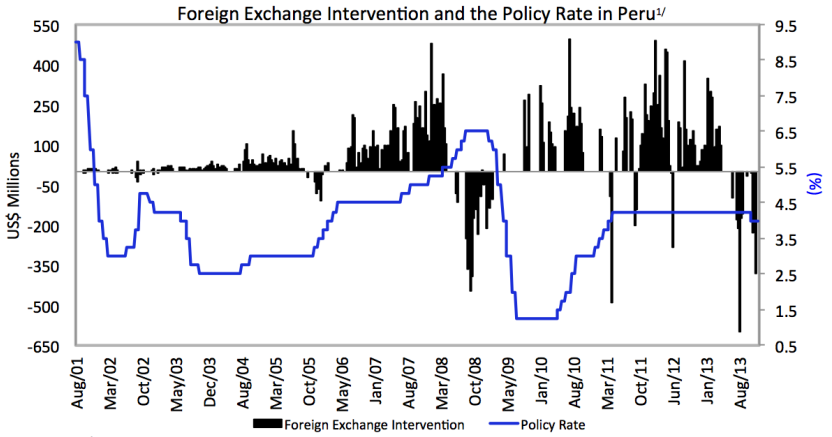








1/ After January 21, 2008 the overnight interest rate is adopted as the operational target.
Source: Banco de Mexico (Central Bank of Mexico).



1/ Before September 2003, the policy rate corresponds to the monetary credit regulation interest rate.
Source: Central Reserve Bank of Peru.

C. Tables

Table C.1: Descriptive Statistics of Daily Exchange Rate Returns, 2000-2013

Statistic	Brazil	Chile	Colombia	Mexico	Peru
Mean	0.007	-0.000	0.000	0.009	-0.006
Median	-0.017	-0.012	0.000	-0.024	-0.008
Maximum	8.918	4.458	4.804	7.332	2.064
Minimum	-9.360	-3.799	-5.621	-5.597	-2.753
Standard Deviation	0.959	0.622	0.627	0.634	0.250
Skewness	0.078 (0.056)	0.535 (0.000)	0.016 (0.701)	0.743 (0.000)	0.188 (0.000)
Excess Kurtosis	12.047 (0.000)	5.474 (0.000)	9.872 (0.000)	14.009 (0.000)	16.213 (0.000)
LB (5)	28.788 (0.000)	80.875 (0.000)	84.524 (0.000)	20.307 (0.001)	149.825 (0.000)
$LB^2(5)$	2212.54 (0.000)	1057. 49 (0.000)	1448.16 (0.000)	2463.04 (0.000)	924.24 (0.000)
ADF	-25.036	-23.828	-23.964	-25.014	-23.199

Notes: Daily exchange rate returns are calculated as the log difference of the nominal exchange rate vis-à-vis the US dollar multiplied by 100. LB and LB^2 denote the Ljung Box-Q statistics for the exchange rate returns and the squared returns, respectively. ADF denotes the augmented Dickey-Fuller test. P-values are in parentheses.

Table C.2: Descriptive Statistics of Daily Foreign Exchange Intervention, 2000-2013

Statistic	Brazil	Chile	Colombia	Mexico	Peru
Frequency					
Number of trading days	3,517	3,491	3,420	3,526	3,533
Number of intervention days	3,492	409	1,325	1,517	1,445
Frequency of central bank intervention (%)	99	12	39	43	41
Intensity (in US$ millions)					
Average absolute value of purchases	1,636	50	29	152	53
Average absolute value of sells	716	42	69	42	69
Maximum daily purchases	15,126	50	733	600	494
Maximum daily sells	9,709	129	200	6,400	600
Forms of intervention (average absolute value in US$ millions)					
Spot intervention	1,032				
Purchases	1,553				
Sells	521				
Swap auctions	-239				0
Purchases	803				7
Sells	1,041				6
Tender purchase of dollars		50			
Option auctions					
For reserves accumulation			-29	152	
Put option auctions			40	152	
Call option auctions			69	0	
For volatility control			-12		
Put options			56		
Call options			69		
Discretional intervention		-54	39		
Dollar-denominated Central Bank bills		-37			
Direct pre-announced intervention			23		
Contingent dollar sales mechanism				50	
To slow the pace of reserve accumulation				24	
Extraordinary auctions of dollars				2,200	
Dollar auctions with a minimum price				290	
Dollar auctions without a minimum price				72	
Over the counter operations					-42
Purchases					56
Sells					98

Source: Own calculations using data from Central Banks websites.
Notes: Extraordinary auctions of dollars in Mexico may be classified as discretional intervention. Forms of intervention other than swap operations may be classified as spot market intervention but the mechanisms of intervention are disaggregated by country.

Table C.3: P-Values of the LM-test against Nonlinearity

Delay Parameter	Brazil	Chile	Colombia	Mexico	Peru
d=1	1.638×10^{-10}	0.107	1.099×10^{-7} *	1.419×10^{-7} *	6.515×10^{-6}
d=2	1.594×10^{-10}	0.126	3.887×10^{-7}	9.678×10^{-6}	2.523×10^{-5}
d=3	6.601×10^{-11} *	0.384	1.926×10^{-7}	3.223×10^{-3}	6.105×10^{-14} *
d=4	5.376×10^{-10}	0.074	* 5.343×10^{-6}	1.035×10^{-4}	5.873×10^{-8}
d=5	3.416×10^{-10}	0.120	1.083×10^{-5}	3.206×10^{-5}	1.523×10^{-7}
d=6	6.634×10^{-10}	0.549	9.938×10^{-6}	6.286×10^{-5}	6.685×10^{-6}
d=7	7.110×10^{-10}	0.103	1.119×10^{-6}	7.533×10^{-4}	1.024×10^{-4}
d=8	2.034×10^{-9}	0.457	5.441×10^{-6}	1.846×10^{-2}	1.260×10^{-6}
d=9	4.307×10^{-8}	0.401	6.213×10^{-6}	1.118×10^{-3}	1.658×10^{-5}
d=10	1.671×10^{-8}	0.335	5.673×10^{-6}	6.214×10^{-3}	1.446×10^{-5}

Notes: P-values of the linearity test using the F distribution. The test is calculated assuming constant conditional variance. * denotes the lag length selected of the delay parameter.

Table C.4: No ARCH Tests of the STR Model with Constant Conditional Variance

Lags	Brazil	Chile	Colombia	Mexico	Peru
			Engle LM-Test		
L=1	725.81	102.98	334.90	290.83	261.27
L=2	897.39	423.50	530.55	987.99	315.36
L=3	959.54	505.93	668.46	1001.95	347.25
L=10	1038.86	671.44	736.62	1052.09	470.54
			McLeod and Li Test		
L=1	726.62	103.09	335.27	291.15	261.56
L=2	1299.66	479.36	697.25	1204.30	393.57
L=3	1770.49	674.21	1092.51	1453.70	497.79
L=10	3259.13	1701.26	1975.64	2169.77	1072.70

Notes: Test statistics of no autoregressive conditional heteroscedasticity (ARCH) reported. The Engle LM-Test and McLeod and Li Test are asymptotically distributed as Chi-squared.

Table C.5: STR GARCH-M Models Regardless of the Direction of Intervention

	Brazil	Chile	Colombia	Mexico	Peru
			Conditional Mean		
δ	0.040	-0.056**	0.037**	0.037***	0.000
	(0.033)	(0.025)	(0.018)	(0.007)	(0.003)
φ_1	0.106***	0.135***	0.189***	0.094***	0.176***
	(0.016)	(0.017)	(0.017)	(0.015)	(0.027)
φ_2				-0.034***	-0.044**
				(0.011)	(0.021)
ψ	0.009*	0.062	0.007**	-0.317***	0.188*
	(0.005)	(0.111)	(0.003)	(0.359)	(0.101)
γ	-1.822*	3.193**	-0.612	-0.682*	-1.282*
	(1.067)	(1.318)	(1.076)	(0.376)	(0.705)
κ	-0.014	0.058	-0.096**	-0.073***	-0.034
	(0.027)	(0.046)	(0.040)	(0.016)	(0.034)
ϕ_1	0.073***	2.041***	0.083***	1.750*	0.396***
	(0.020)	(0.053)	(0.019)	(1.022)	(0.099)
ϕ_2	0.007*	0.035***	0.001***	0.269	0.0006
	(0.003)	(0.001)	(0.000)	(0.252)	(0.000)
			Conditional Variance		
α_0	0.013***	0.009***	0.006***	0.006***	0.001***
	(0.002)	(0.000)	(0.002)	(0.000)	(0.000)
α_1	0.169***	0.100***	0.219***	0.099***	0.229***
	(0.008)	(0.002)	(0.026)	(0.002)	(0.028)
α_2	0.823***	0.877***	0.780***	0.882***	0.770***
	(0.004)	(0.002)	(0.026)	(0.001)	(0.028)

Notes: The STR GARH-M model incorporates the direct amount of intervention in the transition function instead of the intervention indicator used in the benchmark model. Robust standard errors in parentheses. ***, **, * denotes significance level at the 1%, 5%, and 10% level.

Table C.6: STR GARCH-M Model by Type of Intervention in Colombia

Type	Options	Discretional	Options	Pre-announced
Period	16/02/2000 - 08/09/2004	21/09/2004 - 01/03/2006	03/05/2007 - 05/06/2008	03/03/2010 - 30/12/2013
ϕ_2	0.044***	-0.001***	0.042***	0.003***
	(0.009)	(0.000)	(0.002)	(0.000)

Notes: The model is estimated for different periods of intervention in Colombia. Periods of less than one year length are excluded due to the lack of model convergence. The parameters ψ and ϕ_1 are equal to the values obtained from the benchmark model. Robust standard errors in parentheses. ***, **, * denotes significance level at the 1%, 5%, and 10% level.

Chapter 3

The Determinants of Private Capital Flows in Emerging Economies: The Role of Fed Unconventional Monetary Policies

3.1 Introduction

The adoption of Unconventional Monetary Policies (UMP) in industrialized and emerging economies have increased the interest of policymakers in studying their international spillover effects, especially on capital flows. The Federal Reserve adopted a set of unconventional policies as an alternative to conventional measures to stimulate the aggregate demand at the zero lower bound and to restore the functioning of the financial system. The change in the dynamics of capital flows during periods of crises makes it crucial to understand its main drivers, and especially the role played by UMP.

In this paper I study the determinants of gross private capital inflows in Emerging

Economies (EMEs) focusing on the role of Unconventional Monetary Policies (UMP) adopted by the Federal Reserve. Using the approach of Rajan and Zingales (1998), the hypothesis is that the effect of UMP on capital flows depends on the degree of financial exposure of each country to the US and varies according to the type of unconventional measure examined (e.g. Liquidity Measures, purchases of Long Term Treasury Bonds, and purchases of Long Term Mortgage Backed Securities). If this channel is really working, I should see the effects of UMP being greatest in countries which are more financially exposed to the US.[1]

The literature on the role of Fed UMP in driving capital flows has focused on the effects of announcements and actual operations, and the channels through which these measures affect the dynamics of international capital flows. This paper makes two contributions to the existing literature. First, using a dynamic panel data approach with country fixed effects and controlling for the recent financial crisis, I identify that the impact of UMP on international capital flows is differentiated between economies and depends on the degree of financial exposure to the US. Instead of examining UMP as part of a set of global variables as the existing literature usually does, I am able to isolate the effect of UMP on capital flows that can be confounded with global events such as the recent financial crisis. As there is not conclusive evidence regarding the post-crisis increase in capital inflows in EMEs due to Fed UMP, this approach could be the smoking gun in this debate as I attempt to find evidence of a specific mechanism by which these policies affect capital flows in EMEs.

Second, unlike the literature on Fed UMP, I use gross private capital inflows instead of net private capital flows and include other flows in addition to portfolio flows. As I want to analyze the impact of UMP adopted in the US on all capital

[1]Rajan and Zingales (1998) study the impact of external financing on economic growth taking into consideration within-country differences as they estimate a model where the dependence on external financing varies by industry and the financial development varies by country. After correcting for country and fixed effects, they find that the relationship between external financial dependence and economic growth is positive.

flows in EMEs, I analyze the dynamics of capital flows from the foreign investor perspective. The aim of this approach is to examine if these policies have any effect on the international supply of capital flows. If I use net capital flows as the existing literature does (i.e gross inflows net of gross outflows), it will be more difficult to isolate and identify the overall effect of unconventional policies adopted by the Federal Reserve. As Forbes and Warnock (2011) note, analyzing only net capital flows may give inaccurate results as the decisions of domestic investors incorporated in capital outflows could be driven by different factors even if gross capital inflows and gross capital outflows have a similar pattern.

The data used comprise quarterly information of foreign direct investment, equities, debt and other private inflows in EMEs from the IMF balance of payments data. This data is compiled for 46 EMEs. The results suggest that UMP exerted an important effect on capital inflows to EMEs. These effects depend on the type of unconventional measure examined and the effect is strengthened if there is a higher financial exposure of each country to the US. There is evidence of portfolio recomposition across countries and the global investor risk, the real GDP growth jointly with other specific country variables play an important role in driving capital flows. Finally, there is evidence of cross-sectional dependences in the static panel data specification. Controlling for this dependences in the error distribution strengthen the previous results.

Although I focus my analysis on UMP adopted by the Fed, I cannot disregard the importance of other variables as determinants of capital flows. Bernanke's speech on October 14 2012 about the international spillover effects of unconventional policies explains that not only policies taken in developed countries (i.e. UMP) are responsible for the recent increase in capital flows to EMEs. There are other variables such as the investor risk appetite and the decisions made by policymakers in EMEs that are crucial in driving capital flows. Based on Bernanke's analysis, I include

the Chicago Board of Options Exchange Volatility Index (VIX) as a measure of risk but with a differential effect for each country, real GDP growth differentials between each economy and the US, short term interest rates differentials and other underlying domestic factors.

There are three main strands in the literature on capital flows. First, the traditional push and pull factors approach analyzing global and country specific determinants of capital flows. For instance, Ahmed and Zlate (2013) study the impact of a set of global and domestic variables and examine the impact of UMP announcements on net portfolio capital flows in 12 EMEs. They use dummy variables indicating announcement dates and actual UMP operations. In addition, they isolate the direct effect of these policies on long term treasury rates and then evaluate their impact on capital flows. Fratzscher (2011) and Fratzscher et al. (2012) analyze at the micro level the impact of global and domestic factors and the role of unconventional measures on net portfolio capital flows in advanced and developing economies during the recent global crisis and in the recovery. They use dummy variables as measures of Fed announcements and continuous variables as the weekly change of actual operations to examine the existence of portfolio recomposition. Byrne and Fiess (2011) examine if there are common factors driving the volatility of capital flows in emerging and developing countries. Forbes and Warnock (2011) study the dynamic of capital flows using gross flows instead of net flows to examine the behaviour of domestic and foreign investors and to identify periods of extreme capital flows classified as episodes of surges, stops or flight and retrenchment.

Second, the literature studying the unobserved components of capital flows breaking down the data into unobserved permanent and temporary components. This literature uses state space models estimated by Kalman filtering methods (e.g. Sarno and Taylor 1999 and Mody et al. 2001). Finally, few studies have analyzed the determinants of capital flows using a supply and demand disequilibrium approach.

Mody and Taylor (2002) and Felices and Orskaug (2008) are the only papers to my knowledge that have estimated demand and supply functions for capital flows, allowing for market disequilibrium. This implies that the supply and demand of capital is not always in equilibrium, and the role of imperfect information emphasized in these papers is crucial in determining capital flows.

This paper relates closely to the literature of push and pull factors. However, I go one step further as I estimate the effect of global factors as heterogeneous across countries. The main essential difference is that I incorporate in my estimations a differential effect of UMP on gross capital inflows in EMEs that relies on the degree of financial exposure of each country to the US. In addition, as I study the impact of UMP from a foreign investor perspective, this analysis builds on the theory of disequilibrium between the supply and demand of capital because I am studying the effect of the US supply of capital in EMEs using data on gross private capital inflows. Modelling a disequilibrium econometric approach with panel data analysis is challenging and there are no studies approaching the impact of UMP on capital flows using this framework. This is the next stage of my research.

The next section describes the adoption of UMP in the US and their international spillovers. Section 3.3 analyses the recent evolution of capital flows in EMEs. Section 3.4 explains the empirical methodology and the data set. Section 3.5 discusses the empirical results of the benchmark model and robustness tests. Section 3.6 covers the conclusions and the next stage of my research.

3.2 Fed Unconventional Monetary Policies and International Spillovers

Non conventional monetary policy measures are usually called unconventional balance sheet policy measures as they have expanded the size and changed the com-

position of the Federal Reserve balance sheets. There are two different types of measures. First, financial stability measures aimed to restore the functioning of the financial system. Second, macro-stability measures to boost the economic activity by reducing long term rates. The timeline and description of each of the measures adopted by the Federal Reserve are summarized in Table B.1.

Financial stability policies take two forms, domestic and foreign exchange liquidity provision measures. The Term Auction Facility Program was introduced in December 2007 to reduce the pressure in short term funding markets associated with problems in the subprime mortgage market. In early 2008, the Term Securities Lending Facility and the Primary Dealer Credit Facility were introduced to alleviate term funding and collateral pressures faced by primary dealers. In addition, after the collapse of Lehman Brothers the Fed established additional measures to provide liquidity in key credit markets. Within these liquidity facilities were introduced the Commercial Paper Funding Facility, the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility, the Money Market Investor Funding Facility, and the Term Asset-Backed Securities Loan Facility. Regarding foreign exchange liquidity measures, bilateral foreign exchange swaps arrangements were introduced in order to alleviate periods of liquidity stress in US dollar funding in foreign financial markets.

Macro-stability measures in the US adopted by the Federal Reserve are related to the Large Scale Asset Purchases Program (LSAP) introduced in late 2008. This round of quantitative easing was called QE1. As the Fed states, this program involves purchases of long term securities (i.e mortgage-backed securities) issued or guaranteed by government sponsored agencies such as Freddie Mac or Fannie Mae and purchases of long term Treasury bonds. The aim of this program is to reduce mortgage interest rates, improving house markets functioning, and to lower long term interest rates in order to boost the economy as conventional policies are ineffective

due to short term rates are near to the zero lower bound. Two rounds of quantitative easing, QE2 and QE3 were announced in November 2010 and September 2012 respectively. In addition to the LSAP, the Fed introduced the Maturity Extension Program between September 2011 and December 2012 in order to increase the average maturity of its Treasury securities holdings and to lower even more long term interest rates.

It is important to mention that the liquidity conditions that followed the recent financial crisis forced some EMEs to adopt unconventional central bank measures. These measures include domestic liquidity easing, foreign exchange easing and credit easing instruments. However, the role of unconventional policies in EMEs is different than in advanced economies. Unconventional polices in EMEs have limited impact on the volume of capital flows as their aim is to alleviate periods of domestic and foreign exchange liquidity stress in the short run but not to attain macroeconomic objectives or to restore the functioning of key markets as in advanced economies. According to Ishi et al. (2009), factors such as external vulnerability, limited financial stress, and less policy credibility in EMEs restrict the use of unconventional policies such as quantitative easing. Following Ishi et al. (2009), I find that unconventional policies in EMEs are not homogeneous within countries and the only way to characterize them is using indicator variables. This methodology is not appropriate with quarterly data because only captures discreet shifts in the average level of capital flows and not the overall effect of these type of policies. Due to the nature of unconventional policies in EMEs, this paper only focuses in studying non standard monetary policies adopted in the US and their effect on capital flows in EMEs. Nevertheless, 34 countries from the sample used in this paper are economies which adopted non conventional policies during the recent financial crisis.

What are the channels through which UMP adopted by the Fed affect the dynamic of capital flows? The recent literature consider four main channels. The

portfolio channel implies that the Fed can reduce the supply of a specific security and investors with certain degree of preference for the asset will push up its price (i.e. reduce its yield). This channel works under the assumption of imperfect substitutability. For instance, Gagnon et al. (2010) and D' Amico et al. (2012) find evidence that the LSAP has reduced long term Treasury yields and investors have rebalanced their portfolios towards riskier assets increasing their prices. Fratzscher et al. (2012) show evidence that the LSAP adopted by the Fed lowered long term bond yields in the US and significantly in EMEs. In addition, long term Treasury purchases increased equity returns in the US and in EMEs and this is related to the degree of substitutability between assets.

The signaling channel works when announcements made by the Fed change expectations regarding the future stance of monetary policy. The impact of the first and second round of quantitative easing announcements are different from the third round of announcements known as tapering news. While the first two rounds are related to a highly loose monetary policy, the third round modifies expectations as market participants anticipate that the Fed will start to increase its short-term policy rate. For instance, if announcements are credible they could convince markets that the Fed is committed to reduce or increase future policy interest rates and this will rebalance investors portfolios. Fratzscher et al. (2012) finds evidence that Treasury purchases and announcements depreciated the US dollar versus other currencies, especially against currencies of developed countries. This goes in line with the channel of transmission of conventional monetary policies when the Fed is committed to a loose policy stance.

Fratzscher et al. (2012) describes two additional channels. The confidence channel implies that in addition to the signals that announcements give about the future stance of monetary policy, they could give information about the economic performance. For instance, if markets perceive that Fed announcements indicate a dete-

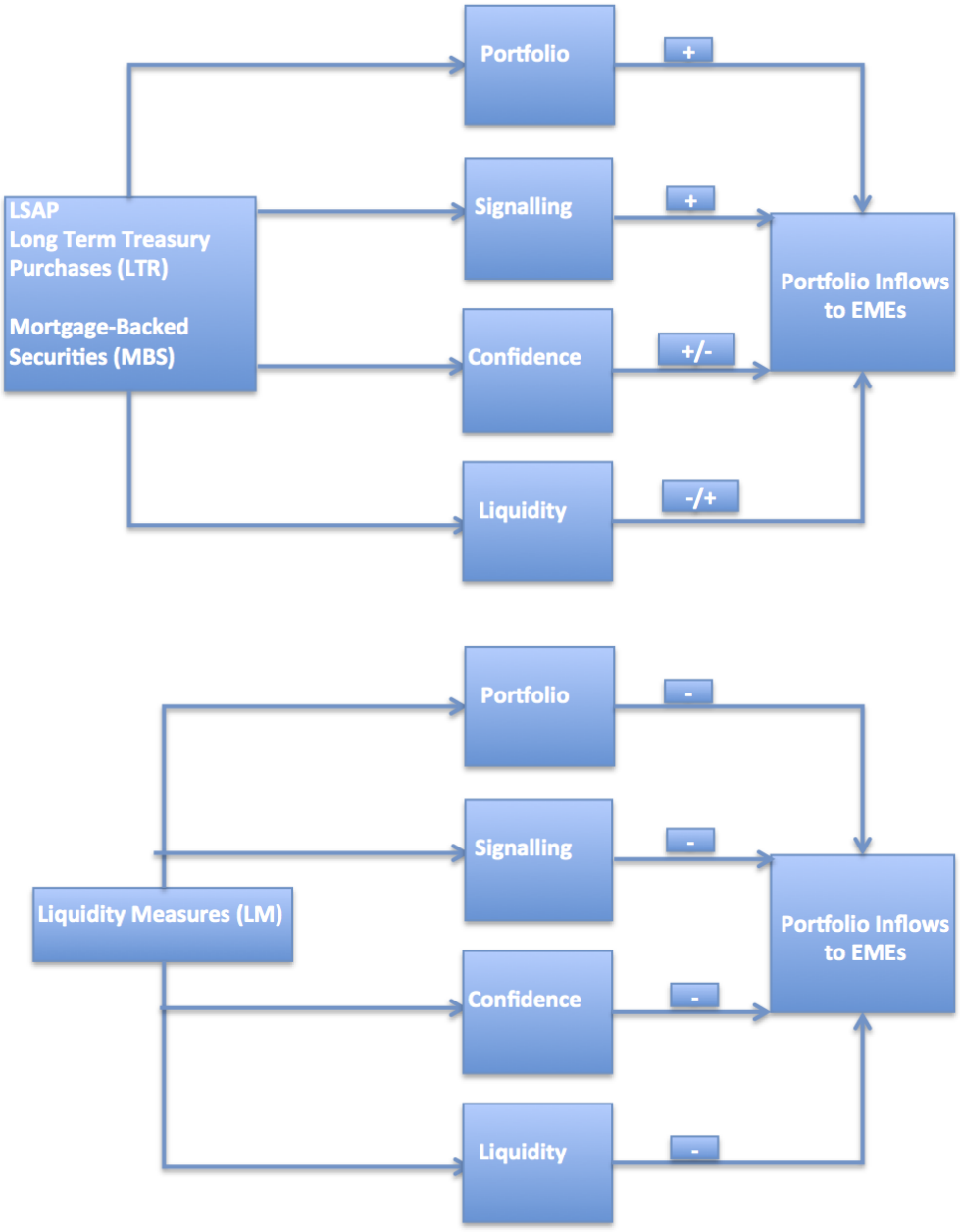
rioration in the US economy that would decrease asset prices and trigger investors to invest in safer securities. Finally, the liquidity channel operates through liquidity operations and purchases of mortgage-backed securities aimed to restore the functioning of key markets and to reduce the liquidity premia. If financial deleveraging is not prevented by these measures that will imply fire sales in different type of assets, affecting the dynamic of capital flows. The effects of liquidity operations and purchases of mortgage-backed securities on the US dollar are different than purchases of long term bonds. For instance, Fratzscher et al. (2012) find that these operations aimed to restore the functioning and intermediation in key markets appreciated the US dollar as result of an increased of capital inflows in the US.

Although the literature on the international spillovers of UMP has evaluated extensively their impact on asset prices, the focus of this paper is on the relevance of Fed UMP for international private capital flows. The effects of Fed UMP on capital flows in EMEs may depend on the type of measure adopted, the degree of substitutability between assets and the financial exposure of each country to the US. It is important to follow the heterogeneity of effects of different forms of UMP across asset type (e.g. foreign direct investment, equity, debt and other flows) under an econometric framework where the degree of financial exposure to the US explains the differential effects of Fed policies in each country. For instance, it is expected that liquidity measures and purchases of agencies bonds sponsored by the government attract capital flows to the US and reduce capital flows to EMEs because they are aimed to improve the functioning of key markets in the US. However, announcements and purchases of long term Treasuries are expected to decrease their yield and increased the demand of other class of assets such as equities or other banking investments, increasing capital flows in EMEs. If bonds and equities and other type of assets are imperfect substitutes as I explained before, this generate a rebalancing of portfolios between assets and countries. Finally, all these effects on capital flows are

expected to be diminished in countries who have lower degree of financial exposure to the US.

Figure 3.1 describes the different channels through which UMP affect portfolio capital flows to EMEs. A positive sign implies an increase in capital inflows in EMEs and a negative sign a decline. I analyze separately the LSAP and Liquidity Measures adopted by the Fed. Regarding the LSAP operations, I expect an increase in portfolio inflows to EMEs through the portfolio and signaling channel. However, the effect on each type of portfolio flow (i.e. equity or bonds) depends on the degree of substitutability between assets. The effect of LSAP through the confidence and liquidity channel is ambiguous. For instance, an increase in confidence might boost consumption and the willingness of private investors to invest either in US assets or in assets in EMEs. In addition, as MBS operations aim is to improve the house market functioning, this would imply a portfolio rebalancing from equities into bonds in the US and probably an increase in portfolio capital inflows in EMEs. Regarding the Liquidity Measures, I expect a decline in capital inflows in EMEs as they are aimed to improve the functioning of the US financial system. Although I do not include other flows (i.e. banking flows) in Figure 3.1, the expected signs of this type of flow are positive as a decrease in the liquidity premium induced by UMP will reduce private sector borrowing costs increasing bank lending in the US and in EMEs. Regarding foreign direct investment (FDI), the effect of UMP may be diminished by its higher persistence compared to other type of assets. However, according to the IMF (2011b), the permanence of FDI has decreased since the early 2000s and this could affect positively the effect of UMP on the pattern of this type of flow. Nevertheless, I expect that the effect of UMP on FDI flows is marginal in comparison to the other type of assets.

Figure 3.1: Transmission Channels of Fed Unconventional Monetary Policies on Portfolio Capital Inflows in EMEs



I want to emphasize that all these channels may work simultaneously as Fratzcher et al. (2012) explains, and the objective of this paper is to evaluate the overall impact

of UMP on international capital inflows that is the result of the interaction of these channels. The expected signs of the effects of these measures described in Figure 3.1 are just an indication of how UMP effects on capital flows are transmitted through different mechanisms.

3.3 The Dynamic of Capital Flows in EMEs

The selection of an appropriate measure of capital flows is fundamental in this paper. First, I examine the dynamics of US bilateral capital outflows vis-a-vis the rest of the world, focusing on EMEs. I divide the analysis in three periods. The baseline or pre-crisis period from January 2000 to December 2007, the crisis period from January 2008 to June 2009, and the Quantitative Easing (QE) period, divided in QE1 from April 2009 to September 2009, QE2 from October 2010 to June 2011, and QE3 from October 2012 to June 2013. QE1, QE2 and QE3 correspond to the first, second and third phase of the LSAP program respectively. I do not include a separate period for the Liquidity Measures adopted by the Fed as they where announced and implemented during the beginning of the crisis period. This analysis is based on the approach used by Morgan (2011) that evaluates the impact of the first two rounds of quantitative easing on US bilateral capital flows to Asia. The main difference is that I include the pre-crisis and the crisis period, the third round of quantitative easing known as QE3 and other regions such as Latin America, the Middle East and Africa.

Table B.2 describes US Gross Capital Outflows to the rest of the world using data from the US Bureau of Economic Analysis. During the pre-crisis period there were total outflows of US$183 billion. This dynamic was reverted during the crisis with reverse outflows of US$98 billion. During QE1 there were total outflows of US$238 billion that represents an excess of capital outflows from the US to the rest of the world of US$55 billion comparing with the baseline period. In addition, the pattern

of capital outflows from the US to the rest of the world is similar for the second and third phase of the LSAP program. For instance, during QE2 and QE3 there were total outflows of US$176 billion and US$149 billion, respectively.

How much of this outflows went to emerging Asia, Latin America, the Middle East, Africa and Europe? Tables B.3 to B.7 show that during the pre-crisis period there were outflows of US$10 billion to emerging Asia, US$36 billion to Latin America and Other Western Hemisphere, only US$2 billion to the Middle East and Africa, and US$111 billion to Europe. This means that about 61% of the total outflows from the US to the rest of the world went to Europe. There are no significant differences during the adoption of QE. In the first round, US$14 billion went to emerging Asia, US$6 billion to the Middle East and Africa, US$160 billion to Europe, and US$24 billion were repatriated from Latin America. A similar pattern is observed for the second and third round of QE, with the exception of Latin America which experienced capital inflows from the US during QE3.

Morgan (2011) compares the first two rounds of quantitative easing to the post crisis period between October 2009 and September 2010. He finds that large excess of capital flows ended up in Europe. Although in my analysis I only find evidence of excess of capital outflows from the US in the first phase of quantitative easing, the inspection of data on US bilateral flows suggests that the effect of QE on capital flows in EMEs is marginal. In addition, as Morgan (2011) explains, analyzing US bilateral capital outflows vis-a-vis the rest of the world could produce misleading results because Europe and in particular the UK acts as a channel for capital flows to the rest of the world. This is the main reason that I choose cross border gross capital flows data in my empirical analysis as they include all the transactions of each country with the rest of the world.

Figure 3.2 describes the dynamics of cross border gross capital inflows in EMEs by type of flow using information from the IMF. Between January 2000 and June

2007, gross capital inflows in EMEs experienced a positive trend due to different factors that changed positively foreign investors sentiment in these economies. The continuos decrease of short term interest rates in advanced economies to face the slow down of their economies and the higher prospects of economic growth in EMEs are within other factors crucial in explaining the dynamics of capital inflows during that period. During the crisis period, it was notable the reversal of capital flows to EMEs. This fact as Arias et al. (2012) explain coincides with lower interest rates in advanced economics as countercyclical measures taken by the monetary authorities.

It is evident from the data the lagged effects of the crisis on FDI flows. This may be the result of a higher permanent component that the existing literature finds. However, although FDI is the less volatile type of flow, according to the IMF (2011b) it has been less stable during the last decade. During the QE period gross capital inflows in EMEs peaked due to different factors such as the persistent lower interest rates in advanced economies and lower risk aversion of foreign investors to invest in EMEs. However, that surge of capital inflows to EMEs was stronger during the first two phases of the LSAP program. As Nechio (2014) notes, the adoption of unconventional policies in advanced economies is not the only factor affecting investor decisions, domestic economic conditions in EMEs play an important role in determining the pattern of capital flows. This is the explanation of why capital flows to EMEs started to slow down at the beginning of 2013 when the Fed announced to scale back large-scale purchases of government and asset-backed securities.

Figure 3.2: Gross Capital Inflows in EMEs

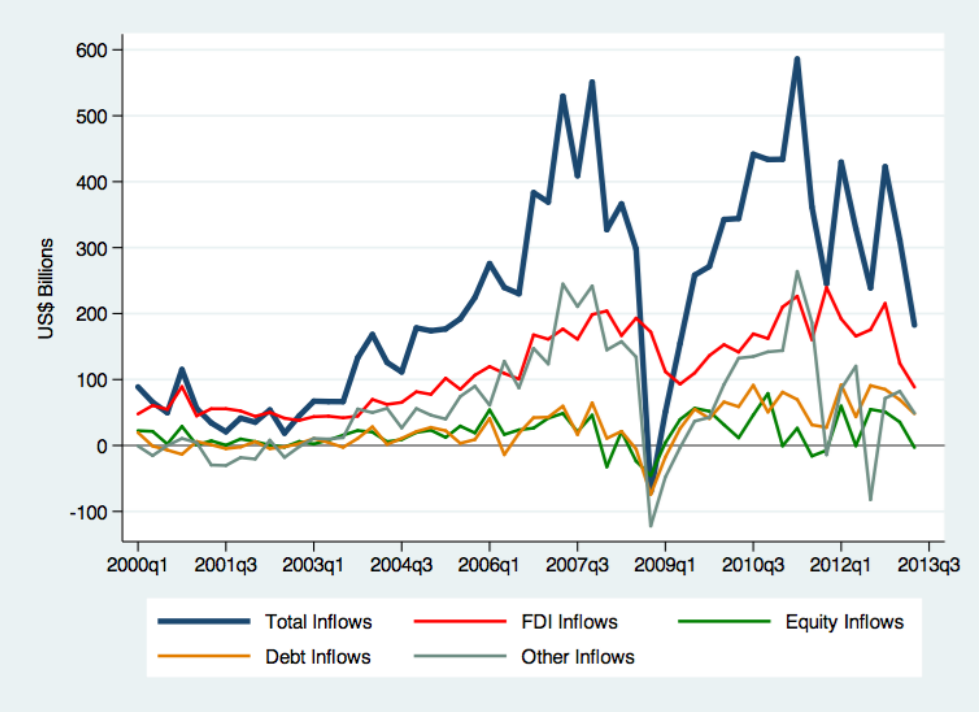
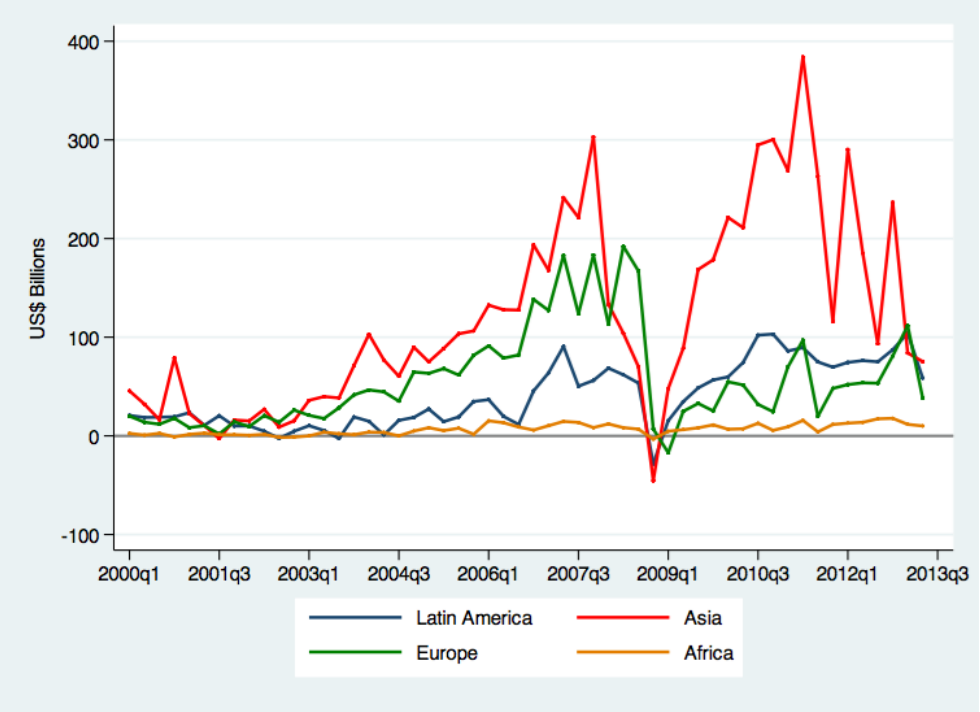


Figure 3.3 describes the dynamics of capital inflows in EMEs by region. Between 2000 and 2007 capital inflows experienced an incremental growth in emerging Asia, Latin America and Europe. However, during the crisis emerging Europe and emerging Asia were the most affected as a result of the deterioration of some macroeconomic indicators. During the QE period gross capital flows in EMEs were recovering to the previous levels of the crisis, especially in emerging Asia. However, since late 2009 the sovereign debt crisis in the Eurozone has adversely affected capital flows to this region. Nevertheless, only until I analyze the behaviour of capital flows using the econometric methodology explained in the next section, I could infer what are the real effects of UMP on capital flows in EMEs.

Figure 3.3: Gross Capital Inflows in EMEs by Region



3.4 Empirical Methodology and the Data Set

This study uses quarterly data on cross border gross capital inflows from the Balance of Payments (BOP) statistics of the IMF. As I explained in section 3.3, I do not use data on US bilateral flows vis-a-vis Emerging Economies as it may bias the results because an important percent of the supply of capital flows from the US to the rest to the world is channeled through Europe, especially through the UK.

The period analyzed covers January 2000 to June 2013, and the sample includes 46 EMEs. The list of countries included in the analysis are listed in Table B.8. I exclude offshore financial centers in the baseline estimations, and they are included only for robustness tests. I use gross private capital inflows of Foreign Direct Investment (FDI), equities, debt and other private flows (i.e. banking flows) excluding other investment flows to the monetary authorities and the general government. In

addition, I construct a series of overall gross capital inflows to EMEs adding all these type of flows. Although the analysis can be done in terms of gross nominal capital flows or gross real capital flows, I use nominal capital inflows data. Under a scenario of high and volatile inflation rates, it is better to do the analysis in real terms. However, if an economy is experiencing high inflation rates it is difficult to infer the effect of unconventional policies on capital flows as a possible increase in the supply of capital from the US to EMEs could be undermined by a high inflation rate. Thus, the main objective of this paper which evaluates the impact of UMP on the dynamics of capital flows would depend on the behaviour of domestic prices. It is important to note that 16 out of 46 countries of the data sample analysed in this paper adopted inflation targeting as monetary framework which attempts to maintain a low and stable inflation level. The relative merit of using nominal capital flows is that foreign exchange policies taken by policy makers such as capital controls are usually based upon nominal flows into and out of the country's capital account.

The literature usually uses indicator variables to evaluate the impact of UMP announcements on capital flows with the exception of Fratzscher et al. (2012) that also use actual interventions. In this paper I only use actual interventions for two reasons. First, as I am using quarterly data it is not possible to capture the overall effect of announcements on capital flows using indicator variables because they will imply a discreet shift in the average level of capital flows in an specific quarter but are not capturing the immediate effect of any announcement at any specific day. Second, as I want to test that UMP have a differential effect in each country and depends on their financial exposure to the US, actual purchases are more appropriate in my model. The reason is that actual interventions have a direct effect on the amount of capital available in the US economy and this affects directly the supply of capital from the US to the rest of the world. Nevertheless, I am not saying that forward looking agents do not react to announcements. Using actual

interventions is suitable in this case to get an appropriate regressor that captures the differential effect of UMP on each country. I divide unconventional Fed policies into two categories: liquidity market operations (LM) and the Large Scale Asset Purchase Program (LSAP) which includes purchases of mortgage-backed securities (MBS) and long term treasury bonds (TR).

Although I focus my analysis on UMP adopted by the Fed, I include another variables as important factors driving capital flows. As Bernanke states in his speech on October 14 2012, different factors could affect the behaviour of capital flows in EMEs. First, the policy measures adopted in developed countries (i.e. UMP). Second the investors risk appetite and finally the decisions made by policymakers in EMEs. Hence, I specify what variables need to be included as explanatory variables in my baseline model in line with Bernanke's considerations.

My baseline regression specification is a standard dynamic panel data model with country fixed effects, including the first lag of the dependent variable in order to account for the degree of persistence of capital flows as follows:

$$\begin{aligned} CF_{i,t} = \lambda CF_{i,t-1} + \beta_1(k_i \times LM_t) + \beta_2(k_i \times LSAP_t) + \beta_3(\delta_i \times VIX_{t-1}) \\ + \gamma' X_{i,t-1} + \varphi Crisis_t + \alpha_i + u_{i,t} \end{aligned} \tag{3.4.1}$$

where i refers to country i; $CF_{i,t}$ are gross private capital inflows in EMEs in US dollars for each type of asset and aggregated; LM_t and $LSAP_t$ are the quarterly change in the amount outstanding of liquidity market operations and the Large Scale Asset Purchase Program respectively, with LSAP divided in purchases of long term government bonds (TR) and mortgage-backed securities (MBS); k_i is a measure of the direct financial exposure of each country to the US; VIX_{t-1} is the Chicago Board of Options Exchange Volatility Index as a measure of global risk but weighted by

a measure of international financial exposure of each country δ_i; $X_{i,t-1}$ is a vector of controls such as the real GDP growth differential between each economy and the US, the interest rate differential between short term rates in each country and the effective federal funds rate, the ratio of imports plus exports over GDP as a measure of openness, the real effective exchange rate (REER), and sovereign credit ratings; $Crisis_t$ is a crisis indicator variable equal to one between 2008Q3 and 2009Q2 and zero otherwise as this is the period that coincides with the collapse of Lehman Brothers in September 2008 and when capital flows dropped dramatically as a result of this and other events related to the recent financial crisis; α_i are country fixed effects; $u_{i,t}$ is the residual with mean equal to zero. $\beta_1 k_i$ and $\beta_2 k_i$ are the immediate effects of Liquidity Measures and LSAP respectively on gross capital inflows in country i with financial exposure to the US k_i relative to a country with no financial exposure to the US. A detailed description of the dataset sources can be found in the Appendix Table B.9.[2]

As the literature has recognised that the Least Squared Dummy Variable (LSDV) estimator for equation(3.4.1) is not consistent for finite T (Nickell 1981), I use the Bias-corrected LSDV estimator with bootstrapped standard errors to avoid sample size bias following Bruno (2005a). Although the Arellano and Bond estimator is one of the most used techniques for dynamic panel data, the results can be biased as its properties hold when the sample size is large. The recent literature in econometrics finds that the Bias-corrected LSDV estimator outperforms the Arellano and Bond estimator in terms of bias and root mean squared error criteria for small cross-sections

[2]I use a similar approach to the IMF (2011b). They analyze the impact of conventional monetary policies in the US on capital flows in EMEs and advanced economies, where changes in the US monetary policy are weighted by a measure of direct financial exposure to the US. There are three main differences of my approach. First, I focus my analysis on unconventional monetary policies and their effect on capital flows in EMEs. Second, I only use gross capital inflows instead of net flows for the reasons explained in the introduction of this paper. Third, I construct in a different way the direct and international financial exposure measures used to weight the UMP and the VIX regressors, respectively. For instance, the IMF (2011b) uses assets and liabilities of country i to the US to construct those measures. I only use liabilities as my study focuses on capital investment of non-residents abroad.

(N) and finite (T) time periods. In addition, the Bias-corrected LSDV estimator is suitable for unbalanced panel-data models. The bias correction was initialized by Anderson and Hsiao estimator as it has the highest root mean squared error and the best bias performance for all the coefficients according to Bruno (2005b). The standard errors were bootstrapped in *Stata* calculating a bootstrap variance-covariance matrix using 100 repetitions. *Stata* allows three possible bias approximations and I chose the one with higher degree of accuracy up to order $O(N^{-1}T^{-2})$. Furthermore, the errors are assumed to be normal, and I use a parametric bootstrap technique as there is dependency in the data generation process. This procedure follows Kiviet and Bun (2001) as they find it simpler, relatively more accurate, and it is suitable for any type of Bias-corrected LSDV estimator.

The coefficients β, γ and φ from the Bias-corrected LSDV model of the equation (3.4.1) can be thought as short-run coefficients measuring the immediate effect of temporary shocks in UMP, the set of control variables $X_{i,t-1}$, and the financial crisis on the dynamic of capital flows. Long-run parameters can be identified as $\frac{\beta}{1-\lambda}$, $\frac{\gamma}{1-\lambda}$ and $\frac{\varphi}{1-\lambda}$ following Pesaran and Zhao (1999) and Pesaran and Shin (1999). According to Pesaran and Zhao (1999), when the sample size is small it is necessary to correct the bias introduced by the non-linear transformation of the short-run parameters in order to get long-run unbiased coefficients. As the sample size is relatively long (54 quarters), I do not use the bootstrap bias-corrected estimator proposed by Pesaran and Zhao (1999). Instead, I follow Pesaran and Shin (1999) that use the autoregressive distributed lag model (ARDL) to analyse long-run relations when the underlying regressors are I(1) or I(0) using standard normal asymptotic theory. Pesaran and Shin (1999) find that irrespective of whether the explanatory variables follow a stationary process or not, the ARDL model yields consistent long-run parameters.

According to the analysis of the different channels through which UMP may affect capital flows, the prior for the signs of β_1 and β_2 are negative (-) and positive (+)

respectively. Liquidity Measures are aimed to restore the functioning of the financial system and will reduce capital inflows to EMEs as investors will gain confidence in the US economy, while LSAP are aimed to reduce mortgage and long term interest rates, increasing the liquidity available in the economy and making investors more willing to direct their capital to different assets in EMEs. However, MBS interventions might reduce capital inflows to EMES as they are also aimed to restore the functioning of the house market in the US.

The weight used for each of the UMP categories as a measure of the direct financial exposure of each country to the US is constructed as follows:

$$\kappa_i = \left(\frac{\sum_{c=1}^{C} L_{US,i}^{c}}{L_i} \right) \tag{3.4.2}$$

where i refers to country i; c are the different types of capital such as foreign direct investment, bank loans, bonds and other investment class; $L_{US,i}^{c}$ represents the liabilities of country i to the US; and L_i is the international liability position of country i. As I analyze the dynamics of capital flows from the foreign investor perspective, I only include liabilities of each country i to the US because asset liabilities of domestic residents from the Balance of Payments definition are related to gross capital flows from the rest of the world to EMEs. The source of bilateral equity, bonds, banking and non banking claims of the US vis-à-vis EMEs is the U.S. Treasury International Capital (TIC) System database; US FDI abroad is collected from the U.S Bureau of Economic Analysis Foreign Direct Investment Statistics; and the international liability position for each economy is obtained from the IMF's Balance of Payments Statistics International Investment Position Section.

The ideal measure of the direct financial exposure would be a quarterly time-varying indicator. However, there is no information available between 2000 and 2003

in the database of the TIC System. In addition, the data on US FDI abroad is only available on an annual basis and quarterly data on the international liability position is available without gaps in 10 countries of the sample analyzed. In view of these considerations, I construct the financial exposure weight to the US as the annual average over 2003 and 2007 for the numerator and denominator as this is the period with higher coverage that precedes the recent financial crisis. In addition, I construct this weight taking the annual average over the years 2003-2007 and 2011-2012 to analyze if there are substantial changes in the financial exposure of each economy to the US after the peak of the crisis that may change the overall effect of UMP on capital flows. Figures A.1 to A.4 describe the annual time-varying direct financial exposure by region between 2003 and 2012. There is evidence that the financial exposure to the US has been fairly stable during that period with notable changes between 2008 and 2010, especially in countries of emerging Asia. This is the main reason to exclude 2008-2010 in the construction of the direct financial exposure weight.

Similarly, I weight the VIX variable with the international financial exposure of each country in order to isolate the effect of this global factor on each economy. This measure is given by

$$\delta_i = \left(\frac{L_i}{GDP_i} \right) \tag{3.4.3}$$

where L_i are the average external liabilities of each country i between 2003 and 2007, and GDP_i is the annual nominal gross domestic product of country i averaged for the same period. Following the approach of Rajan and Zingales (1998), the advantage of weighting UMP is to identify a causal effect of these policies on the dynamics of capital flows by focusing on a specific mechanism. Using this mecha-

nism that relies on the degree of financial exposure of each country to the US makes more credible the empirical approach as assuming that the impact of UMP is homogeneous across countries may result in an omitted variable problem, especially if the effect coincides with major global events such as the recent financial crisis. From an econometric point of view, I address the omitted variable problem present in the existent literature using an interaction between a variable that varies across countries (i.e direct financial exposure to the US) with a variable that varies over time (i.e. UMP) but controlling for the recent financial crisis as the most important global event in the period analyzed. Table B.10 lists all the EMEs included in this methodology with their corresponding financial exposures to the US and the international financial exposure. Panama, Israel, Mexico, Brazil, Chile and Korea have the highest degree of financial exposure to the US from a foreign investor perspective.

One important caveat is that the adoption of unconventional policies by the Fed may have been endogenous to financial shocks and market developments. As Fratzscher et al. (2012) explain, it is difficult to deal with the endogeneity bias, especially using instrumental variables due to the lack of good instruments to model endogeneity. They deal with it including variables that control for global market developments such as the VIX and including lags of Fed interventions. Fratzscher et al. (2012) state that UMP adopted by the Fed were in the majority of cases countercyclical and if the endogeneity bias is eliminated from the estimations this will make stronger the estimated coefficients. In addition to these considerations, I include a crisis dummy variable in order to distinguish the effects of common global events on capital flows from the effects of the adoption of unconventional policies as they could have occurred at the same time. Finally, with the exception of UMP I include all the control variables with one quarter lag in order to reduce simultaneity problems.

3.5 Results

3.5.1 Benchmark Model

In the baseline model I do not include offshore financial centers as the nature of capital flows may be different in these economies. I use the Im-Pesaran-Shin test and the Maddala and Wu Fisher-ADF and Fisher-PP tests as first generation unit root tests for strongly balanced data. The null hypothesis evaluated with these tests is that all the panels have a unit root. For instance, the Im-Pesaran-Shin test assumes that the autoregressive parameter is panel specific and the errors are independently distributed normal, while the Maddala and Wu Fisher-ADF and Fisher-PP test conduct a unit root test for each panel separately and then combine the p-values to get an overall test. I consider two cases for the Im-Pesaran-Shin Test. The first one assumes serially uncorrelated errors and reports the usual t statistic under the assumption that both the number of panels (N) and the time (T) are fixed. The second case allows for serially correlated errors and reports an statistic that follows an asymptotically standard normal distribution as N and T tends to infinity. The number of lags in the second case are chosen by minimizing the AIC criterion.

The Fisher-ADF and Fisher-PP tests perform either ADF or Phillips-Perron unit root tests. Although these tests report in *Stata* the inverse χ^2, the inverse logit transformation, the inverse normal, and a modified inverse χ^2, I report the inverse normal statistic as is suitable for the data sample used with finite N. Cross-sectional means are removed in the Im-Pesaran-Shin test and the Fisher-ADF and Fisher-PP tests to mitigate the impact of cross-sectional dependence. In addition, I use the Pesaran's CIPS test as a second generation unit root test in heterogeneous panels with cross-sectional dependence. The null hypothesis tested is that all series are non-stationary, and the test reported is distributed standard normal as the panels are unbalanced.

Table B.11 reports the results of unit root tests. The IPS test with serial correlation in the residuals reject the null hypothesis of unit root only at the 10% significance level for the ratio of imports plus exports over GDP and the Pesaran test does not reject it. However, I include this variable in levels as the other unit root tests reject the same hypothesis at the 5% significance level. In addition, I include REER in first differences in the main regressions as there is evidence of unit root in all tests with the exception of the IPS test with serial correlated residuals and the Fisher-ADF test. The Institutional Investor's Country Credit index is a measure of country risk provided by leading global banks and money management firms. This measure is constructed based on the answers regarding different types of risk such as political risk, exchange rate risk, sovereign risk, and economic risk. Each country is graded on a scale from 0 to 100, with 100 implying the least probability of default. As this variable is an index which represents different probabilities of default, it is not appropriate to think that it follows a non stationary process as the rating for each country represents if the credit score is bad or good. In this paper, I use the first difference of the index to see the direct impact of various likelihoods of default on capital flows and I do not test the null hypothesis of unit root.[3]

The benchmark specification estimates for gross total capital inflows are reported in Table 3.1. The model reports a higher degree of persistence of total gross capital inflows. I will focus at first instance on the estimates of UMP, the variable of interest in this paper. The results reported in Table 3.1 indicate that UMP exerted an important effect on total private inflows and this depends on the degree of financial exposure of each country to the US. The magnitude of these effects depends on the type of unconventional measure examined and the impact on capital flows is strengthen if countries have higher financial exposure to the US. The coefficients

[3]One alternative way I might have used this index is creating dummy variables for different ranges of credit scores. For instance, a dummy variable for bad credit scores equal to one if the score is between 0 and 50, and another dummy variable for good scores equal to one with scores between 50 and 100.

on LM, TR and MBS are significant at 1 percent level and statistically different according to the Chi-squared tests reported. There are not significant differences in

Table 3.1: Gross Private Capital Inflows - Bias-Corrected LSDV, 2000Q1-2013Q2

Dependent Variable: Total Flows		
Financial Exposure Weight[1/]	2003-2007	2003-2007 & 2011-2012
(Total Flows)$_{t-1}$	0.696	0.697
	(0.019)***	(0.019)***
	Unconventional Policy Measures	
Liquidity Measures (LM)$_t$	-0.085	-0.087
	(0.014)***	(0.014)***
Treasuries (TR)$_t$	0.039	0.036
	(0.017)***	(0.017)***
Mortgage-Backed Securities (MBS)$_t$	0.053	0.054
	(0.017)***	(0.017)***
	Controls	
(VIX)$_{t-1}$	-0.004	-0.001
	(0.025)*	(0.023)*
(Real GDP Differential)$_{t-1}$	0.064	0.065
	(0.051)*	(0.052)*
(Interest Rate Differential)$_{t-1}$	-0.047	-0.045
	(0.035)	(0.035)
((Imports + Exports)/GDP)$_{t-1}$	0.821	0.794
	(0.144)***	(0.145)***
Δ(REER)$_{t-1}$	0.001	0.001
	(0.026)	(0.027)
Δ(Credit Ratings)$_{t-1}$	0.051	0.049
	(0.051)	(0.051)
(Crisis)$_{t-1}$	-0.747	-0.658
	(0.905)	(0.893)
Chi2-test	72.69	70.89
P-value	0.00	0.00
N (countries)	1,883 (37)	1,883 (37)

1/ Unconventional Policy Measures and the VIX are weighted by the average of the direct financial exposure of each country to the US and by the average of the economy's international financial exposure, respectively.

Notes: Offshore financial centers are excluded. Least-squares dummy variable dynamic regression with bootstrapped standard errors reported in parenthesis. Bias correction initialized by Anderson and Hsiao estimator. Chi2-test refers to the joint null hypothesis that the coefficients on Unconventional Policy Measures are statistically equal. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

the estimations using the average financial exposure weight to the US over 2003-2007 and over the same period but including 2011-2012. It can be observed in Table B.10 that the average financial exposure weight to the US changed marginally in these two periods. Furthermore, these results may be related to the fact that post-crisis gross capital inflows returned to the levels experienced before the beginning of the recent financial crisis.

There is evidence that Liquidity Measures (LM) reduced total gross capital inflows in EMEs as their main objective is to improve the functioning of the US financial system. This may have increased the willingness of investors to rebalance their portfolios within the US. In addition, according to the baseline results, Mortgage-Backed Securities purchases (MBS) and Long Term Treasury (TR) purchases increased gross capital inflows in EMEs. MBS purchases restored the functioning and confidence in key markets such as the house market, and as Fratzscher et al. (2012) explain this induced inflows not only into US bond markets, it increased capital inflows in other markets, especially in bond market segments. This may be the reason to get a positive coefficient in the estimations. Long term government bonds purchases are aimed to boost the economy decreasing long term interest rates that jointly with an increase in market liquidity encourage investors to reallocate their capital in EMEs. These results are in line with the prior expectations described in Section 3.2. In addition, they give conclusive evidence in terms of the overall effect of UMP on capital inflows in EMEs in contrast to the previous literature that have found mixed results due to the fact that it has not recognized the differential effect of unconventional policies on capital inflows which depends on factors such as the financial exposure of each economy to the US.

The results by type of flow are reported in Table 3.2. UMP are found to be significant for all type of assets with the exception of FDI inflows. The results for the Bias-corrected LSDV estimator show a higher degree of persistence of FDI

Table 3.2: Gross Private Capital Inflows by Type - Bias-Corrected LSDV, 2000Q1-2013Q2

Dependent Variable:	**FDI**		**Equity**		**Debt**		**Other**	
Financial Exposure Weight[1/]	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012
(Type of Flow)$_{t-1}$	0.767	0.768	0.366	0.368	0.427	0.427	0.476	0.477
	(0.019)***	(0.019)***	(0.022)***	(0.022)***	(0.022)***	(0.023)***	(0.023)***	(0.023)***
				Unconventional Policy Measures				
Liquidity Measures (LM)$_t$	0.006	0.005	-0.017	-0.017	-0.025	-0.025	-0.048	-0.047
	(0.009)	(0.009)	(0.003)***	(0.003)***	(0.004)***	(0.004)***	(0.009)***	(0.010)***
Treasuries (TR)$_t$	0.015	0.014	0.002	0.002	0.015	0.016	0.031	0.029
	(0.011)*	(0.011)*	(0.004)	(0.004)	(0.004)***	(0.005)***	(0.010)***	(0.011)***
Mortgage-Backed Securities (MBS)$_t$	0.004	0.004	0.017	0.017	0.014	0.014	0.016	0.017
	(0.012)	(0.011)	(0.004)***	(0.004)***	(0.005)***	(0.005)***	(0.011)*	(0.011)*
				Controls				
(VIX)$_{t-1}$	-0.009	-0.010	-0.001	-0.001	0.008	0.007	-0.013	-0.011
	(0.017)	(0.016)	(0.006)*	(0.006)*	(0.008)	(0.008)	(0.018)**	(0.017)**
(Real GDP Differential)$_{t-1}$	0.020	0.020	0.001	0.001	-0.002	-0.002	0.075	0.074
	(0.036)	(0.035)	(0.012)	(0.012)	(0.015)	(0.015)	(0.031)***	(0.031)***
(Interest Rate Differential)$_{t-1}$	-0.001	-0.001	-0.006	-0.006	-0.029	-0.028	-0.032	-0.031
	(0.024)	(0.024)	(0.008)	(0.008)	(0.011)***	(0.011)***	(0.024)	(0.024)
((Imports + Exports)/GDP)$_{t-1}$	0.101	0.117	0.378	0.381	0.616	0.612	0.179	0.179
	(0.101)	(0.101)	(0.340)*	(0.341)*	(0.373)**	(0.374)**	(0.107)**	(0.108)**
Δ(REER)$_{t-1}$	0.011	0.011	0.002	0.001	0.002	0.002	0.018	0.018
	(0.019)	(0.019)	(0.006)	(0.006)	(0.009)	(0.009)	(0.023)	(0.023)
Δ(Credit Ratings)$_{t-1}$	0.006	0.006	0.013	0.012	0.002	0.002	0.012	0.011
	(0.035)	(0.034)	(0.012)	(0.012)	(0.014)	(0.015)	(0.032)	(0.032)
(Crisis)$_{t-1}$	-0.573	-0.537	0.192	0.194	-0.223	-0.218	-0.955	-0.972
	(0.623)	(0.614)	(0.216)	(0.213)	(0.265)*	(0.268)*	(0.542)*	(0.553)*
Chi2-test	1.98	1.65	56.65	55.13	72.71	71.99	56.75	51.87
P-value	0.577	0.649	0.000	0.000	0.000	0.000	0.000	0.000
Number of Observations	1,883 (37)	1,883 (37)	1,883 (37)	1,883 (37)	1,854 (37)	1,854 (37)	1,874 (37)	1,874 (37)

1/ Unconventional Policy Measures and the VIX are weighted by the average of the direct financial exposure of each country to the US and by the average of the economy's international financial exposure, respectively.
Notes: Offshore financial centers are excluded. Least-squares dummy variable dynamic regression with bootstrapped standard errors reported in parenthesis. Bias correction initialized by Anderson and Hsiao estimator. Chi2-test refers to the joint null hypothesis that the coefficients on Unconventional Policy Measures are statistically equal. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

flows in comparison to the other type of flows. This goes in line with the economy rationale as I expect a higher degree of persistence in FDI flows due their long-term nature. One important fact is that the parameters on LM and MBS become insignificant for FDI inflows. This may indicate that the degree of persistence of this type of flow plays an important role in determining its dynamics jointly with other variables such as market size that are not included in this model. All the coefficient signs are in line with the prior expectations except for the effect of LM on FDI inflows. Although the reason that LM increased FDI inflows in EMEs is not completely obvious, it could be related to the fact that foreign investors allocate this type of investment according to long-term considerations and they prefer to continue allocating capital in economies where they already have presence and with higher prospects of economic growth. There is a positive effect of TR purchases on FDI inflows possibly as result of the lower FDI stability over the last decade jointly with the reasons previously explained for LM. The effect of MBS purchases is marginal in comparison with other type of assets. There are two possible explanations. First, although FDI has recently experienced a lower degree of stability, it still has a higher degree of persistence in comparison with other flows that makes more difficult to capture the direct effect of UMP. Second, as Sarno and Taylor (1999) explain, the nature of FDI flows is different from portfolio and other type of flows and they are usually driven by long-term factors such as market size and availability of infrastructure.

Equities are positively affected by MBS interventions, while long term Treasury purchases have not any impact on them. Long-term government bonds purchases have increased debt capital inflows in EMEs and may imply a portfolio recomposition out of equities into bonds and other flows as Fratzscher et al. (2012) explains. However, I do not study in this paper the mechanism or the degree of portfolio recomposition within investors. Finally, other inflows such as banking flows are

notably affected by the adoption of Fed UMP, especially TR purchases and LM. For instance, TR purchases have increased other capital inflows and this goes in line with the reduction of lending costs that may encourage the supply of capital to EMEs.

Long-run coefficients of the bias-corrected LSDV model are reported in Tables 3.3 and 3.4. I only report the coefficients related to UMP to see if these policies might have differential effects on inflows in the short and long-run. There is evidence that the long-run impact of UMP on capital inflows in EMEs is higher than the short-run effect, especially for debt and other capital flows. This result is due to the higher persistence in the dependent variable captured by its lag in each estimation. All the signs go in line with the short-run estimations and the coefficients on LM, TR and MBS are significant at the 1 percent significance level for total gross capital inflows and debt flows, while LM and MBS are significant at the same level for equity flows, and LM and TR for other flows.

Table 3.3: Gross Private Capital Inflows - Bias-Corrected LSDV Long Run Estimates, 2000Q1-2013Q2

Dependent Variable: Total Flows		
Financial Exposure Weight	2003-2007	2003-2007 & 2011-2012
	Unconventional Policy Measures	
Liquidity Measures (LM)$_t$	-0.281	-0.287
	(0.048)***	(0.048)***
Treasuries (TR)$_t$	0.129	0.119
	(0.054)***	(0.056)***
Mortgage-Backed Securities (MBS)$_t$	0.177	0.179
	(0.059)***	(0.059)***

Notes: Long-run coefficients of Unconventional Policy Measures are calculated as $\beta/(1-\lambda)$ where β is the short-run coefficient of each type of unconventional measure and λ is the coefficient of the lagged dependent variable. Offshore financial centers are excluded. Least-squares dummy variable dynamic regression with bootstrapped standard errors reported in parenthesis. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

Table 3.4: Gross Private Capital Inflows by Type - Bias-Corrected LSDV Long Run Estimates, 2000Q1-2013Q2

Dependent Variable:	**FDI**		**Equity**		**Debt**		**Other**	
Financial Exposure Weight	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012
				Unconventional Policy Measures				
Liquidity Measures (LM)t	0.024	0.023	-0.027	-0.027	-0.043	-0.043	-0.091	-0.091
	(0.041)	(0.042)	(0.005)***	(0.005)***	(0.007)***	(0.008)***	(0.018)***	(0.019)***
Treasuries (TR)t	0.064	0.061	0.002	0.002	0.027	0.028	0.060	0.054
	(0.049)	(0.050)	(0.006)	(0.006)	(0.008)***	(0.008)***	(0.019)***	(0.020)***
Mortgage-Backed Securities (MBS)t	0.015	0.016	0.026	0.026	0.024	0.024	0.031	0.033
	(0.050)	(0.051)	(0.006)***	(0.006)***	(0.009)***	(0.009)***	(0.021)*	(0.021)*

Notes: Long-run coefficients of Unconventional Policy Measures are calculated as $\beta/(1-\lambda)$ where β is the short-run coefficient of each type of unconventional measure and λ is the coefficient of the lagged dependent variable. Offshore financial centers are excluded. Least-squares dummy variable dynamic regression with bootstrapped standard errors reported in parenthesis. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

Recent literature in capital flows (Nechio 2014) have noted that not only policies adopted in advanced economies have influenced the pattern of capital flows. Domestic factors have played an important role in determining the recent slow down of capital inflows to EMEs, especially after the Fed announcement of tapering Quantitative Easing in 2013. Although the main objective of this paper is to analyze the impact of UMP on capital inflows in EMEs, it is appropriate to explain the importance of domestic factors and other global factors in driving international capital flows. The coefficients of the controls used in the estimations have the expected sign with the exception of interest rate differentials. For instance, the results reported in Table 3.1 show that an increase in the global risk measured by the VIX index has slowed down capital inflows. This is consistent with the economic rationale that a higher degree of risk implies a higher risk aversion to invest.

Domestic variables such as the ratio of exports and imports over GDP are significant in the estimations. Their signs go in line to the economic rationale as a higher degree of openness has a positive effect on capital inflows. Although the coefficients on the real GDP growth differential are only significant at the 10 percent level for total capital inflows estimations and the coefficients on REER are not significant, they have the expected signs indicating that total capital inflows respond positively to economic growth and they may be affected by the real exchange rate appreciation according to the portfolio theory. In addition, credit ratings have the same pattern. The insensitivity of total gross capital flows to short-term interest rate differential may indicate the inclusion of an alternative measure that capture more accurately arbitrage opportunities across countries. This variable may be the EMBI spread over the US risk free rate as a measure of the cost of capital or expected return.

3.5.2 Robustness Tests

I test the robustness of my baseline specification in different ways. First, I include offshore financial centers to determine if the nature of capital flows in these economies affect the baseline estimations. Second, I augment the benchmark specification including additional control variables. I include reserves over short term external debt as an indicator of the ability to meet short run obligations; and the inflation differential between each emerging country and the US as excess inflation over the US may erode the value of any investment of the US abroad. I include lags of UMP but I do not report them as they are not significant. Third, I estimate a static panel data model with country fixed effects and I perform tests of heteroskedasticity and cross-sectional dependence. I test the null hypothesis of groupwise homoskedasticity in the residuals using a modified Wald test that is distributed χ^2. This test is suitable when the assumption of normality in the residuals is violated. In order to test cross-sectional dependence, I use the Pesaran (2004) test for unbalanced data, the Friedman test (1937) based on Spearman's rank correlation coefficient, and the Frees test (1995, 2004) based on the sum of squared rank correlation. The Pesaran test is normally distributed when N is large, while the Friedman test and the Frees test are asymptotically χ^2 and Q distributed, respectively. Finally, I estimate the static panel data model between 2003 and 2012 using a time-varying direct financial exposure measure. As I explained in section 3.4, the direct financial exposure to the US has been relatively stable during that period and I want to test econometrically if the results are robust when a time-varying weight is used taking into consideration that the data sample is reduced.[4]

The robustness estimations are reported in Tables B.12-B.21. The results indicate that the benchmark estimations for total capital inflows are robust to the inclusion

[4]Although there are no gaps in the data to construct the direct financial exposure measure between 2003 and 2012, the information is only available at annual basis and I assume that this measure is equal for each quarter in each year.

of offshore financial centers and additional control variables. However, the short-run and long-run estimates are smaller in magnitude after including offshore financial centers which confirm the different nature of these economies (Tables B.12-B.15). The estimations of the static panel data model without offshore financial centers are reported in Tables B.16 and B.17. As there is evidence of heteroskedasticity in the errors according to the Wald test, I use clustered errors according to Stock and Watson (2008) to allow for serial error correlation in each cross section and for heteroskedasticity across countries. In addition, as the hypothesis of cross-sectional independence is rejected according to the Pesaran test reported, I use Driscoll-Kraay standard errors in Tables B.18 and B.19 to control for cross-sectional dependence as they are consistent standard errors under heteroskedasticity and robust to different forms of cross-sectional dependence. I only report the results of the Pesaran test as the Friedman and Frees tests reach the same conclusion. According to the results reported in Table B.18, using standards errors that account for cross-sectional dependences eliminate the significance of MBS purchases in determining the pattern of capital flows. Although this is not the main objective of this paper, cross-sectional dependences may be crucial in the role played by UMP in driving capital flows and modelling them is fundamental in the analysis of their international spillovers. Overall, the estimations of the static panel data model are robust to the main results and all the coefficients of UMP continue to be significant as in the baseline results confirming the previous findings. Finally, the static panel data model is robust to the inclusion of a time-varying financial exposure (Table B.20), with the exception of the coefficient on MBS purchases that is only significant at the 10 percent level.

The baseline estimations for capital flows by type are robust to the inclusion of offshore financial centers, additional controls and the correction of cross-sectional dependences in the error (Table B.19). However, as in the case of total flows controlling for this dependences make insignificant the effect of MBS purchases, particularly in

debt flows. The control variable reserves over external debt is significant for debt and other flows highlighting the importance to meet short run obligations as a fundamental factor in the supply of capital. Finally, all the main results regarding the effect of UMP on equity, debt and other flows are still robust to these new specifications even in the estimations that include a time-varying financial exposure measure reported in Table B.21.

3.6 Conclusions and Future Research

This paper analyses the impact of Unconventional Monetary Policies on gross capital inflows in EMEs from a different perspective. The recent literature models UMP as a set of global factors without recognizing that non-conventional monetary policies have a differentiated effect on each economy. In addition, the literature has focused on studying the channels through which these policies affect capital flows. I use an approach that follows Rajan and Zingales (1998) reasoning, as I estimate a causal effect of UMP on the dynamics of capital flows in EMEs by focusing on a specific mechanism. This mechanism relies on the direct financial exposure of each economy to the US which augments or diminishes the impact of UMP on gross capital inflows transmitted by different channels (i.e portfolio, signaling, coordination and liquidity channel). This study is of interest to economic policymakers because I find evidence of a specific mechanism by which these policies affect the dynamics of capital flows and it may be the smoking gun in the mixed evidence found in the literature. In addition, Central Banks may adopt strong macroeconomic policies to face the overall effects of Fed policies if they take into consideration the degree of exposure to the US without ignoring the importance of other underlying fundamentals such as domestic factors.

Using a bias-corrected LSDV panel data model with fixed effects for 46 EMEs and

controlling for the recent financial crisis, I find that UMP play an important role in driving capital flows. The magnitude of these effects depends on the type of measure examined, the type of flow and the size of the direct financial exposure to the US. All the coefficients related to UMP are significant for total gross capital flows. There is evidence that liquidity measures have slowed down the volume of capital inflows in EMEs, while purchases of treasury government bonds and mortgage-backed securities have increased capital inflows. These results go in line with the prior expectations derived from the different channels of transmission. By type of flow the results are in line with the previous findings. Debt flows and other flows are the main drivers of total capital flows in these economies. The effect of UMP on FDI flows is marginal in comparison to other type of flows due to their higher degree of persistence found in the dynamic panel data regressions and may be due to other important factors such as market size that are not modeled in this paper. As UMP might have differential effects on inflows in the short and long-run, I estimate the long-run coefficients and find evidence that the long-run impact of UMP on capital inflows in EMEs is higher than the short-run effect, especially for debt and other capital flows.

It is evident from the estimations that non-conventional measures are not the only fundamental factors driving capital flows. Other factors such as the VIX, the real GDP growth differences, the ratio of imports plus exports over GDP, and the REER are important drivers of capital flows. Although I do not measure the contribution of each factor on capital inflows, this is important for policymakers as both, policies taken in advanced economies and the weakness of domestic economic fundamentals may change the pattern of the supply of capital in EMEs.

Tests for the implicit homogeneity assumption made across groups could be used in future research. For instance, Pesaran and Smith (1995) test as null hypothesis that the coefficients of the regressors differ randomly across cross-section units but are constant over time. In addition, I could include cross-sectional means into

the dynamic panel data model used in this paper to remove omitted cross-sectional dependence following Pesaran (2006) that proposes a procedure to estimate panel data models under the presence of error cross-section dependence. He basically filters specific regressors using means of cross-section averages in order to remove the potential differentiated effects of unobserved features as the number of cross-section units tends to infinity. The financial exposure measure used in this paper is differentiated across cross-section units and capture a source of cross-country heterogeneity. However, it is possible that there are other sources of heterogeneity that are not uniquely captured by this variable. Another important extension is to compare the estimated results of this paper that use a differentiated degree of financial exposure of each country to the US, with a dynamic heterogeneous panel data model as in Pesaran and Smith (1995) that lets the data freely determine the degree of heterogeneity.

Modelling a disequilibrium econometric approach with panel data analysis is challenging and this is the next stage of my research. I want to study the determinants of capital flows in Emerging Economies (EMEs) using a disequilibrium econometric approach for the demand and supply of capital flows, focusing on the role of UMP adopted by the Federal Reserve. The hypothesis is that on the supply side of capital, UMP have exerted an important effect on capital flows during the recent global crisis and the volume of gross capital inflows is determined by the short side of the market. Although I am in the first stage of this project, I include the econometric framework of this approach at the end of the Appendix.

Appendix

A. Figures

Figure A.1: Direct Financial Exposure of Latin America to the US

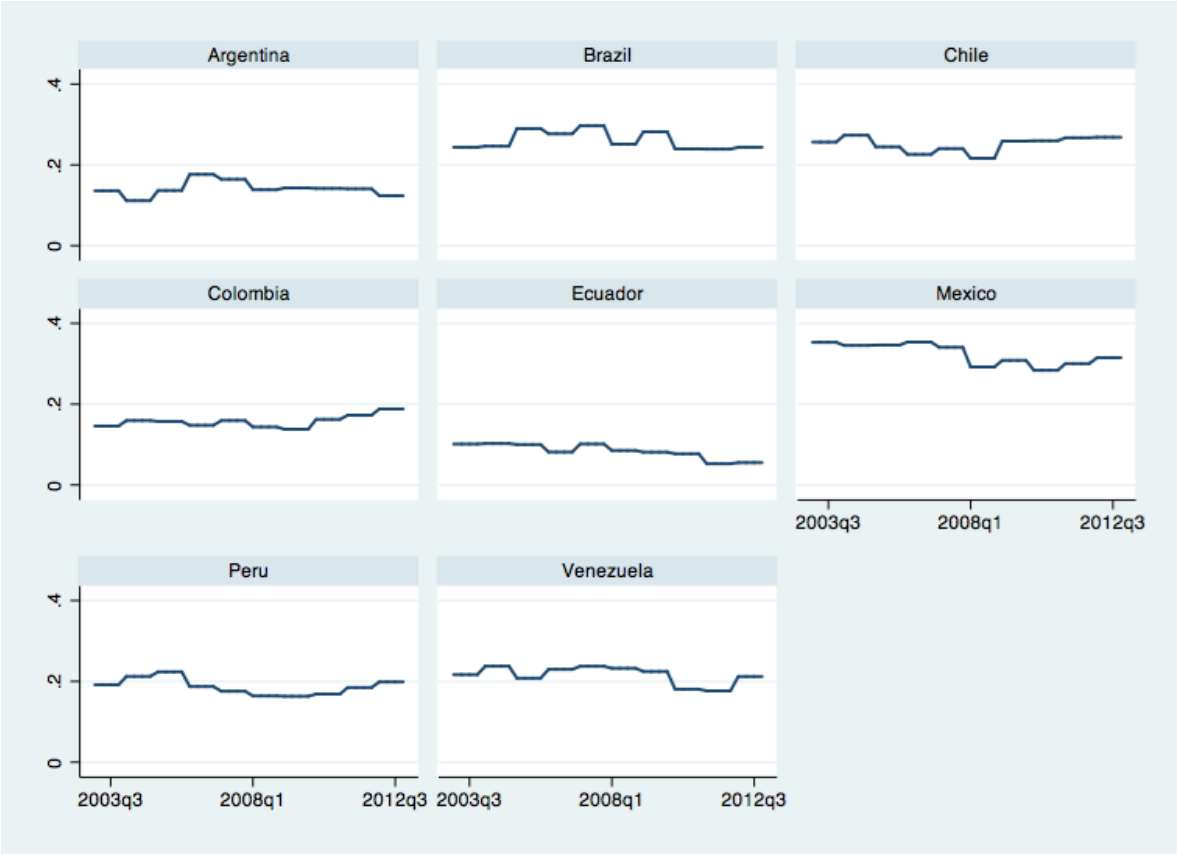


Figure A.2: Direct Financial Exposure of Asia to the US

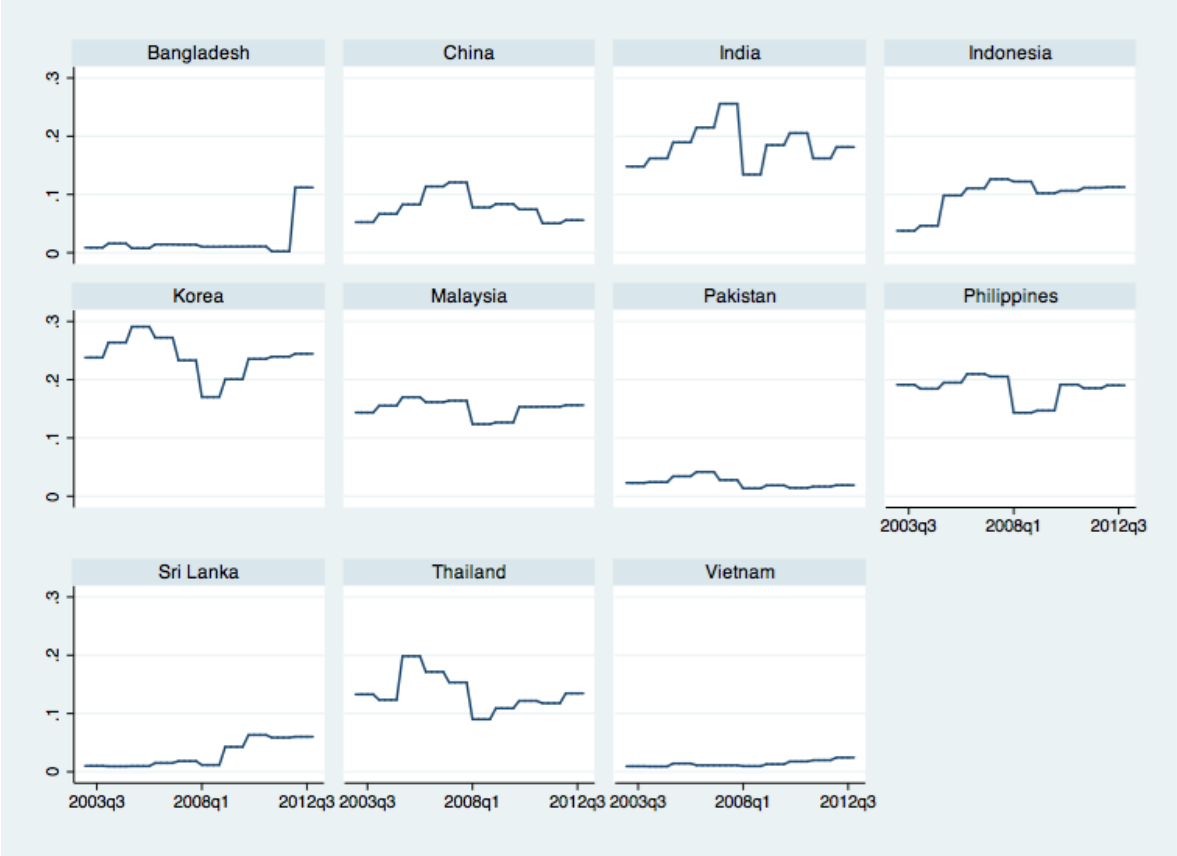


Figure A.3: Direct Financial Exposure of Europe to the US

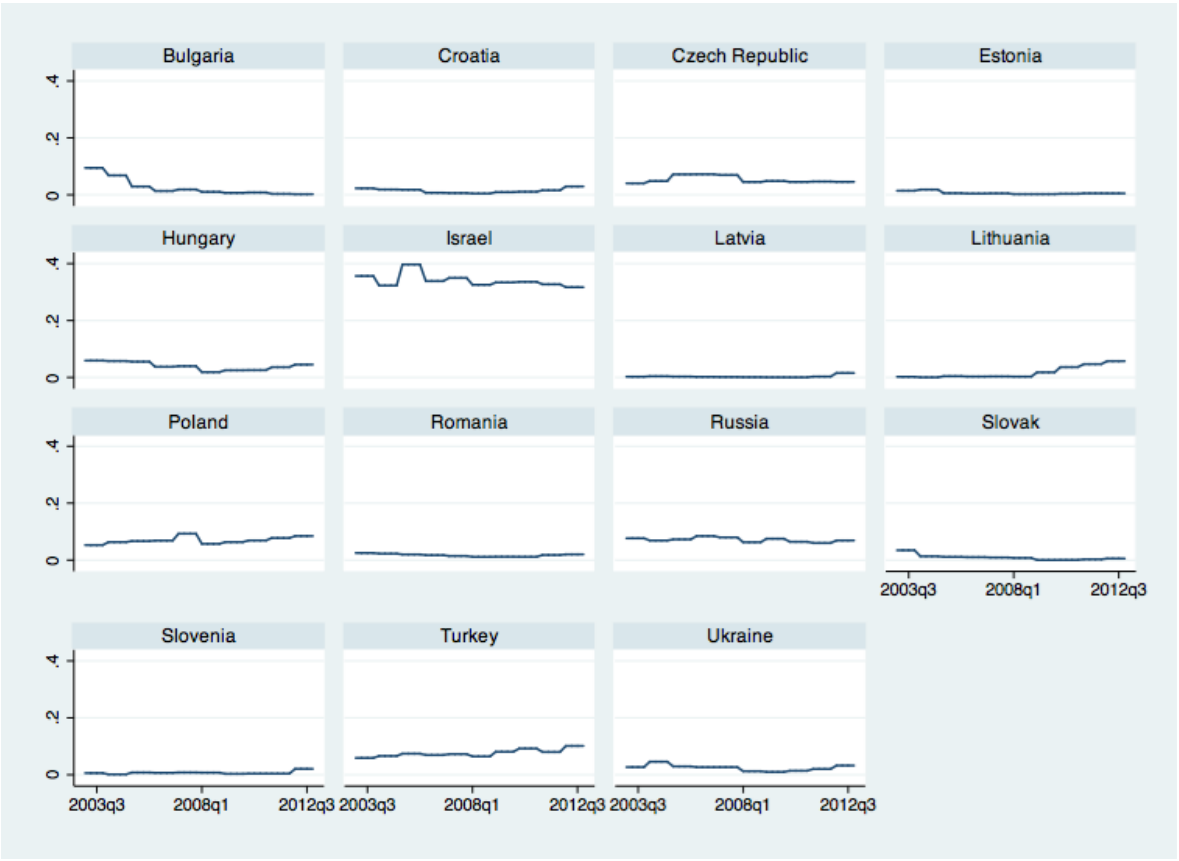
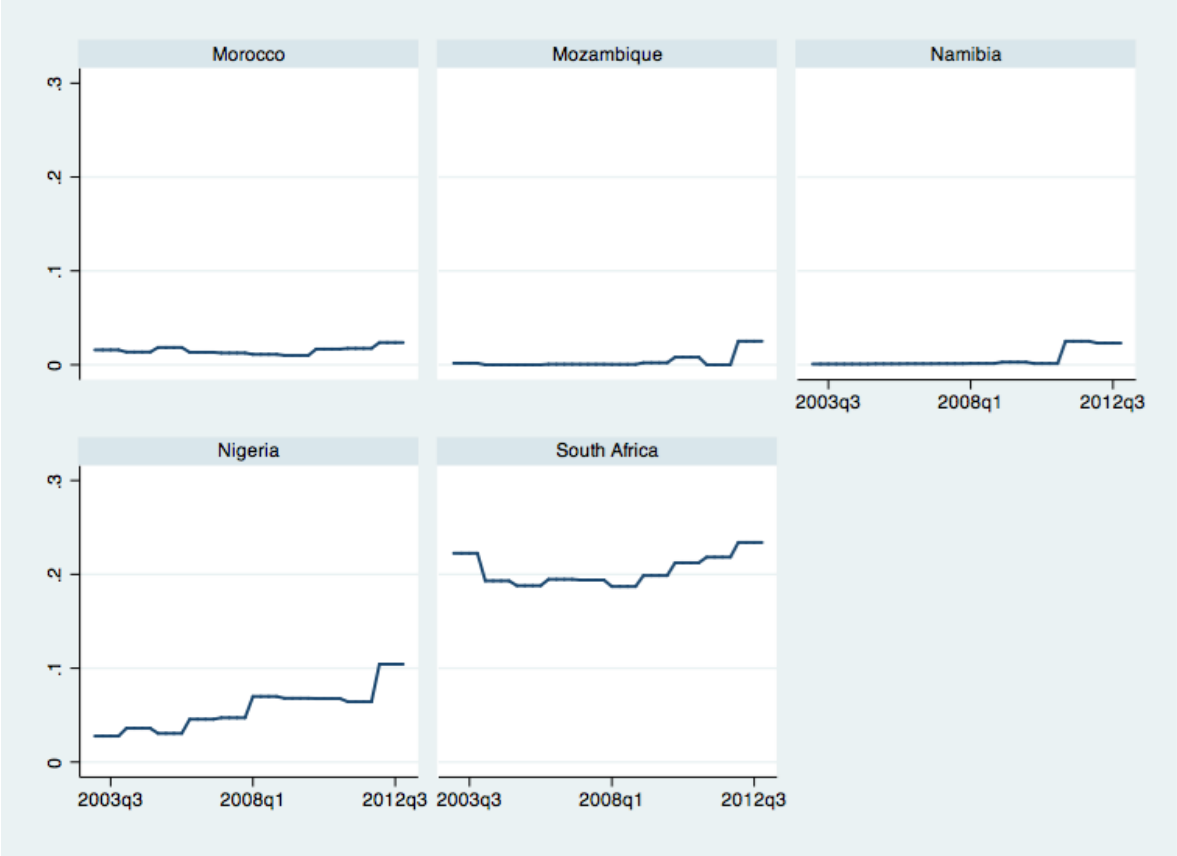


Figure A.4: Direct Financial Exposure of Africa to the US



B. Tables

Table B.1: Timeline of Unconventional Monetary Policies in the US

Financial stability measures	Date	Description
Term Auction Facility	12/12/2007-08/03/2010	The Fed established this facility to alleviate the pressure in term funding markets. The loans under this scheme were fully collateralized and allocated through an auction.
Term Securities Lending Facility	11/03/2008-01/02/2010	This program aimed at supporting the liquidity pressures faced by primary dealers in their access to term funding and collateral.
Primary Dealer Credit Facility	16/03/2008-01/02/2010	This program aimed at supporting the liquidity pressures faced by primary dealers providing overnight loans fully collateralized.
Asset-Backed Commercial Paper Money Market Fund Liquidity Facility	19/09/2008-01/02/2010	It was introduced to help money market mutual funds to meet significant redemptions by investors and to improve the liquidity in the asset-backed commercial paper market.
Commercial Paper Funding Facility	07/10/2008-01/02/2010	This program aimed at addressing strains in the commercial paper market.
Money Market Investing Funding Facility	21/10/2008-30/10/2009	It was created to provide liquidity to money market mutual funds in the US. However, no loans were made under this program.
Term Asset Backed Securities Loan Facility	25/11/2008-30/06/2010	This facility was introduced to improve market conditions for asset-backed securities.
Bilateral Foreign Exchange Swaps	12/12/2007-01/02/2014	It was introduced to alleviate periods of stress in global short-term dollar funding markets.
Macro-stability measures		
Large Scale Asset Purchases Program (LSAP)		
Longer-Term Treasury Securities Program	18/03/2009-Ongoing[1/]	This program aimed at putting downward pressure on longer-term interest rates and boost the economic activity.
Agency Mortgage-Backed Securities (MBS) Program	25/11/2008-Ongoing[2/]	This program aimed at reducing longer-term interest rates and improve financial conditions.
Maturity Extension Program	21/09/2011-31/12/2012	This facility aimed at reducing pressure on longer-term interest rates through the extension of the average maturity of Treasury securities holdings.

1/ Purchases were terminated once in October 2009, then from November 2010 to June 2011 and started again in January 2013 at a pace of US$45 billion per month.
2/ Purchases were terminated once in March 2010, then started again from September 2012 at a pace of US$45 billion per month.
Source: Board of Governors of the Federal Reserve System.

Table B.2: US Gross Private Capital Outflows

Billions of US$	Pre-Crisis Jan 00 - Dec 07	Crisis Jan 08 - Jun 09	QE1 Apr 09 - Sep 09	QE2 Oct 10 - Jun 11	QE3 Oct 12 - Jun 13
Direct Investment	-50.5	-81.1	-84.5	-90.3	-89.3
Portfolio	-49.0	11.1	-74.2	-61.0	-95.4
Other Investment	-83.4	168.0	-79.5	-24.8	35.4
Total	-182.9	98.0	-238.2	-176.1	-149.3

Source: U.S. Bureau of Economic Analysis.
Notes: Quarterly average data. Other investment includes debt securities, loans, currency and deposits and excludes other investment flows to the general government and monethary authorities.

Table B.3: Gross Private Capital Outflows from the US to Asia-Pacific

Billions of US$	Pre-Crisis Jan 00 - Dec 07	Crisis Jan 08 - Jun 09	QE1 Apr 09 - Sep 09	QE2 Oct 10 - Jun 11	QE3 Oct 12 - Jun 13
Asia-Pacific					
Direct Investment	-9.2	-8.8	-9.9	-5.1	-15.7
Portfolio	-4.5	7.5	-13.3	-16.3	-12.7
Other Investment	-5.6	2.0	-34.9	-25.8	6.9
Total	-19.4	0.8	-58.1	-47.1	-21.5
Asia-Pacific excluding Australia and Japan					
Direct Investment	-6.8	-6.4	-4.7	0.2	-7.9
Portfolio	-0.5	6.8	-6.0	-9.3	-2.5
Other Investment	-2.2	9.0	-2.9	-8.2	-11.9
Total	-9.6	9.3	-13.6	-17.3	-22.3
Asia-Pacific Major Economies					
China					
Direct Investment	-0.7	-1.0	2.9	-1.1	-1.5
Portfolio	1.1	1.8	0.7	3.0	-0.2
Other Investment	-0.5	3.1	0.4	-3.1	-4.1
Total	-0.1	3.9	4.0	-1.3	-5.9
Hong Kong, China					
Direct Investment	-1.1	-0.1	-2.3	7.1	-0.5
Portfolio	-0.6	3.0	-3.6	-6.6	-1.5
Other Investment	-0.4	2.1	-3.4	-6.5	4.6
Total	-2.1	5.0	-9.3	-6.1	2.6
India					
Direct Investment	-0.3	-0.9	-0.9	-0.8	-1.1
Portfolio	-0.3	0.8	-0.3	-0.8	-1.7
Other Investment	-0.1	-0.3	-0.5	-1.5	-0.9
Total	-0.7	-0.4	-1.7	-3.1	-3.7
Korea					
Direct Investment	-0.5	-0.6	-1.0	-0.8	-0.5
Portfolio	-0.1	-0.7	-3.4	-4.1	0.9
Other Investment	-0.7	2.8	-0.2	1.6	-0.3
Total	-1.3	1.5	-4.6	-3.3	0.1
Singapore					
Direct Investment	-1.6	-1.9	-2.3	-2.2	-3.8
Portfolio	0.6	2.8	3.2	1.2	2.7
Other Investment	-0.1	0.0	0.1	2.3	-9.0
Total	-1.1	0.9	1.1	1.2	-10.1

Source: U.S. Bureau of Economic Analysis.
Notes: Quarterly average data. Other investment includes debt securities, loans, currency and deposits and excludes other investment flows to the general government and monethary authorities.

Table B.4: Gross Private Capital Outflows from the US to Latin America and Other Western Hemisphere

Billions of US$	Pre-Crisis Jan 00 - Dec 07	Crisis Jan 08 - Jun 09	QE1 Apr 09 - Sep 09	QE2 Oct 10 - Jun 11	QE3 Oct 12 - Jun 13
Latin America and Other Western Hemisphere					
Direct Investment	-6.0	-16.4	-13.4	-10.7	-19.4
Portfolio	-10.5	-3.8	2.3	-9.4	-10.7
Other Investment	-19.9	49.1	34.9	38.3	22.0
Total	-36.4	28.9	23.8	18.2	-8.1
South and Central America					
Direct Investment	-3.5	-5.0	-5.2	-3.8	-6.1
Portfolio	-1.4	3.0	-6.5	-5.7	-5.2
Other Investment	-0.5	1.3	-0.9	-11.8	-2.6
Total	-5.4	-0.7	-12.7	-21.2	-13.9
Latin America Major Economies					
Argentina					
Direct Investment	-0.2	-0.4	-0.4	1.8	-0.2
Portfolio	0.2	0.5	0.6	-1.3	0.1
Other Investment	0.2	-0.2	0.4	-0.3	0.0
Total	0.2	-0.2	0.5	0.3	0.0
Brazil					
Direct Investment	-0.4	-0.7	-1.5	-3.0	-1.5
Portfolio	-1.3	-0.3	-6.0	-3.1	0.0
Other Investment	-0.4	1.2	-3.1	-5.4	-1.4
Total	-2.1	0.2	-10.6	-11.5	-3.0
Mexico					
Direct Investment	-2.1	-1.6	-1.2	-1.2	-2.1
Portfolio	0.2	2.1	-1.8	-2.4	-2.4
Other Investment	-0.2	0.1	1.7	-2.4	0.2
Total	-2.1	0.6	-1.3	-6.0	-4.2
Venezuela					
Direct Investment	-0.2	-0.4	-0.7	-0.4	-0.6
Portfolio	-0.1	-1.1	-0.7	0.5	0.4
Other Investment	0.0	0.2	0.0	-0.1	-0.1
Total	-0.3	-1.3	-1.4	0.0	-0.3

Source: U.S. Bureau of Economic Analysis.
Notes: Quarterly average data. Other investment includes debt securities, loans, currency and deposits and excludes other investment flows to the general government and monethary authorities.

Table B.5: Gross Private Capital Outflows from the US to Middle East

Billions of US$	Pre-Crisis Jan 00 - Dec 07	Crisis Jan 08 - Jun 09	QE1 Apr 09 - Sep 09	QE2 Oct 10 - Jun 11	QE3 Oct 12 - Jun 13
Middle East					
Direct Investment	-0.7	-0.9	0.2	-0.5	-1.2
Portfolio	-0.2	0.8	0.6	1.6	1.0
Other Investment	-0.4	3.0	-2.5	-1.0	-1.2
Total	-1.3	3.0	-1.8	0.1	-1.4

Source: U.S. Bureau of Economic Analysis.
Notes: Quarterly average data. Other investment includes debt securities, loans, currency and deposits and excludes other investment flows to the general government and monethary authorities.

Table B.6: Gross Private Capital Outflows from the US to Africa

Billions of US$	Pre-Crisis Jan 00 - Dec 07	Crisis Jan 08 - Jun 09	QE1 Apr 09 - Sep 09	QE2 Oct 10 - Jun 11	QE3 Oct 12 - Jun 13
Africa					
Direct Investment	-0.6	-1.2	-3.6	-2.1	-0.4
Portfolio	-0.1	0.8	1.1	0.3	0.2
Other Investment	-0.2	0.7	-1.2	0.1	0.5
Total	-0.8	0.3	-3.7	-1.7	0.4
South Africa					
Direct Investment	-0.1	-0.1	-0.3	-0.2	0.0
Portfolio	-0.2	-0.4	0.3	0.2	-0.3
Other Investment	0.1	0.2	-0.1	0.1	0.1
Total	-0.2	-0.4	-0.1	0.1	-0.3

Source: U.S. Bureau of Economic Analysis.
Notes: Quarterly average data. Other investment includes debt securities, loans, currency and deposits and excludes other investment flows to the general government and monethary authorities.

Table B.7: Gross Private Capital Outflows from the US to Europe

Billions of US$	Pre-Crisis Jan 00 - Dec 07	Crisis Jan 08 - Jun 09	QE1 Apr 09 - Sep 09	QE2 Oct 10 - Jun 11	QE3 Oct 12 - Jun 13
Europe					
Direct Investment	-25.2	-44.3	-47.4	-60.4	-41.0
Portfolio	-31.4	7.5	-45.3	-32.5	-62.8
Other Investment	-54.7	112.2	-67.6	-21.1	16.7
Total	-111.3	75.4	-160.2	-113.9	-87.1
European Union					
Direct Investment	-22.4	-37.5	-40.9	-55.5	-39.1
Portfolio	-29.8	6.0	-44.8	-36.7	-63.3
Other Investment	-51.2	90.4	-78.5	-23.8	20.0
Total	-103.5	58.9	-164.2	-116.0	-82.4
Europe, excluding European Union					
Direct Investment	-2.8	-6.8	-6.5	-4.8	-2.0
Portfolio	-1.6	1.5	-0.5	4.2	0.5
Other Investment	-3.5	21.8	11.0	2.7	-3.3
Total	-7.8	16.5	4.0	2.1	-4.8
Europe Major Economies					
Germany					
Direct Investment	-1.6	-0.9	-0.4	-0.7	-0.6
Portfolio	-0.8	2.5	2.5	-0.5	13.8
Other Investment	1.1	-10.2	2.9	-0.5	3.6
Total	-1.3	-8.6	5.0	-1.8	16.8
France					
Direct Investment	-1.0	-1.0	-2.1	-1.1	-0.3
Portfolio	-2.3	2.0	-0.8	-2.0	-2.5
Other Investment	-5.5	4.6	-0.8	-24.3	0.0
Total	-8.8	5.5	-3.7	-27.4	-2.8
Italy					
Direct Investment	-0.7	-0.7	-1.4	-0.3	-0.2
Portfolio	0.1	1.7	0.8	0.2	0.6
Other Investment	-0.9	-0.7	-1.3	6.0	2.0
Total	-1.5	0.4	-1.9	6.0	2.4
UK					
Direct Investment	-5.6	-7.4	-9.9	-8.0	-8.1
Portfolio	-22.7	-3.8	-29.9	-25.2	-32.7
Other Investment	-31.4	86.4	-84.2	1.2	31.9
Total	-59.7	75.1	-124.0	-32.1	-8.9

Source: U.S. Bureau of Economic Analysis.
Notes: Quarterly average data. Other investment includes debt securities, loans, currency and deposits and excludes other investment flows to the general government and monethary authorities.

Table B.8: Emerging Economies Coverage

Emerging Asia	Emerging Latin America	Emerging Europe	Emerging Africa
Bangladesh (513)	Argentina (213)	Bulgaria (918)	Morocco (686)
China (924)	Brazil (223)	Croatia (960)	Mozambique (688)
Hong Kong (532)	Chile (228)	Cyprus (423)	Namibia (728)
India (534)	Colombia (233)	Czech Republic (935)	Nigeria (694)
Indonesia (536)	Costa Rica (238)	Estonia (939)	South Africa (199)
Korea (542)	Ecuador (248)	Hungary (944)	
Malaysia (548)	Mexico (273)	Israel (436)	
Pakistan (564)	Panama (283)	Latvia (941)	
Philippines (566)	Peru (293)	Lithuania (946)	
Singapore (576)	Uruguay (298)	Malta (181)	
Sri Lanka (524)	Venezuela (299)	Poland (964)	
Thailand (578)		Romania (968)	
Vietnam (582)		Russia (922)	
		Slovak Republic (936)	
		Slovenia (961)	
		Turkey (186)	
		Ukraine (926)	

Notes: Offshore financial centres are not included in the main estimations. I exclude from the main estimations Costa Rica, Cyprus, Malta, Panama, Hong Kong, Singapore, and Uruguay. I classify these countries as offshore financial centres according to the classification of the IMF (2007).

Source: IMF. The numbers in parenthesis denote the country code according to the IFS classification.

Table B.9: Data Description and Sources

Variable	Definition	Source
Liquidity Measures (LM)	Quarterly change in the amount outstanding of non-conventional liquidity market operations	Federal Reserve, Federal Reserve Economic Data FRED St. Louis Fed.
Treasuries (TR)	Quarterly change in the amount outstanding of Long-Term Treasury Securities Purchases within the Large Scale Asset Purchase Program (LSAP)	Federal Reserve, Federal Reserve Economic Data FRED St. Louis Fed.
Mortgage-Backed Securities (MBS)	Quarterly change in the amount outstanding of Mortgage-Backed Securities and Federal Agent Debt Securities within the Large Scale Asset Purchase Program (LSAP)	Federal Reserve, Federal Reserve Economic Data FRED St. Louis Fed.
Total Flows	Sum of gross private foreign direct investment, equities, debt and other inflows in EMEs. Gross private capital inflows are gross liabilities in the Balance of Payments statistics	IMF Balance of Payments Statistics
FDI	Gross foreign direct inflows in EMEs	IMF Balance of Payments Statistics
Equity	Gross equity inflows in EMEs	IMF Balance of Payments Statistics
Debt	Gross debt inflows in EMEs. It principally covers bonds, notes, money market and financial derivative instruments	IMF Balance of Payments Statistics
Other	Other gross inflows in EMEs excluding other investment flows to the monethary authorities and the general government. It principally covers trade credits, loans, and currency and deposits	IMF Balance of Payments Statistics
VIX	Chicago Board of Options Exchange Volatility Index	Chicago Board Options Exchange
Real GDP Differential	Difference between the Real GDP growth rate of the emerging economy and the US	Datastream, OECD, National Sources
Interest Rate Differential	Difference between the money market or deposit interest rate of the emerging economy and the Fed policy rate	IMF International Finantial Statistics
GDP[1/]	Nominal Gross Domestic Product in US dollars	IMF International Finantial Statistics
(Imports+Exports)/GDP[1/]	Current Account Balance/Nominal Gross Domestic Product	IMF International Finantial Statistics
REER[2/]	Real Effective Exchange Rates are calculated as geometric weighted averages of bilateral exchange rates adjusted by relative consumer prices	BIS
Reserves/External Debt	International Reserves excluding gold/Short Term External Debt	World Bank Joint External Debt Hub
Credit Ratings	Institutional Investor Credit Rating	Institutional Investor Magazine
Inflation Differential	Difference between the inflation rate of the emerging economy and the US	IMF International Finantial Statistics
Crisis	Dummy variable equal to 1 between 2008Q3 and 2009Q2	
Bilateral US External Assets	US External Assets in an emerging economy (external liabilities to the US)	U.S. Treasury International Capital System Database (Liabilities to the US), U.S. Bureau of Economic Analysis (Foreign Direct Investment Statistics)
External Liabilities	Total International External Liabilities of an emerging economy	IMF Balance of Payments Statistics

1/ Series seasonally adjusted using Census X-13 in Eviews.

2/ Where unavailable, quarterly data was completed with the updated database at Bruegel http://www.bruegel.org/datasets/real-effective-exchange-rates-for-178-countries-a-new-database/ based on the working paper Darvas, Zsolt (2012a) 'Real effective exchange rates for 178 countries: a new database', Working Paper 2012/06, Bruegel, 15 March 2012

Table B.10: Financial Exposure Weights

Financial Exposure Weight to the US				International Financial Exposure Weight			
Economy	Average 2003-2007	Economy	Average 2003-2007 &2011/12	Economy	Average 2003-2007	Economy	Average 2003-2007 &2011/12
Panama	0.8474	Panama	0.6482	Singapore	7.7518	Hong Kong	8.2572
Israel	0.3526	Israel	0.3415	Hong Kong	7.2447	Singapore	7.4822
Mexico	0.3474	Mexico	0.3315	Malta	4.6061	Malta	5.3711
Brazil	0.2759	Brazil	0.2581	Cyprus	3.0773	Cyprus	3.8957
Korea	0.2588	Chile	0.2569	Panama	2.4458	Hungary	2.4509
Chile	0.2462	Korea	0.2523	Hungary	2.0420	Panama	2.4218
Venezuela	0.2259	Venezuela	0.2140	Estonia	1.7190	Estonia	1.7189
Costa Rica	0.2137	South Africa	0.2089	Mozambique	1.6077	Mozambique	1.6050
India	0.2058	Philippines	0.1943	Latvia	1.4084	Latvia	1.5357
Philippines	0.1984	Peru	0.1940	Bulgaria	1.2054	Bulgaria	1.3413
South Africa	0.1959	India	0.1887	Croatia	1.1799	Croatia	1.2557
Peru	0.1956	Costa Rica	0.1853	Malaysia	1.1003	Malaysia	1.1738
Malaysia	0.1601	Colombia	0.1673	Israel	1.0992	Slovenia	1.1162
Thailand	0.1577	Malaysia	0.1577	Uruguay	1.0564	Chile	1.0930
Colombia	0.1544	Thailand	0.1431	Chile	1.0041	Czech Republic	1.0373
Argentina	0.1458	Argentina	0.1410	Slovenia	0.9956	Slovak	1.0052
Uruguay	0.1333	Uruguay	0.1385	Czech Republic	0.9862	Israel	0.9986
Singapore	0.1220	Singapore	0.1195	Lithuania	0.8854	Lithuania	0.9430
Ecuador	0.0972	Indonesia	0.1010	South Africa	0.8647	Thailand	0.9256
China	0.0945	Hong Kong	0.0888	Slovak	0.8600	Poland	0.9240
Indonesia	0.0899	Ecuador	0.0828	Thailand	0.8511	Uruguay	0.9074
Hong Kong	0.0858	Turkey	0.0791	Poland	0.8316	Ukraine	0.9025
Russia	0.0779	Poland	0.0768	Argentina	0.8174	South Africa	0.8978
Poland	0.0731	Russia	0.0725	Russia	0.8118	Romania	0.8297
Turkey	0.0695	China	0.0698	Philippines	0.8113	Morocco	0.7649
Czech Republic	0.0633	Nigeria	0.0588	Morocco	0.7250	Korea	0.7208
Hungary	0.0453	Czech Republic	0.0560	Vietnam	0.7217	Philippines	0.7113
Nigeria	0.0373	Sri Lanka	0.0435	Ukraine	0.7144	Peru	0.7076
Bulgaria	0.0334	Hungary	0.0433	Peru	0.6913	Russia	0.6997
Pakistan	0.0304	Ukraine	0.0279	Romania	0.6860	Turkey	0.6724
Ukraine	0.0295	Pakistan	0.0253	Korea	0.6782	Vietnam	0.6568
Cyprus	0.0212	Lithuania	0.0238	Namibia	0.6502	Mexico	0.6494
Romania	0.0180	Cyprus	0.0227	Indonesia	0.6474	Argentina	0.6378
Morocco	0.0144	Vietnam	0.0197	Sri Lanka	0.6411	Brazil	0.6333
Slovak	0.0133	Bulgaria	0.0190	Turkey	0.6394	Indonesia	0.6223
Sri Lanka	0.0129	Romania	0.0185	Ecuador	0.6253	Costa Rica	0.6149
Bangladesh	0.0122	Morocco	0.0170	Brazil	0.6238	Namibia	0.5893
Croatia	0.0121	Malta	0.0162	Mexico	0.5932	Sri Lanka	0.5553
Vietnam	0.0111	Croatia	0.0160	Costa Rica	0.5805	Colombia	0.5376
Malta	0.0086	Bangladesh	0.0125	Venezuela	0.5652	Ecuador	0.5271
Estonia	0.0079	Namibia	0.0093	Nigeria	0.5508	Nigeria	0.5215
Slovenia	0.0065	Slovak	0.0091	Colombia	0.5400	Venezuela	0.4838
Lithuania	0.0030	Slovenia	0.0090	Pakistan	0.4562	Pakistan	0.4323
Latvia	0.0023	Estonia	0.0068	Bangladesh	0.4059	China	0.3950
Namibia	0.0010	Mozambique	0.0068	China	0.3658	India	0.3417
Mozambique	0.0005	Latvia	0.0054	India	0.3219	Bangladesh	0.3078

Notes: Offshore financial centres are not included in the main estimations. I exclude from the main estimations Costa Rica, Cyprus, Malta, Panama, Hong Kong, Singapore, and Uruguay. I classify these countries as offshore financial centres according to the classification of the IMF (2007).

Sources: U.S. Treasury International Capital System Database (Liabilities to the US); U.S. Bureau of Economic Analysis (Foreign Direct Investment Statistics); Balance of Payments Statistics IMF (International Investment Position); World Economic Outlook Database (GDP); and own calculations.

Table B.11: Panel Unit Root Tests, 2000Q1-2013Q2

	Method				
Variable	**IPS**	**IPS-SC**	**Fisher-ADF**	**Fisher-PP**	**Pesaran's CIPS**
Total Flows	-3.740	-11.321	-9.034	-16.837	-10.775
FDI	-3.464	-4.141	-1.980	-13.792	-8.667
Equity	-5.593	-25.735	-18.354	-31.252	-13.092
Debt	-5.153	-19.194	-15.276	-27.024	-16.665
Other	-4.603	-16.165	-7.821	-23.891	-9.356
VIX	-2.998	-11.505	-11.507	-12.760	-2.089
Real GDP Differential	-2.603	-5.604	-3.899	-9.694	-2.369
Interest Rate Differential	-2.018	-7.619	-6.489	-5.543	-5.349
(Imports+Exports)/GDP	-1.733	-1.516	-1.598	-1.748	-1.661
REER	-1.591	-3.379	-1.825	-1.490	-0.819
Reserves/External Debt	-2.301	-4.439	-2.299	-5.118	-1.858
Inflation Differential	-2.326	-9.106	-7.667	-7.746	-4.179
Number of Panels	46	46	46	46	46
Number of Periods	54	54	54	54	54

Notes: IPS and IPS-SC represent the Im-Pesaran-Shin test with serially uncorrelated and correlated errors, respectively. Fisher-ADF and Fisher-PP represent the Maddala and Wu Fisher-ADF and Fisher-PP test,respectively. Pesaran's CIPS is a second generation unit root test in heterogeneous panels with cross-sectional dependence. Cross-sectional means removed to mitigate the impact of cross-sectional dependence. Unit root tests on VIX correspond to tests on the variable VIX weighted by the international financial exposure of each country.

Table B.12: Gross Capital Inflows with Offshore Financial Centers - Bias-Corrected LSDV, 2000Q1-2013Q2

Dependent Variable: Total Flows		
Financial Exposure Weight[1/]	2003-2007	2003-2007 & 2011-2012
(Total Flows)$_{t-1}$	0.603	0.602
	(0.017)***	(0.017)***
	Unconventional Policy Measures	
Liquidity Measures (LM)$_t$	-0.049	-0.061
	(0.012)***	(0.014)***
Treasuries (TR)$_t$	0.029	0.033
	(0.013)**	(0.015)**
Mortgage-Backed Securities (MBS)$_t$	0.028	0.034
	(0.013)**	(0.016)**
	Controls	
(VIX)$_{t-1}$	-0.018	-0.018
	(0.011)*	(0.010)*
(Real GDP Differential)$_{t-1}$	0.078	0.082
	(0.057)	(0.057)
(Interest Rate Differential)$_{t-1}$	-0.016	-0.015
	(0.034)	(0.034)
((Imports + Exports)/GDP)$_{t-1}$	0.395	0.403
	(0.134)***	(0.134)***
Δ(REER)$_{t-1}$	0.009	0.009
	(0.029)	(0.029)
Δ(Credit Ratings)$_{t-1}$	0.052	0.054
	(0.057)	(0.057)
(Reserves/External Debt)$_{t-1}$	0.316	0.308
	(0.125)***	(0.125)***
(Inflation Differential)$_{t-1}$	0.001	0.001
	(0.034)	(0.034)
(Crisis)$_{t-1}$	-0.665	-0.541
	(0.794)	(0.822)
Chi2-test	29.93	34.12
P-value	0.00	0.00
N (countries)	2,246 (46)	2,246 (46)

1/ Unconventional Policy Measures and the VIX are weighted by the average of the direct financial exposure of each country to the US and by the average of the economy's international financial exposure, respectively.

Notes: Offshore financial centers are included. Least-squares dummy variable dynamic regression with bootstrapped standard errors reported in parenthesis. Bias correction initialized by Anderson and Hsiao estimator. Chi2-test refers to the joint null hypothesis that the coefficients on Unconventional Policy Measures are statistically equal. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

Table B.13: Gross Private Capital Inflows with Offshore Financial Centers - Bias-Corrected LSDV Long Run Estimates, 2000Q1-2013Q2

Dependent Variable: Total Flows		
Financial Exposure Weight	2003-2007	2003-2007 & 2011-2012
	Unconventional Policy Measures	
Liquidity Measures (LM)t	-0.124	-0.154
	(0.031)***	(0.037)***
Treasuries (TR)t	0.073	0.084
	(0.034)**	(0.039)**
Mortgage-Backed Securities (MBS)t	0.072	0.086
	(0.035)**	(0.041)**

Notes: Long-run coefficients of Unconventional Policy Measures are calculated as $\beta/(1-\lambda)$ where β is the short-run coefficient of each type of unconventional measure and λ is the coefficient of the lagged dependent variable. Offshore financial centers are included. Least-squares dummy variable dynamic regression with bootstrapped standard errors reported in parenthesis. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

Table B.14: Gross Private Capital Inflows by Type with Offshore Financial Centers - Bias-Corrected LSDV, 2000Q1-2013Q2

Dependent Variable:	**FDI**		**Equity**		**Debt**		**Other**	
Financial Exposure Weight[1/]	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012
(Type of Flow)$_{t-1}$	0.735	0.735	0.231	0.229	0.308	0.305	0.406	0.407
	(0.016)***	(0.017)***	(0.019)***	(0.019)***	(0.022)***	(0.022)***	(0.021)***	(0.021)***
				Unconventional Policy Measures				
Liquidity Measures (LM)$_t$	0.003	0.004	-0.011	-0.013	-0.012	-0.015	-0.028	-0.035
	(0.007)	(0.008)	(0.002)***	(0.003)***	(0.002)***	(0.002)***	(0.008)***	(0.009)***
Treasuries (TR)$_t$	0.009	0.011	0.001	0.002	0.010	0.013	0.021	0.023
	(0.007)	(0.009)	(0.003)	(0.003)	(0.003)***	(0.003)***	(0.010)***	(0.011)***
Mortgage-Backed Securities (MBS)$_t$	0.002	0.003	0.009	0.011	0.007	0.009	0.008	0.009
	(0.007)	(0.009)	(0.003)***	(0.003)***	(0.004)**	(0.004)**	(0.011)	(0.012)
				Controls				
(VIX)$_{t-1}$	-0.000	-0.000	-0.005	-0.005	0.003	0.002	-0.024	-0.024
	(0.006)	(0.006)	(0.002)**	(0.002)**	(0.003)	(0.003)	(0.008)***	(0.008)***
(Real GDP Differential)$_{t-1}$	0.026	0.026	0.004	0.005	-0.008	-0.007	0.084	0.086
	(0.032)	(0.032)	(0.013)	(0.013)	(0.013)	(0.013)	(0.033)***	(0.033)***
(Interest Rate Differential)$_{t-1}$	0.003	0.003	-0.003	-0.003	-0.017	-0.016	-0.008	-0.007
	(0.019)	(0.019)	(0.007)	(0.007)	(0.009)**	(0.009)**	(0.024)	(0.024)
((Imports + Exports)/GDP)$_{t-1}$	0.624	0.617	0.453	0.483	0.736	0.758	0.313	0.316
	(0.761)	(0.762)	(0.299)*	(0.299)*	(0.355)**	(0.354)**	(0.804)***	(0.804)***
Δ(REER)$_{t-1}$	0.016	0.017	0.006	0.006	0.003	0.003	0.005	0.005
	(0.016)	(0.016)	(0.006)	(0.006)	(0.008)	(0.008)	(0.024)	(0.024)
Δ(Credit Ratings)$_{t-1}$	0.003	0.003	0.005	0.006	-0.004	-0.004	0.031	0.032
	(0.031)	(0.032)	(0.013)	(0.013)	(0.016)	(0.016)	(0.041)	(0.041)
(Reserves/External Debt)$_{t-1}$	0.041	0.040	0.004	0.003	0.065	0.062	0.229	0.225
	(0.070)	(0.069)	(0.028)	(0.028)	(0.035)**	(0.035)*	(0.103)**	(0.103)**
(Inflation Differential)$_{t-1}$	-0.000	-0.000	0.003	0.003	-0.008	-0.008	0.003	0.002
	(0.019)	(0.019)	(0.007)	(0.008)	(0.009)	(0.009)	(0.020)	(0.020)
(Crisis)$_{t-1}$	-0.531	-0.562	0.168	0.174	-0.395	-0.383	-0.681	-0.566
	(0.445)	(0.461)	(0.181)	(0.187)	(0.199)**	(0.202)**	(0.683)	(0.709)
Chi2-test	1.83	1.91	27.89	32.01	50.88	62.37	25.00	29.10
P-value	0.607	0.591	0.00	0.00	0.00	0.00	0.00	0.00
Number of Observations	2,246 (46)	2,246 (46)	2,246 (46)	2,246 (46)	2,217 (46)	2,217 (46)	2,237 (46)	2,237 (46)

1/ Unconventional Policy Measures and the VIX are weighted by the average of the direct financial exposure of each country to the US and by the average of the economy's international financial exposure, respectively.
Notes: Offshore financial centers are included. Least-squares dummy variable dynamic regression with bootstrapped standard errors reported in parenthesis. Bias correction initialized by Anderson and Hsiao estimator. Chi2-test refers to the joint null hypothesis that the coefficients on Unconventional Policy Measures are statistically equal. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

Table B.15: Gross Private Capital Inflows by Type with Offshore Financial Centers - Bias-Corrected LSDV Long Run Estimates, 2000Q1-2013Q2

Dependent Variable:	**FDI**		**Equity**		**Debt**		**Other**	
Financial Exposure Weight	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012
				Unconventional Policy Measures				
Liquidity Measures (LM)t	0.011	0.013	-0.014	-0.017	-0.018	-0.022	-0.049	-0.060
	(0.027)	(0.031)	(0.004)***	(0.004)***	(0.035)***	(0.004)***	(0.014)***	(0.015)***
Treasuries (TR)t	0.036	0.041	0.002	0.002	0.014	0.019	0.036	0.040
	(0.028)	(0.032)	(0.004)	(0.005)	(0.005)***	(0.005)***	(0.017)**	(0.019)**
Mortgage-Backed Securities (MBS)t	0.007	0.010	0.012	0.015	0.011	0.014	0.014	0.016
	(0.024)	(0.034)	(0.004)***	(0.005)***	(0.006)**	(0.007)**	(0.019)	(0.021)

Notes: Long-run coefficients of Unconventional Policy Measures are calculated as $\beta/(1-\lambda)$ where β is the short-run coefficient of each type of unconventional measure and λ is the coefficient of the lagged dependent variable. Offshore financial centers are included. Least-squares dummy variable dynamic regression with bootstrapped standard errors reported in parenthesis. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

Table B.16: Gross Private Capital Inflows - Static Panel Data Model, 2000Q1-2013Q2

Dependent Variable: Total Flows		
Financial Exposure Weight[1/]	2003-2007	2003-2007 & 2011-2012
	Unconventional Policy Measures	
Liquidity Measures (LM)t	-0.063	-0.063
	(0.031)***	(0.032)***
Treasuries (TR)t	0.134	0.128
	(0.043)***	(0.038)***
Mortgage-Backed Securities (MBS)t	0.036	0.039
	(0.012)***	(0.013)***
	Controls	
(VIX)t-1	-0.053	-0.047
	(0.027)**	(0.022)**
(Real GDP Differential)t-1	0.210	0.211
	(0.094)**	(0.095)**
(Interest Rate Differential)t-1	-0.096	-0.096
	(0.107)	(0.108)
((Imports + Exports)/GDP)t-1	0.905	0.925
	(1.625)	(1.603)
Δ(REER)t-1	0.078	0.079
	(0.041)**	(0.042)**
Δ(Credit Ratings)t-1	0.026	0.026
	(0.047)	(0.047)
(Crisis)t-1	-2.328	-2.417
	(1.110)**	(1.183)**
F-test	5.61 (0.007)	5.70 (0.001)
Pesaran test	32.14 (0.000)	32.62 (0.000)
Fixed Effects	Yes	Yes
N (countries)	1,883 (37)	1,883 (37)
R-Squared	0.522	0.520
Adjusted R-Squared	0.510	0.508

1/ Unconventional Policy Measures and the VIX are weighted by the average of the direct financial exposure of each country to the US and by the average of the economy's international financial exposure, respectively.
Notes: Offshore financial centers are excluded. F-test (p-value) refers to the joint null hypothesis that the coefficients on Unconventional Policy Measures are statistically equal. Pesaran represents the Pesaran (2004) test for unbalanced data. Clustered errors in parentheses at the country level to allow for heteroscedasticity across countries and arbitrary autocorrelation of the error term within each country. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

Table B.17: Gross Private Capital Inflows by Type - Static Panel Data Model, 2000Q1-2013Q2

Dependent Variable:	**FDI**		**Equity**		**Debt**		**Other**	
Financial Exposure Weight[1/]	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012
				Unconventional Policy Measures				
Liquidity Measures (LM)t	0.018	0.017	-0.022	-0.023	-0.023	-0.023	-0.035	-0.034
	(0.007)***	(0.006)***	(0.008)***	(0.008)***	(0.007)***	(0.007)***	(0.020)**	(0.020)**
Treasuries (TR)t	0.040	0.037	0.007	0.007	0.031	0.032	0.054	0.051
	(0.019)**	(0.017)**	(0.005)	(0.005)	(0.008)***	(0.009)***	(0.020)***	(0.017)***
Mortgage-Backed Securities (MBS)t	0.004	0.004	0.022	0.023	0.013	0.014	-0.003	-0.002
	(0.006)	(0.006)	(0.009)***	(0.009)***	(0.004)***	(0.004)***	(0.008)	(0.008)
				Controls				
(VIX)t-1	-0.017	-0.017	-0.006	-0.004	0.001	0.001	-0.031	-0.026
	(0.009)**	(0.008)**	(0.005)	(0.006)	(0.011)	(0.010)	(0.015)**	(0.011)**
(Real GDP Differential)t-1	0.064	0.065	0.005	0.004	-0.006	-0.006	0.144	0.143
	(0.042)*	(0.043)*	(0.006)	(0.006)	(0.012)	(0.012)	(0.053)***	(0.053)***
(Interest Rate Differential)t-1	0.001	0.001	-0.007	-0.008	-0.042	-0.041	-0.048	-0.049
	(0.048)	(0.048)	(0.007)	(0.007)	(0.017)**	(0.017)**	(0.046)	(0.046)
((Imports + Exports)/GDP)t-1	0.392	0.393	0.391	0.399	0.729	0.724	-0.568	-0.553
	(0.664)	(0.664)	(0.254)*	(0.253)*	(0.633)	(0.630)	(0.877)	(0.846)
Δ(REER)t-1	0.021	0.022	0.008	0.009	0.010	0.010	0.038	0.039
	(0.014)*	(0.014)*	(0.007)	(0.008)	(0.008)	(0.008)	(0.020)**	(0.021)**
Δ(Credit Ratings)t-1	0.022	0.022	0.005	0.005	-0.006	-0.006	0.003	0.003
	(0.019)	(0.019)	(0.005)	(0.005)	(0.015)	(0.015)	(0.021)	(0.021)
(Crisis)t-1	-0.131	-0.093	0.024	0.011	-0.726	-0.729	-1.516	-1.624
	(0.455)	(0.428)	(0.214)	(0.222)	(0.319)**	(0.318)**	(0.736)**	(0.831)**
F-test	1.87 (0.169)	1.82 (0.176)	3.56 (0.038)	3.53 (0.039)	9.06 (0.000)	9.18 (0.000)	3.42 (0.043)	3.59 (0.038)
Pesaran test	22.59 (0.000)	22.93 (0.000)	12.52 (0.000)	14.01 (0.000)	18.66 (0.000)	18.90 (0.000)	29.49 (0.000)	29.90 (0.000)
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	1,883 (37)	1,883 (37)	1,883 (37)	1,883 (37)	1,854 (37)	1,854 (37)	1,874 (37)	1,874 (37)
R-Squared	0.616	0.615	0.228	0.225	0.236	0.237	0.226	0.224
Adjusted R-Squared	0.607	0.606	0.208	0.205	0.217	0.218	0.207	0.204

1/ Unconventional Policy Measures and the VIX are weighted by the average of the direct financial exposure of each country to the US and by the average of the economy's international financial exposure,respectively.
Notes: Offshore financial centers are excluded. F-test (p-value) refers to the joint null hypothesis that the coefficients on Unconventional Policy Measures are statistically equal. Pesaran represents the Pesaran (2004) test for unbalanced data. Clustered errors in parentheses at the country level to allow for heteroscedasticity across countries and arbitrary autocorrelation of the error term within each country. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

Table B.18: Gross Private Capital Inflows Controlling for Cross-Sectional Dependence - Static Panel Data Model, 2000Q1-2013Q2

Dependent Variable: Total Flows		
Financial Exposure Weight[1/]	2003-2007	2003-2007 & 2011-2012
	Unconventional Policy Measures	
Liquidity Measures (LM)$_t$	-0.043	-0.053
	(0.009)***	(0.011)***
Treasuries (TR)$_t$	0.077	0.090
	(0.010)***	(0.012)***
Mortgage-Backed Securities (MBS)$_t$	0.019	0.023
	(0.015)	(0.019)
	Controls	
(VIX)$_{t-1}$	-0.046	-0.044
	(0.026)*	(0.024)*
(Real GDP Differential)$_{t-1}$	0.225	0.228
	(0.068)***	(0.068)***
(Interest Rate Differential)$_{t-1}$	-0.022	-0.021
	(0.028)	(0.028)
((Imports + Exports)/GDP)$_{t-1}$	0.901	0.911
	(0.327)***	(0.324)***
Δ(REER)$_{t-1}$	0.067	0.067
	(0.031)**	(0.031)**
Δ(Credit Ratings)$_{t-1}$	0.037	0.039
	(0.042)	(0.041)
(Reserves/External Debt)$_{t-1}$	0.466	0.455
	(0.368)	(0.368)
(Inflation Differential)$_{t-1}$	-0.007	-0.009
	(0.032)	(0.031)
(Crisis)$_{t-1}$	-1.791	-1.775
	(1.519)	(1.419)
Fixed Effects	Yes	Yes
N (countries)	2,246 (46)	2,246 (46)

1/ Unconventional Policy Measures and the VIX are weighted by the average of the direct financial exposure of each country to the US and by the average of the economy's international financial exposure, respectively.

Notes: Offshore financial centers are included. Driscoll-Kraay standard errors in parentheses to control for cross-sectional dependence. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

Table B.19: Gross Private Capital Inflows by Type Controlling for Cross-Sectional Dependence - Static Panel Data Model, 2000Q1-2013Q2

Dependent Variable:	**FDI**		**Equity**		**Debt**		**Other**	
Financial Exposure Weight[1/]	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012	2003-2007	2003-2007 & 2011-2012
				Unconventional Policy Measures				
Liquidity Measures (LM)t	0.006	0.007	-0.012	-0.015	-0.011	-0.014	-0.025	-0.030
	(0.003)**	(0.004)**	(0.002)***	(0.003)***	(0.002)***	(0.002)***	(0.006)***	(0.008)***
Treasuries (TR)t	0.024	0.027	0.003	0.004	0.016	0.020	0.034	0.038
	(0.003)***	(0.004)***	(0.003)	(0.004)	(0.002)***	(0.003)***	(0.005)***	(0.006)***
Mortgage-Backed Securities (MBS)t	0.001	0.001	0.011	0.014	0.008	0.010	-0.001	-0.002
	(0.006)	(0.008)	(0.003)***	(0.005)***	(0.005)*	(0.006)*	(0.005)	(0.006)
				Controls				
(VIX)t-1	-0.003	-0.003	-0.009	-0.007	0.002	0.001	-0.035	-0.034
	(0.011)	(0.010)	(0.004)**	(0.004)**	(0.002)	(0.002)	(0.018)**	(0.017)**
(Real GDP Differential)t-1	0.069	0.069	0.007	0.008	-0.011	-0.010	0.155	0.157
	(0.026)***	(0.026)***	(0.012)	(0.012)	(0.013)	(0.013)	(0.047)***	(0.047)***
(Interest Rate Differential)t-1	0.011	0.011	-0.004	-0.004	-0.021	-0.021	-0.009	-0.009
	(0.013)	(0.013)	(0.007)	(0.007)	(0.008)***	(0.009)***	(0.016)	(0.016)
((Imports + Exports)/GDP)t-1	0.253	0.253	0.483	0.520	0.889	0.908	0.523	0.526
	(0.105)***	(0.105)***	(0.524)	(0.523)	(0.415)**	(0.396)**	(0.239)**	(0.236)**
Δ(REER)t-1	0.031	0.031	0.012	0.012	0.012	0.012	0.012	0.012
	(0.012)***	(0.013)***	(0.008)*	(0.008)*	(0.010)	(0.009)	(0.019)	(0.019)
Δ(Credit Ratings)t-1	0.014	0.014	0.001	0.001	-0.010	-0.009	0.031	0.032
	(0.018)	(0.018)	(0.013)	(0.013)	(0.017)	(0.016)	(0.024)	(0.023)
(Reserves/External Debt)t-1	0.118	0.116	0.005	0.003	0.086	0.082	0.261	0.257
	(0.189)	(0.188)	(0.038)	(0.038)	(0.031)***	(0.031)***	(0.179)	(0.179)
(Inflation Differential)t-1	-0.001	-0.002	0.004	0.004	-0.011	-0.011	0.000	-0.000
	(0.010)	(0.010)	(0.005)	(0.004)	(0.008)	(0.008)	(0.017)	(0.017)
(Crisis)t-1	-0.077	-0.148	0.070	0.071	-0.727	-0.725	-1.060	-0.952
	(0.564)	(0.584)	(0.267)	(0.232)	(0.384)**	(0.336)**	(0.843)	(0.806)
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N (countries)	2,246 (46)	2,246 (46)	2,246 (46)	2,246 (46)	2,217 (46)	2,217 (46)	2,237 (46)	2,237 (46)

1/ Unconventional Policy Measures and the VIX are weighted by the average of the direct financial exposure of each country to the US and by the average of the economy's international financial exposure, respectively.
Notes: Offshore financial centers are included. Driscoll-Kraay standard errors in parentheses to control for cross-sectional dependence. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

Table B.20: Gross Private Capital Inflows with a Time-Varying Financial Exposure - Static Panel Data Model, 2003Q1-2012Q4

Dependent Variable: Total Flows	
Unconventional Policy Measures[1/]	
Liquidity Measures (LM)t	-0.071
	(0.034)***
Treasuries (TR)t	0.114
	(0.036)***
Mortgage-Backed Securities (MBS)t	0.060
	(0.033)*
F-test	5.05
P-value	0.011
Baseline Controls	Yes
Fixed Effects	Yes
N (countries)	1,456 (37)
R-Squared	0.614
Adjusted R-Squared	0.602

1/ Unconventional Policy Measures and the VIX are weighted by a time-varying direct financial exposure of each country to the US and by a time-varying international financial exposure, respectively.
Notes: Offshore financial centers are excluded. F-test refers to the joint null hypothesis that the coefficients on Unconventional Policy Measures are statistically equal. Clustered errors in parentheses at the country level to allow for heteroscedasticity across countries and arbitrary autocorrelation of the error term within each country. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

Table B.21: Gross Private Capital Inflows by Type with a Time-Varying Financial Exposure - Static Panel Data Model, 2003Q1-2012Q4

Dependent Variable:	**FDI**	**Equity**	**Debt**	**Other**
	Unconventional Policy Measures[1/]			
Liquidity Measures (LM)t	0.019	-0.023	-0.029	-0.037
	(0.009)**	(0.009)***	(0.009)***	(0.022)**
Treasuries (TR)t	0.030	0.010	0.027	0.046
	(0.016)**	(0.006)*	(0.007)***	(0.016)***
Mortgage-Backed Securities (MBS)t	-0.005	0.028	0.007	-0.008
	(0.007)	(0.012)***	(0.004)*	(0.010)
F-test	2.96	3.00	7.63	3.55
P-value	0.064	0.062	0.001	0.039
Baseline Controls	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes
Number of Observations	1,456 (37)	1,456 (37)	1,452 (37)	1,452 (37)
R-Squared	0.698	0.266	0.276	0.269
Adjusted R-Squared	0.688	0.242	0.252	0.245

1/ Unconventional Policy Measures and the VIX are weighted by a time-varying direct financial exposure of each country to the US and by a time-varying international financial exposure, respectively.

Notes: Offshore financial centers are excluded. F-test refers to the joint null hypothesis that the coefficients on Unconventional Policy Measures are statistically equal. Clustered errors in parentheses at the country level to allow for heteroscedasticity across countries and arbitrary autocorrelation of the error term within each country. ***,**,* denotes significance level at the 1%, 5%, and 10% level.

C. Disequilibrium Econometric Framework of International Capital Flows

I use a disequilibrium model approach for a panel of 46 EMEs. I assume that the volume of capital inflows to EMEs is determined by the short side of the market. Following Fair and Jaffee (1972) and extending the model to panel data, the disequilibrium model can be represented by the following equations:

$$CF^d_{i,t} = \gamma' X^d_t + u^d_{i,t}$$
$$CF^s_{i,t} = \beta' X^s_t + u^s_{i,t}$$
$$CF_{i,t} = min(CF^s_{i,t}, CF^d_{i,t})$$
$$i = 1, ..., n \text{ and } t = 1,.....,\text{T}$$

where $CF^d_{i,t}$ and $CF^s_{i,t}$ are the demand and supply of capital flows for country i at any given time t respectively, X^d_t and X^s_t are vectors of explanatory variables that influence the demand and supply of international capital flows respectively. These vectors could share common variables but as Felices and Orskaug (2008) explain it is necessary to have at least one unique variable due to exclusion restrictions. In addition, the residuals $u^d_{i,t}$ and $u^s_{i,t}$ are assumed to be independent and normally distributed as in Maddala and Nelson (1974). $CF_{i,t}$ is the volume of capital inflows observed that is determined by the short side of the market.

In the supply function, I include as global push factors the actual unconventional market interventions by the Fed, the VIX implied volatility, and the EMBI Index spread over the US risk free rate as a measure of capital cost. In addition, I include time effects in order to capture the effect of global common factors on capital inflows, and I consider domestic factors such as credit ratings, stock market index, domestic

short interest rates and the ratio of reserves to short term debt. In the demand function, the variables included are generally related to country specific factors. I consider the consumer price index, the domestic stock market index, the domestic industrial production, the ratio of reserves to imports, the domestic short term interest rate and the cost of capital as in the supply function.

If there is excess supply of capital flows to EMEs (i.e $CF^d_{i,t} < CF^s_{i,t}$), then the observed volume of capital inflows is on the demand function. In addition, if there is excess demand of capital flows to EMEs (i.e $CF^d_{i,t} > CF^s_{i,t}$), there is an international capital crunch and the observed volume of capital inflows is on the supply function. Fair and Jaffe (1972) examines the pattern of prices to sort out the data into two groups, one where is excess supply and another where is excess demand. For instance, increasing prices imply excess demand which suggest that the short side of the market is the supply, while decreasing prices imply excess supply and the demand determines the quantity observed.

In the context of capital flows, Mody and Taylor (2002) state that it is not straightforward to determine if there is excess demand or excess supply in capital flows studying the pattern of interest rates as they could be unresponsive to changes in supply and demand due to asymmetric information. Given this argument, this approach follows Kiefer (1980) and Maddala (1983) to estimate a disequilibrium model assuming unknown sample separation (i.e. the demand and supply of capital flows are not observed) and using all the sample information contained in the data of capital flows. With this model, it is possible to estimate the probability of observed capital flows being in the demand or the supply function.

The probability that any given observation CF_{it} belongs to the supply schedule is given by

$$\pi_t = Pr(CF^s_{i,t} < CF^d_{i,t})$$
$$= Pr(u^s_{i,t} - u^d_{i,t} < \gamma' X^d_t - \beta' X^s_t)$$

This probability is known as the probability of an international capital crunch. I assume that $u^d_{i,t}$ and $u^s_{i,t}$ are independent and normally distributed and$f(u^d_{i,t}, u^s_{i,t})$ is their joint density function. In addition, I let $g(CF^d_{i,t}, CF^s_{i,t})$ be the joint density function of $CF^d_{i,t}$ and $CF^s_{i,t}$ derived from $f(u^d_{i,t}, u^s_{i,t})$. If an observation of capital flows at time t is on the supply function, then $CF^s_{i,t} = CF_{i,t}$ and $CF^d_{i,t} > CF_{i,t}$. The conditional density is

$$h(CF_{i,t}|CF_{i,t} = CF^s_{i,t}) = \int_{CF_{i,t}}^{\infty} g(CF^d_{i,t}, CF_{i,t})\, dCF^d_{i,t}/\pi_t$$

If an observation of capital flows at time t is on the demand function, then $CF^d_{i,t} = CF_{i,t}$ and $CF^s_{i,t} > CF_{i,t}$. The conditional density is

$$h(CF_{i,t}|CF_{i,t} = CF^d_{i,t}) = \int_{CF_{i,t}}^{\infty} g(CF_{i,t}, CF^s_{i,t})\, dCF^s_{i,t}/(1 - \pi_t)$$

The unconditional density function of $CF_{i,t}$ is given by

$$h(CF_{i,t}) = \pi_t\, h(CF_{i,t}|CF_{i,t} = CF^s_{i,t}) + (1 - \pi_t)\, h(CF_{i,t}|CF_{i,t} = CF^d_{i,t})$$
$$= \int_{CF_{i,t}}^{\infty} g(CF^d_{i,t}, CF_{i,t})\, dCF^d_{i,t} + \int_{CF_{i,t}}^{\infty} g(CF_{i,t}, CF^s_{i,t})\, dCF^s_{i,t}$$

The likelihood function is

$$L = \prod_t h(CF_{i,t})$$

Kiefer (1980) explains that π_t is not accurate because does not include all the information on the sample. Taking this consideration, I follow Kiefer (1980) and Maddala

(1983) to calculate the probability of a capital crunch. Then, the probability that any given observation $CF_{i,t}$ belongs to the supply schedule given the observed volume of capital inflows at time t is given by

$$\theta_t = Pr(CF^s_{i,t} < CF^d_{i,t} | CF_{i,t})$$
$$= \frac{Pr(CF_{i,t} | CF^s_{i,t} < CF^d_{i,t}) \cdot Pr(CF^s_{i,t} < CF^d_{i,t})}{Pr(CF_{i,t})}$$
$$= \int_{CF_{i,t}}^{\infty} g(CF^d_{i,t}, CF_{i,t})\, dCF^d_{i,t} / h(CF_{i,t})$$

Given that $u^d_{i,t}$ and $u^s_{i,t}$ are independent, $g(CF^d_{i,t}, CF^s_{i,t})$ can be expressed as the product of the standard normal density functions $g_1(CF^d_{i,t}) \cdot g_2(CF^s_{i,t})$ and the corresponding distribution functions are given by G_1 and G_2. Hence, the likelihood function to be estimated is

$$L = \prod_t [\ (1/\sigma^d)\, g_1 \left[(CF_{i,t} - \gamma' X^d_t)/\sigma^d\right] [1 - G_1 [(CF_{i,t} - \beta' X^s_t)/\sigma^s]]$$
$$+ (1/\sigma^s)\, g_2 [(CF_{i,t} - \beta' X^s_t)/\sigma^s] \left[1 - G_2 \left[(CF_{i,t} - \gamma' X^d_t)/\sigma^d\right]\right]\ ]$$

Then, the probability θ_t can be expressed as

$$\theta_t = \frac{(1/\sigma^s)\, g_2[(CF_{i,t} - \beta' X^s_t)/\sigma^s]\left[1 - G_2\left[(CF_{i,t} - \gamma' X^d_t)/\sigma^d\right]\right]}{(1/\sigma^d)\, g_1\left[(CF_{i,t} - \gamma' X^d_t)/\sigma^d\right][1 - G_1[(CF_{i,t} - \beta' X^s_t)/\sigma^s]] + (1/\sigma^s)\, g_2[(CF_{i,t} - \beta' X^s_t)/\sigma^s]\left[1 - G_2\left[(CF_{i,t} - \gamma' X^d_t)/\sigma^d\right]\right]}$$

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