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Effects of Capital Controls on the Flow of International Assets and Price Volatility

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Effects of Capital Controls on the Flow of International Assets and Price Volatility

A dissertation submitted in partial satisfaction
of the requirements for the degree
Doctor of Philosophy in Economics

by

Carlos Armando de Jesús Cantú García

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ABSTRACT OF THE DISSERTATION

Effects of Capital Controls on the Flow of International Assets and Price Volatility

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Carlos Armando de Jesús Cantú García

Doctor of Philosophy in Economics

University of California, Los Angeles, 2016

Professor Aaron Tornell, Chair

The main objective when a country implements capital controls is to prevent large fluctuations in the exchange rate and asset price volatility. The direct mechanism through which these policies work is simple: a tax on foreign borrowing reduces flows, which prevents the price from changing considerably. Since foreign borrowing involves transactions in the foreign exchange market, the price of the asset can also be thought of as the exchange rate. However, the empirical literature has not come to a consensus on the effectiveness of capital controls on managing the exchange rate. Therefore, could there be other channels, different from their direct effect on flows, through which capital controls have the undesired effect of increasing fluctuations in the exchange rate? In particular, can capital controls increase the sensitivity of prices to sudden changes in capital flows?

The dissertation answers this question using two approaches. First, I embed into a market microstructure model a mechanism through which capital controls reduce the ability of the market to sustain large amounts of foreign capital without a substantial change in their price. This characteristic is called market depth. The deeper the market, the price reacts less to adjust for an excess supply or demand of the asset. Second, I verify the existence of the theoretical mechanism in the data by analyzing the case of Mexico

and Brazil. I focus on these countries because they are two similar foreign investment destinations, but with the main difference that Brazil has implemented capital controls in the past and Mexico has not.

In the first chapter I present a survey of the theoretical and empirical literature of capital controls and capital flows. In the second chapter I present the theoretical model that analyzes the effect of capital controls on market depth. The third chapter proposes a new measure on capital account restrictiveness. This measure is, to the best of my knowledge, the first index of capital controls that has quarterly periodicity and that is an intensive index. Finally, the last chapter analyzes two econometric models that explain the effect of capital controls on the levels and composition of capital flows, and on the probability of extreme events of flows.

If policymakers choose to implement capital controls for their short-term effect on the exchange rate, my results show that there are permanent effects on price sensitivity that could outweigh their immediate benefits. Moreover, the new measure proposed in this work can be used to find new evidence on the effect of capital controls on capital flows.

The dissertation of Carlos Armando de Jesús Cantú García is approved.

Jernej Copic

Roger E. Farmer

Alexander Stremitzer

Aaron Tornell, Committee Chair

University of California, Los Angeles

2016

To God, my parents, and my husband.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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CHAPTER 1

Introduction

In 2010, a sudden wave of capital inflows flooded emerging economies. These flows were a result of accommodative monetary polices in advanced economies and permissive funding conditions in international financial markets. Several proposal were made to manage these flows, and policies were introduced to strengthen the financial system against the risks associated with them. At the same time, new literature and models surfaced with the main goal of assessing the impact of capital flow management policies on capital flows, macroeconomic variables and the financial system. To provide a more concrete example, in response to a surge in portfolio inflows during 2010, Brazil implemented a tax on financial operations (IOF). The purpose was to slow these flows and control the appreciation of the exchange rate. Mexico experienced the same unexpected surge of capital inflows, and most economists were expecting Mexico to also implement capital controls. However, this was not the case and flows continued to flow freely into the country. In this way, the implementation of the tax in Brazil provided a natural experiment to asses the effect of capital controls on flows, and contrast their effect with a country that, at the time, was considered a similar investment destination. The graph below shows net and gross inflows[1] and their two main components (foreign direct investment and portfolio investment) for Mexico and Brazil[2]:

[1] Net inflows are equal to the negative value of the financial account, which implies that a positive value of net inflows means that the country is a net borrower, and a negative value means that the country is a net lender. Gross inflows correspond to the net transaction of financial liabilities, that is, acquisition of liabilities less reduction in liabilities.

[2] Flows are expressed in millions of dollars. Source IMF International Financial Statistics.

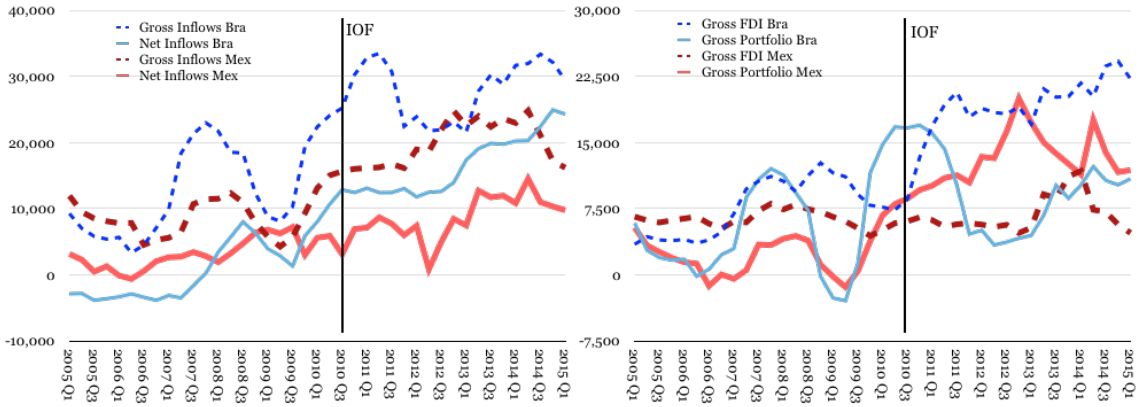


Figure 1.1: Net Flows, Gross Flows and their Composition for Mexico and Brazil

The dynamics of net and gross inflows, and their components for both countries are similar from 2005 to 2010. However, there is a sharp contrast on the evolution of the composition of flows after Brazil implemented the IOF tax. This might point out that, as a whole, the dynamic of flows did not change. However, investors rearranged the composition of their investments in Brazil (Magud et al. [2011]). Moreover there were spillover effects of the imposition of the tax, in the sense that it also affected the composition of flows to Mexico.

This work seeks to contribute to the debate on the short and long-run effects that capital controls may have on the fundamental structure of asset markets, and the levels and composition of capital flows. The purpose of this chapter is to provide a literature review on models of capital flows and capital controls. The rest of the chapter is distributed as follows. The next section presents the risks and benefits associated with capital flows, which provides a justification of why countries might decide to implement capital controls. The next section provides a survey of the theoretical models on capital controls. Finally the last section presents a survey of empirical papers that address the determinants of the behavior of capital flows, as well as the impact of capital controls on flows.

1.1 The Risks and Benefits of Foreign Capital Flows

There are several benefits associated with capital inflows. They allow emerging markets to borrow against high future growth opportunities. They promote financial market development by introducing new investment instruments and increasing absorption capacity. Finally, a lower cost of capital can fund investment needs and can help stimulate consumption and investment. However, there are also risks associated with large waves of capital inflows. Olaberria [2012] shows that net debt inflows, such as portfolio inflows, exhibit a strong and significant association with booms in real asset prices. Shin [2012] argues that accommodative monetary policies carried out by the central banks of advanced economies and permissive funding conditions generated by global banks can affect the autonomy of monetary policy in emerging economies. A study by the International Monetary Fund (IMF [2011]) shows that policy rates in emerging economies are currently at levels lower than past policy rates when inflation was at the same level. The risk is that raising domestic interest rates may backfire by inducing greater carry trade inflows, resulting in looser domestic financial conditions.

Another risk associated with capital flows is that large inflows result in sharp, sustained currency appreciations, which can make export sectors uncompetitive. Moreover, an important characteristic of the surge that occurred during 2010 was that portfolio flows corresponded to the largest share of inflows. These type of flows are known to be very volatile, which affects the stability of the financial system. Finally, a risk that is of the utmost importance when investors are leveraged is that flows can suddenly and sharply reverse, particularly when risk sentiment shifts. If such reversals are accompanied by a domestic credit bust, the resulting damage can be protracted.

Given the risks associated with sudden and large waves of capital inflows, a debate resurfaced on how to manage these flows and how to reduce the exposure of the financial system to these risks. The types of policies that have been proposed are macroprudential

policies and capital flow management policies (CFMs). A report by the Bank for International Settlements (for International Settlements [2010]) explains that macroprudential policies focus on the interactions between financial institutions, markets, infrastructure, and the wider economy. The objective of macroprudential policies is to strengthen the financial system's resilience to economic downturns and other adverse aggregate shocks. Moreover, these policies actively limit the build-up of financial risks. On the other hand, CFMs encompass a broad range of administrative, tax, and prudential measures that are designed to influence (some or all) capital flows. The report by the IMF [2011] classifies CFMs into two types: CFMs that do not discriminate on the basis of residency and residency-based CFMs. The first category includes measures that target foreign currency holdings, like broad limits on foreign currency borrowings and currency-specific reserve requirements. Also included are measures typically applied to the nonfinancial sector, such as minimum holding periods, and taxes on certain investment. Other measures in this category include policies designed to strengthen the institutional framework. Their objective is to increase the capacity of the economy to absorb capital inflows and to ensure the resilience and soundness of financial institutions. Some examples are capital adequacy and loan-to-value ratios, limits on net open foreign exchange positions, and limits on foreign currency mortgages. The second category, residency-based CFMs, encompass a variety of measures (including taxes and regulations) affecting cross-border financial activity that discriminate on the basis of residency. These measures are often referred as capital controls.

1.2 Theoretical Models of Capital Controls and Macroprudential Policies

Models on capital controls can be broadly classified into two types: models that include an overborrowing externality and models with nominal rigidities. The overborrowing models focus on the difference between the amount of credit that an agent obtains acting atomistically in an environment with a given set of credit frictions, and the amount obtained by a social planner. The social planner faces similar frictions but internalizes the general-equilibrium effects of its borrowing decisions.

Korinek [2010] was the first to introduce the concept of overborrowing in an economic model with financial frictions. In the model, agents face an incentive compatibility constraint that restricts their ability to borrow depending on their current endowment of tradable and non-tradable goods. That is, their endowment serves as collateral to back the amount they borrow. The borrowing constraint is expressed in terms of the tradable good, which implies that a depreciation of the real exchange rate (relative price of tradables and non-tradables) generates a decline in the domestic borrowing capacity. Decentralized agents take prices as given, therefore they do not internalize that larger repayments in states where the borrowing constraint is binding lead to larger capital outflows. This in turn generates a stronger exchange rate depreciation and tighter constraints. On the other hand, a constrained planner internalizes the link between the economy's aggregate financing decisions, the level of exchange rate, and the tightness of financial constraints. When choosing the optimal composition of foreign liabilities, the planner recognizes that reducing repayments in states where the constraint is binding has the indirect effect of reducing price declines and relaxing binding constraints on agents across the economy. The second-best constrained social optimum can be implemented by imposing a tax that internalizes the externality associated with capital inflows by raising the cost of capital on each asset to its socially efficient level.

Bianchi and Mendoza [2010] and Bianchi [2011] extends Korniek's model to consider incomplete financial markets. The difference between the two papers is that in the first one there is an endowment economy and in the second one there is a production economy. In these models, asset prices (capital) determine the value of the agent's collateral. On the demand side, as access to debt becomes constrained, consumption drops, and induces an endogenous decline in asset prices. The drop in asset prices tightens the collateral constraint further and leads to fire-sales of assets, and a spiraling decline in asset prices, consumption, and debt. On the supply side, production and labor demand are affected by the collateral constraint because firms buy labor using working capital loans that are limited by the constraint. Hence, when the constraint binds, the effective cost of labor rises, so the demand for labor and output drops. This affects dividend rates and feeds back into asset prices. Private agents do not internalize the supply-side effects of their borrowing decisions. However, a regulator that is subject to the pricing function from the competitive equilibrium (conditional efficiency), internalizes the effects of its borrowing decisions on the market prices of assets and labor. In the high-externality region, the regulator chooses higher bond positions (lower debt) than private agents. This behavior arises from the effect of the externality on the regulator's decision when the constrained region is near. In the model, the conditional efficiency equilibrium can be implemented by introducing taxes on debt and dividends.

The models of Korinek, Bianchi, and Mendoza introduce ex-ante policies that focus on reducing the amount of borrowing by agents. Benigno et al. [2013] argue that two forces affect the current marginal value of saving: the future marginal value of saving and the severity of future crises. The first one can be observed in endowment and production economies alike. By taking into account the future effect of the pecuniary externality, the social planner values current savings more than private agents, and tends to borrow less than them. The second force is present only in the production economy since it arises from the planner's ability to manipulate the allocation of productive resources across sectors in

crisis states. When the constraint binds, the planner allocates resources across sectors to increase the market price that enters the borrowing constraint. In their model, the social planner is constrained by the intertemporal allocation of consumption, or pricing rule, of the competitive equilibrium (constrained efficiency). The planner allocates labor across sectors in such a way that the real exchange rate is relatively higher than in the competitive allocation, which alleviates the cost of the crisis. During normal times, the planner takes into account the fact that a crisis is less costly and might be induced to borrow more than private agents, that is, the economy would display underborrowing. Their results show that the gains of a higher average consumption may outweigh the costs of a more volatile consumption caused by more frequent crises. Even though Bianchi and Mendoza [2010] consider a production model too, the economy presents overborrowing and not underborrowing because the central planner is constrained by the pricing function of the competitive equilibrium, that is, the equilibrium prices that depend on the state.

Models with nominal rigidities are based on Mundell's trilemma, which states that a country cannot simultaneously have free capital flows, independent monetary policy and a fixed exchange rate. In that case, capital controls emerge as a second best option to solve the distortions in the economy. Schmitt-Grohe and Uribe [2012] propose a model with fixed exchange rate and nominal downward wage rigidities. In their model, capital inflows appreciate the real wage by increasing the demand of tradables and non-tradables. However, when flows reverse, wages cannot adjust and the peg doesn't allow the exchange rate to depreciate, which generates involuntary unemployment in the non-tradables sector. The government has incentives to regulate capital flows to mitigate the initial expansion in consumption of tradables and dampen the initial increase in the nominal wage. Their model implements capital controls in such a way that during crisis, the government subsidizes the absorption of tradables, which increases the demand for non-tradables, and reduces unemployment in the non-tradables sector. Their optimal capital control policy is prudential in the sense that it imposes restrictions in capital inflows during booms and re-

duces restrictions during contractions. The optimal capital control policy strengthens the role of the current account as a vehicle to stabilize domestic absorption over the business cycle.

Farhi and Werning [2012] analyze the use of capital controls in currency unions with different degrees of price and wage rigidities. With a flexible exchange rate, a risk-premium shock, or sudden stop, that affects capital flows results in a devaluation of the currency. With a fixed exchange rate, domestic interest rates must rise one-to-one. This implies that the economy must surrender control over their monetary policy if it allows free mobility of flows. However, each country still has some monopoly power over its terms of trade. Absent more direct trade barriers, capital controls arise as an imperfect tool to manipulate the terms of trade by introducing a wedge in the uncovered interest rate parity equation. In this setting, capital controls are a second best instrument. They allow the country to regain some monetary autonomy and some control over the intertemporal allocation of spending. However, the reallocation is costly since it introduces a wedge between the intertemporal prices for home and foreign households. Their findings are that the optimal use of capital controls depends on the nature of the shock that affects the economy, on the stickiness of prices, and on the openness of the economy. In their model, capital controls are more effective for transitory shocks in economies that are not too open, and they are particularly powerful to respond to fluctuations in the risk premium demanded by foreign investors.

The contributions of the research departments of central banks has been focused more towards macroprudential policies rather than capital controls. To provide some examples, from the central bank of Brazil, Agénor and Pereira da Silva [2014], Agénor et al. [2012], and Agénor et al. [2011] present New Keynesian models that study the use of extended monetary policy rules. Their research analyzes the use of capital requirements, reserve requirements, foreign exchange interventions, and ceilings on commercial bank's leverage ratio; and the interaction between these measures and conventional monetary policy.

Agénor et al. [2011] extend the monetary policy rule to include the growth rate of nominal credit. They include a counter cyclical regulatory capital rule that has two components: a minimum capital adequacy ratio and a cyclical component that follows a dynamic rule related to the growth rate of real credit. Agénor and Pereira da Silva [2014] introduce reserve requirements and limits on the bank's leverage ratio, emphasizing their impact on the monetary policy transmission mechanism. In Agénor et al. [2012], the central bank intervenes in the foreign exchange market to adjust the actual foreign-currency value of its reserves so as to achieve a desired value. Banks are subject to risk-based capital requirements, and their augmented interest rate rule includes exchange rate depreciation.

In a study prepared for the Central Bank of Chile, Shin [2012] proposes a tax on non-core liabilities of commercial banks (liabilities to another bank or a foreign creditor). He argues that non-core liabilities serve as a measure of the risk appetite of financial intermediaries, both for domestic institutions and their foreign creditors, and hence of the potential for a rapid curtailment of funding as global funding conditions deteriorate. Moreover, he contends that non-core liabilities can serve as an indicator of the "supply push" factor of global liquidity resulting from expansive monetary policies pursued by advanced economy Central Banks.

Colombia was one of the countries that used reserve requirements as a macroprudential policy measure during the 2008 financial crisis. From the Central Bank of Colombia, Vargas and Cardozo [2012] study the use of reserve requirements and their impact on the monetary policy transmission mechanism. They find that the use of reserve requirements is justified when monetary policy has several transmission channels. Reserve requirements are not used actively in their model if the economy is closed and the aggregate demand is the only monetary policy transmission mechanism. On the other hand, reserve requirements play an important role in an open economy in which there is also an exchange rate transmission mechanism. Finally, reserve requirements can be implemented if the Central Bank has additional objectives such as financial stability, and when their

effects differ from that of the policy rate.

From the Central Bank of Mexico, Sámano [2011] introduces a financial block to a New Keynesian small open economy model estimated for Mexico. He finds that by implementing a capital adequacy ratio rule in combination with a Taylor rule, the macroeconomic outlook is better than with a Taylor rule alone.

From the Central Bank of Peru, Carrera and Vega [2012] study reserve requirements in a DSGE model with an interbank market structure and monitoring costs. Reserve requirements act as a tax to financial intermediation, increasing the cost of funding economic activity through deposits an ultimately affecting output and inflation. Their result is that a central bank can achieve a similar reaction on inflation and output with a lower increase of the policy interest rate if reserve requirements are increased at the same time. Bacchetta et al. [2012] analyze the accumulation of international reserves for the provision of domestic liquidity in a semi-open economy.They define an semi-open economy as one where the Central Bank has access to international capital markets, but the private sector does not have access. Therefore, to improve consumer's welfare, the central bank can match the desired domestic liquidity by accumulating reserves.

1.3 Empirical Evidence on the Impact of Capital Controls

Fratzscher [2012] establishes four motives for the use of capital controls that have emerged in the recent policy debate. The first, a foreign exchange policy objective, is related to maintaining a stable exchange rate that is not overvalued, and does not impinge on the on the competitiveness of the domestic economy. However, critics of capital controls argue that, in some cases, restrictions on the flow of capital have been used to achieve or maintain undervalued exchange rates. The second motive is a capital flow management goal. The objective is to reduce both the volume and volatility of capital flows and to lower the share of relatively more risky portfolio flows. The third motive is a financial stability goal,

which aims to shield the domestic economy and financial institutions from volatile capital flows, and avoid an overheating and over-reliance on foreign capital. The final motive is a macroeconomic policy objective that is concerned with the real economy (growth, growth volatility, inflation or public debt), or external vulnerability (current account, external debt). Given these objectives, empirical literature has surfaced to show whether the use of capital controls can affect the main variables targeted with each motive.

Abarca et al. [2012] analyze the relationship between capital controls and fluctuations in the exchange rate for Brazil, Chile, Colombia, Indonesia, South Korea and Turkey. Their results are that capital controls are ineffective in affecting the exchange rate for long horizons. However, in days close to the announcement of the measure, and for some currencies, the effect seems to go in the direction desired by authorities, that is, in terms of containing a sudden appreciation of the exchange rate given the massive inflows of capital. Their results indicate that the capital control measures have had a persistent effect in increasing the probabilities allocated to extreme events mainly in countries that implemented these types of measure more aggressively (Brazil, Indonesia and Colombia). They conclude that their results might suggest that the market allocates more probability to extreme movements in those countries where governments were implementing capital controls or banking regulations more intensively.

Forbes et al. [2012] study the effects of the implementation of Brazil's tax on financial operations on the composition of investors' portfolios. They use data from the Emerging Portfolio Fund Research database and investors interviews, and find that an increase in the tax reduces portfolios allocations in both bonds and equities. They argue that the effects of capital controls are through a change in investors expectations about future policies, rather than from the cost of controls. This means that capital controls might signal an increase probability of future policy changes that negatively affect investors. Finally, they find that as investors reduce their portfolio allocations in Brazil, they simultaneously increase their allocations to countries with exposure to China and reduce them to countries viewed as

more likely to use capital controls.

Finally, Magud et al. [2011] present a survey of the empirical literature on capital controls and present a model on the effects of capital controls on short-term flows using a portfolio balance approach. Their survey covers more than 30 papers and, in general, the results obtained suggest that capital controls were successful in altering the composition of capital flows toward longer maturities and in making monetary policy more independent. However, the papers are not very informative regarding the effectiveness of capital controls in reducing the volume of capital flows and reducing real exchange rate pressures. From their model, their results are that capital controls on inflows seem to make monetary policy more independent, alter the composition of capital flows and reduce the real exchange rate. However, they show that capital controls on inflows seem not to reduce the volume of flows, and thus the current account balance. Finally, they find that there is little systemic evidence of success in imposing capital controls on outflows. On of the problems that they find is that there is no unified approach on how to measure the existence of restrictions on capital flows.

CHAPTER 2

Adverse Second-Round Effects of Capital Controls on Market Depth

2.1 Introduction

Capital controls are policies implemented with the intended purpose of shielding an economy from the risks associated with sudden surges of capital inflows (Ostry et al. [2012]). As surveyed in the previous chapter, the literature on capital controls has focused on their use as tools that reduce fluctuations of flows of foreign capital to an economy. Capital controls are modeled as second-best measures that ameliorate distortions in the financial system caused by the overflow of capital. However, could these policies have an undesired effect on how prices in the financial market adjust to large fluctuations in capital flows? Instead of targeting the direct effect of capital controls on flows, I propose a mechanism, embedded into a market microstructure model, through which capital controls reduce the ability of the market to sustain large order flows without a significant change in the price of the assets. This characteristic of the market is called *market depth*. I show that if capital controls are implemented to reduce flows for the potential hazards of price volatility, their implementation can exacerbate that which they were intended to prevent.

There are two main strands of literature of capital control models. In the first strand, capital controls address an overborrowing externality in financially constrained economies (Korinek [2010], Bianchi [2011], Benigno et al. [2013], Bengui and Bianchi [2014], Korinek and Sandri [2014]). Agents are vulnerable to pecuniary externalities when their

borrowing capacity is collateralized by assets. In an event of a shock, there is an amplification effect where capital outflows and the depreciation of the exchange rate further tighten financial constraints. As a second-best solution, taxes on capital increase the domestic interest rate in order to curb domestic borrowing and encourage domestic saving. In contrast, in my model, capital controls deter the entrance of potential traders to the financial markets. The number of traders determines the liquidity supply of the market, hence a shallow market is characterized by a smaller number of traders. In the event of a liquidity shock, the country that did not implement controls possesses a deeper market that is able to sustain a greater flight of capital without a significant change in price.

Another branch of literature focuses on the use of capital controls as tools that correct aggregate demand externalities in models with nominal rigidities and limitations on the use of monetary policy (Farhi and Werning [2012], Farhi and Werning [2013], Farhi and Werning [2014], Schmitt-Grohe and Uribe [2012]). These rigidities include fixed exchange rates and stickiness in both prices and wages. In models of small open economies with flexible exchange rate and free capital mobility, the economy recovers from a sudden stop by increasing the nominal interest rate and depreciating the exchange rate. These models provide an alternative solution when the latter mechanisms are not available. Capital controls can prevent large fluctuations in the demand and smooth the terms of trade, which subside the amplification effect generated by the nominal rigidities in the models. The role of capital controls is to tame the outflow of capital, not because of the flow itself, but because of the negative effects the depreciation of the exchange rate has on the financial constraints. In my model, a secondary effect, through which market depth is reduced, can make the economy even more vulnerable to external shocks. Capital can flow out of an economy when investors face liquidity shocks, but the relevant policy implication is how financial markets respond to those episodes of capital flight. In my model, the depreciation needed for the economy to recover would be lower in the country where controls where not implemented. Flows are more volatile in the deeper market, but the

key variable, the exchange rate, is less volatile since prices in the market are better suited to respond to those flows.

The model is based on Vayanos and Wang [2012], who analyze how asymmetric information and imperfect competition affect liquidity and asset prices. In their model, the agent's heterogeneity is introduced through different agent's endowments and information. In my model, there are two segmented markets where a risky asset with the same expected return is traded at different prices. Every agent receives the same endowment in each market and there is perfect information. However, heterogeneity arises from a probability that agents will face a liquidity shock that will force them to reduce their holdings of the risky asset in exchange for liquidity. Traders base their selling decision on how their trades affect the prices in both markets. In this way, my model determines how liquidity shocks affect differently each market depending on its depth. Kyle [1985], Pagano [1989], Gromb and Vayanos [2003], and Foucault et al. [2014] also propose models where market depth is determined endogenously, but all these models focus more on how privileged information can affect price volatility.

The equilibrium of the model shows that capital controls deter the entrance of potential new investors to an economy, increasing the share each holds of the asset. A latter unforeseen increase in price sensitivity caused by the previous implementations of controls could outweigh their immediate benefits and could generate a hazardous environment in the financial system. The results from the model are of special interest when considering which policy measures to implement in order to strengthen the financial system and prevent sudden crisis.

2.2 Entry Model with Inventory Risk

The model is based on Vayanos and Wang [2012]. There are three periods, $t = 0, 1, 2$ and two segmented financial markets $j \in A, B$. In each financial market a riskless and a

risky asset are traded, both paying off in period 2 in terms of a consumption good. In each individual market, both assets are in the same fixed supply. The riskless asset pays off one unit of the consumption good with certainty, and the risky asset pays off V units, where V has a normal distribution with mean μ and variance σ^2. Taking the riskless asset as the numeraire, the price of the risky asset in period t is P_t, where $P_2 = v$.

There are M traders who in period 0 choose first whether to enter one or both of the markets. Traders who decided to enter one market then decide which of the two markets to enter. I will denote as N the number of traders who entered both markets and as N_j the traders who only enter market $j \in \{A, B\}$. In each market traders receive an endowment of the per capita supply of the risky asset in that market (e_{0j}) and an endowment of the total per capita supply of the riskless asset. The difference between each market is that in market B there are capital controls. Capital controls will enter the model as a fixed cost of entry to market B, which needs to be payed in period 0. This fixed cost can represent quantitative limits on the amount of trades that can be performed, total cost of taxes to inflows or the perceived cost of future imposition of controls to outflows. The reason why it is modeled as a fixed cost is to abstract on any direct effect that the controls might have on flows. Instead, I am assuming that controls influence the decision of traders on whether to enter the market or not, but not the amount they trade in each market. Since the model is solved using backwards induction, the effect of controls on the number of each type of investor is analyzed in a subsequent section.

Wealth of agents type i in market j during period t will be denoted as W^i_{tj}. Where i denotes whether the agent trades in both markets, trades only in A or trades only in B. Wealth in period 2 is equal to consumption:

$$C^i_2 = W^i_{2A} + W^i_{2B}$$

In period 1, traders maximize the expected utility of their wealth in each market in period 2 (W^i_{2j}). The assumption that traders do not maximize the expected utility of their

total wealth is to emphasize that markets are segmented. If this was not the case, traders would trade until the price in both markets were the same. With this assumption it is possible to obtain different prices in each market in equilibrium. Another justification of this assumption is that the implementation of capital controls in one of the markets prevent dealers from perfectly adjusting their holdings of the asset between markets, then the best they can do is to maximize their wealth in each market.

Traders are risk averse and preferences can be represented by a *CARA* utility function with common risk aversion coefficient ρ. Given that the return of the asset is normally distributed, the utility function can be expressed as a mean-variance function:

$$E[U(W_{2j}^i)] = E[W_{2j}^i] - \frac{\rho}{2} Var[W_{2j}^i]$$

I introduce heterogeneity by assuming that with probability π traders who entered both markets are subject to a liquidity shock in period 0. This shock forces them to sell from both markets a total value of L of the risky asset. Since these traders exchange the risky asset for liquidity I will denote them as liquidity demanders. On the other hand, agents who only trade in one market do not face the liquidity shock, but instead provide liquidity. Hence I will denote them as liquidity suppliers. Traders who enter both markets can be though of as large hedge funds, who allocate funds based on the market characteristics rather than on specific characteristics of each country. This type of traders are more prone to change their investment strategy when there are changes to the global environment. Hence to invest in other markets, they require liquidity obtained by exiting some other market.

The trading mechanism through which liquidity suppliers and demanders trade works through an auctioneer in each market who receives the desired net asset holdings of all dealers. The auctioneer then determines the equilibrium price that clears the market. The desired asset holdings that the traders send to the auctioneer can take two forms. The first type are *price schedules*, which are a function of the price and specify a quantity depend-

ing on the clearing price in each market. The second type are *market orders*, which are fixed quantities independent of the price. Whether traders decide to send price schedules or market orders to the auctioneer in each market is determined by the functional form of their equilibrium net asset holdings.

2.2.1 Liquidity Suppliers Problem

Traders behave competitively and the market is organized as a call auction. In period 1, liquidity suppliers choose net asset holdings s_{1j} of the risky asset in market j to maximize their expected wealth in each market:

$$W_{2j}^s = W_{1j}^s + P_{1j}s_{1j} + V[e_{0j} - s_{1j}]$$

where e_{j0} is the endowment of the risky asset the agent received in market j in period 0.

The liquidity suppliers solve the following problem:

$$\max_{s_{1j}} \sum_{j\in\{A,B\}} W_{1j}^s + P_{1j}s_{1j} + \mu[e_{0j} - s_{1j}] - \frac{\rho\sigma^2}{2}[e_{0j} - s_{1j}]^2$$

It is not necessary to distinguish between traders that only have holdings of the asset in one market or traders who have assets in both markets but are not subject to the liquidity constraint since the utility specification is separable in the wealth in each market. Suppliers who trade only in one market would have a wealth of zero in the other market. Taking first order conditions, the optimal price schedule is:

$$s_{1j}^* = \frac{P_{1j} - \mu}{\rho\sigma^2} + e_{0j}$$

Traders want to sell their period 0 endowment of the asset in the first period because its return involves risk. To compensate for the risk, the price has to be lower than the risk adjusted mean of the return. If s_{1j} is negative, it indicates that the trader is buying the asset and instead supplying liquidity. To persuade the trader to buy an amount of the asset

even greater than his initial endowment, the price has to be low enough not only to absorb the risk from his endowment but it also needs to include a risk premium (a discount) from the extra liquidity he is providing.

2.2.2 Liquidity Demanders Problem

A liquidity demander's objective function is the same function as the objective of the liquidity supplier; however, their problem includes two constraints. The first constraint is the *liquidity constraint*, which forces traders to reduce their holdings of the asset in both markets to collect liquidity with value L. This constraint represents any type of situations where investors need to liquidate assets in some markets either for liquidity needs, credit shocks, or reversal of capital flows. The second constraint is the *no-short constraint*, which indicates that traders can not take a short position in either market. This constraint is necessary to prevent that traders engage in arbitrage to satisfy the liquidity constraint. Otherwise they could take a short position in the market with the higher price to avoid having to exit the market with the lower price. This constraint, in addition to the utility specification, is what keeps market segmented and allows that in equilibrium the same asset is traded at different prices.

Liquidity demanders choose net asset holdings m_{1j} of the risky asset in market j to solve the following problem:

$$\begin{aligned} \max_{m_{1j}} \quad & \sum_{j\in\{A,B\}} W_{1j}^D + P_{1j}m_{1j} + \mu[e_{0j} - m_{1j}] - \frac{\rho\sigma^2}{2}[e_{0j} - m_{1j}]^2 \\ \text{subject to} \quad & P_{1A}m_{1A} + P_{1B}m_{1B} \geq L \\ & m_{1j} \leq e_{1j},\ j \in \{A,B\}. \end{aligned}$$

Taking first order conditions, the optimal net asset holdings of the liquidity demander is[1]:

[1]The complete solution can be found in the appendix

$$m_{1j}^{*} = \frac{(1+\lambda)P_{1j} - \mu - \eta_j}{\rho\sigma^2} + e_{0j}$$

where λ is the Lagrange multiplier associated with the liquidity constraint and η_j is the Lagrange multiplier associated with the no-short constraint in market j.

When the liquidity constraint is binding, the optimal net asset holdings of the liquidity demanders and suppliers have different characteristics. Unlike liquidity suppliers, who send price schedules to the market-clearing auctioneer, liquidity demanders send market orders, that is, quantities that are not a function of the market clearing price. The difference between the net asset holdings of the two traders arises from the Bertrand competition nature of the market clearing mechanism. Traders who need to sell the asset would want to sell in the market with the higher price. By sending a price schedule they would be dragging the price down as they compete against themselves to obtain the best price.

Lemma 2.2.1. *The liquidity constraint is binding and liquidity demanders send market orders to the market-clearing auctioneers.*

The proof of the lemma can be found in the appendix, but the result is intuitive. If the liquidity constraint is not binding, the liquidity demanders' desired net asset holdings would be the same as the liquidity suppliers. Net asset holdings also represent the excess supply of each of the traders, which in equilibrium have to add up to zero. All traders want to sell their initial endowment of the risky asset, which implies that the equilibrium price will compensate them just enough to cover the risk from holding that endowment. In equilibrium, the individual net asset holdings of any trader would be zero and there would be no trade in equilibrium. Therefore, the liquidity constraint would not be satisfied and this would lead to a contradiction.

The distinction that liquidity demanders send market orders instead of price schedules is crucial in determining the market's depth. Liquidity suppliers will be responsible for

absorbing the excess supply of the asset by liquidity demanders. Then, how the equilibrium price responds to the market orders characterizes market depth.

2.2.3 The Liquidity Supply and Market Depth

An auctioneer in each market ($j \in \{A,B\}$) receives the price schedules (s_{i1j}) of the $(1-\pi)N+N_j$ liquidity suppliers and parcels out the market orders (m_{k1j}) of the πN liquidity demanders at the price that clears the market. That is, to clear the market, the net asset holdings of all traders have to be equal to zero:

$$\sum_{i=1}^{(1-\pi)N+N_j} s_{i1j} + \sum_{k=1}^{\pi N} m_{k1j} = 0$$

Since only the price schedules of liquidity suppliers depend on the price, we can substitute their equilibrium net asset holdings in the market clearing condition to obtain an equation that determines the market's supply of liquidity. Then, by solving for the price as a function of the market orders[2] and the initial endowment we obtain the inverse liquidity supply:

$$P_{1j} = \mu - \rho\sigma^2 e_{0j} - \frac{\rho\sigma^2\pi N}{(1-\pi)N+N_j} m_{1j}$$

To better understand the inverse liquidity supply, we can decompose it in two parts. The first two terms represent the equilibrium *midquote*. The midquote reflects the asset's expected fundamental value (μ) and the inventory risk adjustment ($\rho\sigma^2 e_{0j}$). At this price the liquidity suppliers are willing to hold precisely their initial endowment. Deviations from this price can be interpreted as bid-ask spreads. If the market orders (excess supply) of the asset m_{1j} is positive, the price includes a discount to compensate liquidity suppliers from adding more stock to their initial holdings of the risky asset.

Market depth (Δ_j) is defined as the sensitivity of the price to the market orders of

[2]There is no heterogeneity between liquidity demanders, so we can factor out their number when adding their market orders.

liquidity demanders. In this case, the inverse of the coefficient that multiplies the market orders in the inverse liquidity supply:

$$\Delta_j = \frac{(1-\pi)N + N_j}{\rho\sigma^2\pi N}$$

The main difference between the two markets is given by the number of liquidity suppliers that trade only in market j (N_j). The bigger their number, the less each liquidity supplier will bear of the market orders, and hence, the smaller the compensation. Moreover, market depth is decreasing in the risk aversion coefficient of the traders (ρ), the variance of the return of the risky asset (σ^2), the probability of the liquidity shock (π) and the number of traders who hold stock of the asset in both markets (N).

The first two relationships are consistent with the literature of market microstructure (Kyle [1985], Pagano [1989]). The more risk averse the traders and the riskier the stock, implies a greater risk premium included in the price of the asset. Not only does an increase in these variables reduce market depth, but it also reduces the midquote the asset would be valued in a no-trade equilibrium. Finally, an increase in the probability of a trader being subject to the liquidity shock and a larger number of traders who hold stock of the asset in both assets increases the relative number of liquidity demanders to liquidity suppliers. Each supplier would have to take on more of the market orders of the demanders, which involves a higher discount on the price of the asset.

2.2.4 Equilibrium Market Orders and Price

To solve for the equilibrium market orders we substitute the inverse liquidity supply into the optimal net asset holdings of liquidity demanders. From Lemma 2.2.1, the liquidity constraint is always binding, and assuming, without loss of generality, that the no-short constraint is not binding, i.e. the Lagrange multiplier associated with the constraint is

zero, $\eta_j = 0$ for $j \in A, B$)[3], we obtain a closed form solution for the market orders as a function of market depth[4].

Proposition 2.2.2. *In response to a liquidity shock that forces traders to sell a total value of (L) from their stock of the risky asset in two segmented markets, liquidity demanders sell proportionally more assets in the deeper market:*

$$m_{1j}^{*} = \frac{\lambda}{1 + \frac{(1+\lambda)}{\Delta_j}}(\mu - \rho\sigma^2 e_{0j})$$

where Δ_j is the depth of market j, μ the mean return of the asset, λ is the Lagrange multiplier associated with the liquidity constraint and e_{0j} the initial endowment in market j.

Traders that require immediate liquidity are forced to trade the asset at a discount. Therefore they will start to withdraw from the market where their trades will have a smaller impact, that is, the deeper market. The assumptions on the separability in wealth of the utility function and the no-short constraint, segment the markets, which allows for the price of an asset with the same stochastic return to be different in each market. The following result characterizes prices in each market with respect to their midquote price:

Proposition 2.2.3. *The price discount from the midquote as a result of the liquidity shock, is lower in the deeper market:*

$$P_{1j}^{*} = \frac{1}{1 + \frac{\pi N \lambda}{N_j + N}}(\mu - \rho\sigma^2 e_{0j})$$

[3]The importance of the constraint is that it prevents arbitrage, but for a large enough initial endowment we can assume that it is not binding.

[4]The complete proof can be found in the appendix.

The difference in market depth between markets is completely determined by the number of traders who have a stock of the asset in only one market (N_j). As their number increases, the depth of the market is greater and the discount at which the price is traded compared to the midquote is smaller. In equilibrium, the price in both markets adjust to incorporate the extra demand for liquidity. Even though more funds are withdrawn from the deeper market, the price is lower in the shallow market. Why wouldn't traders withdraw funds from both markets until the price in both of them are the same? The answer lies on the assumptions on market segmentation. The utility specification of traders implies that they perceive risk independently from each market. When deciding on which market to sell, they not only take into account the discount at which they are selling the asset, but also that they will be reducing their risky inventory of the asset. That is, by selling the asset in the deeper market there is a lower discount, but by selling in the shallow market they are getting rid of some risk. The result would be different if, instead, traders maximized the expected utility of their total wealth. In this case, the effect on the relative position in each market would not be present and the price in both markets would be the same.

With the equilibrium price and net asset holdings of liquidity suppliers and demanders we can calculate their expected wealth. Going back one period, traders consider the advantages and disadvantages of entering both markets or only one.

2.3 Period 0: Choice of Markets

In period 0 there are M traders choosing to enter both markets or only one market. If the trader enters both markets, he receives an endowment of the risky asset in each market. If he decides to enter only one of them, he then decides which of the two markets to enter ($j \in \{A, B\}$), receiving an endowment of the risky asset only in the market he entered. The supply of the risky asset is the same in both markets (e) and it is divided equally

among all the traders that entered that market. Then, if N traders entered both markets and N_j traders only entered market j, each receive an endowment of the risky asset of: $e_{0j} = \frac{e}{N+N_j}$.

As mentioned before, the return of the risky asset is the same in both markets. The difference between markets is that in one of them (from now on market B) there are capital controls. Capital controls will be modeled as a fixed cost (C) of entering market B. I emphasize again that capital controls will not have a direct effect on flows into the country. Rather, they will affect the decision of traders on whether to enter the market or not, which will affect how the endowment of the asset is distributed among the remaining traders. In equilibrium, a trader must be indifferent between choosing to enter both markets, entering market (A) or entering market (B). That is, the equilibrium N and N_j, $j \in \{A,B\}$ must satisfy:

$$\begin{aligned} &E[U(W_{2A}^s)] = E[U(W_{2B}^s)] - C \\ &= \pi\left(E[U(W_{2A}^s)] + E[U(W_{2B}^s)] - C\right) + (1-\pi)\left(E[U(W_{2A}^d)] + E[U(W_{2B}^d)] - C\right) \end{aligned}$$

where W_{2j}^i is the period 2 wealth of the trader in market $j \in \{A,B\}$ and the superscript s denotes a liquidity supplier and d a liquidity demander.

The safe asset is also in fixed supply in both markets, but unlike the risky asset, each trader receives a share equal to the total per capita supply of the asset. This means that every trader starts with the same endowment of the safe asset across markets. The benefit from entering both markets is that in each market they will receive an endowment of the risky asset, if they only enter one, they will only receive an endowment in that market. The risk from entering both markets is that with probability π they will be subject to the liquidity shock that will require them to sell some of their assets at a discounted price. By entering only one market, traders get rid of this risk and with certainty form part of the liquidity supply. The type of traders that enter both markets can be though of as large hedge or investment funds that allocate their funds based on the overall characteristics

of a market (return of the asset) and not on the particular characteristics of each country (capital controls). This type of traders are more prone to face liquidity needs when wanting to reallocate their investment to other markets after unexpected shocks to the global economy or changes in the tide of flows.

In contrast, traders that only enter one market can be thought as smaller investors that prefer to choose one market based on its specific characteristics. An example can be domestic firms that borrow foreign capital to fulfill their investment needs. These traders will always receive benefits from forming part of the liquidity supply but at a lower overall return. The fixed cost of entering market B encompasses the overall effects of capital controls. This fixed cost includes initial costs of entry (controls on inflows) and potential restrictions on exiting the market (controls on outflows). To abstract from any effect that capital controls may have on the initial supply of the asset the fixed cost will not have an effect on the total flow of foreign assets that enter the economy (e), but only in the amount that each trader receives as endowment.

In the literature of market microstructure (Pagano [1989], Foucault et al. [2014]) liquidity bequests liquidity in the sense that traders want to enter deeper markets because prices are less volatile. In contrast, in my model, if we assume a starting point where the midquote is the same across markets, a trader would prefer to enter the shallow market. The reason is that the trader already knows that he will form part of the liquidity supply, hence he will receive higher returns in the market where the asset is sold at a higher discount, that is, the shallow market. However, there is an endowment effect that goes in the opposite direction to the depth effect. By entering the market, the trader receives a lower share of the risky asset, which would lower his overall wealth. Without capital controls, these effects will balance out[5].

Lemma 2.3.1. *In absence of capital controls, traders who only enter one market will divide equally among markets.*

[5]The complete proof can be found in the appendix.

The implementation of capital controls in one market will deter the entrance of investors to that market. In equilibrium, the magnitude of the controls will balance out the price effect and the endowment effect. As capital controls increase, less traders will enter that market, making it more shallow. These traders will receive a larger share of the endowment and trade it at a higher discount, but the returns from these benefits will cancel out by the cost of the controls. Given a positive capital control policy, in equilibrium, there is a positive number of traders in each of the categories[6]:

Proposition 2.3.2. *For a given cost (C) of entering market B, if M is the total number of traders:*

$$0 < N < M \text{ Not all traders enter both markets.}$$
$$0 < N_B < \frac{N}{2} \text{ At least some traders enter the market with controls.}$$

where N is decreasing in L (liquidity shock) and π (probability of a liquidity shock), and N_B is decreasing in the cost of entry C.

In this sense, the difference between the type of traders who enter only the individual markets lies in the type of investment they are making. There will be less traders in the market with capital controls, however they will receive a larger endowment than in the market where there are more traders. This type of investment can be though of as foreign direct investment, where traders are required to own assets with a value of equity or stock that gives them at least 10 percent of the voting power of the enterprise. On the other hand, traders who enter market without controls receive a lower endowment of the risky market, which means that their investment can be thought of as portfolio investment.

The effect of implementing controls in the model can be characterized by the type of investment that traders make in each of the countries. In the country with controls the type of investment requires a larger share of the assets, and in the one without it requires a smaller share. If the supply of foreign capital is fixed, this means that there are

[6]The complete proof can be found in the appendix

a lower number of traders in the country with capital controls. The number of investors in each country completely differentiates market depth. The country with a larger number of investors will have a deeper market. Large hedge funds that enter both markets will withdraw more of their funds from the deeper marker when facing a liquidity shock. However, the price will drop less in the deeper market since it is better suited to absorb the extra demand for liquidity.

2.4 Conclusions

Due to the risks related to volatile waves of capital flows, policymakers have started to consider the use of capital flow management policies (IMF [2011], for International Settlements [2010]). These policies are intended to shield the economy against imbalances generated by extreme episodes of capital flows and to strengthen the financial system. The economic literature has not come to a consensus on the effectiveness and consequences of the use of capital controls. The theoretical literature has focused on the use of controls as policies that reduce foreign flows to correct pecuniary externalities in borrowing, or as alternative policy measures in models with nominal rigidities. This paper provides an alternate effect of capital controls by analyzing their effect on the ability of the market to sustain large order flows without a large change in price (market depth).

The model shows that the imposition of controls deters the entrance of investors and creates a more shallow market. During a period where traders of a risky asset are subject to a liquidity shock, they reduce their stock holdings from deeper markets. However, the deeper market is able to sustain the bigger flight of capital, which translates into a smaller drop in prices.

If capital controls are intended to reduce price volatility for the potential hazards it generates in the financial system, the proposed model indicates that their implementation could be exacerbating that which they were intended to prevent. With the start of the

process of monetary policy normalization of the advanced economies, this model predicts that economies (like Brazil) that previously introduced controls will observe a greater exchange rate volatility. In countries with balance sheet effects and debt denominated in foreign currency, sharp exchange rate depreciation can be detrimental to the stability of the financial system. If the objective is to have a stronger financial system and lower price volatility, unintended adverse second-round effects of capital controls indicate that they might not be the right policy choice.

2.5 Appendix: Proofs of Lemmas and Propositions

Lemma 2.2.1 *The liquidity supply is always binding and liquidity demanders send market orders to the market-clearing auctioneers.*

Proof. The liquidity demander's problem is the following:

$$\begin{aligned} \max_{m_{1j}} \quad & \sum_{j\in\{A,B\}} W_{1j}^D + P_{1j}m_{1j} + \mu[e_{0j} - m_{1j}] - \frac{\rho\sigma^2}{2}[e_{0j} - m_{1j}]^2 \\ \text{subject to} \quad & P_{1A}m_{1A} + P_{1B}m_{1B} \geq L \\ & m_{1j} \leq e_{1j},\ j \in \{A,B\}. \end{aligned}$$

The associated Lagrangian is:

$\mathscr{L}(m_{1A}, m_{1B}, \lambda, \eta A, \eta_B) = \sum_{j\in\{A,B\}} W_{1j}^D + P_{1j}m_{1j} + \mu[e_{0j} - m_{1j}] - \frac{\rho\sigma^2}{2}[e_{0j} - m_{1j}]^2$
$-\lambda\left(L - P_{1A}m_{1A} - P_{1B}m_{1B}\right) - \sum_{j\in\{A,B\}} \eta_j\left(m_{1j} - e_{1j}\right)$

and the first order conditions are:

$$\begin{aligned} P_{1A} - \mu + \rho\sigma^2[e_{0A} - m_{1A}] + \lambda P_{1A} - \eta_A &= 0 \\ P_{1B} - \mu + \rho\sigma^2[e_{0B} - m_{1B}] + \lambda P_{1B} - \eta_B &= 0 \\ L - P_{1A}m_{1A} - P_{1B}m_{1B} &= 0 \\ m_{1A} - e_{1A} &= 0 \\ m_{1B} - e_{1B} &= 0 \\ \lambda\left(L - P_{1A}m_{1A} - P_{1B}m_{1B}\right) \quad \lambda &\geq 0 \\ \eta_A\left(m_{1A} - e_{1A}\right) \quad \eta_A &\geq 0 \\ \eta_B\left(m_{1B} - e_{1B}\right) \quad \eta_B &\geq 0 \end{aligned}$$

If the liquidity constraint is not binding, and without loss of generality we assume that the no-short constraint is not binding either, then we have that the optimal net asset holdings of liquidity demanders are:

$$m_{1j}^{*} = \frac{P_{1j} - \mu}{\rho\sigma^2} + e_{0j}$$

To clear the market, the sum of the optimal net asset holdings of liquidity suppliers and demanders have to add up to 0:

$$\begin{aligned}
\sum_{i=1}^{(1-\pi)N+N_j} s_{i1j} + \sum_{k=1}^{\pi N} m_{k1j} &= 0 \\
\sum_{i=1}^{(1-\pi)N+N_j} \left(\frac{P_{1j} - \mu}{\rho\sigma^2} + e_{0j} \right) + \sum_{k=1}^{\pi N} \left(\frac{P_{1j} - \mu}{\rho\sigma^2} + e_{0j} \right) &= 0 \\
(N + N_j) \frac{P_{1j} - \mu}{\rho\sigma^2} + e_{0j} &= 0 \\
P_{1j} &= \mu - \rho\sigma^2 e_{0j}
\end{aligned}$$

Substituting the equilibrium price into the net asset holdings of liquidity demanders we obtain $m_{1j} = 0$

$$m_{1j}^{*} = \frac{P_{1j} - \mu}{\rho\sigma^2} + e_{0j} = \frac{\mu - \rho\sigma^2 e_{0j} - \mu}{\rho\sigma^2} + e_{0j} = 0$$

but this clearly violates the liquidity constraint. Hence the liquidity supply is binding.

□

Proposition 2.2.1 In response to a liquidity shock (L) liquidity demanders sell more assets in deeper markets:

$$m_j^{*} = \frac{\lambda}{1 + \dfrac{(1+\lambda)}{\Delta_j}} (\mu - e_j)$$

where Δ_j is the depth of market j, μ the mean return of the asset, λ is the Lagrange multiplier associated with the liquidity constraint and e_j the initial endowment in market j.

Proof. Using Lemma 2.2.1 $\lambda > 0$, and liquidity demanders send market orders to the auctioneer. This means we can treat the net asset holdings of liquidity demanders as constants in the market clearing condition to solve for the liquidity supply of the market:

$$\sum_{i=1}^{(1-\pi)N+N_j} s_{i1j} + \sum_{k=1}^{\pi N} m_{k1j} = 0$$

$$((1-\pi)N+N_j)\left(\frac{P_{1j}-\mu}{\rho\sigma^2}+e_{0j}\right)+(\pi N)m_{1j}=0$$

$$P_{1j} = \mu - \rho\sigma^2 e_{0j} - \frac{\rho\sigma^2\pi N}{(1-\pi)N+N_j}m_{1j}$$

is the inverse liquidity supply of the market, then if we define market depth as:

$$\Delta_j = \frac{(1-\pi)N+N_j}{\rho\sigma^2\pi N}$$

We can substitute the optimal price schedule into the first order condition of liquidity demanders:

$$m^*_{1j} = \frac{(1+\lambda)P_{1j}-\mu}{\rho\sigma^2}+e_{0j} =$$

$$\frac{(1+\lambda)\left(\mu-\rho\sigma^2 e_{0j}-\frac{\rho\sigma^2\pi N}{(1-\pi)N+N_j}m_{1j}\right)-\mu}{\rho\sigma^2}+e_{0j} =$$

$$\frac{\lambda}{1+\frac{(1+\lambda)}{\Delta_j}}(\mu-\rho\sigma^2 e_{0j})$$

□

Proposition 2.2.2 The price discount from the midquote as a result of the liquidity shock, is lower in the deeper market:

$$P_{1j}^{*} = \frac{1}{1+\frac{\pi N\lambda}{N_j+N}}(\mu-\rho\sigma^2 e_{0j})$$

Proof. Substituting the result from Proposition 2.2.1 and the definition of market depth into the inverse liquidity supply we obtain the result:

$$P_{1j} = \mu-\rho\sigma^2 e_{0j}-\frac{\rho\sigma^2\pi N}{(1-\pi)N+N_j}m_{1j} =$$

$$\mu-\rho\sigma^2 e_{0j}-\frac{\rho\sigma^2\pi N}{(1-\pi)N+N_j}\left(\frac{\lambda}{1+\frac{(1+\lambda)}{\frac{(1-\pi)N+N_j}{\rho\sigma^2\pi N}}}(\mu-\rho\sigma^2 e_{0j})\right) =$$

$$\frac{1}{1+\frac{\pi N\lambda}{N_j+N}}(\mu-\rho\sigma^2 e_{0j})$$

□

Lemma 2.3.1 In absence of capital controls, traders who only enter one market will divide equally among markets.

Proof. In absence of controls the equilibrium condition requires:

$$
\begin{aligned}
E[U(W_{2A}^s)] = E[U(W_{2B}^s)] &\iff \\
W_{1A}^s + P_{1A}s_{1A} + \mu[e_{0A} - s_{1A}] - \frac{\rho\sigma^2}{2}[e_{0A} - s_{1A}]^2 &= \\
W_{1B}^s + P_{1B}s_{1B} + \mu[e_{0A} - s_{1B}] - \frac{\rho\sigma^2}{2}[e_{0B} - s_{1B}]^2 &\iff \\
P_{1A}\left(\frac{P_{1A}-\mu}{\rho\sigma^2} + e_{0A}\right) + \mu\left[-\frac{P_{1A}-\mu}{\rho\sigma^2}\right] - \frac{\rho\sigma^2}{2}\left[-\frac{P_{1A}-\mu}{\rho\sigma^2}\right]^2 &= \\
P_{1B}\left(\frac{P_{1B}-\mu}{\rho\sigma^2} + e_{0B}\right) + \mu\left[-\frac{P_{1B}-\mu}{\rho\sigma^2}\right] - \frac{\rho\sigma^2}{2}\left[-\frac{P_{1B}-\mu}{\rho\sigma^2}\right]^2 &\iff \\
P_{1A} = P_{1B} &\iff \\
\frac{1}{1+\frac{\pi N\lambda}{N_A+N}}(\mu - \rho\sigma^2\frac{e}{N_A+N}) = \frac{1}{1+\frac{\pi N\lambda}{N_B+N}}(\mu - \rho\sigma^2\frac{e}{N_B+N}) &\iff \\
N_A = N_B &
\end{aligned}
$$

Where in the third line their initial wealth in period 1 is the same because the riskless asset is divided equally among all traders independent on the market they choose. □

Proposition 2.3.1 For a given cost (C) of entering market B, if M is the total number of traders in the market:

$$0 < N < M \text{ Not all traders enter both markets.}$$
$$0 < N_B < \frac{N}{2} \text{ At least some traders enter the market with controls.}$$

where N is decreasing in L (liquidity shock) and π (probability of a liquidity shock), and N_B is decreasing in the cost of entry C.

Proof. Assume that all traders enter both markets, then there would be no difference in the price in both markets. A trader could obtain higher profits by only entering market A, not paying the fixed cost of entry to market B and receiving positive profits with certainty in that market. Therefore not all traders enter both markets. Now assume that there is a

fixed number of traders who enter both markets (N), then to show that there is a lower number of traders we can follow the inequalities from lemma 3.1 to obtain that $N_A > N_B$, where the fixed cost C counteracts the benefits the traders receive by selling the asset at a higher discount in the shallow market. □

CHAPTER 3

A Quarterly Intensive Measure of Capital Account Restrictiveness

3.1 Introduction

To determine the impact of capital flow management policies on the volume and composition of capital flows, it is necessary to obtain a measure of capital controls[1]. Several researchers have innovated in creating different measures of capital controls or of financial and capital account openness. However, there is no consensus on which measure is superior, and each has its own advantages and disadvantages. The main drawback from the existing measures is that the majority have an annual periodicity. During the fourth quarter of 2009 Brazil implemented a tax of 2 percent on financial transactions related to non-resident fixed income, and then increased the rate to 6 percent during the fourth quarter of 2010. The annual measures would reflect an increase in capital controls during the whole year of 2009 and then again during the whole year of 2010. Moreover, the data of capital flows collected by the IMF has quarterly periodicity, therefore using these annual measures using quarterly data on flows would not accurately establish the effects of capital controls on flows. The second drawback is that most of these measures are binary indices. This implies that they indicate only if the country has in effect controls or not, but they do not differentiate in their magnitude. For example, an increase in the IOF tax

[1]Empirical papers on the effect of capital controls on capital flows and other macroeconomic variables include: Magud et al. [2011], Forbes et al. [2012], Forbes and Warnock [2012a], Olaberria [2012], Bluedorn et al. [2013], and Contessi et al. [2013].

from 2 percent to 4 percent would only show as a constant imposition of controls through 2009 and 2010.

In this chapter I provide a survey of the most commonly used measures of capital controls in the literature. Then I propose a new quarterly measure of capital account restrictiveness (QMCAR) based on information from the International Monetary Fund's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER IMF [Various Years]). The QMCAR index is the standardized first principal component of indices of five categories in the *AREAER* and was constructed as an intensity measure to account for the change in tightening or loosening of restrictions. This new measure will be used in the last chapter to assess how capital controls affect capital flows.

3.2 A Survey of Measures of Capital Account Restrictiveness

Measures of financial openness and indices of capital controls can be classified into two categories: *de jure* and *de facto* measurements. *De jure* indices are based on rules or legal restrictions, while *de facto* indices use an instrumental variable or actual capital flows data to measure the degree of capital mobility. Most *de jure* measures use the IMF's *AREAER* as their main source of information. For each IMF member country, the *AREAER* presents information on the exchange rate system, administration of control, prescription of currency, imports and import payments, payments for invisibles, exports and export proceeds, proceeds from invisibles, and capital transactions[2]. Moreover, for every year, it includes a time line of the changes that occurred in every category. Since 1996, the capital transactions category was expanded into 13 categories, differentiating between residency, and restrictions on inflows and outflows. However, this change in reporting poses a challenge for researchers trying to construct an index that covers periods

[2]For a complete list of the categories, subcategories, and their definitions refer to the appendix in this chapter.

before 1996, since the two classification methodologies cannot be easily mapped onto each other. A way in which this problem can be solved is by interpreting the facts in the aggregated version of the capital transactions category and determining which change corresponds to each of the categories in the subsections. However, this solution relies heavily on personal judgment, which makes the indices hard to replicate for the pre-1996 period.

The first most popular capital account openness index that reflects the intensity of controls based on the information of the *AREAER* was proposed by Quinn [1997]. This index was constructed for 64 countries from 1950 to 1994, and then was extended to 1999 for 94 countries by Quinn and Toyoda [2008]. The purpose of the index was first to associate political and economic variables to financial regulation (Quinn [1997]), and then to relate capital account liberalization with economic growth (Quinn and Toyoda [2008]). Quinn's openness index is constructed using three categories: capital transactions, trade (exports and imports), and invisibles (payments and receipts for financial and other services), where each category is scored from 0 to 4 in increments of 0.5. A score of 4 in the capital transactions category represents an economy fully open to capital flows, and a score of 4 in the trade and invisibles categories corresponds to an economy where the proceeds from the international trade of goods and services are free from government restrictions.

To eliminate bias when using the information from the pre-1996 *AREAER*, while still constructing an intensity index, Potchamanawong [2007] proposes an index that only uses the information from the post-1996 *AREAER*. His objective was to associate currency crises with capital restrictions by creating an index that measures separately controls on capital inflows from capital restrictions on outflows, and using Exchange Market Pressure Indices as proxies for currency crises. His index is based on the 13 subcategories of the capital transactions category, plus an indicator for the existence of dual or multiple exchange rates. For each category, the index takes a value from 0 to 1 with 0.25 increments.

A value of zero indicates that there are no restrictions of any kind being enforced on that type of transaction, and a value of 1 indicates that the particular type of transaction is not permitted.

Montiel and Reinhart [1999] propose a different intensity index. Their index is used to determine how policies designed to promote the development of the financial system and policies focused on macroeconomic stabilization, in the face of capital inflows, can affect the level and composition of capital flows. Their index can take three values. A value of zero corresponds to countries where in a given year no restrictions or taxes were imposed on capital inflows, a value of one corresponds to a year when capital account restrictions took the form of prudential regulations, and a value of two indicates the existence of explicit measures, such as prohibitions, deposit requirements, or financial transaction taxes.

Even with detailed coding, intensity indices are prone to bias and rely ond the personal judgment of each author. In this way, some authors prefer to use a binary variable to represent the existence or the lack of controls. The most popular aggregate index based on binary variables was proposed by Chinn and Ito [2013]. Their work was based on Mody and Murshid [2005], who try to find the relationship between capital account liberalization and growth. Both indices consist of an aggregate of four variables: a variable indicating the presence of multiple exchange rates, a variable indicating restrictions on current account transactions, a share of a five-year period of capital account restrictions, and a variable indicating the requirement of the surrender of export proceeds. For each variable, a value of one is assigned if there are no restrictions in that category. The difference between these two indices is that Mody and Murshid [2005] only consider the sum of the four variables, while Chinn and Ito [2013] calculate the first standardized principal component of the four categories. Moreover, Chin and Ito's index covers 184 countries, starts from 1970, it's publicly available, and it's updated yearly. I will follow Chin and Ito's methodology to construct the index I propose.

Another aggregate index that assigns a value of one or zero depending on the existence of controls on the capital account at a year-end was proposed by Glick and Hutchison [2005]. Their motivation for creating the index was to investigate whether capital account restrictions help insulate developing countries from speculative attacks on their currencies. For the pre-1996 *AREAER*, they assign a value of one if there are any restrictions in the category of capital transactions. After 1996, they assign a value of one if there are restrictions in at least 5 of the subcategories of the capital transactions category.

Other authors have opted to calculate disaggregated indices of capital controls using the categories and subcategories in the *AREAER*. The first of this type of indices was proposed by Johnston and Tamirisa [1998]. Their objective was to examine the structure and determinants of capital controls by using disaggregated measures based on the classification in the *AREAER*. Their measure distinguishes between capital inflows and outflows, and between the different types of specific transactions, for example: purchases of local securities by nonresidents, sales or issues of securities abroad by residents, purchases of securities abroad by residents, and sale or issue of securities locally by nonresidents. A disadvantage is that this index is only calculated for 1995. However, Miniane [2004] uses the same methodology and extended the index starting from 1983 to 2000, though at the cost of not distinguishing between inflow and outflow restrictions. Miniane argues that it is questionable whether the pre-1996 editions of the *AREAER* contain enough text information to disaggregate by direction of flows taking into account each of the subcategories of capital transactions. However, Brune and Guisinger [2007] construct a disaggregated index with fewer categories than Miniane but that distinguishes between controls on inflows and outflows starting from 1965.

Schindler [2009] also constructs a disaggregated index but his categories correspond to major components in the Balance of Payment statistics and does not cover some components of capital flows, such as derivatives, real estate transactions, and personal capital transactions.

Table 3.1: *De jure* Measures of Capital Controls

Index	Period	Disagg. direction of flows	Disagg. type of flows	Intensity index
Quinn and Toyoda (2008)	1950-1999	Yes	No	Yes
Potchamanawong (2007)	1995-2004	Yes	Yes	Yes
Montiel and Reinhart (2009)	1990-1996	No	No	Yes
Chinn and Ito (2008)	1970-2011	No	No	No
Mody and Murshid (2005)	1979-1999	No	No	No
Glick and Hutchison (2005)	1975-1997	No	No	No
Johnston and Tamirisa (2008)	1995	Yes	Yes	No
Miniane (2004)	1983-2000	No	Yes	No
Brune and Guisinger (2007)	1965-2004	Yes	Yes	No
Schindler (2009)	1995-2005	Yes	Yes	No

De jure measures have the disadvantage that they might not reflect how capital flows respond to legal restrictions, since actual implementation or enforceability might differ from the measures as described in the regulations. In this sense, other authors have opted to use *de facto* indices to measure the degree of financial integration of countries. The most popular *de facto* measure was proposed by Lane and Milesi-Ferretti [2007]. They construct estimates of external assets and liabilities for 145 countries from 1970 to 2004. Their measure of financial integration is defined as the sum of the stock of external assets and liabilities as a percentage of GDP. Edison and Warnock [2003] compute a monthly measure of the intensity of capital controls across 29 countries that is based on the degree of restrictions on foreign ownership of equities. Their measure is based on the ratio of the market capitalization underlying a country's *Investable and Global Indices* as computed by the International Financial Corporation. The Global index is designed to represent the market and the Investable index is designed to represent the portion of the market available to foreign investors. Therefore, the ratio represents a quantitative measure of the availability of the country's equities to foreigners, and their index (one minus the ratio) would give a measure of the intensity of capital controls. However, as Quinn et al. [2011] argue, the direction of causality between *de facto* measures and a government's policy stand can go both ways. For example, there can be an increase in capital inflows without any change in capital account regulations, or countries might implement capital controls to respond to a destabilizing surge in inflows. In this way, *de jure* measures would be preferable when analyzing the relationship between the international flows of capital and capital account restrictiveness.

All of the *de jure* indices presented above have an annual periodicity, which is a disadvantage when trying to employ them to determine the effects of capital controls on capital flows. For example, during the fourth quarter of 2009 Brazil imposed a tax of 2 percent on financial transactions related to non-resident fixed income, and then increased the rate to 6 percent during the fourth quarter of 2010. The annual *de jure* measures would reflect

an increase in capital controls during all 2009 and then during all 2010, which would affect the results when employing quarterly data on capital flows. In the next section a new quarterly *de jure* measure of capital controls is introduced, the index is calculated for Mexico and Brazil and the new measure is compared with the capital account measures presented in this section.

3.3 Construction of the Index

A measure of capital controls, or financial openness, that can be implemented to quantify the effect on the international movement of capital flows should balance various features. These features include: information by assets, disaggregation by direction of flows and residency, intensity of the controls, and time coverage. The quarterly measure of capital account restrictiveness (QMCAR) presented in this section is a *de jure* measure based on information from the *AREAER*. The QMCAR is an intensity index that can be disaggregated to distinguish between different assets, but does not disaggregate by direction of flows or residency. This index was estimated starting from the first quarter of 2008 to the second quarter of 2012, and was calculated for Mexico and Brazil.

The QMCAR is the standardized first principal component of indices of five categories: exchange arrangements, arrangements for payments and receipts, controls on payments for invisible transactions and current transfers, proceeds from exports and/or invisible transactions, and capital transactions. In turn, the category of exchange arrangements is divided into three subcategories: exchange rate structure, exchange tax, and exchange subsidy). The category of proceeds from exports and/or invisible transactions is divided into two subcategories: repatriation requirements and surrender requirements. Finally the category of capital transactions is divided into eight subcategories: capital and money market, derivatives and other instruments, credit operations, direct investment, real estate transactions, provisions specific to commercial banks, personal capital transactions,

and provisions specific to institutional investors. The type of structure or transactions included in each category and subcategory as explained in the *AREAER* are described in the appendix.

3.3.1 Coding

Binary measures can only capture extreme cases, either control or fully liberalized, and don't take into account the transition from strong controls to weak controls. The QMCAR was constructed as an intensity index to account for the change in tightening or loosening of restrictions. For every category, the index was normalized to ten in the first quarter of 1980. This would represent the initial condition of the restrictiveness of the capital account. Using the information on the monthly changes in regulations provided in the *AREAER*, for each category, the index increases one unit if the restrictions were tightened, or decreases one unit if the restrictions were loosened[3]. Examples of an increase in the index are: a new regulation requires capital transactions to be made through authorized banks or exchange houses, the implementation of a new tax on financial operations, or an increase in quantitative limits, such as limited ownership or limited amount of transferring. This coding procedure implies that the index is easy to update since the change in restrictions does not depend on the overall history of controls but only on the regulation from the previous quarter. Once the index was constructed for each of the subcategories, principal component analysis was used to calculate the QMCAR.

[3]The coding rule was changed for the implementation of the Brazilian Tax on Financial Operations. When the tax was implemented, the index increased in one unit, but subsequent increments in the tax rate accounted for half a unit increase in the index. Also, changes in the categories of transactions that were required to pay the tax were accounted for half a unit increments in the index, if more transactions were subject to the tax, or half a unit reductions in the index, if less transactions were subject to the tax.

3.3.2 Principal Component Analysis

Principal component analysis involves obtaining linear combinations of variables that explain the variance structure of the data. The principal components of a data set are uncorrelated linear combinations of the original variables whose variance are as large as possible. The direction of maximum variance corresponds to the first principal component and the remaining principal components correspond to uncorrelated directions that maximize the remaining variance. In order to simplify the interpretation of the coefficients of the linear combinations, the variables can be standardized and the principal components can be obtained from the eigenvectors of the correlation matrix. Variables are usually standardized if they are measured on scales with widely differing ranges or if the units of measurements are not commensurate (Johnson and Wichern [2007]. Principal component analysis can be used to construct indices that summarize the variables, and their corresponding coefficients can be interpreted as the importance of each variable in explaining the variance of the index. For the QMCAR, principal component analysis was used in two steps. First, the first principal component was obtained for the categories that are disaggregated into subcategories. The first principal component would correspond to the index associated with these categories. Then, the QMCAR corresponds to the first principal component of the standardized indices of the five categories. The table in the next page shows the results of the calculation of the QMCAR for Mexico and Brazil.

Table 3.2: Principal Components Analysis

Categories	Mexico	Brazil
A) Exchange arrangements	-	0.33
A.1) Exchange rate structure	0.49	*0.71*
A.2) Exchange tax	-	*0.71*
A.3) Exchange subsidy	-	-
B) Arrangements. for payments and receipts	0.50	0.54
C) Payments for invisible transactions and transfers	-	0.43
D) Proceeds from exports and/or invisible transactions	-	0.33
D.1) Repatriation requirements	-	*0.71*
D.2) Surrender requirements	0.51	*0.71*
E) Capital transactions	0.50	0.54
E.1) Capital and money markets	*0.38*	*0.36*
E.2) Derivatives and other instr.	*0.43*	*0.39*
E.3) Credit operations	*0.43*	*0.38*
E.4) Direct investment	*0.44*	*0.39*
E.5) Real estate transactions	-	*0.32*
E.6) Provisions specific to commercial banks	*0.39*	*0.24*
E.7) Personal capital transactions	-	*0.37*
E.8) Provisions specific to institutional investors	*0.37*	*0.35*
Total Variance Explained	83.26	64.40

As shown in the table, the QMCAR is an approximately equally weighted average of the indices of the different categories. This implies that all the categories contribute almost the same proportion to the variance of the QMCAR. The only exception would be the categories of exchange arrangements and proceeds from exports and/or invisible transactions, which have a lower weight in the QMCAR of Brazil. Since the principal components were obtained from the standardized variables, the weight (divided by the number of categories) is the correlation between the QMCAR and each of the index of the categories. The following two figures show the QMCAR and the indices that comprise it for Mexico and Brazil[4].

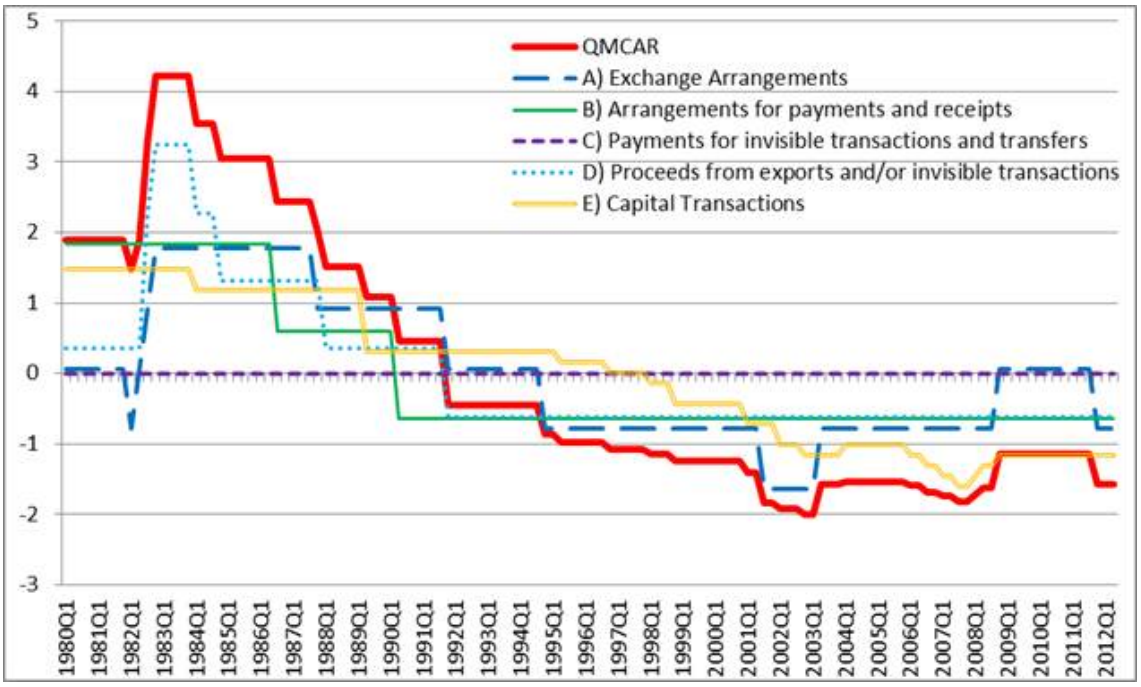


Figure 3.1: QMCAR Index Mexico

As shown in the graph, the period of highest capital account restrictiveness for Mexico was during the 1982 crisis. The government implemented regulations such as a dual exchange rate, the prohibition of payments and other transactions abroad in pesos by Mexican credit institutions, all export receipts were made subject to surrender at the ordinary

[4]The graph corresponds to the standardized indices.

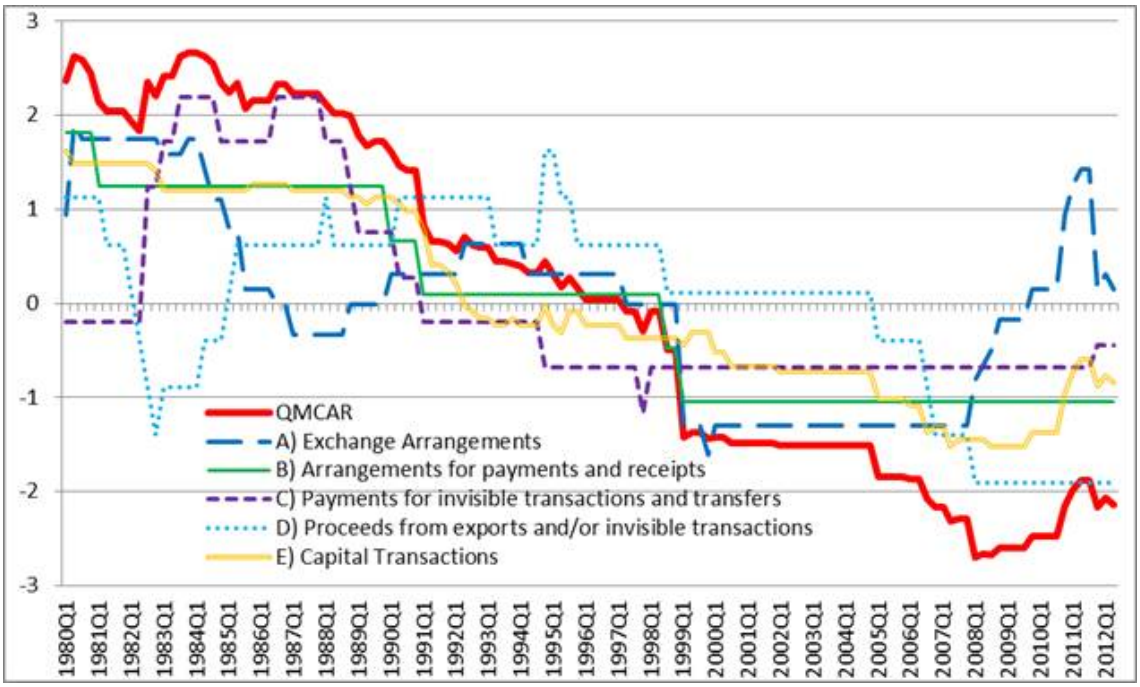


Figure 3.2: QMCAR Index Brazil

exchange rate, and Mexican credit institutions were required to surrender to the Bank of Mexico their net foreign exchange holdings, including gold and silver. Two of the largest drops in the index occurred during the second quarter of 1989, when restrictions on foreign capital participation in new foreign direct investment were liberalized substantially, and during the fourth quarter of 1991, when the exchange rate was unified.

For Brazil, the largest drops occurred during the second quarter of 1991, when the government liberalized the stock markets to foreign institutional investors by exempting profits from income taxes, and during the first quarter of 1999, when the exchange rate was unified and all trade between MERCOSUR partners was liberalized. It is worth mentioning that the QMCAR captures the evolution of the implementation of the Brazilian tax on financial operations during the quarters after the 2008 financial crisis.

3.4 Comparison with other Indices

The greatest advantage of the QMCAR is that it is a quarterly intensity index, which means it can be used to find a relationship between a tightening or weakening of controls using quarterly data on flows. Another advantage is that it covers a long period of time and can be updated easily. It also has its disadvantages: it does not distinguish between inflows or outflows, or between taxes or quantitative limits, and it constitutes a subjective judgment of the regulations. However, the correlation between the QMCAR and other popular indices in the literature is high, as shown in the table below:

Table 3.3: Correlation between QMCAR and other Indices

Index	Mexico	Brazil
Quinn and Toyoda (2008)	-0.82	-0.88
Chinn and Ito (2008)	-0.61	-0.86
Miniane (2004)	0.89	0.76
Schindler (2009)	0.75	0.45
Edison and Warnock (2003)	0.92	0.94
Lane and Milesi-Ferretti (2007)	0.23	0.56

The correlations were calculated for indices that were publicly available. Since the indices are only available annually, the values for QMCAR correspond to the fourth quarter of the respective year. Except for Edison and Warnock's index, where the value corresponds to the last month in each trimester. The correlations between Quinn and Toyoda's index, and Chin and Ito's index is negative because their indices are of capital account openness. The index calculated in this section will be the variable used to measure capital controls in the analysis of the relationship between capital account restrictiveness and the level and composition of the international flows of capital.

3.5 Appendix: Categories and Subcategories of the Quarterly Measure of Capital Account Restrictiveness

A) Exchange arrangements

A.1) Exchange rate structure- If there is one exchange rate, the system is called unitary. If there is more than one exchange rate that may be used simultaneously for different purposes and/or by different entities, and if these exchange rates give rise to multiple currency practices or differing rates for current and capital transactions, the system is called dual or multiple.

A.2) Exchange tax- Foreign exchange transactions are subject to a special tax. Bank commissions charged on foreign exchange transactions are not included in this category.

A.3) Exchange subsidy- Foreign exchange transactions are subsidized by using separate, nonmarket exchange rates.

B) Arrangements for payments and receipts- The official requirements affecting the selection of currency and the method of settlement for transactions with other countries. When a country has payments agreements with other countries, the terms of these agreements often lead to a prescription of currency for specified categories of payments to, and receipts from, the countries concerned. This category includes information on the use of domestic currency in transactions between residents and nonresidents, both domestically and abroad; it also indicates any restrictions on the use of foreign currency among residents.

C) Controls on payments for invisible transactions and current transfers- Describes the procedures for effecting payments abroad in connection with current transactions in invisible, with reference to prior approval requirements, the existence of

quantitative and indicative limits, and/or bona fide tests. Indicative limits establish maximum amounts up to which the purchase of foreign exchange is allowed on declaration of the nature of the transaction.

D) Proceeds from exports and/or invisible transactions

D.1) Repatriation requirements- The obligation of exporters to repatriate export and/or invisible transactions proceeds.

D.2) Surrender requirements- Regulations requiring the recipient of repatriated export proceeds to sell, sometimes at a specified exchange rate, any foreign exchange proceeds in return for local currency to the central bank, commercial banks, exchange dealers authorized for this purpose, or on a foreign exchange market.

E) Capital transactions- Describes regulations influencing both inward and outward capital flows. Controls on capital transactions include prohibitions; need for prior approval, authorization, and notification; dual and multiple exchange rates; discriminatory taxes; and reserve requirements or interest penalties imposed by the authorities that regulate the conclusion or execution of transactions or transfers and the holding of assets at home by nonresidents and abroad by residents.

E.1) Capital and money markets- Refers to public offerings or private placements on primary markets or their listing on secondary markets. Capital markets refers to shares and other securities of a participating nature and bonds and other securities with an original maturity of more than one year. Money markets refers to securities with an original maturity of one year or less and includes short-term instruments, such as certificates of deposit and bills of exchange. The category also includes treasury bills and other short-term government paper, bankers' acceptances, commercial paper, interbank deposits, and

repurchase agreements.

E.2) Derivatives and other instruments- Refers to operations in other negotiable instruments and nonsecured claims not covered under the above subsections. These may include operations in rights; warrants; financial options and futures; secondary market operations in other financial claims (including sovereign loans, mortgage loans, commercial credits, negotiable instruments originating as loans, receivables, and discounted bills of trade); forward operations (including those in foreign exchange); swaps of bonds and other debt securities; credits and loans; and other swaps (e.g., interest rate, debt/equity, equity/debt, foreign currency, and swaps of any of the instruments listed above). Also included are controls on operations in foreign exchange without any other underlying transaction (spot or forward trading on the foreign exchange markets, forward cover operations, etc.).

E.3) Credit operations- Covers operations directly linked with international trade transactions or with the rendering of international services. It includes guarantees, sureties, and financial backup facilities provided by residents to nonresidents and vice versa. It also includes securities pledged for payment or performance of a contract, such as warrants, performance bonds, and standby letters of credit, and financial backup facilities that are credit facilities used as a guarantee for independent financial operations.

E.4) Direct investment- Refers to investments for the purpose of establishing lasting economic relations both abroad by residents and domestically by nonresidents. These investments are essentially for the purpose of producing goods and services, and, in particular, in order to allow investor participation in the management of an enterprise. The category includes the creation or extension of a wholly owned enterprise, subsidiary, or branch and the acquisition of full or partial ownership of a new or existing enterprise that results in effective

influence over the operations of the enterprise.

E.5) Real estate transactions- Refers to the acquisition of real estate not associated with direct investment, including, for example, investments of a purely financial nature in real estate or the acquisition of real estate for personal use.

E.6) Provisions specific to commercial banks- Describes regulations that are specific to these institutions, such as monetary, prudential, and foreign exchange controls. It also describes regulations on certain commercial bank balance sheet items (including capital) and on limits covering commercial banks' positions in foreign currencies (including gold).

E.7) Personal capital transactions- Covers transfers initiated on behalf of private persons and intended to benefit other private persons. It includes transactions involving property to which the promise of a return to the owner with payments of interest is attached (e.g., loans or settlements of debt in their country of origin by immigrants) and transfers effected free of charge to the beneficiary (e.g., gifts and endowments, loans, inheritances and legacies, and emigrants' assets).

E.8) Provisions specific to institutional investors- Describes controls specific to institutions, such as insurance companies, pension funds, investment firms (including brokers, dealers, or advisory firms), and other securities firms (including collective investment funds). Incorporates measures that impose limitations on the composition of the institutional investors' foreign or foreign currency assets (reserves, accounts) and liabilities (e.g., investments in equity capital of institutional investors or borrowing from nonresidents) and/or that differentiate between residents and nonresidents.

Source: IMF, Annual Report on Exchange Arrangements and Exchange restrictions, (2012).

CHAPTER 4

Determinants of the Composition and Dynamics of Capital Flows

4.1 Introduction

Mexico and Brazil are the two largest economies of Latin America. In 2010 Brazil implemented a tax on financial operations (Imposto sobre Operações Financeiras *IOF*) in response to a surge in foreign flows and risks of currency appreciation (Pereira da Silva and Harris [2012]). Since Mexico and Brazil share similar characteristics, most policy analysts where expecting Mexico to also implement capital controls. However, this was not the case and flows continued to flow freely into Mexico. A debate initiated on the effectiveness of these controls to curb the flow of capital into Brazil and the possible spillover effect they could have on other countries. For example Forbes et al. [2012] study the effects of the implementation of Brazil's tax on financial operations on the composition of investors' portfolios using data from the Emerging Portfolio Fund Research database and investors interviews. They find that an increase in the tax reduces portfolio flows, and they argue that the effects of capital controls operate through a change in investors expectations about future policies, rather than from the cost of controls. As mentioned in the first chapter of the dissertation, the dynamics of net and gross inflows, and their components for both countries are similar from 2005 to 2010. However, there is a sharp contrast on the evolution of the composition of flows after Brazil implemented the IOF tax. This might point out that, as a whole, the dynamic of flows did not change. However,

investors rearranged the composition of their investments in Brazil (Magud et al. [2011]). Moreover there were spillover effects of the imposition of the tax, in the sense that it also affected the composition of flows to Mexico. Just as in the theoretical model, the country that imposed controls (Brazil) receives more foreign direct investment and the country that did not (Mexico) receives more portfolio investment.

This chapter begins with a survey of literature that focuses on factors that determine capital flows. Then I estimate two models. First a simple OLS regression to assess the impact of capital controls on the level of flows, and then a binary choice model to determine how capital controls affect the probability of extreme dynamics of flows.

4.2 A Review of Factors that Determine Capital Flows

The factors that affect the international flows of capital can be classified into two: push and pull factors. Push factors are those external to the country receiving the inflows of capital. They typically refer to global factors that affect all emerging markets across the board, such as world interest rates and global risk appetite. These factors operate by reducing the attractiveness of lending to industrial-country borrowers. Pull factors typically refer to the relative attractiveness of different destinations for investment opportunities, that is, the domestic characteristics of each country. They operate through improvements in the risk-return characteristics of assets issued by developing-country debtors (Montiel and Reinhart [1999]).

There is a considerable amount of literature that details how pull and push factors affect the levels of capital flows and their composition. Calvo et al. [1993] and Calvo et al. [1996] contend that push factors are more important than domestic fundamentals in driving capital flows. In particular, they find that movements in the US interest rates were the factor that determined the direction of international flows to Latin America during the early 1990s.

Forbes and Warnock [2012a] contribute to the literature by analyzing the factors that determine the movement of gross inflows, instead of net inflows. They define four type of episodes based on the growth or reduction of gross inflows and outflows. A surge episode is characterized by a rapid increase in gross inflows, a stop arises when gross inflows suddenly reverse, a flight happens when domestic investors send large amounts of capital abroad (increase in gross outflows), and a retrenchment episode is defined as a reduction in gross outflows. Their findings are that global risk, which incorporates both risk aversion and economic uncertainty, is the only variable that consistently predicts each type of episode. They discern that an increase in global risk is associated with more stops and retrenchments, and fewer surges and flights. They also find that strong global growth is associated with an increased probability of surges and decreased probability of stops and retrenchment. High global interest rates are associated with retrenchments. Finally contagion, whether through financial linkages, trade linkages or just regional proximity, is strongly associated with stop and retrenchment episodes. In Forbes and Warnock [2012b], they extend their previous work to further disaggregate flows into debt and equity. They find that most episodes of extreme capital flow movements around the world are debt-led. Their results show that risk measures are highly correlated with sudden changes in debt inflows, that is, when risk aversion is high, debt-led surges are less likely and debt-led stops are more likely. Moreover, contagion (geographic, trade and financial linkages) is important for debt-led episodes. Debt-led stops are more likely in countries experiencing a negative growth shock, and debt-led surges are more likely in countries with a positive growth shock. Finally, they find that equity-led episodes appear to be idiosyncratic, bearing little systemic relation to the explanatory variables.

Arias et al. [2013] also disaggregate flows by type (portfolio, foreign direct investment and debt), but don't differentiate between inflows and outflows. They find that the only variables that were statistically significant for every type of flow considered were: the level of economic openness, GDP growth, VIX variation, an index of financial glob-

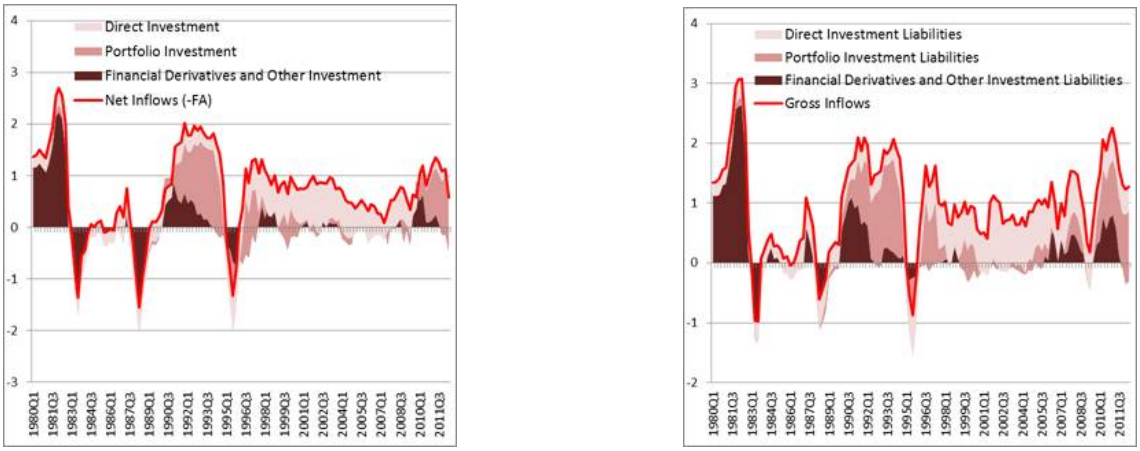
alization and total public debt. Contessi et al. [2013] study changes in the volatility of capital flows and in the co-movement between flows and macroeconomic variables over business cycle breaks. They find that total inward flows are pro-cyclical with respect to output, investment and the real interest rate. Outflows, on the other hand, are counter-cyclical with respect to output and investment. Their results show that outflows are pro cyclical with respect to the interest rate in developing counties, but counter-cyclical in most industrial economies. Finally, Bluedorn et al. [2013] find that net capital flows are strongly correlated with changes in global financing conditions, and that economies that have a direct foreign financial exposure to the US experience an additional decline in their net capital flows in response to US monetary tightening.

4.3 Empirical Evidence of the Determinants of Capital Flows for Mexico and Brazil

Data on gross and net inflows and their composition were obtained from the IMF [2013] and are reported in dollars. Net inflows are equal to the negative value of the financial account, which implies that a positive value of net inflows means that the country is a net borrower, and a negative value means that the country is a net lender. Gross inflows correspond to the net transaction of financial liabilities, that is, acquisition of liabilities less reduction in liabilities. The GDP for Mexico and Brazil was obtained from the Central Bank of Mexico and the Central Bank of Brazil, respectively, and the data is expressed in national currency. To express the GDP of both countries in dollars, the exchange rate was obtained from the IFS.

The financial account shows net acquisition and disposal of financial assets and liabilities and measures how net lending to or borrowing from nonresidents is financed. The financial account shows transactions in net terms, which are shown separately for financial assets and liabilities (i.e., net transactions in financial assets shows acquisition

of assets less reduction in assets, not assets net of liabilities). Net inflows are equal to the negative value of the financial account, which implies that a positive value of net inflows means that the country is a net borrower, and a negative value means that the country is a net lender. Gross inflows correspond to the net transaction of financial liabilities, that is, acquisition of liabilities less reduction in liabilities. Net and gross inflows were disaggregated into three categories: foreign direct investment, portfolio investment, and financial derivatives and other investment[1]. The following graphs show the dynamics of the levels and composition of gross inflows and net inflows for Mexico and Brazil[2].



(a) Net Inflows.

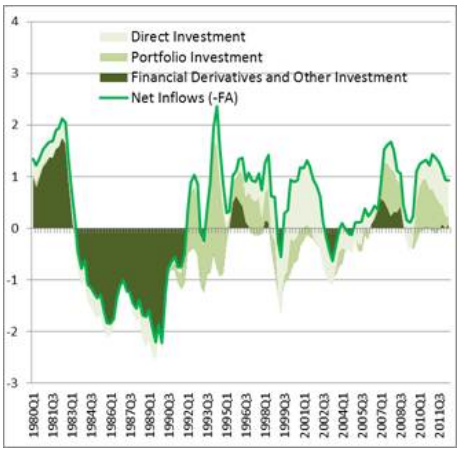
(b) Gross Inflows.

Figure 4.1: Capital Flows to Mexico

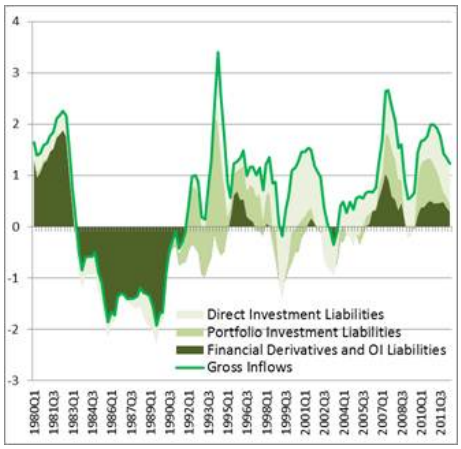
For Mexico there are three clear periods of sharp reductions in capital flows: the 1982 debt crisis, the stock market crash in 1987 and the 1994 crisis. For Brazil, the period from 1983 to 1990 was characterized by hyperinflation and economic recession which maintained capital flows in low levels. After the liberalization of the stock market in 1991 flows started to rebound. The reduction in flows starting from 1998 can be explained by an increase in risk aversion of investors to emerging markets caused by the Aisan financial

[1]The formal definition of the components of capital flows can be found in the appendix.

[2]Net inflows and gross inflows are expressed as a percentage of GDP. The graph shows a four quarter moving average of the flows.



(a) Net Inflows.



(b) Gross Inflows.

Figure 4.2: Capital Flows to Brazil

crisis and the Russian bond default in 1998. Moreover, flows decreased in 2001 as a result of the Argentinian crisis and fears that Brazil would default on its debt; however, flows rebounded as growth prospects started to increase. For both countries, there was a considerable decrease in capital flows during the 2008 financial crisis, but the most notable change after the financial crisis is the alteration in the composition of flows. Whereas before the crisis foreign direct investment represented the larger proportion of flows in Mexico, after the crisis portfolio investment is now the most predominant component. The opposite behavior can be observed for Brazil: portfolio investment represented the larger proportion of flows before the crisis and, after the crisis, direct investment comprises most inflows. The question is whether the imposition of capital controls in Brazil can provide a reasonable explanation for this drastic change in the composition of flows in both countries.

The push factors included in the analysis are global liquidity, global interest rate, global risk and global growth. The way to measure these variables was taken from Forbes and Warnock [2012a]. All variables, except for global risk are obtained from the IMFS's International Financial Statistics (IFS) (IMF [2013]). Global liquidity is measured as the

annual growth in the world's money supply. The money supply is calculated as the sum of M2 of the United States, Euro Area and Japan, and M4 of the United Kingdom, all converted into dollars using the IFS exchange rates. The global interest rate is measured as the average of the interest rates of long-term government bonds from the United States, Euro Area and Japan. Global growth is the percentage annual change in the advanced economies' GDP volume as reported in the IFS. Finally, global risk is measured by the VXO calculated by the Chicago Board Options Exchange (CBOE). The VXO is a volatility index based on trading of S&P 100 (OEX) options, that starts from 1986. To obtain a measure of risk before 1986, monthly returns volatilities are calculated as the monthly standard deviation of the daily S&P500 index normalized to the same mean and variance as the VXO index when they overlap from 1986 (Bloom [2009]).

The pull factors incorporated in the analysis are financial integration, capital controls, domestic growth, country indebtedness and trade openness. Financial integration is measured as the stock market capitalization of each country as a percentage of GDP obtained from the Global Financial Data database. The QMCAR is used as a measure of capital controls. The domestic growth shock is measured as the deviations of real GDP growth from its trend, with data from the IFS. Country indebtedness is represented by total net public debt as a percentage of GDP using data from each country's Central Bank. The results from the OLS analysis are summarized in the following tables. Standard errors are adjusted for presence of both heteroskedasticity and autocorrelation of unknown form (HAC-Newey-West).[3].

[3]Dependent variables: net inflows (NI), direct investment (DI), portfolio investment (PI), other investment and financial derivatives (OI), gross inflows (GI), direct investment liabilities (DIL), portfolio investment liabilities (PIL), and other investment and financial derivatives liabilities (OIL). Independent variables: capital controls (CC), global liquidity (LIQ), global interest rate (IR), global growth (GG), global risk (VXO), financial integration (SMC), domestic growth (GS), and country indebtedness (IND).

Table 4.1: Results of OLS Regression Mexico

	NI	DI	PI	OI	GI	DIL	PIL	OIL
CC	-0.411***	-0.082**	-0.048	-0.280*	-0.439***	-0.086**	-0.054	-0.299**
	(0.159)	(0.039)	(0.097)	(0.148)	(0.162)	(0.038)	(0.102)	(0.131)
LIQ	0.014	0.001	0.001	0.011	0.009	-0.000	-0.001	0.011
	(0.015)	(0.003)	(0.012)	(0.013)	(0.015)	(0.003)	(0.009)	(0.012)
IR	0.290***	0.025	0.155***	0.109*	0.184**	-0.020	0.111**	0.092
	(0.070)	(0.018)	(0.056)	(0.056)	(0.070)	(0.015)	(0.049)	(0.061)
GG	-0.133**	0.031*	-0.034	-0.130***	-0.129**	0.015	-0.042	-0.102**
	(0.061)	(0.016)	(0.044)	(0.049)	(0.054)	(0.013)	(0.044)	(0.045)
VXO	0.000	0.003**	0.004	-0.007*	-0.009	0.001	0.001	-0.012***
	(0.005)	(0.001)	(0.004)	(0.004)	(0.006)	(0.001)	(0.004)	(0.004)
SMC	-0.001	-0.012***	0.025**	-0.014**	0.015	-0.008***	0.029***	-0.005
	(0.011)	(0.003)	(0.010)	(0.007)	(0.011)	(0.003)	(0.009)	(0.008)
GS	0.123***	-0.023**	0.062**	0.083**	0.133***	-0.019**	0.050**	0.102***
	(0.038)	(0.009)	(0.024)	(0.037)	(0.034)	(0.008)	(0.023)	(0.034)
IND	-0.010	-0.006	-0.004	0.000	0.011	-0.001	0.002	0.009
	(0.010)	(0.004)	(0.007)	(0.009)	(0.011)	(0.002)	(0.007)	(0.007)
AdjR^2	0.297	0.292	0.151	0.185	0.212	0.337	0.207	0.203

HAC (Newey-West) standard errors in parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

All variables except for CC, LIQ and IR were winsorized at the 1% level.

Table 4.2: Results of OLS Regression Brazil

	NI	DI	PI	OI	GI	DIL	PIL	OIL
CC	-0.738***	-0.000	-0.200**	-0.530***	-0.758***	-0.049	-0.212**	-0.480***
	(0.177)	(0.051)	(0.096)	(0.122)	(0.167)	(0.052)	(0.098)	(0.099)
LIQ	-0.010	-0.014**	-0.008	0.013	-0.007	-0.006	-0.010	0.010
	(0.013)	(0.005)	(0.008)	(0.009)	(0.013)	(0.005)	(0.008)	(0.009)
IR	0.192*	-0.064**	0.209***	0.032	0.181	-0.068**	0.217***	-0.002
	(0.113)	(0.031)	(0.073)	(0.067)	(0.114)	(0.030)	(0.074)	(0.055)
GG	0.062	0.018	0.030	0.014	0.082*	0.029	0.034	0.020
	(0.052)	(0.022)	(0.037)	(0.032)	(0.047)	(0.021)	(0.038)	(0.030)
VXO	-0.016****	-6.53E	0.004	-0.021***	-0.021***	-0.001	0.005	-0.024***
	(0.006)	(0.002)	(0.003)	(0.004)	(0.005)	(0.002)	(0.003)	(0.004)
SMC	0.019**	-0.003	0.021***	0.000	0.026***	-0.001	0.021***	0.004
	(0.009)	(0.002)	(0.005)	(0.004)	(0.009)	(0.002)	(0.005)	(0.004)
GS	-0.038	-0.013	-0.001	-0.029	-0.042	-0.008	0.002	-0.047
	(0.039)	(0.013)	(0.025)	(0.027)	(0.041)	(0.012)	(0.025)	(0.028)
IND	-0.017	-0.002	0.001*	-0.020***	-0.009	-0.001	0.002	-0.016**
	(0.011)	(0.002)	(0.006)	(0.007)	(0.014)	(0.002)	(0.007)	(0.006)
AdjR^2	0.515	0.170	0.317	0.569	0.561	0.309	0.321	0.620

HAC (Newey-West) standard errors in parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

All variables except for CC, LIQ and IR were winsorized at the 1% level.

Pull factors seem to explain better the levels of capital flows and their different components in Mexico, whereas in Brazil push factors seem to be more relevant. For Mexico, the two important push factors are global risk and global growth, and all of the pull factors are significant in determining the types of flows, with the exception of country indebtedness. For Brazil, the pertinent push factors are financial integration and capital account restrictiveness, and the most important pull factors are the global interest rate and global risk. The different explanatory variables have the same sign in both countries, whenever relevant, but it can also be noted how the different components of capital flows respond in different ways to each of the variables. In particular, the determinants of foreign direct investment (net and liabilities) often have a different sign compared to the other components. For example, for Mexico, global growth has a negative effect on the levels of all flows with the exception of foreign direct investment. This might indicate that as there are better global growth prospects, investors are willing to invest a higher share in the international markets, since portfolio and foreign direct investment represent the same type of securities with the only difference on the proportion of total stocks acquired. The same can be observed with respect to global risk, as risk increases, the flows of other investments and financial derivatives are lower but foreign direct investment is higher. This represents a shift in the type of securities that investor are willing to acquire since the category of financial derivatives include options and forward types of contract, which have more inherent risk than other types of securities included in portfolio and foreign direct investment. This findings are consistent with the theoretical model, where an increase in risk (variance of the return of the asset or risk aversion coefficient) reduce market depth (more traders with foreign direct investment stocks than portfolio stocks).

Perhaps, the most important change in sign for Mexico is the impact of domestic growth on the different components of flows, as the economy grows, all flows increase except for foreign direct investment. The reduction on foreign direct investment can be explained again by a shift in the type and proportion of securities investors are willing to

purchase: as the economy grows, investors might be more inclined to diversify and choose other options than acquiring a higher proportion of just one type of security. The same can be observed with respect to the measure of financial integration, where an increase in the stock market capitalization increases the level of all flows except for foreign direct investment. These changes in signs highlight the importance of differentiating between each different type of flows, since factors that attract certain type of investment can repel at the same time other types.

The innovating fact from the results is that the measure of capital account restrictiveness for both countries has a significant value for most of the components and their sign are consistent with the model previously presented. As capital account restrictiveness increases, gross and net flows are reduced. However, the reaction of the components is different. Foreign direct investment has a positive relation with controls, whereas portfolio investment and financial derivatives have a negative relationship. The analysis shows that as capital controls increase investors change the composition of their portfolios and trade assets that require a larger share of participation. To show the benefits of using the measure of capital account restrictiveness introduced in the previous chapter, the table below shows the results of the OLS regressions with the type of flows as dependent variable and the push and pull factors as independent variables, but substituting the QMCAR for other indices of capital controls. Only the coefficients for capital controls is shown.

The table show the coefficients corresponding to the different indices of capital account restrictiveness.[4]

[4]The dependent variable is the different types of flows and the independent variables are the push and pull factors. The data is from the IMF's IFS and BPS. The period covered depends on the public availability of the different indices, which is presented in Table 1. *** is significant at the 1% level, ** is significant at the 5% level and * is significant at the 10% level. NI is net inflows, DI is direct investment, PI is portfolio investment, OI is other investment and financial derivatives, GI is gross inflows, DIL is direct investment liabilities, PIL is portfolio investment liabilities, OIL is other investment and finacial derivatives liabilities. QMCAR is the measure presented in the previous chapter, Miniane corresponds to the index in Miniane [2004], Quinn corresponds to Quinn and Toyoda [2008], Chinn-Ito corresponds to Chinn and Ito [2013], EW corresponds to Edison and Warnock [2003], Lane corresponds to Lane and Milesi-Ferretti [2007] and Schindler corresponds to Schindler [2009]. Standard errors in parenthesis.

Table 4.3: Comparison with other Indices (Mexico)

Index	QMCAR	Miniane	Quinn	Chinn-Ito	EW	Lane	Schindler
NI	-0.457***	-25.20**	0.013	0.105	-0.433	-0.274	-2.896
	(0.159)	(10.70)	(0.025)	(0.147)	(1.323)	(0.568)	(2.182)
DI	-0.082**	-0.406	0.000	0.034	0.186	0.173	-0.357
	(0.039)	(2.067)	(0.006)	(0.038)	(0.416)	(0.145)	(0.831)
PI	-0.0048	-30.96***	-0.036**	-0.053	2.315*	-0.551	-4.340**
	(0.097)	(8.083)	(0.017)	(0.118)	(1.330)	(0.423)	(1.980)
OI	-0.280*	6.168	0.050**	0.123	-2.946***	0.103	1.801
	(0.148)	(9.821)	(0.022)	(0.134)	(1.069)	(0.531)	(1.779)
GI	-0.439***	-18.71	0.032	0.208	-2.658*	-0.828	-3.169
	(0.162)	(11.27)	(0.027)	(0.161)	(1.563)	(0.638)	(2.613)
DIL	-0.086**	-0.406	-0.001	0.028	0.148	0.096	-0.101
	(0.038)	(2.067)	(0.006)	(0.038)	(0.473)	(0.152)	(0.957)
PIL	-0.054	-25.14***	-0.027*	-0.090	-0.029	-0.889**	-3.410*
	(0.102)	(7.231)	(0.015)	(0.090)	(1.163)	(0.352)	(2.015)
OIL	-0.299**	6.833	0.061***	0.270**	-2.777***	-0.035	0.342
	(0.131)	(8.271)	(0.021)	(0.127)	(0.868)	(0.517)	(1.022)

Table 4.4: Comparison with other Indices (Brazil)

Index	QMCAR	Miniane	Quinn	Chinn-Ito	EW	Lane	Schindler
NI	-0.738*** (0.177)	2.511 (3.209)	0.089** (0.042)	-1.087*** (0.200)	-4.189** (1.689)	0.685** (0.291)	1.753** (0.829)
DI	0.000 (0.051)	-5.739*** (0.556)	-0.003 (0.012)	-0.058 (0.077)	-1.258** (0.485)	-0.491*** (0.092)	1.671*** (0.282)
PI	-0.200*** (0.096)	1.940 (1.631)	0.045** (0.022)	-0.631*** (0.109)	-1.857* (1.010)	0.479*** (0.149)	0.254 (0.679)
OI	-0.530*** (0.122)	6.017** (2.380)	0.043 (0.032)	-0.315** (0.159)	-0.728 (1.285)	0.657*** (0.205)	-0.172 (0.611)
GI	-0.758*** (0.167)	3.315 (3.169)	0.085** (0.041)	-1.075*** (0.204)	-3.041* (1.677)	0.743** (0.291)	2.157*** (0.774)
DIL	-0.049 (0.052)	-5.942*** (0.570)	-0.002 (0.012)	0.044 (0.068)	-1.196** (0.492)	-0.472*** (0.076)	1.556*** (0.342)
PIL	-0.212** (0.098)	2.011 (1.602)	0.048** (0.022)	-0.645*** (0.109)	-1.788* (1.005)	0.485*** (0.149)	0.296 (0.656)
OIL	-0.480*** (0.099)	6.607*** (2.100)	0.031 (0.029)	-0.297** (0.145)	0.693 (1.032)	0.643*** (0.186)	0.304 (0.556)

For Mexico, the QMCAR does a better job at explaining the impact of capital controls on the levels and composition of capital flows when compared with the other indices. The only type of flow that has a significant relation with the other indices and not with the QMCAR is portfolio investment, both net and liabilities. Edison and Warnock index also has a significant relationship with gross inflows and other investment and financial derivatives. Whenever the signs of the coefficients of the other indices are significant, they are consistent with the sign of the QMCAR, except for Quinn's index which should have an opposite sign since his measure is of financial openness. For Brazil, the coefficients of the different indices are significant, but in most cases their signs are opposite to economic intuition[5], except for Quinn's index. In this case, Quinn's index shows a positive relationship between financial openness and the different types of flows. However, it is not significant in explaining the impact of controls on other investment and financial derivatives, whereas the relationship can be explained using the QMCAR.

4.4 Episodes of Extreme Dynamics of Capital Flows

One of the major risks from capital flows are when their fluctuations are extreme. For example, when there is a sharp increase in inflows and the economy does not have a strong financial structure that can handle these flows, or when flows suddenly reverse and reduce the funding capacity of the economy. To further stress the different results that can be obtained with a measure that's both quarterly and intensive, in this sections I estimate a binary choice model that relates capital controls to the probability of extreme events of flows. The definition of each episode is based on Forbes and Warnock [2012a], here on FW; however, the analysis focuses on net and gross inflows and their composition[6].

[5]Chinn and Ito's index is a measure of capital account openness and therefore should have a positive sign, however, the results show a negative sign.

[6]Forbes and Warnock [2012a] analyze the episodes for gross inflows and gross outflows, and in Forbes and in Forbes and Warnock [2012b] they extend their analysis to consider debt and equity flows in each of the two categories.

FW calculate four quarter moving sums of flows and obtain the annual change in flows. Their trend is represented by a five year moving average of the change in flows, and their episodes defined by whether the change goes above or below the five year rolling standard deviation of the average. In particular, an episode starts when flows increase (decrease) one standard deviation above (below) the mean, and ends when flows decrease (increase) below (above) the one standard deviation line; moreover, for at least one quarter, flows have to increase (decrease) more than two standard deviations.

Instead of constructing the trend using annual changes, I will use the unobservable components method. This method involves decomposing a time series into trend, seasonal, cycle and irregular components, where every component is modeled as a stochastic process that evolves over time. To calculate gaps for capital flows, the analysis focus on the trend and cycle components[7]. The trend component represents the development of the time series in the long term and the cycle component describes the dynamic features of the data. The unobserved components method applies as statistical treatment the Kalman filter and its related methods, given that the technique involves the representation of the equation in state space form. I employ maximum likelihood methods to estimate the parameters, and then use the Kalmar filter to evaluate the likelihood. Once the parameters have been estimated, the unobserved components can be recovered from the observed data and the estimated parameters. The specification of the state equations for each type of flows is as follows:

$$\begin{aligned} f_t &= \tau_t + \gamma_t \\ \tau_t &= \tau_{t-1} + \varepsilon_t^{\tau} \\ \gamma_t &= \alpha_1 \gamma_{t-1} + \alpha_2 \gamma_{t-2} + \varepsilon_t^{\gamma} \end{aligned}$$

where f_t represents each of the categories of capital flows (net, gross and their components), τ_t represent the trend component, γ_t represents the cycle component, and ε_t^{τ} and

[7] As flows are expressed as percentage of GDP there is no seasonal component.

ε_t^{γ} represent the shocks to the trend and cycle, respectively. The trend is modeled as a random walk process, where ε_t^{τ} has a normally independent distribution with zero mean and variance σ_{τ}^2. The initial trend τ_1 is left as an unknown to be estimated together with the variance of the shock. The cycle is modeled as an order 2 autoregresive process, where ε_t^{γ} is a normally independently distributed series with zero mean and variance σ_{τ}^2. In state space form, the signal and state equations are:

$$f_t = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \tau_t \\ \gamma_t \end{bmatrix}$$

$$\begin{bmatrix} \tau_t \\ \gamma_t \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \alpha_1 & 0 \\ 0 & 0 & \alpha_2 \end{bmatrix} \begin{bmatrix} \tau_{t-1} \\ \gamma_{t-1} \\ \gamma_{t-2} \end{bmatrix} + \begin{bmatrix} \varepsilon_t^{\tau} \\ \varepsilon_t^{\gamma} \end{bmatrix}$$

The system of differential equations is solved using the Kalman filter and then each of the series is separated into its two unknown components, both subject to stochastic perturbances. For net (gross) inflows and its components, a sudden increase (surge) episode will start when flows reach a level higher than one standard deviation above its trend and will end when flows reach a level below one standard deviation above its trend. As in FW, to be classified as an episode, flows have to reach a level higher than two standard deviations above its trend for at least one quarter. The definition for a sudden decrease (stop) in net (gross) flows is similar, but in that case flows have to be lower than one standard deviation below its trend. The graphs below shows the evolution of net inflows for Mexico and Brazil, its corresponding gap calculated using the Kalman filter and the episodes of sudden increase and sudden decrease in flows[8].

[8]Flows are expressed as percentage of GDP. The pointed line corresponds to one standard deviation above and below the trend. The dotted line corresponds to two standard deviations above and below the trend. Sudden increase and surge episodes are highlighted in green, and sudden decrease and stop episodes are highlighted in red.

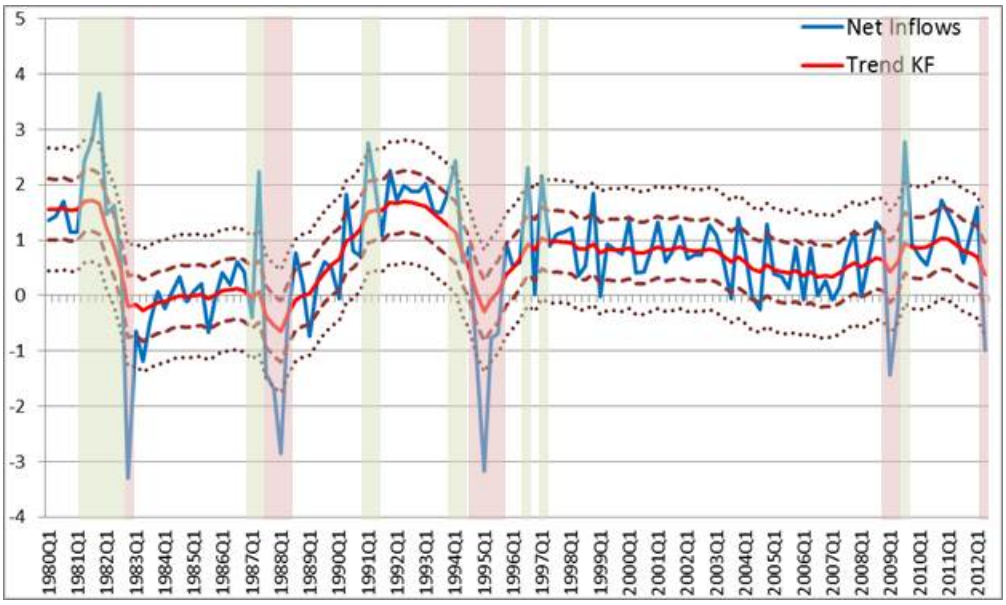


Figure 4.3: Net Flows and Kalman Filter Trend for Mexico

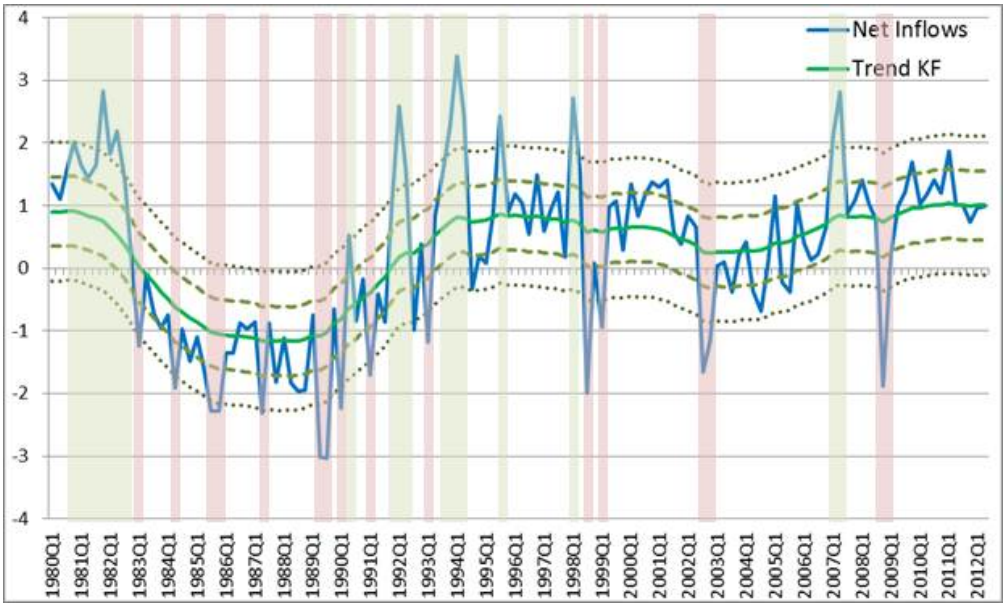


Figure 4.4: Net Flows and Kalman Filter Trend for Brazil

Using the definition of extreme episodes of capital flow movements, the tables below show the quarters where each of the episodes was observed for each type of flow.

Table 4.5: Episodes of Sudden Increase and Sudden Decrease

Country	Mexico		Brazil	
Event	Sudden Increase	Sudden Decrease	Sudden Increase	Sudden Decrease
NI M: 29,11 B: 25,16	1981Q2-1982Q2 1986Q3-1986Q4 1991Q1-1991Q2 1993Q4-1994Q1 2009Q3	1982Q4 1987Q3-1988Q1 1994Q4-1995Q3 2009Q1-2009Q2 2012Q2	1980Q1-1982Q3 1990Q2 1991Q4-1992Q2 1993Q2-1994Q2 1995Q3 1998Q1-1998Q2 2007Q1-2007Q2	1983Q1 1984Q2 1985Q2-1985Q4 1987Q2 1989Q2-1989Q3 1990Q1 1991Q1 1993Q1 1998Q3 1999Q1 2002Q3-2002Q4 2008Q4
DI M: 12, 9 B: 28, 32	1986Q4 1987Q4 1995Q1-1995Q2 1997Q3 2001Q3 2003Q4-2004Q1 2007Q1 2007Q4-2008Q1 2008Q4	1993Q2-1993Q3 2000Q3 2003Q3 2004Q2-2004Q3 2006Q3-2006Q4 2012Q2	1982Q3 1988Q2-1988Q4 1992Q1 1998Q3-2000Q4 2001Q2-2001Q4 2002Q4 2004Q4 2007Q1-2007Q2 2008Q4 2009Q4 2010Q3-2011Q1 2012Q1	1986Q1-1987Q1 1989Q3-1990Q3 1994Q3-1995Q4 1996Q3 2002Q3 2003Q1-2003Q2 2004Q1-2004Q3 2006Q1-2006Q4 2007Q4-2008Q2 2010Q1-2010Q2
PI M: 14,16 B: 28,16	1992Q3-1994Q1 1996Q2-1996Q3 1997Q2 2007Q3 2008Q3-2008Q4 2012Q1	1994Q4-1995Q3 1997Q3-1997Q4 1998Q2-1998Q3 2006Q3 2007Q1-2007Q2 2007Q4-2008Q2 2009Q1-2009Q2	1982Q2-1982Q3 1992Q1-1992Q2 1993Q2 1993Q4-1994Q2 1995Q3 1996Q4 1998Q1-1998Q2 1999Q2 1999Q4-2000Q1 2002Q1 2003Q1-2003Q2 2005Q1 2006Q1 2007Q1-2007Q4 2009Q3-2009Q4	1992Q3-1993Q1 1994Q3-1995Q1 1997Q4 1998Q3 1999Q1 2001Q4 2002Q3-2002Q4 2004Q2 2006Q2 2008Q4-2009Q1
OI M: 16,12 B: 28,21	1981Q2-1982Q2 1986Q3-1986Q4 1991Q1 1994Q1 1997Q3 2007Q4 2008Q2 2009Q3 2010Q4 2011Q2 2011Q4	1982Q4-1983Q2 1987Q3-1988Q1 1997Q2 1999Q1 2007Q3 2008Q3-2008Q4 2011Q3	1980Q3-1982Q3 1990Q2 1991Q4-1992Q1 1995Q1-1996Q1 1997Q4-1998Q1 2004Q2 2005Q4 2006Q2 2006Q4-2008Q1	1983Q1 1984Q2 1985Q2-1985Q4 1987Q2 1988Q2-1988Q4 1989Q2-1989Q3 1990Q1 1991Q1 1993Q1 1994Q2 1998Q3-1998Q4 1999Q4 2002Q3-2002Q4 2008Q4

Table 4.6: Episodes of Surges and Stops

Country	Mexico		Brazil	
Event	Surge	Stop	Surge	Stop
GI M: 33,33 B: 32,23	1981Q2-1982Q2 1986Q4 1987Q2 1990Q1 1990Q3 1991Q1-1991Q2 1991Q4-1992Q1 1992Q3-1993Q2 1993Q4-1994Q1 1995Q4 1996Q3 1997Q2 1998Q4 2001Q3 2005Q1 2006Q2 2007Q1 2008Q1 2009Q3 2010Q1-2010Q2 2010Q4-2011Q1	1982Q3-1983Q3 1986Q1 1987Q1 1987Q3-1988Q2 1989Q1-1989Q2 1992Q2 1994Q4-1995Q3 1997Q3-1997Q4 1998Q3 2000Q3-2000Q4 2002Q2 2003Q3 2004Q2 2006Q3-2006Q4 2008Q3-2009Q2 2011Q3	1980Q1-1982Q3 1991Q4-1992Q2 1993Q3-1994Q2 1995Q3 1998Q1-1998Q2 2000Q3-2001Q3 2006Q4-2007Q2 2010Q2-2010Q4	1983Q1-1983Q4 1985Q1-1985Q4 1986Q2 1989Q2-1990Q1 1993Q1 1997Q4 1998Q3-1999Q1 2002Q3-2002Q4 2003Q3 2008Q4-2009Q1
DIL M: 8, 18 B: 20, 32	1986Q4 1987Q4 1995Q1-1995Q2 1997Q3 2001Q3 2004Q1 2007Q1	1982Q4 1985Q4-1986Q1 1993Q2-1993Q3 2000Q3 2001Q1-2001Q2 2001Q4-2002Q1 2003Q1 2003Q3 2004Q2-2004Q3 2006Q3-2006Q4 2009Q3-2009Q4	1988Q2-1988Q4 1998Q3-1999Q1 1999Q3-2000Q4 2001Q3-2001Q4 2004Q3 2007Q1-2007Q2 2008Q3-2008Q4 2010Q4	1986Q1-1987Q1 1989Q3-1990Q3 1994Q3-1995Q4 1996Q3 2003Q1-2003Q3 2005Q3-2006Q3 2009Q1-2010Q2
PIL M: 12,18 B: 28,19	1991Q1-1991Q2 1993Q3-1994Q1 1996Q2-1996Q3 1997Q2 2004Q3-2005Q1 2012Q1	1994Q4-1995Q3 1997Q3-1997Q4 1998Q2-1998Q3 2000Q2-2000Q4 2002Q2-2002Q3 2003Q2-2003Q3 2008Q3-2009Q1	1982Q3 1992Q1-1992Q2 1993Q2 1993Q4-1994Q2 1995Q3 1996Q4 1998Q1-1998Q2 1999Q2 1999Q4-2000Q1 2001Q3 2002Q1 2003Q1-2003Q2 2005Q1 2006Q4-2007Q4 2010Q3-2010Q4	1992Q3-1993Q1 1994Q3-1995Q1 1997Q4 1998Q3 1999Q1 1999Q3 2001Q2 2001Q4 2002Q2-2002Q4 2004Q2 2006Q2 2008Q4-2009Q1
OIL M: 19,25 B: 24,27	1981Q2-1982Q2 1990Q1-1990Q3 1991Q1-1991Q2 1991Q4-1992Q1 2005Q4 2006Q2 2007Q1 2008Q1 2009Q3 2010Q2 2010Q4	1982Q3-1983Q2 1985Q2-1985Q3 1986Q1-1986Q2 1987Q3-1988Q2 1992Q2-1992Q3 1995Q1-1995Q2 1999Q1-1999Q2 2008Q2-2009Q2	1980Q1-1982Q3 1990Q2 1991Q4-1992Q1 1993Q4-1994Q1 1995Q1-1995Q4 1998Q1 2006Q4-2007Q2	1985Q1-1985Q4 1987Q2-1989Q3 1993Q1-1993Q2 1994Q2 1998Q3-1999Q4 2002Q3-2002Q4 2008Q4-2009Q1

An episode of sudden increase or surge starts when flows increase one standard deviation above their trend and stops when flows fall below one standard devation above its trend. In order to be considered an episode, at least for one quarter flows have to increase two standard deviations above their trend. Episodes of sudden decrease or stop are defined accordingly.The period covered is from 1980Q1 to 2012Q2. Variables are defined in the previous section. NI is net inflows, DI is direct investment, PI is portfolio investment, OI is other investment and financial derivatives, GI is gross inflows, DIL is direct investment liabilities, PIL is portfolio investment liabilities, OIL is other investment and finacial derivatives liabilities.

On average for both countries both types of episodes last two or three quarters. Not all episodes happen at the same time for all type of flows. An increase or reduction in total flows can be explained by episodes in one of the components, or, in some cases, there are no episodes in the components but there is still an episode in total flows. The longest episodes of sudden increases or surges for Mexico last for 5 quarters and they correspond to gross inflows from the third quarter of 1982 to the third quarter of 1983, and for other investment from the second quarter of 2008 to the second quarter of 2009. For episodes of sudden decreases or stops, the longest episode is of 7 quarters and corresponds to portfolio investment from the third quarter of 1992 to the first quarter of 1994. The majority of flows experienced episodes of sudden increase or surge before each of the major crises that affected Mexico: the 1982 debt crisis, the 1994 Mexican crisis and the 2008 financial crisis. Also, most flows show episodes of sudden decrease or stops during the periods corresponding to those three crises.

For Brazil, the longest episode of sudden stop spans 10 quarters an correspond to other investment and financial derivatives liabilities during the period of hyperinflation and economic recession from the second quarter of 1987 to the third quarter of 1989. Also, there was an episode of sudden stop in direct investment liabilities that lasted 7 quarters during the Mexican crisis from the third quarter of 1994 to the first quarter of

1996. The longest sudden increase or surge in flows occurred previous to the 1980's debt crisis for net inflows, gross inflows, and other investment and financial derivatives liabilities, and it lasted 11 quarters starting on the first quarter of 1980. The second longest sudden increase occurred previous to the Asian crisis for direct investment and it lasted 10 quarters from the third quarter to 1998 to the fourth quarter of 2000. Most flows experienced an episode of sudden decrease or stop in 1989, 1999, 2002 and 2008 as a result of the stock market crash, the Asian crisis, the Argentinian crisis and the recent financial crisis respectively. Finally most flows in Brazil show episodes of sudden increase or surge before the 1980's debt crisis, during 1992 after the stock market was liberalized, in 1994 before the Mexican crisis and in 2007 before the recent financial crisis.

The episodes will represent the dependant variable in our model to estimate what are the determinants of the probability that each event occurs.The model is based on FW and is determined by:

$$P(e_{it} = 1) = F(\beta_1 \phi_t + \beta_2 \gamma_{i,t})$$

where e_{it} is a dummy variable representing whether country i experienced an episode in quarter t, ϕ_t is the vector of push factors, common for both countries, and $\gamma_{i,t}$ is a vector of pull factors, specific to each country. The methodology to estimate the equation is determined by the cumulative distribution function $F(.)$. Since these are episodes of extreme dynamics of flows, most of the observations are zero and therefore the distribution is asymmetric. Therefore, as in FW, the complementary logarithmic (or cloglog) framework is used, which assumes that the corresponding cumulative distribution function is the extreme value distribution:

$$F(z) = 1 - \exp(-\exp(z))$$

As in the previous OLS regression, push factors include global liquidity, global interest rate, global growth and global risk, and pull factors include trade openness, financial

integration, domestic growth shock, country indebtedness and a measure of capital controls. Moreover, these regressions include as independent variable the measure of capital controls of the other country to determine the effects of capital flow management policies on the flows of the other country.

As in any binary outcome model, the interpretation of the coefficients is not straight forward. For the case of the cloglog regression, the relevant values to analyze the magnitude of the impact of the independent variables on the probability of an episode are the exponentiated coefficients. These coefficients correspond to the hazard ratio, which is the probability of a positive outcome compared to the probability of no positive outcome, and show the marginal effects. The tables below show the results of the cloglog regressions for each type of flows for the two countries. The tables report the exponentiated coefficients, the standard errors in parenthesis and the sign of the original coefficients.

The dependent variable is a binary variable indicating if there is an episode and the independent variables are the push and pull factors. The data is from the IMF's IFS and BPS. The period covered is from 1980Q1 to 2012Q2. *** is significant at the 1% level, ** is significant at the 5% level and * is significant at the 10% level. Variables are defined in section 4.2. NI is net inflows, DI is direct investment, PI is portfolio investment, OI is other investment and financial derivatives, GI is gross inflows, DIL is direct investment liabilities, PIL is portfolio investment liabilities, OIL is other investment and finacial derivatives liabilities. LIQ is global liquidity, IR is global interest rate, GG is global growth, VXO is global risk, SMC is financial integration, CCM is capital account restrictiveness for Mexico and CCB is capital account restrictiveness for Brazil, GS is domestic growth shock, IND is country indebtedness and TO is trade openness. Standard errors in parenthesis. The coefficients reported are the exponentiated coefficients corresponding to the hazard ratio. The sign of the original coefficient is shown below the standard deviation.

Table 4.7: Results of Cloglog Regression: Mexico

Var	NI		DI		PI		OI	
Event	S. Inc	S. Dec	S. Inc	S. Dec	S. Inc	S. Dec	S. Inc	S. Dec
TO	1.226	1.858*	1.231	0.769	1.168	1.922**	0.895	1.599*
	(0.249)	(0.602)	(0.320)	(0.295)	(0.486)	(0.562)	(0.240)	(0.428)
	+	+	+	−	+	+	−	+
IND	1.049	1.078	1.011	1.000	0.759**	0.678***	1.099**	0.954
	(0.033)	(0.059)	(0.056)	(0.099)	(0.085)	(0.091)	(0.043)	(0.052)
	+	+	+	+	−	−	+	−
GS	1.383***	0.495***	0.868	1.311	1.986*	0.611**	1.276*	0.976
	(0.147)	(0.108)	(0.098)	(0.369)	(0.737)	(0.131)	(0.175)	(0.160)
	+	−	−	+	+	−	+	−
CCM	0.636	6.992*	0.342	0.128	0.063	0.048	0.322*	6.757**
	(0.305)	(8.248)	(0.342)	(0.203)	(0.122)	(0.098)	(0.217)	(5.460)
	−	+	−	−	−	−	−	+
SMC	0.990	1.441**	1.075	0.964	1.164**	1.334***	1.040	1.171**
	(0.028)	(0.269)	(0.055)	(0.044)	(0.077)	(0.103)	(0.039)	(0.085)
	−	+	+	−	+	+	+	+
VXO	0.947*	1.160**	1.089**	0.864**	0.952	1.004	0.969*	1.251***
	(0.030)	(0.083)	(0.043)	(0.068)	(0.055)	(0.048)	(0.017)	(0.107)
	−	+	+	−	−	+	−	+
GG	0.563***	1.056	1.068	0.640	0.151***	0.433*	0.689	1.250
	(0.103)	(0.225)	(0.230)	(0.355)	(0.106)	(0.194)	(0.163)	(0.267)
	−	+	+	−	−	−	−	+
LIQ	1.152***	0.761**	1.207***	1.017	0.956	1.081	1.083*	1.056
	(0.045)	(0.105)	(0.082)	(0.075)	(0.089)	(0.090)	(0.052)	(0.057)
	+	−	+	+	−	+	+	+
IR	2.012**	0.227*	0.882	0.718	3.150*	0.149**	1.651	1.824
	(0.590)	(0.179)	(0.529)	(0.544)	(2.169)	(0.140)	(0.558)	(1.026)
	+	−	−	−	+	−	+	+
CCB	0.362*	41.60***	2.718	1.385	2.879	164.3***	0.464	0.861
	(0.197)	(58.25)	(2.190)	(1.593)	(3.086)	(240.0)	(0.311)	(0.659)
	−	+	+	+	+	+	−	−

Table 4.8: Results of Cloglog Regression: Mexico

Var	GI		DIL		PIL		OIL	
Event	Surge	Stop	Surge	Stop	Surge	Stop	Surge	Stop
TO	0.773*	1.318**	0.848	0.645	0.854	2.118***	0.853	0.802
	(0.113)	(0.175)	(0.345)	(0.183)	(0.199)	(0.585)	(0.164)	(0.156)
	−	+	−	−	−	+	+	−
IND	1.063**	0.987	1.253**	1.016	1.064	0.826**	1.062**	0.982
	(0.029)	(0.023)	(0.141)	(0.039)	(0.061)	(0.073)	(0.032)	(0.028)
	+	−	+	+	+	−	+	−
GS	1.175*	0.828***	0.881	0.839	1.480*	0.827	1.198*	0.815**
	(0.104)	(0.054)	(0.131)	(0.091)	(0.323)	(0.097)	(0.126)	(0.067)
	+	−	−	−	+	−	+	−
CCM	0.322**	1.832*	0.006**	0.869	0.068**	1.410	0.421*	1.987*
	(0.148)	(0.645)	(0.014)	(0.481)	(0.084)	(1.356)	(0.201)	(0.749)
	−	+	−	−	−	+	−	+
SMC	1.030	1.021	1.022	0.923**	1.002	0.988	0.990	1.603*
	(0.023)	(0.032)	(0.060)	(0.034)	(0.038)	(0.048)	(0.028)	(0.036)
	+	+	+	−	+	−	−	+
VXO	0.957	1.065**	0.908*	0.935*	0.861**	1.102*	0.975*	1.127***
	(0.035)	(0.033)	(0.051)	(0.037)	(0.064)	(0.058)	(0.039)	(0.047)
	−	+	−	−	−	+	−	+
GG	0.783	1.019	1.087	1.134	0.569	0.928	0.940	1.106
	(0.132)	(0.110)	(0.371)	(0.228)	(0.247)	(0.254)	(0.174)	(0.133)
	−	+	+	+	−	−	−	+
LIQ	0.991	0.980	1.058	1.003	0.998	1.022	0.990	1.045
	(0.032)	(0.034)	(0.084)	(0.043)	(0.061)	(0.053)	(0.037)	(0.039)
	−	−	+	+	−	+	+	+
IR	1.627**	0.801	0.307	1.020	0.952	1.211	1.983**	1.324
	(0.357)	(0.202)	(0.265)	(0.336)	(0.417)	(0.668)	(0.559)	(0.375)
	+	−	−	+	−	+	+	+
CCB	0.546	2.052*	13.94**	0.165**	2.635	3.644**	0.339*	0.056
	(0.262)	(0.806)	(16.10)	(0.143)	(2.047)	(2.370)	(0.202)	(0.310)
	−	+	+	−	+	+	−	−

Table 4.9: Results of Cloglog Regression: Brazil

Var	NI		DI		PI		OI	
Event	S. Inc	S. Dec	S. Inc	S. Dec	S. Inc	S. Dec	S. Inc	S. Dec
TO	0.563^{*} (0.257) −	1.874^{**} (0.490) +	1.010 (0.206) +	0.582^{***} (0.106) −	0.712^{**} (0.136) −	1.833^{*} (0.609) +	0.390^{*} (0.192) −	1.803^{***} (0.366) +
IND	1.064 (0.038) +	0.997 (0.022) −	1.027 (0.032) +	1.066^{***} (0.025) +	1.057^{**} (0.033) +	0.927 (0.065) −	1.096 (0.109) +	1.006 (0.021) +
GS	0.764 (0.117) −	1.314^{**} (0.163) +	0.818 (0.109) −	1.404^{**} (0.205) +	0.850 (0.116) −	0.923 (0.186) −	0.750 (0.179) −	1.188 (0.151) +
CCB	1.503 (0.578) +	0.214 (0.203) −	0.132^{**} (0.124) −	5.316^{*} (4.585) +	1.433 (0.765) +	9.065^{**} (8.719) +	1.507 (1.300) +	0.407 (0.239) −
SMC	1.115^{***} (0.019) +	0.904^{***} (0.032) −	1.000 (0.016) +	1.003 (0.014) +	1.041^{**} (0.017) +	0.987 (0.027) −	1.060^{**} (0.029) +	0.930^{**} (0.028) −
VXO	0.764^{**} (0.046) −	1.067^{***} (0.023) +	1.076^{***} (0.028) +	0.928^{**} (0.033) −	0.922^{**} (0.038) −	1.068^{*} (0.038) +	0.861^{***} (0.040) −	1.043^{**} (0.0.20) +
GG	0.808 (0.156) −	0.818 (0.126) −	1.671^{***} (0.261) +	0.936 (0.143) −	0.840 (0.163) −	0.725 (0.195) −	2.179^{*} (0.914) +	0.984 (0.120) −
LIQ	0.868^{*} (0.041) −	0.955 (0.048) −	0.959 (0.037) −	1.179^{***} (0.046) +	1.032 (0.038) +	0.975 (0.055) −	1.152^{**} (0.068) +	0.969 (0.046) −
IR	5.643^{***} (0.600) +	0.864 (0.192) −	1.148 (0.330) +	1.155 (0.257) +	1.736^{*} (0.499) +	0.406 (0.226) −	5.253^{***} (2.875) +	1.005^{*} (0.267) +
CCM	0.121^{***} (0.105) −	5.160^{**} (4..141) +	2.722 (1.719) +	0.156^{**} (0.123) −	0.277^{***} (0.128) −	0.098^{***} (0.077) −	0.019^{***} (0.020) −	1.983 (0.735) +

Table 4.10: Results of Cloglog Regression: Brazil

Var	GI		DIL		PIL		OIL	
Event	Surge	Stop	Surge	Stop	Surge	Stop	Surge	Stop
TO	1.306* (0.341) +	1.183 (0.192) +	1.153 (0.358) +	0.543*** (0.100) −	0.832 (0.163) −	1.679* (0.473) +	0.658 (0.266) −	1.561** (0.302) +
IND	0.999 (0.056) −	1.009 (0.020) +	0.983 (0.064) −	1.056*** (0.022) +	1.049 (0.035) +	0.959 (0.049) −	1.051 (0.086) +	0.989 (0.021) −
GS	1.402** (0.194) +	1.030 (0.100) +	0.908 (0.172) −	0.954 (0.104) −	0.959 (0.138) −	0.949 (0.163) −	0.807 (0.227) −	1.079 (0.119) +
CCM	0.180** (0.137) −	1.832** (0.532) +	0.127** (0.111) −	3.880** (2.437) +	2.303 (2.530) +	4.932* (4.075) +	5.470 (5.714) +	2.558** (1.388) +
SMC	1.005 (0.020) +	0.961* (0.022) −	0.964 (0.024) −	1.010 (0.016) +	1.034** (0.015) +	0.975 (0.026) −	1.055** (0.029) +	1.000 (0.023) +
VXO	0.928*** (0.020) −	1.027* (0.014) +	1.073** (0.037) +	0.915** (0.035) −	0.963* (0.021) −	1.057* (0.036) +	0.878** (0.045) −	1.239*** (0.078) +
GG	1.512 (0.477) +	0.704*** (0.089) −	2.137*** (0.607) +	0.653*** (0.106) −	1.140 (0.231) +	0.791 (0.184) −	1.481 (0.789) +	1.177 (0.204) +
LIQ	0.816*** (0.049) −	0.930* (0.039) −	0.976 (0.048) −	1.072** (0.034) +	1.019 (0.037) +	0.956 (0.048) −	1.115* (0.065) +	0.961 (0.035) −
IR	5.085*** (2.466) +	0.952 (0.190) −	1.537 (0.685) +	0.902 (0.181) −	1.632* (0.448) +	0.470 (0.228) −	2.752** (1.320) +	0.566** (0.192) −
CCB	0.081*** (0.053) −	3.548 (0.015) +	1.125 (6.88) +	0.495 (0.265) −	0.107** (0.094) −	0.155*** (0.099) −	0.021*** (0.024) −	1.213 (0.454) +

From the results in the tables, one major contrast between the two countries is in the determinants of the probability of an event in direct investment. For a sudden increase and surge in direct investment both countries have in common that the events seem to be idiosyncratic, since they have a small significance with the explanatory variables. The same is true for the probability of a sudden decrease and stop in direct investment for Mexico, but for Brazil, most variables are significant in explaining the probability of these types of events. Another difference is that while pull variables are the relevant factors in explaining surges and stops in gross inflows for Mexico, push factors are the ones that play an important role in the probability of a surge and stop in gross inflows for Brazil. However, a similarity between both countries is that pull factors seem to be more relevant in explaining the probability of a sudden increase in net inflows, and both types of variables are able to explain a sudden decrease in net inflows. For portfolio investment and other investment and financial derivatives, both types of variables are able to explain some amount of the probability of an event without much contrast between the two countries. These results point out that even though both countries share similar characteristics, investor perceive them in different ways and they are not indifferent between investing in either country.

Global risk is the only variable that almost always is significant in explaining the probability of an event for both countries. As in the previous results, an increase in risk is associated with a higher probability of a sudden decrease and stop, or a lower probability of a sudden increase or surge. This result holds for all types of flows expect for direct investment, where the sign is reversed[9]. As mentioned before, one explanation for this change in sign can be that as investors perceive a higher risk, they prefer to invest in safer types of securities in a larger proportion, and once risk is low, they prefer to change and diversify their portfolio to include other types of options. In contrast with the results from the OLS regressions from the previous section, global growth is not a significant variable

[9]The only exception is direct investment liabilities in Mexico, where the sign is preserved.

in explaining the probability of extreme dynamic of flows, only explaining three types of event for Mexico and five for Brazil. The results for Brazil are in line with economic theory, associating an increase in global growth with an increase in the probability of a sudden increase or surge and a reduction in the probability of a sudden decrease or stop. However, for Mexico, an increase in global growth is associated with a smaller probability of a sudden increase in net inflows and portfolio investment. Since the coefficients on gross inflows are not significant, these results suggest that as global growth increases, the acquisition of foreign assets by Mexican investors is higher, which would imply higher outflows and reduce net inflows.

For the other two remaining push factors, global liquidity and global interest rate, the results are similar from the OLS regressions, but depend on the type of flow and event. In general an increase in global liquidity and a higher global interest rate are associated with an increase in the probability of a sudden increase or surge and a reduction in the probability of a sudden decrease or stop. The exceptions are net and gross inflows in Brazil, where an increase in global liquidity reduces the probability of a sudden increase or surge. This result might be driven by the reduction in foreign direct investment, which from the OLS regression had a negative sign in global liquidity. Once again, the explanation can be that investors tend to diversify more their portfolio once there is more liquidity, while investing lower amounts in the respective stocks.

With respect to the pull variables, a higher country indebtedness is related with an increase in the probability of a sudden increase and surge, and a lower probability of a sudden decrease and stop, except for portfolio investment where the sign is reversed. Portfolio investment includes government bonds, and since a country indebtedness is measured as net public debt as a percentage of GDP, it is consistent that if a country has higher debt, the probability of a sudden increase or surge in portfolio investment is higher and the probability of a sudden decrease or stop is lower. For Brazil, financial integration is positively associated with an increase in the probability of a sudden increase and surge,

and a reduction in the probability of a negative event. However, for Mexico, the results are the opposite given that a higher stock market capitalization is related to an increase in the probability of a sudden decrease or stop. As in the results from the OLS regression, trade openness exhibits a contradictory sign with respect to economic intuition: a lower probability of a sudden increase or surge and a higher probability of a sudden decrease or stop is associated with higher trade openness. As mentioned before, these results might be related to the timing of trade liberalization in both countries, given that in that period capital flows were lower for reasons independent to trade liberalization and since then the index has not changed significantly.

The last two effects to analyze are the impact of capital flow management policies on the country's probability of an extreme event and the probability of an event happening in the other country. For the impact of capital controls in the country where they were implemented the results are less satisfactory than in the OLS regressions. Capital controls seem able to explain extreme dynamics of the liabilities side of flows. An increase in capital account restrictiveness is associated with an increase in the probability of a stop and a lower probability of a surge. However, for total inflows, capital controls are only related positively to sudden decreases in net inflows and other investment and financial derivatives in Mexico, and in direct and portfolio investment in Brazil. Sudden increases and capital controls are negatively related only for other investment and financial derivatives in Mexico and direct investment in Brazil. These results might suggest that capital controls only play an important role in the determination of extreme events of liabilities in flows and that the asset side of flows is not affected as much. Finally, for the effects of the implementation of capital flow management policies on the dynamic of flows in the other country, the results depend on the type of flow and on the country. Both countries have in common that an increase in capital account restrictiveness in the other country lowers the probability of a sudden increase and surge of flows and a higher probability of a sudden decrease in net inflows. For Mexico, this result is the same for portfolio inflows,

but is the opposite for Brazil. That is, the results suggest that as Brazil increases capital controls there is a higher probability of a sudden decrease and stop of portfolio inflows in Mexico, but if Mexico increases capital controls it is less likely that there will be a sudden decrease and stop of portfolio inflows in Brazil. Moreover, for both countries, an increase in capital account restrictiveness seems to reduce the probability of a sudden decrease and stop of direct investment. These last results are in line with the belief that as controls increase in one country, direct investment is redirected to a country with similar characteristics, or at least, that investors won't withdraw their investment in the other country. However, in general the results on sudden increases and surges point out that, even though the determinants of the dynamics of flows might be different for each country, investors tend to associate the imposition of capital controls in one country with an increase in the probability of implementation of controls in countries that are perceived as similar. This would mean that instead of considering investing in that similar economy, they would tend to find another market to place their investment.

To analyze whether the results on the effects of capital control on extreme dynamics of flows hold for other measures of financial openness, the table below show the results of the same cloglog regressions but using other indices of capital account restrictiveness.

The table show the coefficients corresponding to the different indices of capital account restrictiveness. The dependent variable is a binary variable indicating if there is an episode and the independent variables are the push and pull factors. The data is from the IMF's IFS and BPS. The period covered depends on the public availability of the different indices, which is presented in Table 1. *** is significant at the 1% level, ** is significant at the 5% level and * is significant at the 10% level. Variables are defined in the previous section. NI is net inflows, DI is direct investment, PI is portfolio investment, OI is other investment and financial derivatives, GI is gross inflows, DIL is direct investment liabilities, PIL is portfolio investment liabilities, OIL is other investment and finacial derivatives liabilities. QMCAR is the measure presented in the previous chapter, Chinn-

Table 4.11: Comparison with other Indices: Sudden Increase and Surge

Country	Mexico			Brazil		
Index	QMCAR	Chinn-Ito	Lane	QMCAR	Chinn-Ito	Lane
NI	0.636 (0.305) −	1.671 (0.642) +	1.489 (2.135) +	1.503 (0.578) +	1.334 (0.814) +	1.602 (1.323) +
DI	0.342 (0.342) −	2.084 (2.377) +	0.562 (2.605) −	0.132** (0.124) −	1.602 (0.524) +	0.102 (0.083) −
PI	0.063 (0.122) −	0.534 (0.688) −	0.000 (0.000) −	1.433 (0.765) +	0.656 (0.276) −	0.524 (0.401) −
OI	0.322* (0.217) −	3.353** (1.846) +	9.620 (19.97) +	1.507 (1.300) +	4.525* (3.948) +	13.92*** (13.74) +
GI	0.322** (0.148) −	1.117 (0.371) +	0.269 (0.324) −	0.180** (0.137) −	2.936 (2.167) +	0.433 (0.411) −
DIL	0.006** (0.014) −	1.251 (1.956) +	0.385 (1.838) −	0.127** (0.111) −	1.033 (0.662) +	0.115* (0.136) −
PIL	0.068** (0.084) −	0.272* (0.201) −	0.002** (0.007) −	2.303 (2.530) +	0.695 (0.368) −	0.422 (0.377) −
OIL	0.421* (0.201) −	1.228 (0.417) +	0.314 (0.438) −	5.470 (5.714) +	1.318 (1.163) +	61.37*** (77.68) +

Table 4.12: Comparison with other Indices: Sudden Decrease and Stop

Country	Mexico			Brazil		
Index	QMCAR	Chinn-Ito	Lane	QMCAR	Chinn-Ito	Lane
NI	6.992* (8.248) +	19.62** (27.42) +	197.0** (183.0) +	0.214 (0.203) −	2.552 (2.367) +	0.364 (0.307) −
DI	0.128 (0.203) −	0.056* (0.088) −	0.005 (0.022) −	5.316* (4.585) +	0.632 (0.331) −	37.38*** (44.58) +
PI	0.048 (0.098) −	96.15 (2534) +	3.825 (23.17) +	9.065** (8.719) +	0.169** (0.147) −	24.13** (36.58) +
OI	6.757** (5.460) +	2.948 (2.016) +	0.158 (0.554) −	0.407 (0.239) −	1.743 (1.338) +	0.821 (0.604) −
GI	1.832* (0.645) +	1.138 (0.466) +	4.747 (6.307) +	1.832** (0.532) +	4.967** (3.332) +	0.296* (0.196) −
DIL	0.869 (0.481) −	0.448 (0.221) −	0.842 (1.537) −	3.880** (2.437) +	0.203*** (0.120) −	19.37*** (19.81) +
PIL	1.410 (1.356) +	0.006*** (0.11) −	548.8*** (1326) +	4.932* (4.075) +	0.169** (0.147) −	24.13** (36.58) +
OIL	1.987* (0.749) +	0.843 (0.396) −	0.592 (0.910) −	2.558** (1.388) +	0.195** (0.868) −	4.153** (0.049) +

Ito corresponds to Chinn and Ito (2008), Lane corresponds to Lane and Milesi-Ferretti (2007). Only these two indices could be compared given that the other indices do not cover a long period of time. Standard errors in parenthesis. The coefficients reported are the exponentiated coefficients corresponding to the hazard ratio. The sign of the original coefficient is shown below the standard deviation.

For Mexico, the QMCAR performs better in explaining episodes of extreme dynamics of capital flows. The other indices are not able to explain episodes of any additional variable with the exception of stops in portfolio investment, where the sign is consistent with previous results. For Brazil,the two indices considered perform at least as good as the QMCAR, but the sign is inconsistent for stops in gross inflows. As mentioned before, the advantage of the QMCAR is that it is able to capture subtle changes in policies and therefore can be used as a strong measure of capital account restrictiveness.

4.5 Conclusions and Contributions

Due to the risks related to volatile waves of capital flows, policymakers have started to consider the use of capital flow management policies (IMF [2011], for International Settlements [2010]). These policies are intended to shield the economy against imbalances generated by extreme episodes of capital flows and to strengthen the financial system. The economic literature has not come to a consensus on the effectiveness and consequences of the use of capital controls. The theoretical literature has focused on the use of controls as policies that reduce foreign flows to correct pecuniary externalities in borrowing, or as alternative policy measures in models with nominal rigidities. This dissertation provides an alternate effect of capital controls by analyzing their effect on the ability of the market to sustain large order flows without a large change in price (market depth).

The model shows that the imposition of controls deters the entrance of investors and creates a more shallow market. During a period where traders of a risky asset are subject

to a liquidity shock, they reduce their stock holdings from deeper markets. However, the deeper market is able to sustain the bigger flight of capital, which translates into a smaller drop in prices.

The lack of evidence of the effect on capital controls on capital flows could be attributed to the shortfalls of the current measures of capital account restrictiveness. In particular, most measures have annual periodicity or binary measures. To provide evidence of the mechanism through which capital controls affect market depth, this paper introduced a new measure of capital controls (QMCAR) based on information from the IMF's *AREAER.*. This new measure is an intensity index with quarterly periodicity that can account for subtle changes in capital flow management policies. The QMCAR and additional push and pull factors were used to analyze the determinant of the levels and composition of capital flows in Mexico and Brazil. The results show that capital controls have an effect of changing the composition of trader's investment portfolios, leaning more towards foreign direct investment in countries that implemented controls. In terms of the theoretical model, these empirical results translate to a smaller number of traders in Brazil holding larger shares of the assets in a more shallow market than Mexico. Similar results were found when estimating a binary choice model that calculated the probability of extreme events in capital flows.

Both push and pull factors are important in determining the drivers of capital flows and their importance depends on the type of flow. Global risk was the variable that was significant for almost every type of episode for each of the components of capital flows. The QMCAR helped to bust the myth on the ineffectiveness of capital controls on the levels and extreme episodes of flows, at least for the two Latin America countries considered. As a quarterly measure, the QMCAR, performed better or at least as well as other prominent indices in the literature in explaining waves of flows. Moreover, the impact of the use of capital controls on a neighboring country was also considered. As in the case of the impact of capital controls on the country that implemented them, the results

depend on the type of flow. As one country implements capital controls, the probability of a sudden decrease or stop of foreign direct investment is lower, but the probability of a sudden increase or surge of the other type of flows is reduced. Finally, even though the two countries considered are perceived as similar, the effects of capital flow management policies and the determinants of capital flows were different. However, as one country imposes capital controls, the other country might suffer from the perception that they will also most likely implement capital controls.

It is important to mention that just as with the two econometric models presented in this paper, hidden relationship between capital controls and other macroeconomic variables could still be discovered. One important contribution of this dissertation is to carefully outline the construction of the QMCAR. As can be seen, the index is easily updated and not difficult to construct. I will make available the indices for Mexico and Brazil upon request and invite any economists who would like to contribute in constructing the QMCAR index for another country to contact me. As more countries are included, new evidence using the methodology from previous empirical papers can be found and help shed light on the impact of controls on flows.

If capital controls are intended to reduce price volatility for the potential hazards it generates in the financial system, the proposed model indicates that their implementation could be exacerbating that which they were intended to prevent. With the start of the process of monetary policy normalization of the advanced economies, this model predicts that economies (like Brazil) that previously introduced controls will observe a greater exchange rate volatility. In countries with balance sheet effects and debt denominated in foreign currency, sharp exchange rate depreciation can be detrimental to the stability of the financial system. If the objective is to have a stronger financial system and lower price volatility, unintended adverse second-round effects of capital controls indicate that they might not be the right policy choice.

As new and more effective measure of capital controls are introduced, economists will be better able to understand the impact of these policies on flows. In the end, each type of new policy should be tailored to the needs of the specific country, also considering the effects that it can have on economies perceived as similar.

4.6 Appendix: Capital Flows and the Definition of their Components

Financial Account- The financial account shows net acquisition and disposal of financial assets and liabilities and measures how net lending to or borrowing from nonresidents is financed. The financial account shows transactions in net terms, which are shown separately for financial assets and liabilities (i.e., net transactions in financial assets shows acquisition of assets less reduction in assets, not assets net of liabilities). Net inflows are equal to the negative value of the financial account, which implies that a positive value of net inflows means that the country is a net borrower, and a negative value means that the country is a net lender. Gross inflows correspond to the net transaction of financial liabilities, that is, acquisition of liabilities less reduction in liabilities.

Foreign Direct Investment-direct investment is a category of cross-border investment associated with a resident in one economy having control or a significant degree of influence on the management of an enterprise that is resident in another economy. As well as the equity that gives rise to control or influence, direct investment also includes investment associated with that relationship, including investment in indirectly influenced or controlled enterprises, investment in fellow enterprises, debt, and reverse investment. Control or influence may be achieved directly by owning equity that gives voting power in the enterprise, or indirectly by having voting power in another enterprise that has voting power in the enterprise. Immediate direct investment relationships arise when a direct investor directly owns equity that entitles it to 10 percent or more of the voting power in the direct investment enterprise. Control is determined to exist if the direct investor owns more than 50 percent of the voting power in the direct investment enterprise, and a significant degree of influence is determined to exist if the direct investor owns from 10 to 50 percent of the voting power in the direct investment enterprise.

Portfolio Investment- portfolio investment is defined as crossborder transactions and positions involving debt or equity securities, other than those included in direct investment or reserve assets. Reserve assets are those external assets that are readily available to and controlled by monetary authorities for meeting balance of payments financing needs, for intervention in exchange markets to affect the currency exchange rate, and for other related purposes (such as maintaining confidence in the currency and the economy, and serving as a basis for foreign borrowing. Portfolio investment covers, but is not limited to, securities traded on organized or other financial markets, and is distinctive because of the nature of the funds raised, the largely anonymous relationship between the issuers and holders, and the degree of trading liquidity in the instruments.

Financial Derivatives and Other Investments- A financial derivative contract is a financial instrument that is linked to another specific financial instrument or indicator or commodity and through which specific financial risks (such as interest rate risk, foreign exchange risk, equity and commodity price risks, credit risk, and so on) can be traded in their own right in financial markets. The two broad types of financial derivatives are options and forward type contracts. Financial derivatives also include swap contracts, credit derivatives and margins. Finally, other investment is a residual category that includes positions and transactions other than those included in direct investment, portfolio investment, financial derivatives and employee stock options, and reserve assets. Other investment includes: other equity, currency and deposits, loans (including use of IMF credit and loans from the IMF), trade credit and advances, other accounts receivable/payable and SDR allocations.

Source: IMF, 2009. *Balance of Payments and International Investment Position Manual,* 6th edition (Washington: International Monetary Fund).(IMF [2009])

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