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Politique monétaire et régulation du système bancaire dans les pays émergents

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.

To my lovely wife, Mariela, and my beautiful daughter, Berenice
To my parents, Alba and Ricardo, and to my brother Gonzalo

ABSTRACT

This thesis is focused on the implications of financial liberalization in monetary and banking policymaking. The first half of the work simultaneously estimates recovery values and probabilities of default implicit on market prices of the Argentine sovereign bonds. It conducts an empirical research contributing with evidence to the existing limited literature. It also presents a macroeconomic model that allows the analysis of limits and potential consequences of monetary policy in an environment characterized by sovereign default risk. An approach almost disregarded by literature. The second half surveys the literature that relates foreign bank presence with macroeconomic stability and estimates the impact of foreign bank presence on both the level and the volatility of real credit in a panel of eight Latin American countries over the period 1995:1 -2001:4. This is the first time that ARCH techniques are used to analyse this topic.

RÉSUMÉ

Cette thèse est consacrée à l'étude des conséquences de la libéralisation des marchés financiers sur la politique monétaire et la régulation du système bancaire dans les pays émergents. La première partie présente des estimations des taux de recouvrement et des probabilités de non payement des titres du gouvernement argentin. Par la suite, cette étude présente un modèle macroéconomique qui permet d'analyser les limites et conséquences potentielles de la politique monétaire dans un contexte caractérisé par le risque de défaut de l'état. Ceci est une approche qui semble négligée par la littérature. La deuxième partie résume la littérature concernant la relation entre la présence des banques étrangères et la stabilité macroéconomique. Ensuite, l'impact des banques étrangères sur le niveau et la volatilité du crédit réel est estimé dans un panel des pays d'Amérique Latine pour la période 1995:1-2001:4. Ceci est le primer travail qui applique des techniques ARCH pour l'analyse de ce sujet.

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General Introduction

This thesis analyses the challenges for central banks from financial liberalization in developing countries focusing on the implications for monetary and banking policymaking.

Financial globalisation implies, in a limited sense, a fully integrated market where economic agents face a single set of rules, have equal access and are treated equally. It is important to bear in mind, though, that financial globalisation, or cross-border financial integration, is a process rather than a state of nature. That is why it can be defined as the process by which financial markets and institutions become tightly interlinked and closer to full integration. This process is mainly, but not only, driven by government action. To do so, they lift legal restrictions (e.g.: on capital movements) and harmonise diverse rules, regulations and other practices which work as impediments to cross-border financial integration. This stage of the process is also known as financial liberalization.

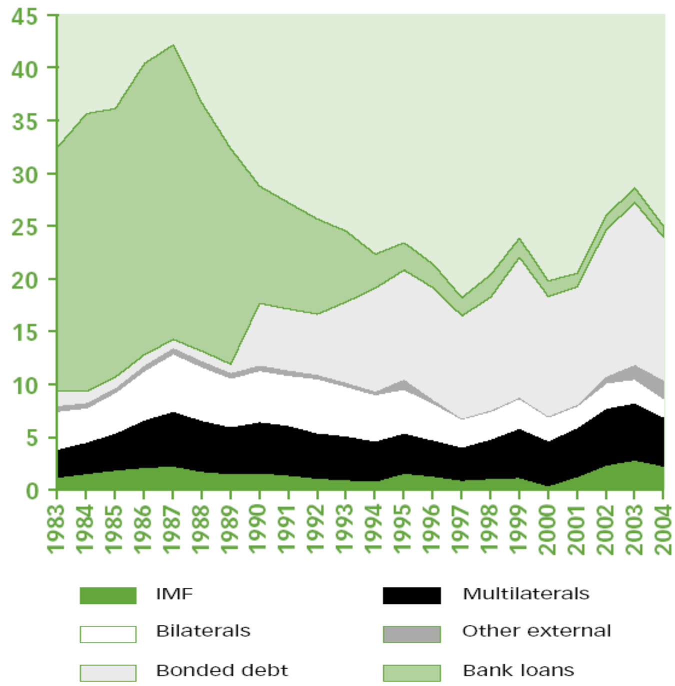
The increased global integration of financial markets over the past decade has raised important new challenges for central banks in both developed and developing countries. The most recent example is the US sub-prime mortgage crisis faced by the US Federal Reserve that lead to plunging property prices, a slowdown in the US economy, and billions of US dollars in bank losses. Prior to this, the second half of the 1990s and the early years of the current century were characterized by a wave of financial and debt crises in developing countries; namely, Mexico at the end of 1994, East Asia in 1997, Russia in 1998, Ecuador in 2000, Brazil in 1999 and 2002, Argentina and Turkey in 2001 and Uruguay in 2003 which led to a rapid increase in public debt (from 64 to 80 percent of GDP over the 1998-2003 period in Latin America and Caribbean). These countries suffered either sovereign debt crisis or currency crisis –sometimes both simultaneously– and in some cases even coupled with banking crises. Whereas some of them defaulted on their financial obligations, others succeeded in avoiding a national default through a combination of domestic adjustment and international aid. Domestic policies play an important role in determining the dimension of financial booms as well as the ability of the financial system and the economy to adjust to the aftermath. These policies play an important role in preventing as well as containing those risks.

On the other hand, the global integration of capital markets has greatly complicated the design and implementation of national monetary and banking policies. For instance, there is no reliable early warning system for financial shocks.

Even though domestic policymaking matters for prevention and mitigation of debt crisis, their occurrence and depth are also influenced by circumstances beyond domestic control. It is true that most of the changes in the more recent stages of globalization have taken place among developed economies; yet, developing countries have participated to some degree in these processes and were affected by this global trend. Capital markets in developed countries have grown substantially during the past thirty years experiencing a particular boom in the past decade (bank credit, stock market capitalization, and private bonds outstanding reached an average of about 250 percent of GDP for G-7 countries in 2000, compared to only 75 percent in 1970).

Developing countries began to participate mainly due to the increasing availability of capital flow after the oil shock of 1973. These funds were specially oriented to finance public debt in the form of syndicated loans. This increasing availability of capitals witnessed during the 1970s and early 1980s led to the debt crisis that started in Mexico in 1982. Thereafter many Latin American countries defaulted on their debt in the 1980's. The Brady Bonds –from former US Treasury Secretary Nicholas Brady–were created in 1989 in order to convert bonds issued mostly by Latin American countries into a variety of new bonds. At that time, the market for sovereign debt was small and illiquid. This standardization of emerging-market debt facilitated risk management and trading. This new instrument, denominated in U.S. dollar, led to the development of sovereign bond markets –substituting syndicated bank loans–in emerging economies in the upcoming years (see the Graph 1).

Graph 1: Composition of the Public External Debt in LAC*
From 1983 to 2004 (as a percentage of GDP)



*Include: Argentina, Brazil, Chile, Colombia, Ecuador, El Salvador, Mexico, Peru, Uruguay and Venezuela.

Source: IADB Report 2007, based on Cowan *et al.* (2006)

Developing countries have tried to attract the new capital available in international markets in different ways. One way to attract this new capital was by liberalizing the financial system. It took place especially in the early 1990s, some years after developed countries liberalized their own financial systems. The liberalization of financial systems implied that international financial institutions moved to developing countries, purchasing local banks and establishing themselves as local branches or subsidiaries. This change in the global banking activity is known as a shift from International Banking activities to Multinational Banking. As part of this liberalization process, governments and firms have actively raised capital in international financial markets and foreigners were allowed to invest in domestic markets. Another way to attract foreign capital was through the privatization process (see Verdier and Winograd, 1998). This process was initiated in Chile and then followed up in most countries. In developing countries, the privatization revenues climbed from 2.6 billion U.S. dollars in 1988 to 25.4 billion dollars in 1996. Finally, developing countries tried to improve their business environments and the climate for capital to flow in by strengthening economic fundamentals through macroeconomic stabilization policies.

The main idea was that capital markets would provide relatively cheap financing, mobilizing savings efficiently to their most productive use and luring investors with attractive investment opportunities.

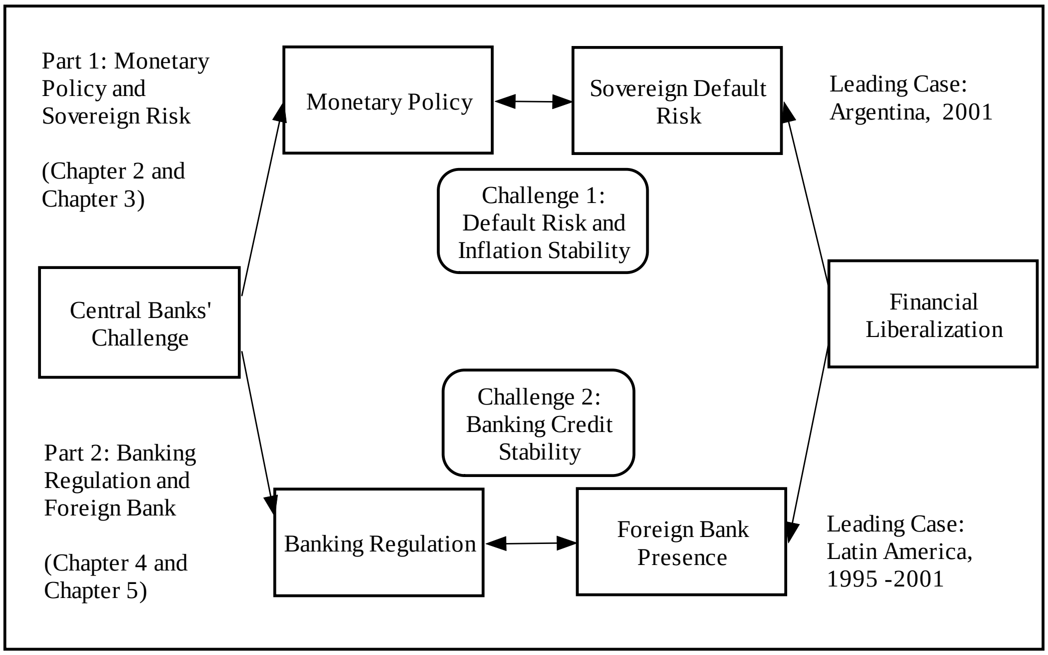
Capital market evolution has shown wide heterogeneity among developing countries during the last decades. While relatively well-developed in East Asia, in Latin America they have lagged behind, characterized by short-termism, illiquidity, and high dollarization. In fact, Latin America also witnessed a substantial growth in domestic bond markets. However, those markets tend to be dominated by public sector debt. Perhaps with the exception of Chile, the efforts to develop corporate bond markets in Latin America have not been very fruitful. In spite of the small size, derivatives markets have started to appear in some countries like Argentina, Brazil, Chile, and Mexico. Another major development in domestic capital markets has been the emergence of institutional investors; the most important are pension funds and mutual funds.

In the early 1990s, economists and policymakers held high expectations on the performance and prospects of domestic capital market development in emerging economies –particularly in Latin America. Quite on the contrary, the result was disappointing. As previously mentioned, the developing world –LAC included– went through a series of financial crises originated in a complex interaction of varied forces. Some being the product of market forces; some others, the afterward of market flaws; and some resulting out of incentives created through policy and regulation. While some were evident at the time, others showed up in the aftermath. On top of a weak bank industry and volatile macroeconomic and fiscal policies, the governments of these countries got used to "taxing" the bank system. Banks were forced to purchase state bond which only worsened the scenario paving the way for a potential sovereign default.

These poor performance and practices have made the conventional recommendations for capital market development questionable, at best. Policymakers are left without clear guidance on the direction (and how) to revise the reform agenda. Moreover, many of them do not envision a bright future for domestic capital markets and market-friendly reforms. Briefly, with financial globalization on the rise, and the increased frequency and severity of the crises further analysis and sharing of experience is needed to meet these challenges.

Against this background, the central banking challenges in designing and implementing both the monetary and banking policy to ensure financial stability became the main motivation of this thesis. The central bank's challenge is twofold as it is this work's. That is why it has been organized in two parts. The first half addresses the challenge of financial stability when the increasing public debt threats price stability by limiting the monetary policy autonomy. The second half looks into the central bank's role in coping with the challenge of financial stability where multinational banking activities –implying high foreign bank presence –play an important role in the banking system. Each half is composed of two chapters. The whole structure of this paper is outlined in the following scheme:

Scheme: Challenges to Central Banking from Financial Liberalization in Developing Countries: Implications for monetary and banking policymaking



Part 1: Monetary Policy and Sovereign Risk

Central banks use to implement their monetary policy by affecting interest rates in the money market. In so doing, central banks need to assess the impact of their actions on the economy, their overall size, channels of transmission and timing. So the first part of this research is focused in modelling and studying the manner and extend to which a central bank affects the cost of the government debt and therefore its risk of default –the sovereign default risk. This channel of transmission and its consequences have become especially relevant in developing countries where sovereign debt had rapidly grown.

The "sovereign debt", also called "public debt", defines the total outstanding financial liabilities resulting from the public sector's obligations of a country's government. And from today's perspective–particularly, in Latin American Countries– the question: "Does sovereign debt matter?" appears quite trivial. However, there exists in economics a very old and well known result called the "Ricardian equivalence" stating that for a given level of expenditure, the decision whether to finance it through debt or taxes has no economic consequence. This means that sovereign debt does not matter. This is an important concept commonly assumed in macroeconomic models.

The economist David Ricardo (1772 –1823) was the first to account for this effect that has remained in the economists' mind since then. However, the concept was not formalised until 1974 by Robert Barro. In his seminal article he argues that every bond-financed deficit must be met by a future tax increase and that this tax increase would be foreseen by living agents who adjust their present consumption accordingly. Thus income received by agents from government deficit-spending is all saved -and hence has no effect on consumption (thus no multiplier) -and that these savings go into the demand for the very same bonds that were supplied to finance that government spending (so bond demand rises exactly to meet higher bond supply, and money demand is unchanged) and thus there is no effect on interest rates either. So national saving, consumption, and economic growth remain unchanged. As a consequence, government's debt financed by tax reduction leads to higher taxes in the future and hence it will only postpone, not reduce, a country's overall tax burden.

However, Barro also states that there are three main necessary conditions for Ricardian equivalence to hold up: first, forward-looking individuals characterized by intergenerational altruism; second, perfect capital markets; third, nondistortionary (lump sum) taxation. If such conditions are necessary, it is clear why in most cases the theory does not hold up and why sovereign debt matters.

Luckily, most economists and policymakers agree that Ricardian equivalence is unlikely to hold in practice subscribing to the called "conventional view" of public debt (see Elmendorf and Mankiw, 1999) that states that government debt has important effects in both in the short and long run. According to this view, a debt-financed tax cut has a positive effect on output in the short run and can then be used to speed up recovery from a recession. This positive effect requires two conditions. First, the Ricardian equivalence must not be satisfied. Consequently, the debt-financed tax cut leads to an increase in aggregate demand through higher household consumption. Second, the economy must be characterized by sticky prices and wages. In this way, an increase in aggregate demand results into higher input in the short run rather than leading to an immediate jump in prices and wages. In the long run the effect is different. Prices and wages fully adjust to their equilibrium level and the availability of resources determines the level of output. As a corollary, the described debt policy results in lower output because this policy increases consumption and reduces saving, thus crowding out private investment which leads to lower capital accumulation.

In developed countries the debate on the consequences of public debt has mostly focused on the trade-off between its expansionary effects in the short run and its contractionary effects in the long run. In developing countries, however, and particularly in Latin America and the Caribbean, these are by far second-order problems. The central issue is how to manage the risks linked to financial crises (including debt crises) and macroeconomic volatility.

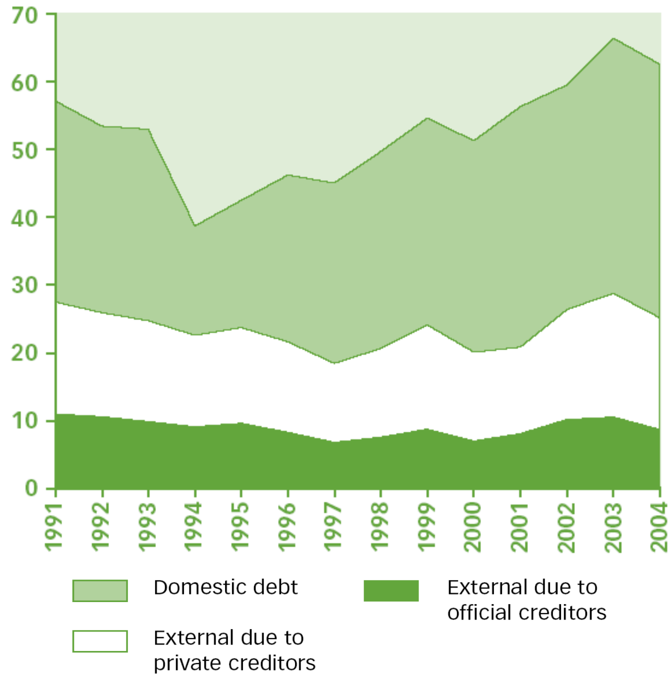
Research focusing on developing countries has also shown that higher levels of debt place substantial constraints on the conduct of an independent monetary authority. For instance, high debt levels denominated in domestic currency reduce a central bank's credibly regarding its commitment in supporting a policy of low inflation. This is because central banks face the temptation as well as the pressure of eroding the real value of the public debt through high inflation rate. Most hyperinflation episodes have resulted from a combination of both irresponsible fiscal and monetary policy and a high debt level (see Dornbusch *et al.*, 1991). As regards sovereign debt denominated in foreign currency, it exposes the government to a foreign exchange risk. For example, an accommodating monetary policy may lead to currency depreciation producing a negative balance sheet effect making the debt harder to repay (see Hausman *et al.*, 2001 and Calvo and Reinhart, 2002). Consequently, sovereign debt becomes particularly risky conditioning the monetary authority as well. Besides, public debt in developing countries relies on volatile capital market flows further increasing sovereign risk and causing these countries to be more sensitive to financial and debt crises.

However, while high levels of public debt negatively affect a central bank's credibility and constrain its policy, moderate levels of debt in the form of liquid government bonds can help develop the private bond market by providing a benchmark yield curve and improve the effectiveness of monetary policy by facilitating the central bank's open market operations. Therefore, public debt plays an important role in promoting the development of private domestic bond markets. This is particularly important in Latin America, a region characterized by small financial markets with excessive reliance on bank credit (See Part II).

The evolution of public indebtedness in this region has shown an upward trend during the 1995–2004 period. This trend is entirely the result of the increase in domestic debt, which rose from 16 percent of GDP in 1994 to 37 percent of GDP in 2004. About two-thirds of domestic debt is denominated in nominal domestic currency–not indexed to prices. (See Graph 2).

Graph 2: Composition of Public Debt Debt in LAC*

From 1991 to 2004 (as a percentage of GDP)



*Include: Argentina, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Honduras, Mexico, Panama, and Peru.

Source: IADB Report 2007, based on Cowan *et al.* (2006)

According to this record, this first part analyses central banks' scope as well as its limits to manage monetary policy when Ricardian equivalence does not hold up –i.e. when sovereign debt matters. This is later translated into a country risk spread reflecting both the cost of the government's debt and default risk. However there is not enough empirical evidence about some of our key variables of interest like probabilities of default and recovery values on sovereign debt as it is the case of corporate bonds. This is due to the fact that developing countries are fewer in number and they do not default as frequently as corporations, among other reasons. This lack of empirical evidence makes me think back to Sir Arthur Conan Doyle (1859–1930) who wrote:

> It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts.

Consequently, Chapter 1 estimates the default probabilities and recovery values of the Argentine sovereign debt during the period preceding the December 2001 default. The estimations are then compared to those generated by Merrick (2001) for Argentina and Russia for August 1998. Finally, it presents a brief assessment on the effect of a haircut over the equilibrium country risk spread after the default. Chapter 2 provides a macroeconomic model to analyze a monetary-fiscal regime when country risk spread emerges affecting the equilibrium before and after defaulting. More precisely, this chapter examines how and to which extend the room for designing and implementing the monetary policy becomes affected by the sovereign risk spread. For instance, a tight monetary policy fighting against high inflation may worsen the consequences of a potential crisis. This is particularly the case when the fiscal policy reform is not an easy option because either tax increases or expenditure reductions desaccelerate economic growth deteriorating fiscal accounts even more.

Part 2: Banking Regulation and Foreign Banks

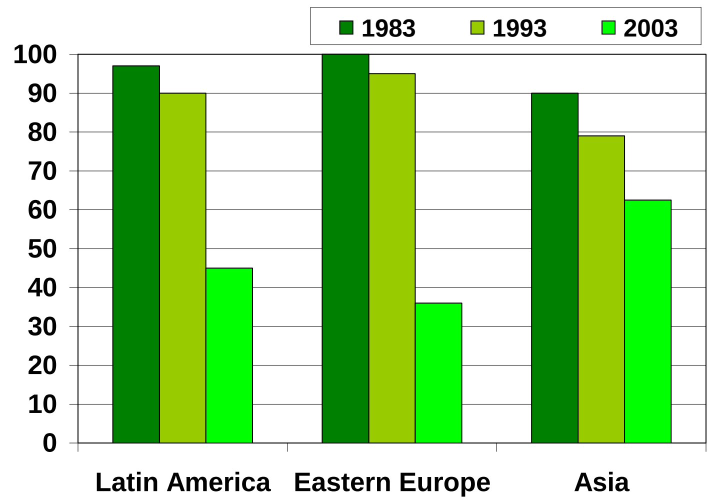
Arguments supporting a banking policy of openness to foreign bank participation are far from being universally accepted. This policy implies both opportunities in terms of modernization of developing countries' banking system and challenges in terms of possible additional volatility and less access to credit; particularly for small firms. The second part of this paper contributes to this debate focusing on foreign bank consequences over the banking system stability by exploring the experience of Latin America and the Caribbean countries that exhibited a significant degree of foreign bank activity for a long period.

In the last decade of the twentieth century, several banks at a worldwide level have shifted from an international banking activity towards a multinational banking strategy (Mc Cauley *et al*, 2002). Contrary to an international bank which concentrates on cross-border activities (lending provided by the head office), a multinational bank provides financing through its branches and subsidiaries in the host country –the country that receives foreign direct investment; whereas home country refers to the head office site.

Favored by the opening up of their foreign sectors and the embracement of a series of market-friendly policy reforms, including deregulation and privatization of the banking sector, international banking institutions have expanded their presence in several emerging market economies by setting up foreign branches and subsidiaries. A trend that had been dominated in the previous decade by cross-border lending activities (see Graph 3).

Graph 3: Shift in the Banking Stratedy

International / Local Currency Claims (in percentage)



Source: Haouat *et al.* (2006) using BIS statistics.

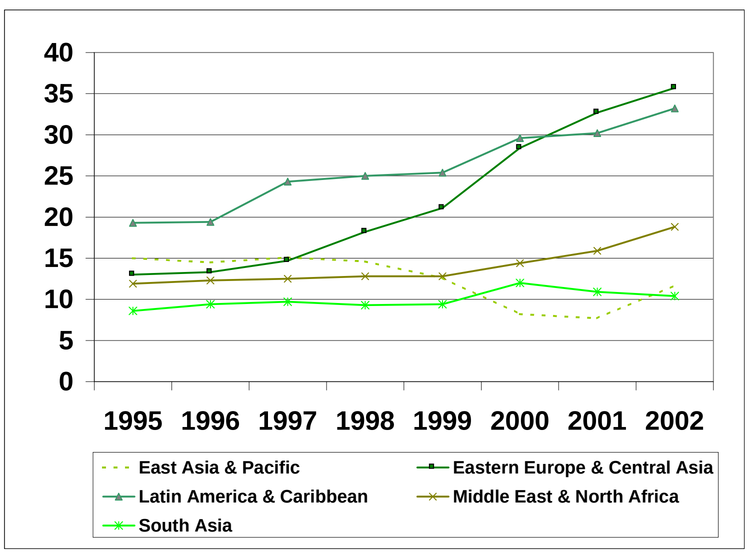
It is worth mentioning that BIS definition of consolidated international claims comprises cross-border claims and foreign currency claims of foreign banks' offices in the host country. Only local currency claims on local residents of foreign banks' affiliates are reported separately. But it is still interesting to look at these statistics to provide some further insight into the decreased trend of cross-border lending in favour of foreign offices' lending –which is obviously underestimated because it only includes local currency claims.

This unprecedented internationalization of the banking sector has prompted a debate on the potential consequences for the recipient countries. For instance, multinational banks are likely to introduce better practices, and improved management and information technologies, helping boost the efficiency and diversification of banking services (Levine, 1997; Goldberg, 2007). However, foreign banks may avoid lending to small and medium sized enterprises (Berger *et al.*, 2001), and attract mainly the wealthier customers while leaving the riskiest borrowers to local banks, thus weakening the latter (Claessens and Jansen, 2000; Barajas *et al.*, 2000; Detragiache *et al.*, 2006).

There are, in particular, two regions that have been very active in attracting foreign direct investment into the banking industry and so being exposed to new challenges. These are Eastern Europe and Central Asia, and Latin America and the Caribbean. In the Middle East and North Africa, foreign bank presence has increased at a generally slower pace, while it remained stagnant or even declined in South and East Asia and the Pacific regions (see Graph 4).

Graph 4: Foreign Bank Presence by Region

Foreign / Total Banking Assets (in percentage)



Source: Haouat *et al.* (2008)

Focusing on bank credit to private sector, both Eastern Europe and Central Asia, and Latin America and the Caribbean present relatively small to medium sized banking systems compared to other emerging regions in the world. During the 1990s, the average level of credit to the private sector in Latin America and the Caribbean was 28 percent of GDP and in Eastern Europe and Central Asia was only 26 percent of GDP. These rates are significantly lower than those of other groups of developing countries, such as Middle East and North Africa with 43 percent and East Asia and the Pacific reaching 72 percent. Just behind Developed Countries recording an average of 84 percent (see Table 1).

Table 1: Financial Development by Region 1990s

Region	Number of countries	Credit to Private Sector -percentage of GDP	Credit and Market Capitalization - percentage of GDP
Developed Countries	24	84	149
East Asia and the Pacific	10	72	150
Middle East and North Africa	12	43	80
Latin America and the Caribbean	20	28	48
Eastern Europe and Central Asia	18	26	38
South Asia	6	20	34
Note: Values are simple averages for the regions for the 1990s			

Source: IADB (2005) based on IMF and World Bank data

Even though the current level of credit to the private sector in Latin America and the Caribbean compares favourably with the level observed in the past, other groups of developing countries have experienced a much faster development of their banking industries. As it can be seen from Table 1, a common element in both regions is the shockingly small market capitalization, particularly when compared to that of developed countries. South Asia, Latin America and the Caribbean, and Eastern Europe and Central Asia present the smallest market capitalization representing 14, 20 and 22 percent of the GDP, respectively. Moreover, market capitalization in Latin America and the Caribbean is to a large extent dominated by the sovereigns. Corporate sector's external finance heavily relies on bank credit.

Apart from financial depth, a central issue for sustainable economic growth is financial stability. Fluctuations (and so uncertainty) in access to bank credit seriously constraints the economic prospect. Whereas developed countries have the lowest credit volatility registering only 6 percent -measured as a country's standard deviation of real credit growth –during the 1990s, some developing regions remain two or three times more volatile (see Table 2). Eastern Europe and Central Asia had the highest credit volatility during the past decade recording 21 percent. This is due to drastic economic changes that former communist countries faced during that period. Not surprisingly, after controlling for country-specific shocks credit volatility decreases in this region. But remains higher than that of the other regions. Relatively closely follows Sub-Saharan Africa with 18 percent and then Latin America and the Caribbean, and East Asia and the Pacific with 14 percent each of them.

Table 2: Credit Volatility,* by Region during the 1990s

Region	Number of countries	Credit Volatility without adjustement -percentage-	Credit Volatility adjusted by GDP -percentage-	Credit Volatility adjusted by external shocks -percentage-
Developed Countries	24	6	8	6
East Asia and the Pacific	16	14	14	12
Middle East and North Africa	16	12	12	8
Latin America and the Caribbean	31	14	14	12
Eastern Europe and Central Asia	20	21	16	18
South Asia	6	9	12	8

* Measured as a country's standard deviation of real credit growth during the 1990s

Note: Results in the third and fourth columns are normalized to have to have the same worldwide credit volatility as in the second column.

Source: IADB (2005) based on IMF and World Bank data

In contrast to the case of Eastern Europe and Central Asia, the credit volatility in Latin America and the Caribbean remains constant after controlling for country-specific shocks and decreases by 2 percent after controlling for external shocks. This implies that even though external shock affected credit volatility, most of this instability is generated and/or reproduced by the banking system in itself. Latin America and the Caribbean credit growth has been characterized by very strong boom-bust cycles. And although real credit volatility might seem not to be free from the effect of external shocks, a natural question arises: Which role did foreign banks play in that period? A time characterized by an important shift from international toward multinational banking.

In the early 1990s, real credit growth was greatly stimulated in the region through the implementation and promise of market-friendly reforms driven by the financial liberalization plans, and large capital inflows. The years 1994 and 1995, the time of the Tequila crisis, witnessed a number of banking crises that weakened the rapid growth trend. Later on, in 1996, real credit recovered its impetus in many countries after banks were either restructured or capitalized (or both). But again in mid-1998 (the afterward of the Asian crisis and the time of the Russian crisis), real credit was negatively affected despite the increase in economic activity.

Between 1974 and 2003, Latin America (excluding the Caribbean countries) displays the highest average number of banking crises per country compared to any other region. This region has the painful record of 1.25 banking crisis by country in that period (35% of the countries have experienced two or more crisis, making this share almost three times higher than in any other region. Latin America and the Caribbean shows 0.90 crisis per country. Very closely follows Eastern Europe and Central Asia accounting an average of 0.89 crisis by country. In the other extreme, the high-income OCDE countries account 0.21 crisis per country.

When it comes to the cost of bank credit, Eastern Europe and Central Asia has the highest spreads in the world, 8.8 percent considering average values for

1995 –2002, followed just behind by Latin America and the Caribbean with an 8.5 percent. Developed countries recorded the lowest spreads in that period; 2.9 percent. There is a strong positive relationship between overhead costs and spreads suggesting that inefficient banking sectors have higher spreads (according to IMF and Bankscope data).

In the end, all this evidence indicates that the private sector in Latin America and Caribbean heavily relies on banking credit which is still relatively scarce, volatile, costly and represents the major source of financing. So, contractions in bank credit necessarily lead to investment reduction and consumption spending. Explaining bank credit volatility (as well as credit stock) along a period characterized by a large entry of foreign banks is the core of the second part of this thesis. Almost all empirical papers analyzing the relationship between foreign banks and economic volatility are based on previous empirical research without explicitly emphasizing the theoretical fundamentals. Exceptions are Morgan *et al.* (2004) and Galindo *et al.* (2005). Consequently, Chapter 3 surveys both theoretical and empirical literature in order to account for the main contributions in this field. Chapter 4 presents an empirical research based on relevant available data on a panel of eight Latin American countries during the period 1995-2001. ARCH techniques are applied in order to consistently test the effects of foreign banks on real credit volatility by disentangling the first and second statistical moments of the dependent variable –i.e. the mean and the variance.

Summary and Main Findings

Chapter 1. Recovery Values Estimates: Evidence from Argentina

During the last three decades, the theory of pricing credit risk has been developed to valuate corporate debt. Credit risk models are focused on default risk adopting static assumptions. They treat default recovery rates either as a constant parameter or as a stochastic variable but independent of the probability of default. The connection between these two variables has traditionally been disregarded by these models. Historically, much more attention has been dedicated to estimate probability of default compared to default recovery rates (or its complement name, the Loss Given Default). This is due to the assumption that recovery rates are related to debt features, like collateral or seniority, and do not depend on systematic factors. On the contrary, PD is considered a systematic risk component which attracts risk premium (see Altman *et al.*, 2004).

Similar approaches should be applied for the estimation of sovereign risk. However, it is important to be aware of the differences between risky corporate bond and risky sovereign debt as well as their consequences in valuing assets. For instance, developing countries issue their sovereign debt in countries such as United States of America and United Kingdom under completely different legal jurisdictions and much less capacity of enforcement in case of default if compared to corporate bonds; making the credit risk price different in each type of asset.

One of the most common approaches was based on a sensitivity analysis. It considers the bond market price (or spreads) in order to calculate the implied default probability for different possible recovery values (see Sturzenegger, 2004, pp. 6).

Moreover, developing countries are more stable than corporations, they have longer-term economic planning, they do not default as frequently as corporations do, they are fewer in number, and they do not typically disappear. As a consequence, there is considerably much less empirical evidence of default on sovereign debt than on corporate bond.

Thus, in 2001, Argentine portfolio managers were faced with the problem of settling default recovery values and the implied default probabilities of their portfolios, exclusively on the grounds of the bond market values. Given the lack of empirical evidence, the approaches applied by analysts were grounded on the analysis of domestic and foreign data generated by earlier international crises, such as those of Mexico (1995), Russia (1998) and Brazil (1999). This method entails forming conjectures about the recovery value and the sovereign bond price (or the size of the spread) under a scenario of financial distress by resorting to evidence provided by earlier crises.

The disadvantage to this approach is that its outcomes result from different bond temporal term structures; and hence from different bond durations when compared to those of the analyzed bonds. Consequently, information is misleading. Moreover, the approach does not include information concerning recently issued bonds nor the particular macroeconomic conditions of the country subject to analysis. This methodology neglects highly relevant information which is later incorporated into the analysis ad-hoc.

In order to avoid the aforementioned disadvantages, the version originally presented by J. Merrick Jr. (2001) is herein applied to estimate the two determinants embedded in Argentine sovereign bond prices simultaneously. This model used throughout this chapter is characterized as a Reduced Form Model and follows the approach presented in Duffie and Singleton (1999). These models introduce separate explicit assumptions about the dynamics of both PD and RR. These models are fundamentally empirical, using observable risky debt prices (or credit spreads) to ascertain the stochastic jump process governing default. This dynamics determine the price of the credit risk, since there is some probability that the sovereign defaults on its obligations in each moment.

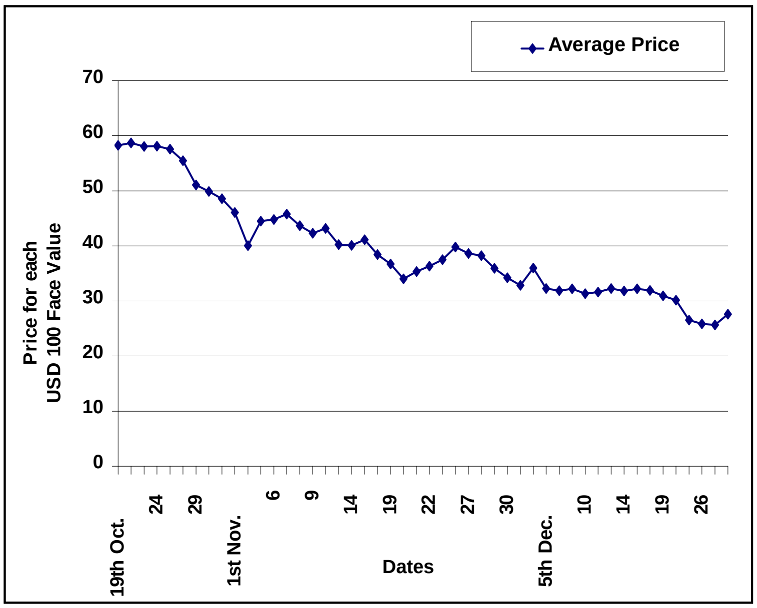
But the open question is: Given such bond market value, the only observable variable is a function of two unknown determinants (default probability and implied recovery rate). How can these determinants be estimated consistently and simultaneously, then?

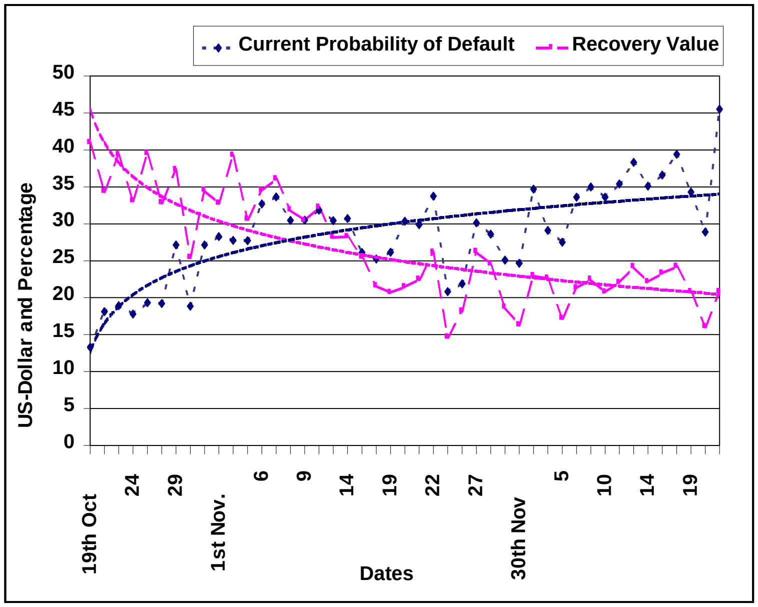
In these models the risky debt price –the observable variable– is a function of two unknown determinants: the default recovery value and the implied default probability. In order to simultaneously estimate both determinants as from only one variable – the bond price– a system of pricing equations is set up. Our set up is consistent given that the Argentine sovereign bonds were provided by a cross-default clause. That is, if one of the bonds is no longer paid then all the bonds will be considered in default. There is an implied recovery value as well as a joint default probability representative of the whole economy. The solver that carries out the estimations computes an algorithm of non-linear optimization subject to non-linear constraints. Thus, the global solution cannot be guaranteed by the convergence algorithm applied by this method. This is a general problem with algorithms in non-linear optimization. It results that experimentation with alternative initial guesses produces the same results.

This chapter estimates both the default recovery values and the risk-neutral default probabilities of the Argentine sovereign bonds for the December 2001 crisis to bring forward new evidence on this field. These estimations help to find out investors' expectations over the capacity of the Argentine government to overcome the sovereign debt crisis and avoid defaulting.

The input data and the main findings for the pre-defaulted period are summed up in the following Table and Graphics:

Argentina 2001: Pre-Default Period			
		Oct. 19th	Dec. 21st
Input Data	Bond Market Price	USD 58,3	USD 45,5
Estimation	Implied Recovery Value	USD 40,9	USD 20,8
Results	Base Default Probability	13,30%	45,50%





Estimations show that from October 19th to December 24th, the default recovery values descended from USD 40.9 for each USD 100 face value to USD 20.8 whereas the default probabilities registered an increase from 13.3% to 45.5%. Thus, both determinants become relevant in explaining the downward trend of the average bond prices, falling from USD 58.3 to USD 26.5. Then, the estimations were compared with those generated by Merrick (2001) for Argentina and Russia for August 1998. Sovereign bonds from emerging countries facing unstable macroeconomic conditions suffer a significant reduction in their recovery value which amounts to approximately 50% when compared with the bonds issued in countries facing stable macroeconomic fundamentals and a stable currency value, as was the case in Argentina in August 1998. Finally, assuming a debt haircut over the Principal of 70% and the average estimated recovery value which amounts to USD 21.7, it is feasible to assert that Argentina could have overcome its default by paying a country risk premium of around 1960 basic points. This result would fully justify a substantial haircut over the face value, interest rate coupons and maturity upon the restructuring process.

Chapter 2. Fiscal Imbalances, Inflation and Sovereign Default Dynamics

The central question this chapter seeks to answer is how monetary policy might affect the equilibrium behaviour of inflation rate and sovereign risk premium. Within the model presented in this paper, public debt becomes risky due to an active fiscal policy, as in Uribe (2006), reflecting the fiscal authority's limited ability to control primary surplus. The insolvency problem is due to a string of bad luck (negative shocks affecting primary surplus). But in contrast to Uribe's results, as the sovereign debt cost increases (which results from weak primary surplus), default becomes anticipated and reflected by a rising country risk premium and default probability. The default is defined as reneging on a contractual agreement and so the decision is set by the fiscal authority. However, conflicting objectives between fiscal and monetary authorities play an important role in leading the fiscal authority to default on its liabilities. The research also underlines the relevance of the government policy implemented after the event of default. It determines the way as the economy either converges to the stable steady state equilibrium or diverges toward another event of default.

The framework is grounded on a closed endowment economy and allows deviations from the Ricardian equivalence. The economy is inhabited by a large number of identical infinitely-lived households. Each period, households are assumed to have access to a one-period nominal government bond, denoted B_t. This bond offers, in period $t+1$, a contractual gross nominal interest rate R_t. However, the fiscal authority may default on its debt and so, in each period it repays a fraction $h_t \in (0,1)$ of its liabilities, named the recovery rate of the sovereign debt. This assumption –$h_t \in (0,1)$ –makes a difference compared to Buiter (1999, 2001 and 2002) and Uribe (2006). They suppose, for instance, that $h_t > 1$ is a possible option.

Besides, in our model, in each period t households also have the opportunity to invest in a complete set of nominal state-contingent assets which pays a risk-free interest rate expressed R_t^f.

The government is made up of a fiscal authority and a central bank. The fiscal authority levies lump-sum taxes, $P_t\tau_t$, which are assumed to follow an exogenous, stochastic process. The central bank is more concerned about tackling high inflation levels than dealing with scenarios dominated by low inflation and by deflation. In most developing countries, high inflation is a relatively frequent phenomena whereas deflation is quite rare and not so deep. Stylized facts on inflation rates in these countries shape an asymmetric behavior. So it seems to be reasonable to suppose an asymmetric behavior from the central bank which can be formalized as,

$$R_t = \phi(\pi_t) = \begin{cases} \bar{R} & if \quad \pi_t \leq \hat{\pi} \\ \bar{R} + \alpha(\pi_t - \hat{\pi}) & \text{otherwise} \end{cases} \qquad \text{with} \quad \alpha > \beta^{-1}$$

This monetary policy takes the form of an asymmetric interest-rate feedback rule whereby the short-term nominal interest rate is set as a function of inflation and with an explicit inflation targeting objective. The monetary rule implies that if current inflation increases beyond the inflation threshold $\hat{\pi}$, the central bank reacts actively –in the sense of Leeper (1991) which means that $\alpha > \beta^{-1}$ –in order to stabilize inflation level around the target. Otherwise, the central bank pegs the current interest rate to its target $\bar{R}$ which is associated to an inflation target $\bar{\pi}$ lower than $\hat{\pi}$.

Given that the fiscal authority does not control the primary surplus, it is useful to suppose the existence of a rule which specifies how the fiscal authority chooses the equlibrium recovery rate, h_t. More precisely, the fiscal authority's behavior is supposed to be defined by:

$$h_t = H(R_t^{nd}) = \begin{cases} 1 & if \quad R_t^{nd} < \bar{\bar{R}} \\ \bar{h}(R_t^{nd}) < 1 & \text{otherwise} \end{cases}$$

Such a rule is a (non increasing) function of the nominal interest rate, denoted R_t^{nd}, to be determined by the monetary authority in the No-Default case. Then, R_t^{nd} represents the potential cost of honoring the whole debt in the future and there is a threshold $\bar{\bar{R}}$ which denotes the maximum nominal interest rate that the fiscal authority will accept on its new issued debt without defaulting on its current liability.

It is important to point out that the main objective of the central bank is monitoring inflation whereas the fiscal authority only cares about the cost of its debt. Note that in order to control current inflation the central bank uses the current interest rate and so affecting the cost of the sovereign debt. Consequently, a conflict of interests between both authorities may arise defining the equilibrium outcome.

Using all the equation that defines a rational expectations competitive equilibrium it turns out,

$$h_t R_{t-1} B_{t-1}/P_t = \sum_{h=0}^{\infty} \beta^h E_t \tau_{t+h} = T_t \qquad \forall t$$

where P_t denotes the price level, $\beta \in (0,1)$ the subjective discount factor and E_t the conditional mathematical expectation operator.

Then, if the fiscal authority is committed to honour the whole of its liabilities –and so $h_t = 1$ –then the current inflation rate, $\pi_t = P_t/P_{t-1}$, will be determined based on the Fiscal Theory of the Price Level (FTPL) determination. This is because T_t is exogenous and $R_{t-1}B_{t-1}$ is predetermined in period t. Thus, the real equilibrium value of the public debt is necessarily equal to the present value of future discounted real fiscal surpluses. On the contrary, if h_t is allowed to be less than unity, then the current value of T_t may affect both current inflation and recovery rate. This may lead to the Buiter's conclusion that any path for h_t and P_t satisfying this equation could be considered as an equilibrium outcome.

After some algebra, the last equation can be expressed as,

$$\frac{\pi_t}{h_t} = \frac{\beta R_{t-1}}{1+\eta_t} \qquad \forall t > 0$$

where $\eta_t = (T_t - E_{t-1}T_t) / E_{t-1}T_t$ is the innovation –say, the fiscal shock –in percentage points on the present discounted value of primary surpluses.

One could conclude, as Buiter (1999, 2001), that any path for h_t and π_t satisfying this could be considered as an equilibrium outcome. But this is not the case. The monetary rule and, especially, the debt recovery rule also affect the equilibrium outcome. Now the objective is to analyze the extent to which each of these variables –h_t and π_t –may react after a shock to T_t.

Three possible scenarios result in this economy. The two first scenarios correspond to the No-Default case –where $h_t = 1$. Under these the fiscal authority considers that the potential cost of servicing the whole debt is affordable and so it honors its liabilities completely. The first scenario is characterized by relatively low current inflation; the central bank, then, behaves passively by pegging current interest rate to its steady state level, $\bar{R}$. This steady state equilibrium is locally stable. This type of periods are usually called "Tranquil Times". The second scenario is characterized by relatively high current inflation where the central bank behaves actively by increasing current interest rates. This scenario corresponds to "Inflation Times" described by Loyo (1999) and the steady state equilibrium is unstable. This means that, depending on the previous value of the nominal interest rate –at the left or at the right from steady state level of the nominal interest rate, denoted R^I –the current interest rate will converge to $\bar{R}$ (if η_t is void or small enough), or increase toward $\bar{\bar{R}}$. Unless a big positive fiscal shocks occurs, the latter scenario inevitably leads to a sovereign default.

The third one is the scenario of Sovereign Default –where $h_t < 1$. In this case, the fiscal authority finds that the potential cost of servicing its whole debt is unaffordable. Consequently, it defaults on its liabilities by honoring only a fraction of its financial obligations. The scenario of Default can be triggered by a hard negative shock –given the level of R_{t-1} –or by a high level of the previous nominal interest rate –for a given shock η_t. But without specifying the recovery rule –$h_t = \bar{h}(R_t^{nd}) < 1$ –the equilibrium in period t remains undetermined. This result is in line with Buiter (1999)'s criticism. It turns out that monetary policy plays a significant role in shaping the equilibrium behavior of default and risk premiums. It is shown that the higher is R_t^{nd}, the potential cost of honoring the entire debt, the smaller is the recovery rate. The recovery rule allows the economy, by defaulting on its financial obligations, to reach the stable steady state equilibrium in the same period t. However, the recovery rule and so the equilibrium recovery rate matters. The economy might reach the stable steady state equilibrium –either in the same period t or progressively, like the Argentine Default on 1989 –or converge again to another default scenario. Thus, the model explicitly emphasizes the role of the government (the fiscal authority) in resolving the financial crisis.

The Expected Recovery Rate, Sovereign Risk Premium and the Probability of Default are calculated explicitly. As the empirical evidence suggests, in the onset of the debt crisis, the risk premium of the sovereign debt increases due to interest rate raises in anticipation of possible default. Both the Probability of Default and Sovereign Risk Premium are consistent with the empirical estimates presented in the previous chapter. This also underlines the fact that the size of the equilibrium default rate matters for the post-equilibrium dynamics. The size of the equilibrium default rate cannot be too high so as to ensure a post-equilibrium dynamics without defaulting. This theoretical result is consistent with the argument presented in the previous chapter as to the assesment of the Argentine Debt Haircut after the last event of default on December, 2001.

Chapter 3. Literature Review on Foreign Banks and Economic Volatility

The theoretical literature examining the link between foreign direct investment in the banking sector and macroeconomic stability is rather limited. To the knowledge of the author, only two studies deal with such an issue: Morgan *et al.* (2004) (MSR) and Galindo *et al.* (2005) (GMP). In both cases, foreign bank presence has ambiguous effects on volatility, depending on the type of shock hitting the economy.

MSR is grounded on the banking model originally developed by Holmström and Tirole (1997) (HT) for a closed economy. In this model, firms have to choose between two sources of financing: bank capital or investors' capital, although they are not perfectly substitutable. Bank capital is the most expensive, because banks provide not only loans but valuable monitoring services. Capital-constrained banking intermediaries are cardinal in this set up, since firms depend on their collateral (or capital) value to first raise bank ("informed") capital to be able to access to the much cheaper investor ("uninformed") capital. Actually, investors invest in the firms' projects after observing that banks have invested their own capital and monitored the firms. Indeed, the banking system may become a main source of instability in the economy, since any shock encountered by banks will have immediate, real effects on the economic activity.

MSR extend the HT model to include another country, letting bank capital be freely distributed between countries, while the amount of firm capital in each individual country is fixed. Uninformed investors in both countries have access to a worldwide securities market (with an exogenous market rate of return). Under this set up, if there is a negative bank capital shock in one of the countries –and it becomes relatively scarcer– the impact on the amount of uninformed and informed capital invested in the affected country is smaller when the banking system is internationally integrated. The mechanism is triggered by the increase in the rate of return of bank capital that attracts this type of capital from the unaffected country and so buffering the negative initial effect. In contrast, the negative impact of a firm's collateral shock is amplified under a multinational system. The lower value of a firm's collateral decreases the bank capital rate of return after a negative shock in an integrated banking system. Therefore, banks will prefer lending their mobile capital in the unaffected country, where the bank's capital rate of return is higher, and firms are backed by better collateral. As a consequence, bank capital is reduced in comparison to a national system, because in this case bank capital is immobile.

GMP presents a portfolio model to examine the behaviour of well-diversified banks across nations in case of shocks to the host country. In their theoretical model, banks in each country have deposits and assets. They show that credit from well-diversified foreign banks will be more stable when liquidity shocks (i.e., shocks to funding costs) hit the economy. In fact, multinational banks have access to a global pool of liquidity, so they may be less sensitive to a rise in deposit interest rates than domestic banks. In contrast, foreign banks may react more aggressively in the case of opportunity shocks (i.e., shocks to expected returns), worsening the impact of globalisation on banking stability in the host country. A worldwide diversified bank is able to rapidly withdraw investments from a host country when there is a decline in expected returns, reassigning the capital to that part of the world with better economic prospects.

It seems clear that, from the theoretical literature, the final effect of foreign financial institutions on macroeconomics volatility depends on the type of shocks hitting the economy. In fact, the overall impact of banking integration on volatility is an empirical question, not free from implementation difficulties. As such, it is very hard to identify and isolate the types of shocks discussed above. These caveats, coupled with problems concerning the availability of data, have led researchers to focus attention on the statistical significance of aggregate measures of foreign bank presence. If banking integration is not significant, this means that the stabilizing and destabilizing effects compensate each other, while if it is negatively signed and statistically significant at conventional statistical levels, stabilizing effects predominate and foreign banks improve the buffer function of the financial system.

Empirical studies concentrate on foreign bank behaviour in case of change in home or host county environment, and particularly in the face of financial crises. Much empirical research examining foreign bank reaction to changes in the host country conditions (pull factors) shows a positive relationship between host country business cycles and foreign bank lending. Foreign banks may reduce their activities in the host country which knows economic difficulties and reallocate their capital over different markets which record better economic growth rates while local banks may not have such an option (Dahl and Shrieves (1999), Jenneau and Micu (2002), Morgan and Strahan (2003)). Barajas and Steiner (2002) show that net foreign liabilities –mainly provided by multinational bank subsidiaries–accelerated credit expansion and amplified credit contractions in Bolivia, Peru, Chile and particularly in Venezuela. However, studies on foreign banks' behaviour during times of financial crisis in the host country underline that foreign banks did not reduce their credit supply (Demirgüç-Kunt *et al.* (1998), Goldberg (2002), Martinez- Peria *et al.* (2005), Detragiache *et al.* (2006), De Haas and van Lelyveld (2004, 2006). On the other hand, foreign banks–internationally diversified and more capitalized than local banks–may expand their credits in a host country. Dages *et al.* (2000) demonstrate that foreign banks in Argentina and Mexico had less volatile loan growth compared to local banks after Tequila crisis (1994-1999). Peek and Rosengren (2000a) find similar results for Argentina, Brazil and Mexico in the same period. However, the withdrawal of certain foreign banks following the 2001Argentine crisis may lead to revisit these conclusions.

Regarding push factors, the situation where foreign banks react to changes in the home country economic environment, the empirical evidence points to an opposing effect. On the one hand, authors like Calvo and Coricelli (1993), Moshiriam (2001), Martinez Peria *et al.* (2005), and De Haas and Van Lelyveld (2006) find that parent banks can expand their activities in the host country when they meet economic problems in their own market. Indeed, worsening country conditions led banks to seek external lending opportunities. This may be due to the lack of profit opportunities in the country of origin. On the other hand, Dahl and Shrieves (1999) and Goldberg (2002) show that economic turmoil in the home country can lead a parent bank to reduce foreign subsidiaries' activities. Such a situation can be explained by the deterioration of banks' financial condition due to a worsening economic environment. Also, Jeanneau and Micu (2002) conclude that foreign bank lending to Latin American countries is positively correlated with the economic cycles in the major industrial countries.

Nevertheless, a number of empirical studies on credit growth show that foreign bank entry may affect credit availability and distribution. Detragiache *et al.* (2006) find that, in poor countries, a stronger foreign bank presence is strongly associated with less credit to the private sector. Besides, for countries with more bank entry, credit growth is slower and there is less access to credit. But there are no adverse effects on foreign bank presence in more advanced countries.

Chapter 4. Foreign Banks and Credit Volatility in Latin America

Most of the applied papers stating that they study the link between foreign banks and stability of different macroeconomic aggregates are in fact grounded on econometric models that analyse only the first conditional moment of the dependent variable (Micco and Panizza, 2006; Galindo *et al.*, 2005; Dages *et al.*, 2000). The only study that has tried to account for the second conditional moment of the data, i.e. volatility, has done so using two-step methods, which are known to be inefficient (Morgan and Strahan, 2003). The method used in this paper deviates from the said empirical literature in that ARCH techniques will be applied to model jointly the first and second conditional moments of real domestic credit in Latin America. To the knowledge of the author, this is the first time that such tools are used to analyse the impact of foreign bank presence on macroeconomic volatility.

The sample of Latin American countries includes Argentina, Bolivia, Brazil, Chile, Costa Rica, Mexico, and Peru. A selection based on data availability. Information is quarterly and spans the period 1995:1–2001:4, for which a balanced panel is available. Banking information was kindly provided by the Inter-American Development Bank (IADB), while macroeconomic data come from the IMF's International Financial Statistics and national sources.

The use of panel data, that pools information together for different cross-sectional units, increases the amount of information and the power of econometric estimations. Nevertheless, the usual concerns about nonsense spurious regressions and misleading statistical inferences still arise when using potential non-stationary panels, in which the time dimension largely exceeds the number of cross-sectional units. Indeed, checking the unit-root properties of the variables is an ineluctable step in disentangling the effect that foreign banks may have on credit volatility in our sample of Latin American countries.

After checking for the presence of unit roots in the panel, a particular to general strategy is applied in order to estimate the final specification for the model. There is a preliminary identification of the presence of fixed effects in the mean and variance equation, testing for poolability of the data, and identification of the presence of ARCH effects in the conditional covariance equation. Indeed, I begin by estimating the mean equation by OLS and testing for the presence of fixed effects using a Chow test, assuming that the data are poolable. Once found the presence of fixed effects in the data, I proceed to test for poolability of the data. The next step consists in using the residuals of the previously estimated mean equation to test for the presence of fixed effects in the conditional variance equation. Once the model's specification has been determined, the first and second moments of the dependent variable are estimated jointly using maximum likelihood techniques, including different sets of explanatory variables in the variance equation.

Main results for the mean equation show that U.S. GDP and the Fed Funds Rate while having the expected signs, are insignificant at standard statistical levels in the econometric estimations, indicating that mainly pull factors–where foreign banks react to changes in the host country's economic environment–played a role in shaping credit behaviour. The lagged degree of financial development is highly significant, pointing that more developed financial systems today (proxying for a lower degree of financial imperfections), help to foster real private credit in subsequent periods. Banking variables including foreign and public bank presence and the degree of concentration of the sector do not seem to have a role to play in affecting the level of loans granted by the system. Only currency crisis are found to have the expected negative sign, while banking crisis do not have a statistically distinguishable effect on credit behaviour. This might be due to the fact that banking crises tend to coincide with deterioration in economic fundamentals, making their impact indistinguishable from other cyclical downturns. Regarding interaction terms, foreign banks do not seem to behave differently than national institutions, both in banking and currency crisis. Nevertheless, government owned banks do seem to have a stabilizing role on credit during banking crisis. A similar result is reported by Micco and Panizza (2006).

As previously mentioned, the variance in credit behaviour is modelled through an ARCH process that includes different sets of explanatory variables susceptible of having a burden on credit volatility. Testing is also run for a differential behaviour of foreign and state-owned banks during financial stress periods, by including in turn interaction terms between the dummies for banking crisis and foreign and public bank presence. In the present case, there does not seem to be such differential behaviour.

Going back to the revision of the theoretical literature presented at the beginning of the paper, it is demonstrated the lack of a definite answer to the question of whether foreign banks raise or reduce credit volatility. It all depends on the types of shocks hitting the economy, which are extremely difficult to isolate in practice. That is why in empirical work only an aggregate measure of foreign bank presence is included in the estimations. If stabilizing effects predominate, then the coefficient should be negatively signed and statistically significant at conventional levels. The opposite is of course true when foreign banks increase credit volatility. According to the empirical evidence presented in this chapter, foreign banks do seem to have contributed to reduce real credit volatility in the presented sample of eight Latin American countries over the period 1995-2001. The coefficient for foreign banks is negative and statistically significant at the 5% level, which is consistent with Dages *et al.* (2000) for Argentina and Mexico, who find that foreign banks exhibit lower volatility of lending than their domestically-owned counterparts, contributing to a lower overall credit volatility.

Of course, it can be argued that foreign bank presence could just be capturing the degree of development of the financial sector, or a more concentrated banking system. The reported evidence shows that deeper banking systems indeed result in lower credit volatility, but the impact is independent from the presence of foreign banks. This finding is coherent with Denizer *et al.* (2002) for other macroeconomic variables, like GDP, consumption and investment. Even including concentration among the explanatory variables in the conditional variance, the previous findings are not modified. The diagnostic tests performed on this and the other models show that we can be pretty confident about the specification of the econometric equations.

To sum up, the evidence presented in Chapter 4 shows that, together with financial development, foreign bank presence has contributed to reduce real credit volatility, improving the buffer shock function of the banking sector in Latin America. This finding is consistent with foreign institutions holding higher quality assets, because of superior risk management systems, better screening devices and home country supervision. It is also grounded on the fact that they are typically well diversified institutions with access to a broad set of liquidity sources as well as having the potential to avoid capital flight in case of negative domestic shocks.

Part 1

Monetary Policy and Sovereign Risk

CHAPTER 1

Recovery Values Estimates: Evidence from Argentina

1.1. Introduction

Credit Risk is the risk due to uncertainty in an obligor's ability to meet its financial obligations. Default occurs when an obligor actually fails to meet its obligations. Thus, the key motivating element for literature addressing Credit Risk Models is the need to manage this risk, a factor affecting almost every financial contract. Literature in this field was initially developed for valuing risky corporate debt and has rapidly grown over the last three decades. More recently, significant attention has been dedicated to this literature by international regulatory agencies, academic and financial institutions due to the Basel Committee's objective related to reform the capital adequacy framework by introducing risk-sensitivity capital requirements. The models covering this literature can be divided into two main groups.

The first group, named Credit Pricing Models, includes two broad categories of academic models. The first category is given by Structural-Form Models with a main purpose to price the firm's liabilities. The later are considered as contingent claims issued against the total value of the firm's assets. Consequently, the key issue is to model the firm's value (the evolution of the firm's market value) and the firm's capital structure. Default occurs when the value of a firm's assets is lower than that of its liabilities. Then, the default risk of the firm is therefore explicitly linked to the variability of the firm's asset value. Under this theoretical framework, the recovery rate (RR) is an endogenous variable; hence, the probability of default

(PD) and RR tend to be inversely related. This is important because it links the default events to the evolution of the firm's capital structure as well as to its market fundamentals.

This category of model was pioneered by Merton (1974) who used the principles of option pricing (Black and Scholes, 1973). Merton derived an explicit formula for risky bonds useful to estimate the Probability of a firm to default and the Credit Spread –i.e. yield differential between a risky bond and a default-free bond.[1]

However, structural-form models have poor empirical performance explained as follows. So as to use this technique, the complex priority of the payoffs structure of all the firm's liabilities need to be specified and included in the valuation procedure. What is more, they still require estimates for the parameters of the firm's asset value, which in practice are neither tradeable nor observable. Finally, most of the models assume that the firm's value is continuous in time and so the time of default can be predicted just before it happens and hence, the PD of a firm will be known accurately.

The second category is given by the Reduced-Form Models pioneered by Jarrow and Turnbull (1995), and Duffie and Singleton (1999). In this approach, the value of the firm's assets and its capital structure are not modelled at all, being its main advantage that parameters related to the firm's value need not be estimated to implement the model. In the event of default, the RR is exogenous and independent from the firm's asset value.

Reduced-Form Models take as primitives the behaviour of default-free interest rates, the RR of defaultable bonds at default, as well as the assumption about the process for default intensity.

These models are fundamentally empirical, using observable risky debt prices (or credit spreads) in order to ascertain the stochastic jump process governing

[1]As a consequence, Structural-Form Models are sometimes referred to as the "option-theoretic approach" or "the firm value approach".

default. These dynamics determine the price of the credit risk. And so, in each time there is some probability for a firm to default on its obligations. These models decompose observed credit spreads on defaultable debt to find out both the PD (conditional on there being no default prior to time t) and the LGD (which is 1-RR). Different assumptions are used to disentangle the PD from the LGD in the observed credit spread. Reduced form models decompose observed credit spreads to detect default probabilities. Then, PD is modelled using the stochastic intensity function that best fits the yield curve data. Other models treat defaults as unpredictable Poisson events and so the time at which default may occur cannot be predicted on the basis of the available information.

Reduced-form models somewhat differ in the manner in which the RR is formalized, unless the following three possible alternatives are distinguished. Recovery of market value (RMV) assumes that the recovery rate is a known fraction of the bond's market value just prior to default (see Duffie and Singleton, 1999). Recovery-of-treasury (RT) assumes that, at default, a bond would have a market value equal to an exogenously specified fraction of an equivalent default-free bond (see Jarrow and Turnbull, 1995). Recovery-of-face value (RFV) assumes that the creditor receives a (random or fixed) fraction of face value immediately upon default. These models assume that bonds of the same issuer, seniority, and face value have the same RR at default, regardless of the remaining maturity (see Duffie, 1998).

The second group of models, known as Portfolio Credit Value-at-Risk (VaR) models, were developed during the second half of the 1990s by banks and consultants. Credit VaR models can be considered as reduced-form models–all credit VaR models treat RR and PD as two independent variables. The RR is usually taken either as an exogenous constant parameter or a stochastic variable (independent from PD).[2] The main difference is that VaR models intend to measure potential losses, with a predetermined confidence level that a portfolio of credit exposures may suffer within a specified time horizon (generally one year). The main output of a VaR model is the probability density function (PDF) of the future losses on a credit portfolio. However, this is not so useful for credit risk measurement because the distribution of credit losses is usually highly asymmetrical and fat-tailed. As a consequence, the probability of large losses is higher than the one associated with a normal distribution. Credit VaR models can also be divided into two types of models; the Default Mode (DM) Models and Mark-to-Market (MTM) Models which are quite similar indeed. The main difference is that whereas the DM model adopts a binomial approach (default and survival) the MTM models allow for all possible changes in the borrower creditworthiness, technically called "credit migrations". As a consequence, in this model losses also arise when credit migrations occur. Thus, for MTM models, the entire matrix of credit transition probabilities must be computed in addition to the default probability for default mode models. Both methodologies rely heavily on the availability of market information, limited in the case of DM models and much wider in the case of MTM models, such as a complete rating transition matrix.

In order to implement these models and arrive to the all-important Loss-Given-Default (LGD) input (or its complement, the RR), most Credit Risk models utilize historical empirical average. Usually referred to as "Ultimate Recovery Rates" to the nominal or discounted value of bonds (or loans) based on the securities' price (or the value of the package) at the end of the restructuring period –also called, post-defaults recoveries. Alternatively, it is also considered the Weighted-Average Recovery Rate based on market price just after the date of default. This Recovery

[2]Some of these models, such as CreditMetrics, CreditPortfolioView and CreditPortfolioManager, treat the RR in the event of default as a stochastic variable –generally modeled through a beta distribution –independent from the PD. Others, such as CreditRisk+, treat it as a constant parameter that must be specified as an input for each single credit exposure.

Rates are documented by credit rating agencies (Moody's, S&P and Fitch) as well as by scholar.[3] For instance, Altman and Pasternack (2006) have compiled the weighted-average recovery rate on high-yield US bond market by seniority for the period 2000-2005 (see Table 1.1).

Table 1.1: Weighted Average Recovery Rates on Defaulted Debt by Seniority per $100 Face Value from 2000 to 2005

Default Year	2005	2004	2003	2002	2001	2000
Senior Secured	76.50	63.67	53.51	52.81	40.95	39.58
Senior Unsecured	45.88	56.77	45.40	21.82	28.84	25.40
Senior Subordinated	32.67	37.44	35.98	32.79	18.37	25.96
Subordinated	0.00	0.00	38.00	0.00	0.00	26.62
Discount and Zero Coupon	14.86	43.06	32.27	26.47	15.05	23.61
All Seniorities	60.55	57.72	45.78	26.25	25.62	26.74

Sources: Altman and Pasternack (2006)'s compilations from various dealer quotes.

It shows an increase to 60.55% in 2005 from the 57.72% in 2004. This is substantially higher than the average 25% in the early 2000s. The usual hierarchy of recoveries by seniority held in 2005 with the weighted-average recovery of senior-secured bonds at 76.50%, the senior-unsecured group at 45.88%, senior subordinated at 32.67% and discounted bonds 14.86%. The two most senior classes had higher recovery rates than historical averages and medians, while the senior subordinated class achieved merely average recoveries. Once again, there were no subordinated bonds, a seemingly extinct variety.

Regarding sovereign bond markets there is much less empirical evidence on average-recovery rates than on corporate bonds. In addition, average-recovery rates on sovereign bonds can not be directly replaced by average-recovery rates on corporate bonds in order to estimate their probability of default. It is worth

[3]Recovery Rates are released for bonds and loans stratified by seniority. The last asset class can additionally be stratified by collateral type.

noticing some differences between both types of assets. For example, developing countries are more stable than corporations, they have longer-term economic planning, they do not default as frequently as corporations do, they are fewer in number and they do not typically disappear. Moreover, sovereign bonds from developing countries are issued in countries such as the United States of America and the United Kingdom, under completely different legal jurisdictions and capacity of enforcement if compared with corporate bonds. Consequently, sovereign bonds are not evenly comparable with corporate bonds.

As a consequence, sensitivity analysis is generally used to estimate the Implied Probability of Default (IPD). Sturzenegger (2004) applies a reduced-form model assuming a multiperiod bond with a probability of default modelled by a Poisson process. Appendix 1.A. presents IPD estimations for different assumptions regarding recovery values and credit spreads; given a risk free interest rate.

However, this method entails conjectures about the recovery rate and the size of spread in the faced of evidence provided by earlier crises. Thus, analysts are grounded on the data evidence generated by earlier international crises, such as those of Mexico (1995), Russia (1998) and Brazil (1999). Yet, this empirical evidence results from different bond temporal term structures; and hence from different bond durations when compared to those of the analyzed bonds. Moreover, this evidence does not consider the particular macroeconomic conditions of the country subject to analysis.

To avoid these disadvantages, this research applies a model, originally presented by Merrick (2001) to simultaneously and consistently estimate the two determinants embedded in Argentine sovereign bond prices. Knowledge of both bond prices determinants–the implied recovery value and the default probability–enables us to anticipate both the value and the risk of their assets.

This chapter is organized in four sections. Section II presents a brief summary of the events preceding the Argentine crisis in 2001. Section III presents the model, the estimation strategy and the data, Section IV presents and analyses the estimation results. Section V concludes with a brief discussion.

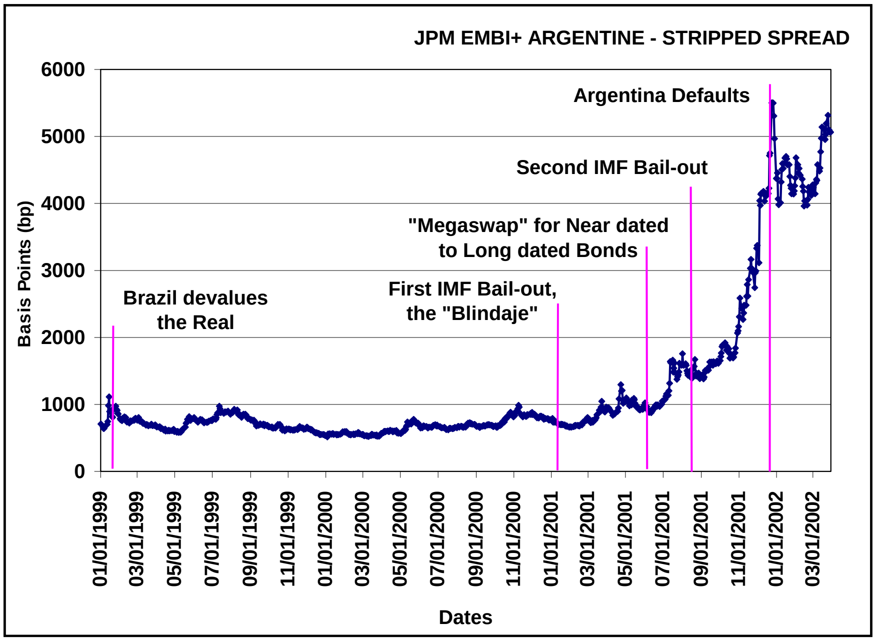
1.2. Events Preceding the Crisis

Before presenting the model, it is worth looking at the most important events preceding the Argentine crisis in December 2001. In August 1998, Russia defaulted on their public debt depriving Argentina of access to the international capital market. Five months later, Brazil devalued their currency causing Argentina's competitiveness in foreign markets to deteriorate. The economy sank into recession with twin deficits–a trade balance gap and a fiscal budget gap–which foreigners were less and less willing to finance. The Argentine economy needed to regain competitiveness but as the exchange rate could not be devaluated due to government policy, prices and wages finally dropped. In December 1999, after a general election, Mr. De la Rúa was elected president but the new political structure was too weak to face the strong political change necessary to overcome the crisis.

As a consequence, the peso quotation edged downwards, tax revenues faltered and Argentina's debts in US dollars became harder to repay. In spite of this, Argentina refused to fold and kept raising the stakes. At the beginning of 2001, Argentina requested a USD 15 billion loan from the IMF, which was known as "blindaje" ("armour"). In order to buy some time, in June 2001, the country completed the notorious "megaswap" in which near-dated securities were exchanged for longer-dated securities, higher-yielding bonds. In August 2001, Argentina received a second $8 billion bail-out. Finally, political turmoil and lack of further assistance from multilateral institutions drove Argentina into default in December 2001 (see Graph 1.1).

Graph 1.1: Argentinean Sovereign-Debt Spread.

Relevant Pre-Default Events. Period: January 1999 –February 2002



1.3. The Model

This section presents the pricing framework for T-period sovereign bonds made up of four elements. The first element is the bond structure composed by coupons and the principal. Thus, let C_t denotes the amount of the coupon paid in period t where $t = 0, ..., T$ and F_T the face value of the principal paid on the due date, period T.

The second component is the implied recovery value. This model follows the same formulation as Duffie (1998) which assumes that, at default, the holder of a bond of a given face value receives a fixed payment, irrespective of the coupon level or maturity, and the same fraction of face value as any other bond of the same issuer.[4] The model works on the assumption that if the fiscal authority defaults on the public debt, then coupon payments become definitely interrupted but investors immediately receive a fixed fractional recovery value of the promised principal denoted as R.[5] The third element is the risk-neutral payment probability distribution.[6]

Let P_t denotes the cumulative probability of no default between the issue date and date t. So, it represents the timely payment probability of a promised date t cash flow. Before stating the cumulative probability of no default, P_t, we must define the risk-neutral default probability, denoted as δ_t. Previous research, such as the one made by Fons (1987) and Bhanot (1998), defined a time independent default probability. They assumed a constant δ_t along the time. Our proposal, as of Merrick's (2001), understands that for the particular case of Argentina during the last quarter 2001, δ_t should be represented as an increasing linear function with respect to time, t. This assumption registers the fact that in that critical period, the probability of default is greater as the deadline of the coupons and the amortisation become closer in time. Formally,

$$\delta_t = \alpha + \beta . [t] \tag{1.1}$$

[4]For the case of corporate debt, this formulation allows to use recovery parameters based on statistics provided by rating agencies such as Moody's, Fitch and Standard & Poor´s, like those presented on Table 1.1.

[5]All the market values are expressed for each USD 100 face value. Thus, the estimation results could either be called recovery rate or recovery value.

[6]This chapter makes reference to risk-neutral probabilities. This is a common assumption in this literature. Nevertheless, if risk premium predominates the actual default probability will be smaller than the risk neutral default probability.

where the alpha, α, defines the current probability of default, called base default probability, and beta, β, allows to draw the temporal term structure of the probability of default at each date t. Then, the cumulative probability of no default, P_t, can be defined as $P_t = (1 - \delta_t)^t$. Using equation (1.1), P_t remains expressed as

$$P_t = (1 - (\alpha + \beta. [t]))^t \tag{1.2}$$

where parameters α and β are restricted so that P_t is always less than or equal to one and greater or equal to zero. The probability of default during the specific date $(t-1)$ to date t becomes defined as

$$p_t = P_{t-1} - P_t \tag{1.3}$$

and so, p_t expresses the probability of receiving the recovery value R on any date t.[7] Finally, the fourth element is the risk-free discount factor for a time t cash flow, noted by f_t.

After describing the four elements, we are in a better position to introduce the pricing equation. First, let V_0 denotes the current market value of a sovereign bond with maturity in period T. Then, the bond value is defined as the sum of its expected cash flows (coupons, the principal, and recovery value) multiplied or weighted by their probability of occurrence. Formally,

$$V_0 = \sum_{t=1}^{T} \{P_t.f_t.C_t\} + \{P_T.f_T.F_T\} + \sum_{t=1}^{T} \{p_t.f_t.R\} \tag{1.4}$$

The current value of the bond is viewed as the probability-weighted sum of the coupon flows, the principal and the recovery value.

[7]Alternatively, the probability of receiving a promised date t coupon payment, P_t , can be expressed as: $P_t = 1 - \sum_{s=0}^{t} p_s$ where $s = 0$ especifies the issuing date.

Expressing the pricing equation in these terms implies that the asset risk becomes captured by weighting each contingent cash flow by its probability while they are discounted at the risk-free rate. Otherwise, the asset risk is generally enclosed in the discount factor.

Finally, using equation (1.2) and (1.3), equation (1.4) remains expressed as,

$$
\begin{aligned}
V_0 = &\sum_{t=1}^{T} \left\{ (1-(\alpha+\beta.(t)))^t .f_t.C_t \right\} \\
&+ \left\{ \left(1-(\alpha+\beta.(T))^T\right) .f_T.F_T \right\} \\
&+ \sum_{t=1}^{T} \left\{ \left[(1-(\alpha+\beta.[t-1]))^{t-1} - (1-(\alpha+\beta.[t]))^t \right] .f_t.R \right\}
\end{aligned}
\tag{1.5}
$$

Equation (1.5) makes explicit the three unknowns, R, α and β we are interested to estimate.

1.3.1. Estimation Strategy

First, let $\widehat{V}_{i,0}$ denotes the estimated value of the bond defined by substituting the three unknown parameters (R, α, β) for its estimations ($\widehat{R}$, $\widehat{\alpha}$, $\widehat{\beta}$) into equation (1.5).

Second, it is considered a cross-section of I outstanding bonds at date $t = 0$ indexed by the subscript i where $i = 1, ...I$. Then, the sum square of residuals (SSR) at date $t = 0$ is defined as

$$
SSR_0 = \sum_{i=1}^{I} \left(V_{i,0} - \widehat{V}_{i,0} \right)^2 \tag{1.6}
$$

where $V_{i,0}$ denotes the market value of the ith bond at date $t = 0$ and $\widehat{V}_{i,0}$ denotes the estimated market value of the same bond.

Finally, the date $t = 0$ estimation can be achieved through the value of $\widehat{R}$, $\widehat{\alpha}$ and $\widehat{\beta}$ which minimise equation (1.6) subject to the cross-section average of the bond pricing residual equalised to zero, which can be expressed as

$$\left(\frac{1}{I}\right)\sum_{i=1}^{I}\left(V_{i,0}-\widehat{V}_{i,0}\right)=0 \tag{1.7}$$

The model implicitly assumes that the bonds have a cross-default clause. This means that, if one of the bonds is not longer paid then all the bonds are considered in default. Consequently, there is an implied representative recovery value and a joint probability of default for all bonds –and so, the economy as a whole.[8]

The three unknowns are estimated by minimising the sum square of residuals (SSR) –equation (1.6) –subject to the average sum of errors –equation (1.7) – equalised to zero. The estimations are carried out using a solver that applies the Generalised Gradients Method.[9]

The estimations were computed using an algorithm of non-linear optimisation subject to non-linear constraints. Thus, the global solution cannot be guaranteed by the convergence algorithm applied by this method. This is a general problem with algorithms in non-linear optimisation. However, it is found that experimentation with alternative initial guesses produce the same results.

The estimations are based on the most representative sovereign bonds of the economy –i.e., the short, medium, and long term bonds which have been most actively traded–as detailed below.

[8]This is a realistic assumption for this case because the Argentine sovereign bonds used throughout this chapter are subject to a cross-default clause.
[9]In this chapter, we have used the Solver included in Microsoft Office Package.

1.3.2. The Data

The period subject to analysis spans from October 1st to December 28th, 2001, and is based on the 5 most liquid (and traded) Global Bonds, denominated Eurobonds, covering short, medium and long maturities. These bonds have a fixed rate, with six-month coupons and amortisation in the end. These characteristics are detailed on Table 1.2.

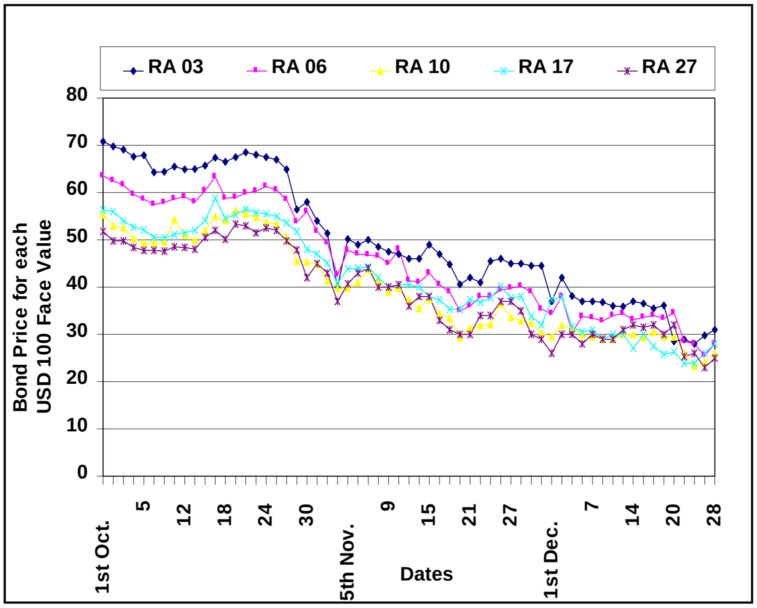
Table 1.2: Sample of US-Dollar denominated Eurobonds

Name	Issue Date	Maturity Date	Coupon (%)
Arg. 03	20-Dec-1993	20-Dec-2003	8,375
Arg. 06	09-Oct-1996	09-Oct-2006	11,000
Arg. 10	15-Mar-2000	15-Mar-2010	11,375
Arg. 17	30-Jan-1997	30-Jan-2017	11,375
Arg. 27	19-Sep-1997	19-Sep-2027	9,750

These bonds are not guaranteed. They have a cross-default clause and are issued under the jurisdiction of English Courts in London. The estimations are based on daily prices supplied by the Argentine Secretary of Finance of the National Ministry of Economy.

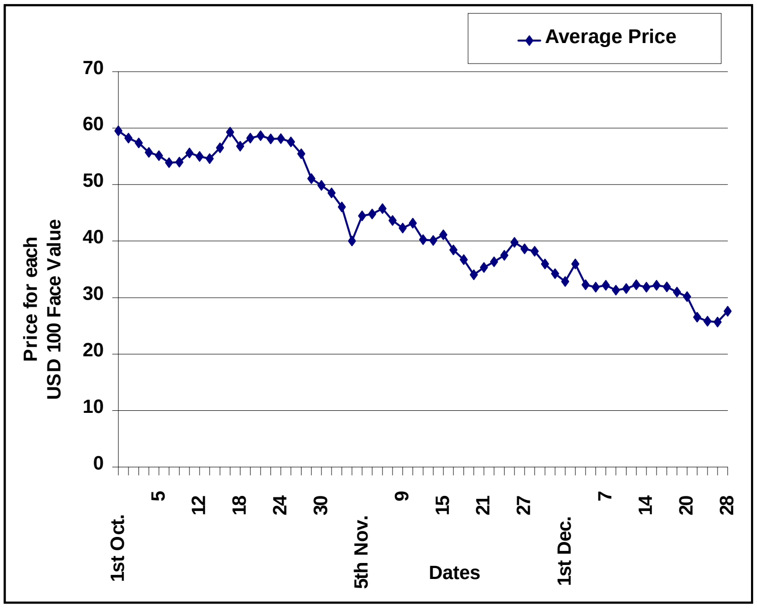
Graph 1.2 shows daily prices for five bonds already described as the most representative of the economy for the period under analysis.

Graph 1.2 : Individual Bond Market Prices



Graph 1.3 depicts, in turn, the average price of the five bonds.

Graph 1.3 : Individual Bond Market Prices

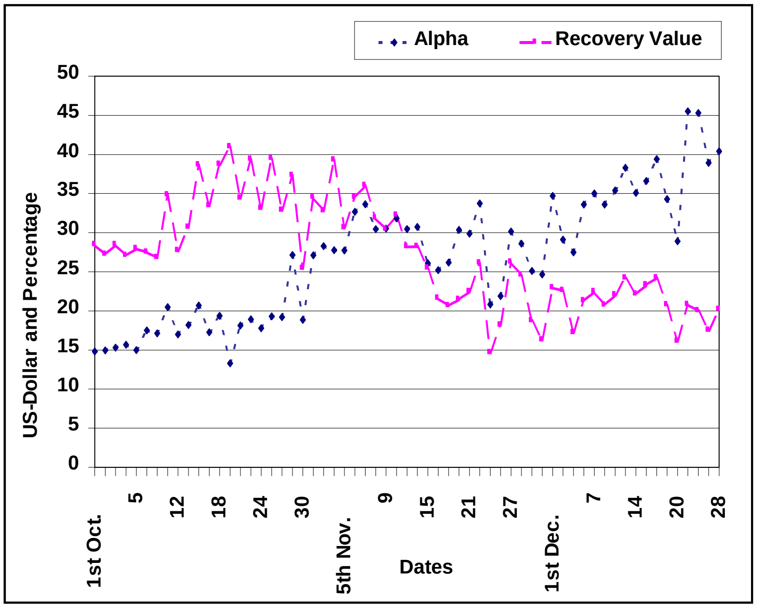


According to Graph 1.2 and 1.3, between October 1st and December 28th 2001, bond market values registered a downward trend. The average market value of the bonds fell from USD 59.5 to USD 27.6 for each USD 100 face value.

1.4. Estimation Results

This section presents the model estimations based on the aforementioned Eurobonds for the case of the Argentine crisis focusing on the fourth quarter of 2001. Both the implied recovery values and base default probabilities are depicted by Graph 1.4.

Graph 1.4: Estimated Recovery Values and
Base Probabilities of Default



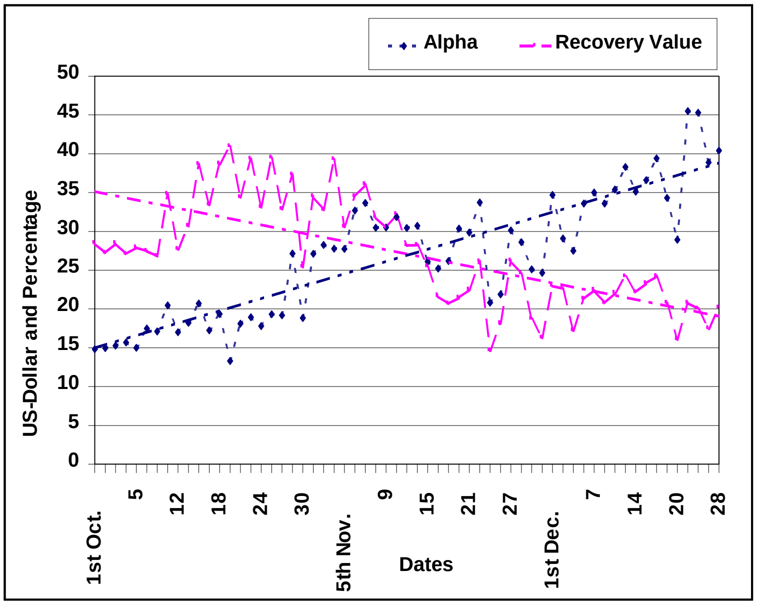
Graph 1.4 shows that the estimated recovery value fell from USD 28.5 to USD 20.1, reaching its maximum level, USD 40.9, on October 19th and its minimum level, USD 14.6, on November 23rd. Simultaneously, the base default probability registered an increase from 14.8% to 40.4% reaching its maximum level, 45.5%, on December 21st and its minimum, 13.3%, on October 19th.

It should be noted that the estimations made for October 19th suggested a maximum level for the recovery value at USD 40.9 and a minimum base default probability of 13.3%. On the other hand, on December 21st the base default probability registered its maximum level, 45.5%, while the default recovery value remained one of the lowest in the sample, USD 20.8. Both embedded determinants become relevant in explaining bond market value volatility while they seem to follow a negative correlation.

Graph 1.5 shows the estimation results depicting linear trend lines.

Graph 1.5: Estimated Recovery Values and

Base Default Probabilities –with linear trendlines



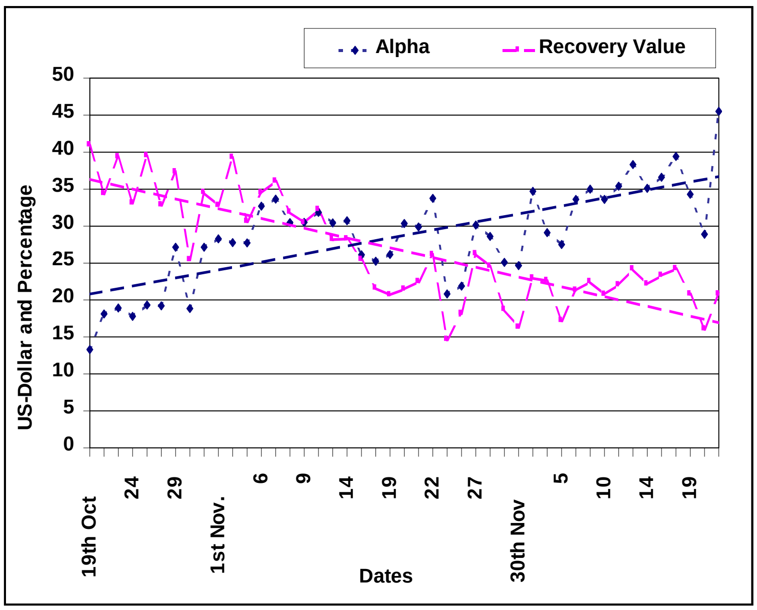
On October 19th 2001, the average market value of the five bonds reaches its maximum level within the analysed period (see Graph 1.3 and Table A.3 in Appendix 1.C). Then, considering the period extending from October 19th to December 21st, along which bond market values registering a downward trend, it is possible to observe that implied recovery values start at USD 40.9 for each USD 100 face value to descend to USD 20.8 whereas base default probability starts at 13.3% to reach 45.5%.

To sum up, the increase in bond market values was accompanied by an increase in implied recovery values and a fall in implied default probabilities. Conversely, the reduction in bond market values was accompanied by a drop in implied recovery values and an increase in implied default probabilities (see below Graph 1.6.a and 1.6.b).

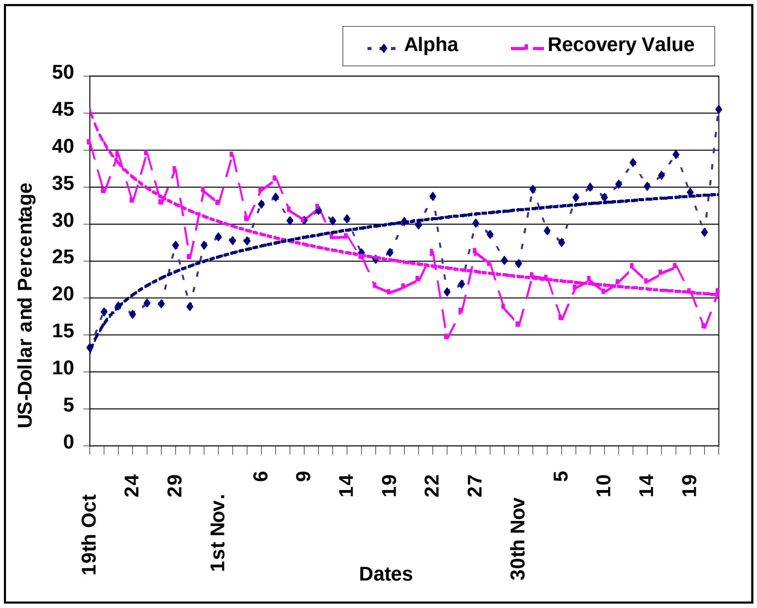
Graph 1.6: Recovery Values and Base Default Probabilities

Period: October 19th –December 21st, 2001

Graph 1.6.a: Linear Trendline



Graph 1.6.b: Logarithmic Trendline



All estimated betas are equal to zero even considering two or more digits after the comma (so these estimates are not reported).[10] See Appendix 1.B which presents an example that shows the estimated results ($\widehat{R}$, $\widehat{\alpha}$, $\widehat{\beta}$) based on the market values of the five sovereign bonds for October 1st, 2001. All the data and estimation results for 2001:Q4 are presented on Appendix 1.C.

Consequently, the estimations provided by the model enables the individualisation of the parameters $-R$, α and β $-$ruling over market prices.

1.4.1. Interpretation of Results

For a proper interpretation of the data, it is important to place the model into its political and time environment. Here follows a brief chronicle of the events leading to the crisis: on December 20th, the Minister of Economy and the President, Dr. Fernando De La Rúa submitted their resignation. On December 21st, the president

[10]This finding is very similar to those presented by Merrick (2001) detailed later on.

of the Senate, Dr. Ramón Puerta, takes over provisionally for a 48-hour period. On December 23rd, Dr. Adolfo Rodríguez Saa is appointed as President. On December 24th, he announces the country's insolvency at a special session of the National Congress.

Market information produced, between December 10th and December 28th, before and after the official announcement of the default, is presented on Table 1.3.

Table 1.3: Estimated Parameters before and after Defaulting

Date	RA 03	RA 06	RA 10	RA 17	RA 27	Average Price	Recovery Rate	RRS
10 Dec	36,8	32,8	29,0	29,0	29,0	31,3	20,7	8,2
11 Dec	36,0	34,0	29,0	30,0	29,0	31,6	22,0	9,0
12 Dec	35,9	34,4	30,1	30,0	31,0	32,3	24,2	10,3
14 Dec	37,0	33,1	30,0	27,1	32,0	31,8	22,2	28,6
17 Dec	36,5	33,6	29,4	30,0	31,5	32,2	23,3	7,0
18 Dec	35,5	34,0	30,5	27,5	32,0	31,9	24,2	28,8
19 Dec	36,1	33,4	29,5	25,8	30,0	31,0	20,8	35,5
20 Dec	28,5	34,5	29,5	26,3	32,0	30,2	16,1	*161,8*
21 Dec	28,9	28,5	26,0	23,9	25,3	26,5	20,8	17,1
26 Dec	28,0	28,0	23,3	23,9	26,0	25,8	20,0	9,4
27 Dec	29,8	25,5	24,0	26,0	23,0	25,7	17,5	5,4
28 Dec	31,0	28,0	26,0	28,0	25,0	27,6	20,2	5,1

These data and estimations show that on December 21st –the day after the resignation of the Minister of Economy and the President–the average of the bond market value adjusted falling from USD 30.2 for each USD 100 face value to USD 26.5. At that time, average market price reduction reached 11.7% overnight. However, on December 26th –after the official announcement of the default–average market price fell from USD 26.5 to USD 25.8; just a 2.6% reduction. This makes this research assume that Argentina actually defaulted on December 20th, 2001 instead on December 26th, 2001.

The average market values registered as from December 21st–the date investors consider that Argentina defaulted–become the actual recovery values of the Argentinean sovereign debt.[11]

According to the market values and model estimates, ones should expected a drop in the average market value from USD 30.2 to approximately USD 21.7 between December 20th and December 21st. Nonetheless, the average market value only drops up to USD 26.5. This might be due to the unexpected length of the debt restructuring period and the surprisingly high debt haircut.[12] Then, prices continued to gradually decrease until stabilised at USD 20 in March 2002.

Note that the estimated recovery value recorded on December 20th registered a three-digit square residual suggesting that this particular estimation is not as accurate as the others (see Table 1.3). Consequently, in order to obtain a better approximation for this value, we take the average value of the estimated recovery values for the pre-default period; i.e. between December 10th and December 19th. This average value amounts to USD 22.5.[13]

The relevant data and estimation results before and after the market adjustment can be summarised as follows:

Pre-default Period: December 10th -December 20th		
Data	**Maximum - Minimum**	**Average**
Average Price	USD 32.3 - USD 30.2	USD 31.5
Recovery Value (1)	USD 24.2 - USD 20.7	USD 21.7

Post-default Period: December 21st -December 28th		
Data	**Maximum - Minimum**	**Average**
Average Price (2)	USD 27.6 - USD 25.8	USD 26.4
Recovery Value	USD 20.8 - USD 17.5	USD 19.6

[11]It must be recalled that the recovery value is the amount paid to the bondholder immediately after defaulting. Thus, the recovery value can interpreted as the expected present value of cash flows which are going to be reprogrammed (See: Merrill Lynch, March 2000).

[12]The renegotiation process took a three-year period and the haircut was two times higher than previous default events.

[13]Given that the average market price on December 20th registers USD 30.2, less than the prices registered between December 10th and December 19th (USD 31.0 - USD 32.3), the recovery value implicit in that price should be marginally smaller than USD 22.48 but in no case close to USD 16.08.

Comparing market values registered in the post-default period –the actual recovery values–to the implied recovery values estimated in the pre-default period, it results that

Data	Maximum - Minimum	Average
The difference: (2) – (1)	USD 5.1 - USD 3.4	USD 4,7

The model estimations suggest that, on the average, Argentine sovereign bonds were overvalued by approximately USD 4.7 –in a range between USD 5.1 and USD 3,4–that is, by 21.7%.

1.4.2. Lessons From the Empirical Evidence

Comparing the estimation results to Merrick's, it appears that the estimated recovery values registered in Russia, before their currency devaluation and the announcement of default, were very similar to those of Argentina in 2001 facing the same scenario. On average, these values were USD 27.3 and USD 21.5, respectively. Under these circumstances, both countries registered a country risk premium ranging from 5000 basic points to 6000 basic points. Nevertheless, during the Russian crisis, in 1998, Argentina preserved a significantly superior level of recovery, if compared to Russia in August 1998 or to Argentina itself in December 2001. In the context of the Russian crisis, Argentina registered a country risk premium which ranged from 600 basic points to 750 basic points and a USD 51.2 average recovery value. This approximately doubled the value registered by Russian and Argentine sovereign bonds in the scenario of local crisis. Sovereign bonds from emerging countries facing unstable macroeconomic conditions suffer a significant reduction in their recovery value which amounts to approximately 50% when compared to bonds issued in countries facing stable macroeconomic fundamentals and a stable currency value, as was the case of Argentina in August 1998. The following Table summarises the data:

Average Estimated Recovery Values		
Crisis	**Russia**	**Argentina**
August 1998	USD 27,3	USD 51,2
December 2001		USD 21,7

Between July 23rd and August 14th, 1998, the base default probability–parameter α–in Russia recorded an increase from 5% to 45%, whereas in Argentina it recorded an slightly increase from 5% to 15%. This contrasts with the increase estimated in this chapter between October 19th and December 20th, 2001. The base default probability increased from 13% to 34% with a maximum (39%) on December 18th, 2001. In the three scenarios, parameter β remains close to zero.[14]

Empirical evidence suggests that significant reductions on recovery values are explained by the increasing current probability of default when bond market values record negative trends. The temporal term structure seems not to play a significant role.[15]

These levels of recovery could be compared with the corporate recovery values. The recovery value estimated in this chapter for Argentina on December 2001 (USD 21.7) is similar to recovery values of Senior Subordinated corporate bonds (18,4) for the same year (see Table 1.1).[16]

Considering total averages and the medians for the period 1978 through 2005, the recovery values estimated for Russia in August 1998 (USD 27,3) and Argentina in December 2001 (USD 21,7) are lower than that of Subordinated Corporate Bonds. However, the estimated recovery value for the case of Argentina in August 1998 (USD 51,2) was much closer to that of Senior Secured corporate bonds (USD 57,4) and much higher than Senior Unsecured bonds (see the Table below).

[14]Between July 23rd and August 14th, 1998, the parameter β recorded a mean of 0,0072 for the Russian case and 0,0063 for the Argentine case. In the case of Argentina 2001, the parameter β is also equal to zero up to the second decimal. Estimated recovery values and base default probabilities remain unchanged even running the solver by letting β to become negative.

[15]It is worth notice that both Russian and Argentinean recovery values and default probabilities were estimated as of US dollar-denominated Eurobonds and using the same methodology in all cases presented in this research, making them trusted comparables.

[16]Note that 2001 recorded particularly low recovery values for all seniorities.

Weighted Average Recovery Rates on Defaulted Debt by Seniority Per $100 Face Amount, 1978–2005						
	Senior Secured	Senior Unsecured	Senior Subordinated	Subordinated	Discount and Zero Coupon	*All Seniorities*
Total Average	58.78	36.22	30.21	31.06	21.91	*36.89*
Median	57.42	43.97	32.73	29.69	18.25	*41.22*
Sources: Extracted from Altman and Pasternack (2006)'s compilations from various dealer quotes.						

The same evidence is observed by both Sturzenegger (2004) and, Sturzenegger and Zettelmeyer (2006) after comparing the estimated recovery values presented in this chapter for the case of Argentina 2001 with those recorded by Jarrow *et al.* (1997) for the case of US corporate bonds between 1974 and 1991.

1.4.3. The Argentinean Debt Haircut: An Assessment

Based on the recovery value estimated through the model (USD 21,7) and assuming a 70% haircut over the principal of the Argentine debt, it turns out that Argentina would have overcome its default by paying a country risk premium of around 1960 basic points –assuming a 2% risk-free interest rate and preserving the current bonds structure –whereas Russia did it by paying 1000 basis points. This result implies that the Argentine restructured bonds would have paid an average annual rate of return of 21.6%. And so, the country risk spread would have reached 19.6% (1960 basis points). The following Table summarises the input data and the results:

Set of Assumptions		**Results**	
Estimated Recovery Value	USD 21,7	Average Annual Rate of Return	21,6%
Debt Haircut	70%		
Bond Term Structure	Constant		
Risk-free Rate	2%	Country Risk Spread	1.960 bp

Such a high country risk premium after debt restructuring, calls for a debt haircut consistent in the long-term. This result suggests that a haircut that applies not only to face value but to the interest rate coupons and the maturity term structure should be fully justified.

Finally, after a three-year period of renegotiation, creditors accepted the Argentine offer taking a 65% loss over the principal –twice the average haircut in recent sovereign defaults –and 75% considering the net present value of the sovereign debt. In other debt restructuring processes, creditors had to accept either a cut in the principal, a lengthening of maturity, or a reduction in interest payments. Argentina has achieved all three offering a 42-year bond. [17]

After the swap, the Argentine debt amounted to 80% of GDP remaining higher than the 52% debt run by its neighbour, Brazil. But the interest burden on Argentine debts were considerably lighter and the maturity schedule more flexible –the coupons in Argentina were between 2% and 5% during the first ten years compared to 10% in Brazil.

1.5. Conclusion

This chapter has provided new empirical evidence by decomposing bond market values in its implicit determinants. These estimates help find out and evaluate investors' perception over macroeconomic conditions as well as the government's ability to overcome a possible crisis.

The table below shows some macroeconomic data registered after the crisis:

Country	Exchange Rate* (and Variation)			
	Before Devaluation	After Devaluation		
		A Month After	A Year After	Two Years After
Russia 1998	6.29	16.06 (155,3%)	17.00 (293,5%)	27.77 (72,9%)
Argentina 2001	1.00	2.15 (115,0%)	3.37 (237,0%)	2.95 (195,0%)
Argentina 1998	1.00	1.00 (0,0%)	1.00 (0,0%)	1.00 (0,0%)

*Local Currency to US Dollar

When analysing macroeconomic conditions by means of the exchange rate devaluation, data suggest that countries recording low implied recovery values and high current probability of default have witnessed deep deterioration in their local currency in the years following the crisis. The opposite seems to prove for countries registering high implied recovery values and low current probability of default.

[17]Once the negotiation process came to an end, the take-up was 75%.

Extending this research to test the contagious effect over the Brazilian economy, data show in the month preceding and following Argentine default, the average market value was never inferior to USD 85 for every USD 100 face value.

However, three months previous to the Argentine default, during the week extending from October 2nd to October 10th, 2001, bond market values stood on average at USD 80. At that time the average estimated recovery value was USD 67.9 and the base default probability 1.45%. Almost 100% of the volatility affecting the market values of the Brazilian bonds was fully explained by the volatility of the implied recovery value, whereas the base default probability remained close to zero. This result provides evidence suggesting that the Argentine default did not affect the macroeconomic fundamentals of Brazil, therefore, their sovereign debt.

When market values of sovereign bonds are deeply stressed –say, low enough – the model is particularly relevant in explaining the trends concerning bond market values by means of both implicit determinants: the implied recovery value and default probabilities. On the contrary, when market values are relatively high, model estimates reveal an almost null and void probability of default. Whereas price fluctuations become traduced through the implied recovery value as it seems to be the case of Brazil on 2001:4. The market value of the Brazilian bonds never reached such low levels as those registered in Argentina in December 2001 or Russia in August 1998.

Appendix 1

Appendix 1.A: Sensitivity Analysis

The analysis assumes a risk-free rate of 7%. Similar tables can easily be estimated with a different assumption on the risk free rate.

Table A1: Implicit Probability of Default

Spread — in basis points i	7%								
	Recovery value (as a % of principal)								
	10%	20%	30%	40%	50%	60%	70%	80%	90%
50	0.5	0.6	0.7	0.8	0.9	1.1	1.4	1.9	3.1
100	1.1	1.2	1.4	1.6	1.8	2.2	2.8	3.8	5.9
150	1.6	1.8	2.0	2.3	2.7	3.3	4.2	5.6	8.6
200	2.2	2.4	2.7	3.1	3.6	4.4	5.5	7.3	11.2
250	2.7	3.0	3.4	3.8	4.5	5.4	6.7	9.0	13.6
300	3.2	3.6	4.0	4.6	5.3	6.4	8.0	10.6	15.9
350	3.7	4.1	4.6	5.3	6.2	7.4	9.2	12.2	18.1
400	4.2	4.7	5.3	6.0	7.0	8.3	10.4	13.7	20.1
450	4.7	5.2	5.9	6.7	7.8	9.3	11.5	15.1	22.1
500	5.2	5.8	6.5	7.4	8.6	10.2	12.6	16.5	23.9
550	5.7	6.3	7.1	8.1	9.4	11.1	13.7	17.9	25.7
600	6.2	6.9	7.7	8.7	10.1	12.0	14.8	19.2	27.4
650	6.7	7.4	8.3	9.4	10.9	12.9	15.8	20.5	29.0
700	7.2	7.9	8.9	10.1	11.6	13.7	16.8	21.7	30.6
750	7.6	8.4	9.4	10.7	12.3	14.6	17.8	22.9	32.1
800	8.1	9.0	10.0	11.3	13.1	15.4	18.8	24.1	33.5
850	8.6	9.5	10.6	12.0	13.8	16.2	19.7	25.2	34.9
900	9.0	10.0	11.1	12.6	14.5	17.0	20.7	26.3	36.2
950	9.5	10.5	11.7	13.2	15.1	17.8	21.6	27.4	37.4
1000	9.9	11.0	12.2	13.8	15.8	18.5	22.4	28.4	38.6
1050	10.4	11.4	12.7	14.4	16.5	19.3	23.3	29.4	39.8
1100	10.8	11.9	13.3	14.9	17.1	20.0	24.1	30.4	40.9
1150	11.3	12.4	13.8	15.5	17.8	20.7	25.0	31.3	42.0
1200	11.7	12.9	14.3	16.1	18.4	21.5	25.8	32.2	43.0
1250	12.1	13.3	14.8	16.6	19.0	22.2	26.6	33.1	44.0
1300	12.5	13.8	15.3	17.2	19.6	22.8	27.3	34.0	45.0
1350	13.0	14.2	15.8	17.7	20.2	23.5	28.1	34.9	45.9
1400	13.4	14.7	16.3	18.3	20.8	24.2	28.8	35.7	46.8

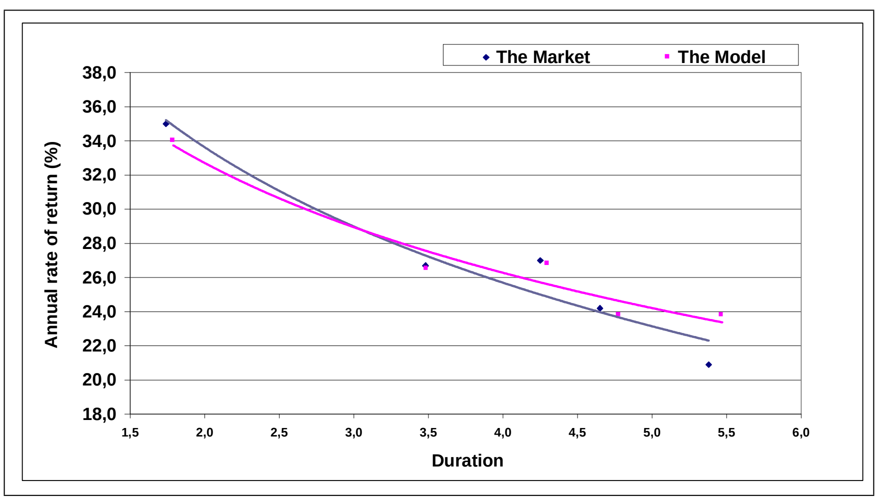
Source: Extracted from Sturzenegger (2004)

Appendix 1.B: Solver Results Sample

The data and the results produced by the Solver for a specific day are presented in the tables. This exercise was repeated for each day in the quarter analysed. Tables and Figure Sample for October 1st 2001.

The Data			
BOND DESCRIPTION	Market		
	Duration	Yield	Price
Global Bond Arg. 03	1.74	35.0%	70.75
Global Bond Arg. 06	3.48	26.7%	63.5
Global Bond Arg. 10	4.25	27.0%	55.25
Global Bond Arg. 17	4.65	24.2%	56.25
Global Bond Arg. 27	5.38	20.9%	51.75

<table>
<tr><th colspan="7">The Results</th></tr>
<tr><th rowspan="2">Bond Description</th><th colspan="3">Model</th><th colspan="3">Parameters</th></tr>
<tr><th>Duration</th><th>Yield</th><th>Price</th><th>Alpha</th><th>Beta</th><th>Recovery</th></tr>
<tr><td>Global Bond Arg. 03</td><td>1,79</td><td>34,0%</td><td>70.6</td><td rowspan="2">0,15</td><td rowspan="2">0,00</td><td rowspan="2">28,45</td></tr>
<tr><td>Global Bond Arg. 06</td><td>3,49</td><td>26,5%</td><td>63.7</td></tr>
<tr><td>Global Bond Arg. 10</td><td>4,3</td><td>26,8%</td><td>54.1</td><td>1.92</td><td colspan="2">Minimised Equation (6)</td></tr>
<tr><td>Global Bond Arg. 17</td><td>4,78</td><td>23,8%</td><td>56.8</td><td rowspan="2">0,00</td><td colspan="2" rowspan="2">Equation (7) Equalised to zero</td></tr>
<tr><td>Global Bond Arg. 27</td><td>5,47</td><td>23,8%</td><td>52.3</td></tr>
</table>



The blue logarithmic curve represents the market curve while the pink line represents the curve that results from the estimations produced by the model. In the figure, it is possible to visualise the degree of adjustment the model proposes in cases of small statistic errors, which are less than 2 as herein shown.

Appendix 1.C: Data and Results

Table A3: Data and Results

Date	RA 03	RA 06	RA 10	RA 17	RA 27	Average Prices	Alpha	Recovery Values	(SSR)
1st Oct.	70,8	63,5	55,3	56,3	51,8	59,5	14,82	28,45	1,92
2	69,8	62,5	53,0	56,0	49,8	58,2	14,95	27,21	1,83
3	69,1	61,6	52,5	54,0	49,8	57,4	15,28	28,45	1,95
4	67,6	59,6	50,3	52,7	48,4	55,7	15,68	27,07	0,38
5	67,9	58,6	49,3	52,1	47,8	55,1	15,00	27,92	0,95
9	64,3	57,5	49,3	50,5	47,8	53,9	17,50	27,47	2,34
10	64,4	57,9	49,6	50,4	47,6	54,0	17,12	26,80	3,69
11	65,5	58,7	54,3	51,1	48,5	55,6	20,46	34,79	**33,78**
12	64,9	59,1	51,0	51,5	48,4	55,0	16,99	27,71	5,04
15	65,0	58,0	49,9	52,0	48,0	54,6	18,21	30,68	2,86
16	65,7	60,4	52,0	54,1	50,5	56,5	20,70	38,65	**15,48**
17	67,4	63,3	55,0	58,8	52,0	59,3	17,25	33,42	7,90
18	66,5	58,8	54,1	54,6	50,1	56,8	19,37	38,71	**19,09**
$\boxed{\textbf{19}}$	67,5	59,0	56,2	55,3	53,3	$\boxed{58,3}$	$\boxed{13,28}$	$\boxed{40,94}$	**20,40**
22	68,5	59,9	55,5	56,5	53,0	58,7	18,12	34,38	7,39
23	68,0	60,3	54,8	55,8	51,5	58,1	18,93	39,35	**15,65**
24	67,5	61,3	53,8	55,5	52,5	58,1	17,79	33,09	1,42
25	67,0	60,5	53,4	55,0	52,0	57,6	19,31	39,48	**11,03**
26	64,9	58,5	50,6	53,6	49,8	55,5	19,20	32,85	0,97
29	56,4	53,8	45,5	51,8	47,9	51,1	27,14	37,29	6,71
30	58,0	56,0	45,3	48,0	42,0	49,9	18,84	25,42	**25,91**
31st Oct.	54,0	51,8	44,9	47,0	45,0	48,5	27,12	34,50	8,47
1st Nov.	51,4	49,4	41,4	45,1	43,0	46,1	28,27	32,77	7,79
2	40,0	42,5	39,8	40,8	37,0	40,0	27,77	39,27	**15,18**
5	50,2	47,8	39,8	43,9	40,7	44,5	27,72	30,59	8,56
6	49,0	47,0	41,0	44,0	43,0	44,8	32,68	34,48	3,49
7	50,0	46,8	43,8	44,3	44,0	45,8	33,64	36,03	5,38
8	48,5	46,5	41,3	42,0	40,0	43,7	30,47	31,83	**12,69**
9	47,5	45,0	39,0	40,0	40,0	42,3	30,51	30,42	9,23
12	47,0	48,0	39,8	40,5	40,5	43,2	31,84	32,21	**27,06**
13	46,0	41,4	37,4	40,5	36,0	40,3	30,44	28,17	6,82
14	46,0	41,0	35,5	40,0	38,0	40,1	30,73	28,22	0,35
15	49,0	43,0	37,5	38,0	38,0	41,1	26,11	25,45	6,76
16	47,0	40,5	34,4	37,3	33,0	38,4	25,22	21,59	5,65
19	44,8	39,0	33,4	35,3	31,0	36,7	26,16	20,66	**10,63**
20	40,6	35,0	29,3	35,3	30,0	34,0	30,35	21,43	6,38
21	42,0	36,0	31,4	37,3	30,0	35,3	29,86	22,46	**15,08**
22	41,0	38,0	31,9	36,8	34,0	36,3	33,74	26,11	2,81
23	45,5	38,0	32,1	37,8	34,0	37,5	20,81	14,63	**40,56**
26	46,0	39,4	36,5	40,1	37,0	39,8	21,89	18,16	**56,97**
27	45,0	39,8	33,6	37,8	37,0	38,6	30,13	26,21	1,33
28	45,0	40,2	32,9	38,0	35,0	38,2	28,60	24,55	2,70
29	44,5	39,0	32,4	33,8	30,0	35,9	25,10	18,71	**12,84**
30th Nov.	44,5	35,3	30,3	32,0	29,0	34,2	24,64	16,28	3,94

Date	RA 03	RA 06	RA 10	RA 17	RA 27	Average Prices	Alpha	Recovery Values	(SSR)
3rd Dec.	37,0	34,4	29,5	37,3	26,0	32,8	34,7	22,94	**50,24**
4	42,0	38,0	32,0	37,9	30,0	36,0	29,1	22,60	**21,92**
5	38,1	30,4	31,3	31,6	30,0	32,3	27,5	17,20	**33,65**
6	37,0	33,8	30,0	30,5	28,0	31,9	33,6	21,28	**12,15**
7	37,0	33,5	29,5	31,0	30,0	32,2	35,0	22,45	3,52
10	36,8	32,8	29,0	29,0	29,0	31,3	33,6	20,73	8,21
11	36,0	34,0	29,0	30,0	29,0	31,6	35,4	22,04	8,98
12	35,9	34,4	30,1	30,0	31,0	32,3	38,3	24,16	**10,34**
14	37,0	33,1	30,0	27,1	32,0	31,8	35,1	22,15	**28,60**
17	36,5	33,6	29,4	30,0	31,5	32,2	36,6	23,30	6,98
18	35,5	34,0	30,5	27,5	32,0	31,9	39,4	24,21	**28,80**
19	36,1	33,4	29,5	25,8	30,0	31,0	34,3	20,77	**35,52**
20	28,5	34,5	29,5	26,3	32,0	30,2	28,9	16,08	**161,81**
21st Dec.	28,9	28,5	26,0	23,9	25,3	26,5	45,5	20,79	**17,10**
26	28,0	28,0	23,3	23,9	26,0	25,8	45,3	20,01	9,41
27	29,8	25,5	24,0	26,0	23,0	25,7	38,9	17,50	5,37
28th Dec.	31,0	28,0	26,0	28,0	25,0	27,6	40,4	20,15	5,11

Some of the estimations register low square residuals (one digit) whereas others register two-digit square residuals ranging from 15 to 30. The bigger Square Residuals are emphasised in bold type. For the cases in which residuals are close to zero (which imply that estimations are quite accurate), the Solver has found a combination of estimated parameters (hence, of estimated bond prices) that reproduce the yield-duration market curve quite accurately.

CHAPTER 2

Fiscal Imbalances, Inflation and Sovereign Default Dynamics

2.1. Introduction

Interactions between fiscal and monetary policy in the determination of the price level have been the object of a great debate in monetary theory for years. Sargent and Wallace (1975) argue that if the monetary authorities adopt a policy rule for the interest rate (rather than the money stock) the equlibrium outcome leads to price level indeterminacy. However, the Sargent and Wallace result is not entirely general. McCallum (1981) firstly accounts for the following well-known result in the literature. Monetary policy feedback rules, linking the nominal interest rate to endogenous variables such as the price level, permit to rule out the classical problem of price level indeterminacy advocated by Sargent and Wallace. Following Taylor's (1993) stimulating article, the so-called 'Taylor rules' have received growing attention in recent years. According to this type of rule, the central bank's interest rate target is set as an increasing function of the inflation rate and the output gap.[1] In order to rule out multiple equilibria, theoretical studies[2] suggest that the monetary authority has to respond to increases in inflation with a more than one-to-one increase in the nominal interest rate. In term of Leeper (1991), this monetary policy rule is known as 'active' –otherwise, it is called 'passive'.

[1]See, among others, Clarida *et al.*, 1998, 2000, that provide empirical evidence to the view that Taylor-type rules consistently describe the behavior of several central banks.

[2]See for instance, Taylor 1999 and Woodford 2003.

However, this literature does not account for the fiscal policy behavior. It means that the 'Ricardian equivalence' proposition applies; then, a comprehensive study of the implications of government deficits (and public debt) over the link between interest rate rules and price stability is not possible. All the same, there are important implications to consider within the relation between monetary and fiscal policies. In the recent macroeconomic debate, it is argued that the lack of a sound fiscal policy undermine the objective of price stability.[3]

The seminal contribution of Leeper (1991) made also an important distinction between 'active' and 'passive' fiscal policy. It defines a fiscal policy as 'active' when taxes respond only weakly to public debt levels and 'passive' ones when taxes respond strongly to debt levels.[4] In a standard model the research showed that two combinations, either (i) active monetary and passive fiscal policy or (ii) active fiscal and passive monetary policy, yield determinacy, a unique stationary rational expectations equilibrium. In case (i) the usual monetarist view that inflation depends only on monetary policy is confirmed. However, case (ii) is fiscalist in the sense that fiscal policy, in addition to monetary policy, has an effect on the inflation rate. Leeper (1991) also showed that the steady state is indeterminate, with multiple stationary solutions, when both policies are passive, while the economy is explosive when both policies are active.

Thus, the so-called 'Fiscal Theory of the Price Level' (FTPL), has emerged.[5] This well-known theoretical framework enables to capture the effects of fiscal policy on the dynamic behavior of nominal variables, like price level.

The FTPL asserts that fiscal variables can fully determine the price level independently of monetary variables. More specificaly, when fiscal solvency is not

[3]The Maastricht Treaty and the Stability and Growth Pact in the European Union which set quantitative limits on fiscal deficits and public debt for the Member States is based on this argument.
[4]Later on, Woodford (1995) will identify this type of policies as a non-Ricardian and Ricardian fiscal policy.
[5]The main contributors are Woodford, 1994, 1995, 2001, Sims, 1994 and Cochrane, 1999.

ensured for each sequence of the price level, fiscal variables uniquely determine the equilibrium level of nominal variables. This extreme result is the polar opposite of the monetarist statement that the price level and the inflation rate depend primarily on monetary variables. Not surprisingly, the Fiscal Theory approach has triggered criticism and controversy.[6]

Controversy concerns the nature of the intertemporal budget constraint of the government. In different papers Buiter argues that FTPL confuses the roles of budget constraints and equilibrium conditions in models of a market economy. But more interesting, Buiter (2002) criticizes FTPL as a theory of price level determination because it explicitly rules out default. Equilibrium price-level changes each period in response to the (stochastic) fiscal shocks. And with price level changes in each period providing the capital gains and losses on public debt level necessary for equilibrium, default is never necessary. Once the possibility of explicit default is properly allowed for, non-Ricardian regimes become Ricardian regimes and the Fiscal Theory of the Price Level vanishes. Buiter shows that under a non-Ricardian fiscal-monetary programme with an exogenous nominal interest rate rule, the equilibrium conditions are the same as under the Ricardian fiscal-monetary programme without contract fulfilment and with an exogenous nominal interest rate rule.

Uribe (2006) presents a dynamic FTPL model of default in which he allows limited inflation rate flexibility. When a shock is so large that limited inflation rate flexibility cannot provide the necessary capital gain or loss on government debt, then the government either devalues or revalues its debt. Default is a reduction in debt below its contractual value. This is an interesting application of the FTPL to the problem of default, but it neither exhibits an increasing probability of default nor a positive expected default rate as empirical evidence suggests.

[6]It has been mainly questioned by Buiter (1999, 2001 and 2002) as well as McCallum (2001) and Niepelt (2004).

The main objective of this chapter is to analyse the price stability and sovereign default risk issue. The model is grounded on a micro-founded equilibrium model with infinitely lived private agents that allow deviations from the Ricardian equivalence. This framework is particularly suitable to study the interactions between monetary and fiscal policy and its effect over both price stability and sovereign risk premium. It is shown that active interest rate rules, overreacting to inflation, are neither necessary nor sufficient to guarantee a unique stable solution for the price level without defaulting. Furthermore, in some cases, even 'passive' interest rate rules might drive the economy to an unsustainable path without defaulting. This results suggest that monetary policy matters being able to worsen a given scenario. Then, sovereign default is required to restore fiscal solvency and price stability. But the default rate must be high enough to ensure the economy to reach a stable equilibrium in the post-default dynamics.

The rest of the chapter is organized in seven sections. Section II presents the model. Section III describes the three possible scenarios for this economy and section IV, the inflation and default dynamics. Section V explicitly calculates the expected recovery rate and sovereing risk premium. Section VI provides further reseach showing how detailed specifications of the monetary rule affect the equilibrium dynamics. Finally, in Section VII, the conclusion.

2.2. The Model

2.2.1. The Households

Consider a closed economy inhabited by a large number of identical infinitely-lived households. Preferences are described by,

$$U_0 = E_0 \sum_{t=0}^{\infty} \beta^t u(c_t) \tag{2.1}$$

where c_t denotes household's consumption level of a perishable good in period t, $u(\cdot)$ is the single-period utility function assumed to be increasing, strictly concave and continuously differentiable, $\beta \in (0,1)$ denotes the subjective discount factor and E_τ is the mathematical expectation operator conditional on period τ.

Each period, households are assumed to have access to a one-period nominal government bond, denoted B_t. This bond offers, in period $t+1$, a contractual gross nominal interest rate R_t. However, the fiscal authority may default on its debt and in each period it repays a fraction h_t of its liabilities. Therefore, household investment in sovereign bonds in period t is given by B_t whereas the earnings from the last-period investment is expressed as $h_t R_{t-1} B_{t-1}$. This expression is called the recovery value of the sovereign debt whereas $h_t \in (0,1)$ represents the recovery rate.

In our notation, Buiter (1999, 2001 and 2002) do not restrain h_t assuming that both $h_t < 0$ and $h_t > 1$ are possible options. The former assumption –$h_t < 0$ –implies that the sovereign can be a net creditor. This seems unrealistic –particularly, in developing countries –and not so relevant in a model focused to analyse scenarios of sovereign debt crisis and default. The last assumption –$h_t > 1$ –also adopted by Uribe (2006), implies that any surplus resources over the contractual value of the outstanding debt are shared out equally among the holders of the contractual government debt. However, this excess of resources shoul not be interpreted as a government subsidy because in general they are allocated to tax payers; not to bondholders. Buiter names these transfers 'super-solvency premium'. But even more important, government bonds are fixed-income securities as opposite to any other variable return security, such as stocks. In a more realistic approach we propose constraint h_t as $h_t \epsilon (0,1)$.

Besides, in each period t households have also the opportunity to invest in a complete set of nominal state-contingent assets. The total investment, in nominal terms, can be expressed as $E_t Q_{t,t+1} D_{t+1}$ where $Q_{t,t+1}$ denotes the stochastic nominal discount factor of an asset with a random nominal payment D_{t+1}. The time t revenue from the investment made in the previous period, is denoted as D_t.

Finally, households are endowed with a constant and exogenous amount of perishable goods denoted by y and they pay real lump-sum taxes τ_t. Their flow budget constraint can be written as,

$$P_t c_t + B_t + E_t Q_{t,t+1} D_{t+1} \leq P_t \left(y - \tau_t\right) + h_t R_{t-1} B_{t-1} + D_t \tag{2.2}$$

where P_t denotes the price level in period t.

Then, the household is subject to an appropriate set of borrowing limits which prevents "Ponzi Games". In the absence of financial market frictions, the borrowing constraint takes the form:

$$h_{t+1} R_t B_t + D_{t+1} \geq -E_{t+1} \sum_{j=t+1}^{\infty} Q_{t+1,j} P_j \left(y - \tau_j\right) \qquad \forall t+1 \tag{2.3}$$

where $Q_{t+1,j} = Q_{t+1,t+2} Q_{t+2,t+3} \cdots Q_{j-1,j}$ and $Q_{t+1,t+1} = 1$.

The representative household maximizes its lifetime utility (2.1) subject to its flow budget constraint (2.2) and to its borrowing limits (2.3) by choosing $\{c_t, B_t, D_{t+1}\}_{t=0}^{\infty}$ taking as given the set of processes $\{P_t, \tau_t, Q_{t,t+1}, h_t R_{t-1}\}_{t=0}^{\infty}$ and the initial values D_0 and B_{-1}. In addition to equation (2.2) holding with equality, the first order conditions are given by,

$$c_t : u_c\left(c_t\right) = \lambda_t \tag{2.4a}$$

$$D_{t+1} : Q_{t,t+1} = \beta \frac{\lambda_{t+1} P_t}{\lambda_t P_{t+1}} \tag{2.4b}$$

$$B_t : R_t^{-1} = \beta E_t h_{t+1} \frac{\lambda_{t+1} P_t}{\lambda_t P_{t+1}} \tag{2.4c}$$

where λ_t denotes the Lagrangian multiplier in period t.

Equation (2.4a) states that the marginal utility of consumption must equal the marginal utility of wealth, λ_t, for all time t. Equation (2.4b) represents the standard pricing equation for each one-period forward nominal contingent asset and equation (2.4c) represents the pricing equation for the case of the risky sovereign bonds between period t and $t+1$.

The transversality condition for the financial assets is written:

$$\lim_{T\to\infty} E_t Q_{t,T}\left[h_T R_{T-1} B_{T-1} + D_T\right] = 0 \tag{2.4d}$$

2.2.2. The Monetary and Fiscal Authorities

The fiscal authority levies lump-sum taxes, $P_t\tau_t$, which are assumed to follow an exogenous, stochastic process. Recalling that fiscal authority issues nominal bonds, B_t, with a contractual gross nominal interest rate, R_t, but may default on its outstanding debt and repays a fraction h_t of its liabilities $R_{t-1}B_{t-1}$, the sequential budget constraint[7] is given by,

$$B_t = h_t R_{t-1} B_{t-1} - P_t \tau_t \tag{2.5}$$

where $B_{t-1}R_{t-1}$ is given in period t and the recovery rate satisfies $h_t \in (0,1)$.

2.2.2.1. The Monetary Rule. Following Uribe (2006), we suppose that the monetary policy takes the form of an interest-rate feedback rule whereby the short-term nominal interest rate is set as a function of inflation. But while Uribe uses a simple linear Taylor rule, active in the sense of Leeper (1991), and with an explicit inflation targeting objective. We wish to consider a slightly different, asymmetric, monetary regime. The central bank behavior can be expressed as,

$$R_t = \phi\left(\pi_t\right) = \begin{cases} \bar{R} & if \quad \pi_t \leq \hat{\pi} \\ \bar{R} + \alpha\left(\pi_t - \hat{\pi}\right) & \text{otherwise} \end{cases} \qquad \text{with} \quad \alpha > \beta^{-1} \tag{2.6}$$

[7]For sake of simplicity, in this paper, we ignore money and seigniorage revenues.

where $\bar{R} = \beta^{-1}\bar{\pi}$ is the stationary value of the gross nominal interest rate associated to the inflation target $\bar{\pi}$, and $\hat{\pi}$ represents an inflation threshold. It will be useful to define: $\hat{R} = \beta^{-1}\hat{\pi}$, about which we make the following assumption:

Assumption 1:: $\hat{R} > \bar{R}$, or, equivalently: $\hat{\pi} > \bar{\pi}$.

The monetary rule (2.6) implies that if current inflation increases beyond the inflation threshold $\hat{\pi}$, the central bank reacts actively[8]: $\alpha > \beta^{-1}$. Otherwise, the central bank pegs[9] the current interest rate to its target $\bar{R}$ which is associated to an inflation target $\bar{\pi}$ lower than $\hat{\pi}$. Note that central bank is more concerned about tackling high inflation levels than dealing with scenarios dominated by low inflation and by deflation. In most developing countries, high inflation is a relatively frequent phenomena whereas deflation is quite rare and not so deep. Stylized facts on inflation rates in these countries shape an asymmetric behavior. So it seems to be reasonable to suppose an asymmetric behavior of the central bank. This monetary policy can be called "monitoring policy of current inflation".

In developed countries, much debate has been devoted to the suitability of the Taylor rule in characterizing the behaviour of central banks, especially in abnormal times. Rabanal (2004), for instance, presents evidence that Taylor rule coefficients changed significantly both with time and economic conditions in the United State between 1960 and 2003 using quarterly data. The qualitative interpretation is that the US Federal Reserve places much more weight on inflation stabilization during expansion periods, while it shifts its focus to output stabilization when in recessions. Analogous reasoning applies to the monetary rule (2.6). In developing countries, Brazil constitutes a successful example of inflation targeting. After being forced to abandon the crawling peg to the US dollar, Brazil adopted an inflation

[8]This condition is identical to that which led Leeper to describe the monetary rule as "active".
[9]Actually, as demonstrated by Uribe (2006), a forward-looking rule of type: $R_t = \bar{R} + \alpha\left(1/(E_t\pi_{t+1}^{-1}) - \bar{\pi}\right)$ will lead to the same results as our simpler pegging rule.

targeting regime in July 1999 which brought annual inflation down to one-digit figures in less than three years.

2.2.2.2. The Debt Recovery Rule. Given that the fiscal authority does not control the primary surplus, it is useful to suppose the existence of a rule $H(\cdot)$ which specifies how the fiscal authority chooses the recovery rate h_t. We will suppose that such a rule is a (non increasing) function of the nominal interest rate, denoted R_t^{nd}, to be determined by the monetary authority in the No-Default case. Then, $R_t^{nd} = \phi\left(\pi_t^{nd}\right)$ represents the potential cost of honoring the whole debt in the future. More precisely, the fiscal authority's behavior is supposed to be defined by:

$$h_t = H(R_t^{nd}) = \begin{cases} 1 & if \quad R_t^{nd} < \bar{\bar{R}} \\ \bar{h}(R_t^{nd}) < 1 & \text{otherwise} \end{cases} \tag{2.7}$$

where the threshold $\bar{\bar{R}}$ denotes the maximum nominal interest rate that the fiscal authority will accept on its new issued debt without defaulting on its current liability. Finally, $\bar{h}(R_t^{nd})$ denotes the fraction of the sovereign debt honored by the fiscal authority in case of default as a decreasing function of R_t^{nd}; function which will be specified later on.

Assumption 2:: $\bar{\bar{R}} > \hat{R}$.

This assumption implies that the fiscal authority is more tolerant – said, *lax* – than its monetary counterpart in terms of equilibrium inflation and interest rates.

However, it is important to point out that the main objective of the central bank is to monitor inflation whereas the fiscal authority only cares about the cost of its debt. Then, note that in order to control current inflation the central bank uses the current interest rate affecting, in this way, the cost of the sovereign debt. Consequently, a conflict of interests between both authorities may arise defining the equilibrium outcome. For instance, an aggressive central bank fighting against inflation may trigger the sovereign default as well as affect its size.

2.2.3. Market Clearing

At equilibrium, the goods market must clear: $c_t = y$, meaning that the consumption level is constant along time t. Thus, from equation (2.4a) it turns out that the marginal utility of consumption, λ_t, is also constant. Equation (2.4b) becomes $Q_{t,t+1} = \beta P_t/P_{t+1}$. Applying conditional expectations operator E_t to the last expression, we obtain $E_t Q_{t,t+1} = \beta E_t\left(1/\pi_{t+1}\right)$ where $\pi_{t+1} = P_{t+1}/P_t$ is the the gross rate of inflation and $E_t Q_{t,t+1}$ denotes the nominal price of a risk-free portfolio which pays one unit of currency in all states of the nature. Consequently, the risk-free interest rate can be expressed as,

$$R_t^f = \beta^{-1}\left[E_t \frac{1}{\pi_{t+1}}\right]^{-1} \tag{2.8}$$

Using the constancy of λ_t, equation (2.4c) becomes,

$$R_t = \beta^{-1}\left[E_t \frac{h_{t+1}}{\pi_{t+1}}\right]^{-1} \tag{2.9}$$

Finally, given that all households are assumed to be identical, at equilibrium, there is no borrowing or lending among them, *i.e.* $D_t = 0\ \forall t$. Thus all the assets held by private agents are in the form of government debt. Using this result and, again, $Q_{t,t+1} = \beta P_t/P_{t+1}$, the transversality condition can be rewritten (in real terms):

$$\lim_{T\to\infty} E_t \beta^{T-t}\left[\frac{h_T R_{T-1} b_{T-1}}{\pi_T}\right] = 0 \tag{2.10}$$

where $b_t = B_t/P_t$.

The sovereign debt dynamics, described by equation (2.5), can also be written in real terms as:

$$b_t = h_t R_{t-1} b_{t-1}/\pi_t - \tau_t \tag{2.11}$$

Therefore, the equilibrium can be defined as follows:

Definition 1. *A rational expectations competitive equilibrium is defined as a set of processes* $\left\{\pi_t, b_t, R_t, R_t^f, h_t\right\}_{t=0}^{\infty}$ *satisfying equations (2.8), (2.9), (2.10), (2.11), the monetary rules (2.6), the debt recovery rule (2.7), and the exogenous process for the primary surpluses* $\{\tau_t\}_{t=0}^{\infty}$ *where* $R_{-1}b_{-1}$ *are given and the recovery rate satisfies* $h_t \in (0,1)$ ⁞

Using equations (2.9), (2.10), (2.11), and some algebra – see Appendix 2.A –, we obtain:

$$h_t R_{t-1} b_{t-1}/\pi_t = \sum_{h=0}^{\infty} \beta^h E_t \tau_{t+h} = T_t \qquad \forall t \tag{2.12}$$

where T_t is the discounted value of present and future primary surpluses. Note that fiscal surpluses are discounted by the gross real risk-free interest rate given by β^{-1} – see equation (2.8).

Under this form, (2.12) is the key equation of the debate between the advocates[10] of the Fiscal Theory of the Price Level determination (FTPL) and its detractors[11]. If the fiscal authority is committed to honour the whole of its liabilities – and so $h_t = 1$ – then the current inflation rate, π_t, becomes determined according to the FTLP. This is because T_t is exogenous and $R_{t-1}b_{t-1}$ is predetermined in period t. On the contrary, if h_t is allowed to be less than unity, then the current value of T_t may affect both current inflation and recovery rate. This may lead to the Buiter's conclusion that any path for h_t and π_t satisfying equation (2.12) could be considered as an equilibrium outcome.

Using (2.12) to eliminate $h_t R_{t-1} b_{t-1}/\pi_t$ from equation (2.11) we get:

$$\begin{aligned} b_t &= T_t - \tau_t \\ &= \beta E_t T_{t+1} \qquad \forall t \geq 0 \end{aligned} \tag{2.13}$$

[10]See Leeper (1991), Sims (1994), Woodford (1994, 1995) and Cochrane (1999), among others.
[11]Buiter (1999, 2001, 2002) for instance.

The real equilibrium value of the public debt is necessarily equal to the present value of future discounted real fiscal surpluses. Now, when $t > 0$ replaces b_{t-1} by this equilibrium value in $t-1$ into equation (2.12) we obtain:

$$\frac{\pi_t}{h_t} = \frac{\beta R_{t-1}}{1+\eta_t} \qquad \forall t > 0 \tag{2.14}$$

where

$$\eta_t = \frac{T_t - E_{t-1}T_t}{E_{t-1}T_t}$$

is the innovation in percentage points on the present discounted value of primary surpluses. Thus, $\eta_t > 0$ if the discounted value of present and future primary surpluses is higher than the value expected for this variable in period $t-1$. Otherwise, η_t becomes either negative or null and void.

Equation (2.14) can receive the same interpretation than equation (2.12).[12] Particularly, one may conclude, as Buiter (1999, 2001), that any path for h_t and π_t satisfying equation (2.14) could be considered as an equilibrium outcome. But this is not the case because equation (2.14) is not the only equilibrium restriction to be satisfied by both π_t and h_t. The monetary rule (2.6) and, especially, the debt recovery rule (2.7) also affect the equilibrium outcome. Thus, the objective of the next section is to analyze the extent to which each of these variables may react after a shock to T_t. Note however that, whatever the monetary and the recovery rules, the ratio π_t/h_t is uniquely determined by equation (2.14).

2.3. Three Scenarios for One Economy

The asymmetric form of both equations (2.6) and (2.7) may potentially imply the existence of four regimes, but assumptions 1 and 2 permit to exclude the case where the central bank naturally[13] pegs the interest rate to $\bar{R}$, leading the fiscal

[12] In period $t = 0$, equation (2.14) becomes $\pi_0/h_0 = \beta R_{-1}/1 + \eta_0$ where $\eta_0 = (T_0 - E_{-1}T_0)/E_{-1}T_0$.

[13] By "naturally", we mean: "considering the inflation rate which would be realized in the case of No Default".

authority to default on its outstanding debt. Indeed, this scenario would require $R_t^{nd} = \bar{R} > \bar{\bar{R}}$ which violates the condition $\bar{R} < \hat{R} < \bar{\bar{R}}$. Three scenarios are left.

The two first scenarios correspond to the No-Default case –where $h_t = 1$ – satisfying $R_t^{nd} \leq \bar{\bar{R}}$. Under these scenarios the fiscal authority considers that the potential cost of servicing the whole debt is affordable and so it honors its entire liabilities. The first scenario is characterized by a relatively low current inflation – say, $\pi_t \leq \hat{\pi}$ – and so the central bank behaves passively by pegging current interest rates to the level $\bar{R}$. This type of periods are usually called "Tranquil Times". The second scenario is characterized by a relatively high current inflation –say, $\pi_t > \hat{\pi}$ – where the central bank behaves actively by increasing current interest rates. This scenario corresponds to "Inflation Times" described by Loyo (1999). The third one is the scenario of Sovereign Default –where $h_t = h^d(R_t^{nd}) < 1$ satisfying $R_t^{nd} > \bar{\bar{R}}$. In this case, the fiscal authority finds that the potential cost of servicing its whole debt is unaffordable. Consequently, it defaults on its liabilities by honoring only a fraction of its financial obligations.

Both "Tranquil Times" and "Inflation Times" are characterized by the absence of sovereign default. Then, the equilibrium level of inflation and interest rates are given by equations (2.14) and (2.6) with $h_t = 1$:

$$\text{(2.15a)} \qquad \pi_t^{nd} = \frac{\beta R_{t-1}}{1+\eta_t}$$

$$\text{(2.15b)} \qquad R_t^{nd} = \phi\left(\pi_t^{nd}\right) = \begin{cases} \bar{R} & if \quad \pi_t^{nd} \leq \hat{\pi} \\ \bar{R} + \alpha\left(\pi_t^{nd} - \hat{\pi}\right) & \text{otherwise} \end{cases}$$

Equation (2.15a) expresses that current inflation is determined by the current fiscal shock, as predicted by the Fiscal Theory of Price Level (FTPL). And equation (2.15b) expresses that in both No-Default scenarios, the current nominal interest rate is determined by the current inflation level.

2.3.1. "Tranquil Times"

When the value of the inflation rate (2.15a) satisfies the condition $\pi_t^{nd} \leq \hat{\pi}$, equation (2.15b) implies that the central bank pegs the interest rate to $\bar{R}$. So, these periods are characterized by both low current inflation and interest rates. We have:

$$\pi_t^T = \frac{\beta R_{t-1}}{1+\eta_t} \leq \hat{\pi} \tag{2.16a}$$

$$R_t^T = \bar{R} \tag{2.16b}$$

where π_t^T denotes current inflation rate during Tranquil Times and R_t^T denotes the risky gross nominal interest rate paid by the fiscal authority during Tranquil Times.

Time-t equilibrium is determined as the FTPL determination asserts (See Woodford 1995). The central bank pegs the nominal interest rate to its target and the equilibrium price level is that level that makes the real value of nominally denominated government liabilities equal to the present value of the expected future government budget surpluses.

Both equations (2.16a) and (2.16b) are satisfied on condition that $\pi_t^T \leq \hat{\pi}$ which implies:

$$R_{t-1} \leq (1+\eta_t)\,\hat{R} \tag{2.17a}$$

remembering that $\hat{R} = \beta^{-1}\hat{\pi}$; or, equivalently:

$$\eta_t \geq \hat{\eta}\,(R_{t-1}) \tag{2.17b}$$

where $\hat{\eta}\,(R)$ is defined as:

$$\hat{\eta}\,(R) \equiv R/\hat{R} - 1 \tag{2.18}$$

Note that, if this scenario applies in period $t-1$, we have $R_{t-1} = \bar{R}$ and the condition (2.17b) can be simplified as: $\eta_t \geq \hat{\eta}\left(\bar{R}\right)$ with $\hat{\eta}\left(\bar{R}\right) < 0$. In this case, Tranquil Times are driven by either positive or not so negative fiscal shocks. It is worth noticing that the negative fiscal shocks must be rather soft. In the case where R_{t-1} verifies $R_{t-1} > \bar{R}$, and especially when $R_{t-1} > \hat{R}$, a positive fiscal shock may be necessary to restore a period of "Tranquil Times".

The deterministic steady state associated to (2.16a)-(2.16b) is given by: $\pi^T = \beta\bar{R} \equiv \bar{\pi}$ and $R^T = \bar{R}$. Of course, it verifies $\pi^T \leq \hat{\pi}$ and $R^T < \bar{\bar{R}}$. This implies that the steady state inflation level is low enough to let the central bank behave passively, while the low steady state level of the interest rate enables the fiscal authority to honor the entire sovereign debt.

Starting from the steady state, the current equilibrium characterizing a Tranquil Time is described by equations (2.16a) and (2.16b) on condition that the economy were not hited by hard negative shocks. Then, if in the next period fiscal shock is void, the economy returns to its steady state.

2.3.2. "Inflation Times"

Compared to the previous case, these periods are characterized by both higher current interest rates and inflation levels. This is linked to the fact that the economy is hit by harder negative fiscal shocks. The current inflation remains defined like in the previous case but it now exceeds the inflation threshold $\hat{\pi}$ and the central bank behaves actively by increasing current interest rates:

$$\pi_t^I = \frac{\beta R_{t-1}}{1+\eta_t} > \hat{\pi} \tag{2.19a}$$

$$R_t^I = \bar{R} + \alpha\left(\frac{\beta R_{t-1}}{1+\eta_t} - \hat{\pi}\right) < \bar{\bar{R}} \tag{2.19b}$$

where π_t^I denotes current inflation rate during infaltion times and R_t^I denotes the risky gross nominal interest rate paid by the fiscal authority during inflation times.

This equilibrium is satisfied on condition that $\pi_t^I > \hat{\pi}$ and $R_t^I < \bar{\bar{R}}$ which implies:

$$(2.20a) \qquad (1+\eta_t)\,\hat{R} < R_{t-1} < (1+\eta_t)\left(\hat{R}+\Gamma\right)$$

using again $\hat{R} = \beta^{-1}\hat{\pi}$;or, equivalently:

$$(2.20b) \qquad \bar{\bar{\eta}}\,(R_{t-1}) < \eta_t < \hat{\eta}\,(R_{t-1})$$

with

$$(2.21) \qquad \Gamma \equiv \frac{\bar{\bar{R}} - \bar{R}}{\alpha\beta} > 0$$

and where the function $\bar{\bar{\eta}}\,(\cdot)$ is defined by:

$$(2.22) \qquad \bar{\bar{\eta}}\,(R) \equiv \frac{R}{\hat{R}+\Gamma} - 1 < \hat{\eta}\,(R)$$

Condition (2.20b) expresses that a period of inflation is driven by a strictly negative shock which is no longer soft, given the level of R_{t-1}. The shock is rather hard but not enough to drive the economy into default.

The deterministic steady state is easily obtained by putting $\eta_t = 0$ and $R_t^I = R_{t-1}$ in equation (2.19a) and (2.19b). We obtain:

$$(2.23a) \qquad R^I = \frac{\alpha\beta\hat{R} - \bar{R}}{\alpha\beta - 1}$$

$$(2.23b) \qquad \pi^I = \beta R^I = \frac{\alpha\beta\hat{\pi} - \bar{\pi}}{\alpha\beta - 1}$$

This deterministic steady state equilibrium exists on condition that $R^I < \bar{\bar{R}}$ and $\pi^I > \hat{\pi}$ or, equivalently:

$$\hat{R} < R^I < \bar{\bar{R}}$$

The left-hand side of the previous inequality is always verified under Assumption 1, and the right-hand side requires the following condition:

Assumption 3:: $\bar{\bar{R}} > \hat{R} + \left(\hat{R} - \bar{R}\right) / (\alpha\beta - 1)$

Assumption 3 implies that $\bar{\bar{R}}$ must be high enough to satisfy $R^I < \bar{\bar{R}}$. This condition is needed to ensure the existence of a deterministic steady state under a period of inflation.

The (partial) dynamics of these two scenarios is represented on Figure 1 in the case $\eta_t = 0$:

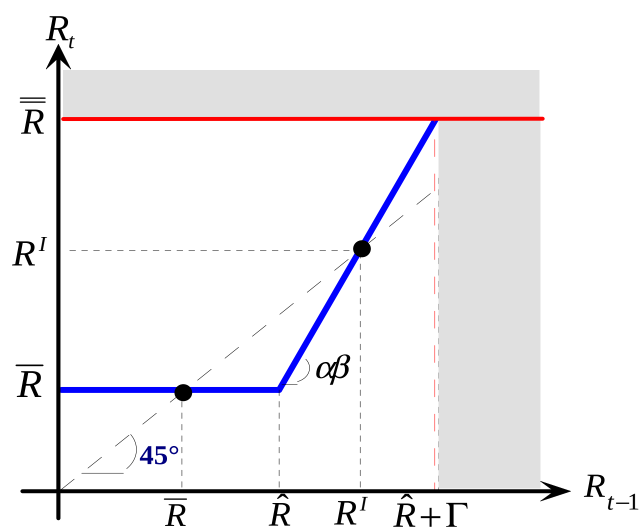


Figure 2.1: The No-Default Case

It is worth noticing that, while $R^T = \bar{R}$ is locally stable, given that $\alpha\beta > 1$, R^I is an unstable steady state equilibrium. This means that, depending on the previous value of the nominal interest rate –at the left or at the right from R^I –the current interest rate will converge to $\bar{R}$ (if η_t is void or small enough), or increase toward $\overline{\overline{R}}$. Unless a big positive fiscal shocks occurs, the latter scenario inevitably leads to a sovereign default.

In the scenario of "Inflation Times", a previous value of the nominal interest rate higher than R^I cause the financial wealth of private agents to grow faster in nominal terms, which calls for higher inflation. Monetary authority responds to higher inflation with sufficiently higher nominal interest rates forming a vicious circle. Usually, hyperinflation is interpreted as a result of the monetary financing of serious fiscal imbalances. However, in this case a fiscalist alternative is presented in which inflation explodes because of the fiscal effects of monetary policy. Most of the action concentrates on the interest rate pays on the government debt and debt rollover instead of seigniorage. This phenomena is known as 'fiscalist hyperinflation' and is the case of Brazil in the late 1970s and early 1980s (See Loyo 1999).

2.3.3. "Sovereign Default Time"

According to the fiscal authority, the potential cost of servicing the whole debt becomes too high when $R_t^{nd} > \overline{\overline{R}}$ which implies:

$$R_{t-1} > (1 + \eta_t) \left(\hat{R} + \Gamma \right) \tag{2.24a}$$

or, equivalently,

$$\eta_t < \overline{\overline{\eta}} \left(R_{t-1} \right) \tag{2.24b}$$

This condition shows that for a given level of R_{t-1}, a scenario of Default can be triggered by a hard negative shock or, for a given shock η_t, by a high level of the previous nominal interest rate.

As a consequence, the fiscal authority defaults on its debt by honoring only a fraction $h_t < 1$ of its liabilities. From equations (2.14) and (2.6), current inflation and interest rate become:

$$\pi_t^D = h_t \frac{\beta R_{t-1}}{1+\eta_t} \tag{2.25a}$$

$$R_t^D = \phi\left(h_t \frac{\beta R_{t-1}}{1+\eta_t}\right) \tag{2.25b}$$

Note that without specifying the recovery rule – $h_t = \bar{h}(R_t^{nd}) < 1$ – the equilibrium in period t remains undetermined and defined by equation (2.25a) and (2.25b). There is a continuum of recovery rate determining the equilibrium inflation rate and so the nominal interest rate. This result is in line with Buiter's criticism.[14] In order to avoid this indeterminacy the fiscal authority has to specify a recovery rule.

Before introducing such a recovery rule, let us rewrite the system in a simplified form, using (2.15a) equations (2.25a) and (2.25b) can be rewritten as:

$$\pi_t^D = h_t \pi_t^{nd} = h_t \phi^{-1}\left(R_t^{nd}\right) \tag{2.26a}$$

$$R_t^D = \phi\left(h_t \pi_t^{nd}\right) = \phi\left(h_t \phi^{-1}\left(R_t^{nd}\right)\right) \tag{2.26b}$$

where the last terms have been obtained by inverting the monetary rule (2.6).

We now can make the following assumption about the recovery function $\bar{h}(R_t^{nd})$:

$$\bar{h}(R_t^{nd}) \equiv \frac{\beta \bar{R}}{\phi^{-1}\left(R_t^{nd}\right)} \tag{2.27}$$

Equation (2.27) shows that the higher is R_t^{nd}, the potential cost of honoring the entire debt, the smaller is the recovery rate. Using the recovery function (2.27) and the monetary rule (2.6) in equations (2.26a) and (2.26b), the equilibrium values of π_t^D and R_t^D become:

[14]See Buiter (1999), pp. 50, Proposition 5.

$$\begin{aligned}\pi_t^D &= \bar{\pi} \\ R_t^D &= \bar{R}\end{aligned}$$

Thus, the recovery rule (2.27) allows the economy, by defaulting on its financial obligations, to reach the stable steady state equilibrium[15] in the same period t. The equilibrium value of the recovery rate is:

$$h_t = \frac{(1+\eta_t)\,\bar{R}}{R_{t-1}} \tag{2.28}$$

2.4. Inflation and Default Dynamics

This section illustrates the economy dynamics in two different cases of default. In the first one, the current fiscal shock is small but the initial value of the nominal interest rate, R_{-1}, is high. The economy jumps into an inflation episode which leads the central bank to rise its interest rate and, after three periods, the fiscal authority to default. In the second case, the initial interest rate is at its "Tranquil Times" stationary value: $\bar{R}$, but the economy experiences a big negative fiscal shock[16] which leads very rapidly to a sovereign default.

[15]Besides, this recovery rule minimizes the probability of default after the sovereign default. See the next sections on Expected Recovery Rate and Sovereign Risk Spread.

[16]Figure 3 and especially 4 are only illustrative because we have to expect that a negative shock - an innovation - has no reason to repeat.

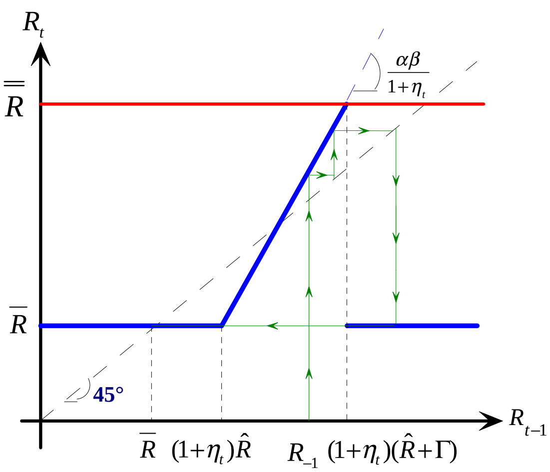


Figure 2.2: A small fiscal shock

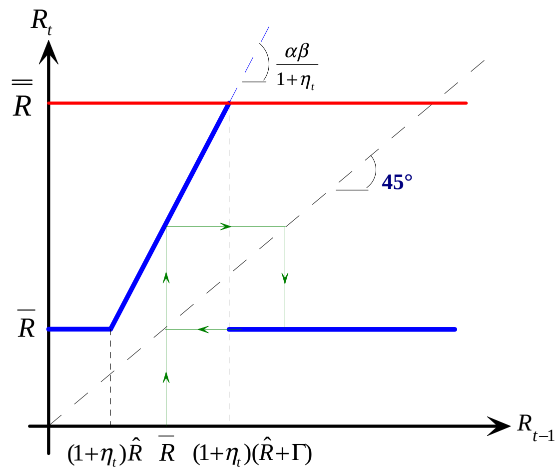


Figure 2.3: A big negative fiscal shock

Deciding to default on the government liabilities is a difficult decision for policy makers. This may explain why, in the data, the actual value of the interest rate $\bar{\bar{R}}$ is greater than what one might expect. This seems to be the case of Argentina in 1989. At the end of 1989, the year in which Argentina defaulted on its debt, the inflation rate had reached a shocking 4923,6%. Then Argentina had gradually converged to its steady state equilibrium (See Table 1):

Table 2.1: Argentine Default, 1989

−expressed as a percentage

Year	1986	1987	1988	**1989**	1990	1991	1992	1993	1994	1995
Inflation	81,9	174,8	387,7	**4923,6**	1343,9	84,0	17,5	7,4	3,9	1,6
Source: Indec										

According to our model, the fiscal authority was both too tolerant and patient, *i.e.* $\overline{\overline{R}}$ was too high. Moreover, Argentina in 1989 could minimize the recovery rate on its debt in order to reach faster the (without inflation) steady state equilibrium. To explain the gradual decline of inflation, it is necessary to modify the recovery rule slightly. Suppose that the rule is now defined by:

$$h^*(R_t^{nd}) \equiv \frac{\beta R^*}{\phi^{-1}\left(R_t^{nd}\right)} \tag{2.29}$$

with $\hat{R} < R^* < R^I$.

The recovery rule (2.29) and the condition $\hat{R} < R^* < R^I$ are well specified in order to ensure a post-default equilibrium which drives progressively the economy to "Tranquil Times", on condition that future fiscal shocks are small enough.

This case is represented on Figure 2.4:

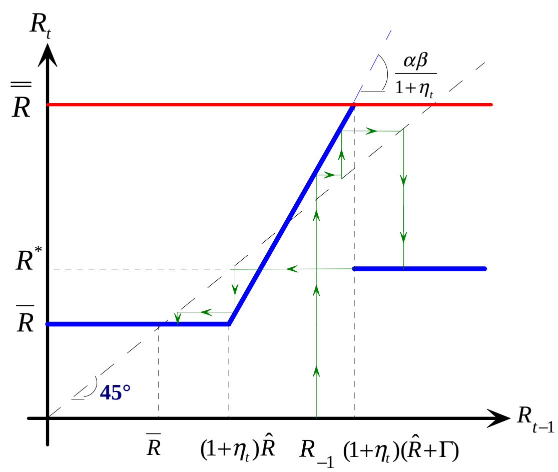


Figure 2.4: Argentinean soft-landing

This policy has the double advantage of reducing the size of the sovereign default necessary to restore the public solvency and to smooth the return toward price stability. On the other hand, this recovery rule does not minimize the probability of a new default after the first sovereign default. For the sake of simplicity, we will adopt in the rest of the paper the simpler assumption $R^* = \bar{R}$.

2.5. Expected Recovery Rate and Sovereign Risk Premium

In this section, we make simplifying assumptions on the fiscal shock distribution and we show that, once the Fiscal Default Rule is known[17], the one-period Expected Recovery Rate, $E_t h_{t+1}$, and the Relative Sovereign Risk Premium, $\left(R_t - R_t^f\right)/R_t^f$, can be explicitly calculated. Note that the period-t probability of default in $t+1$ is simply given by: $F\left(\bar{\bar{\eta}}\left(R_t\right)\right)$.

The three scenarios previously described are summarized by the following table:

Table 2.2: The Three Scenarios

	Tranquil Times	**Inflation Times**	**Sovereign Default Time**
	$\hat{\eta}\left(R_{t-1}\right) < \eta_t$	$\bar{\bar{\eta}}\left(R_{t-1}\right) < \eta_t < \hat{\eta}\left(R_{t-1}\right)$	$\eta_t < \bar{\bar{\eta}}\left(R_{t-1}\right)$
h_t :	1	1	$\left(1+\eta_t\right)\frac{\bar{R}}{R_{t-1}}$
π_t :	$\frac{\beta R_{t-1}}{1+\eta_t}$	$\frac{\beta R_{t-1}}{1+\eta_t}$	$\bar{\pi}$
R_t :	$\bar{R}$	$\bar{R} + \alpha\beta\left(\frac{R_{t-1}}{1+\eta_t} - \hat{R}\right)$	$\bar{R}$

The conditions that determine the current regime are entirely defined by the couple of states variables $\left(R_{t-1}, \eta_t\right)$. Let $F(\eta)$ defines the distribution function of the fiscal shocks, and $\bar{\eta} > 0$ and $-\bar{\eta}$, respectively, the upper and lower bound of the compact set on which the shock is distributed. The Figure 2.5 summarizes these conditions:

[17] Which is summarized by the choice of $\bar{\bar{R}}$ and R^* $(= \bar{R}$ in our case).

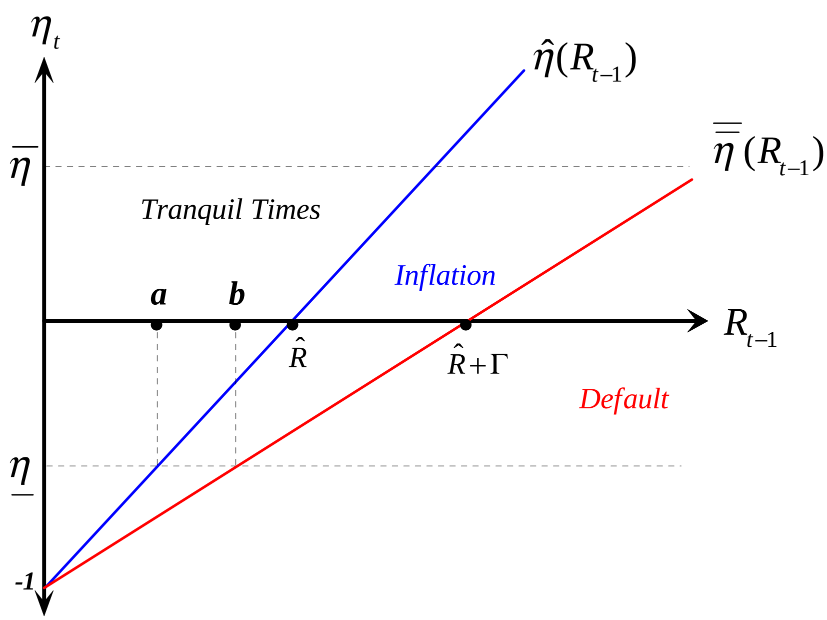


Figure 2.5: The Regime Determination

Note that the period-$t-1$ probability of default in t is simply given by: $F\left(\bar{\bar{\eta}}\left(R_{t-1}\right)\right)$, the probability of a "Tranquil Times" period by: $1-F\left(\hat{\eta}\left(R_{t-1}\right)\right)$, and the probability of an "Inflation Times" episode by: $F\left(\hat{\eta}\left(R_{t-1}\right)\right)-F\left(\bar{\bar{\eta}}\left(RR_{t-1}\right)\right)$. Then, if $R_{t-1}<b$, the *ex ante* probability of a sovereign default in period t is null and, when $R_{t-1}<a$, the probability of a "Tranquil Times" period equals unity.

2.5.1. Expected Recovery Rate

Using Table 1, the one-period Expected Recovery Rate can be written:

$$\begin{aligned} E_t h_{t+1} &= \int_{-\bar{\eta}}^{\bar{\bar{\eta}}(R_t)} \frac{(1+\eta)\bar{R}}{R_t} dF(\eta) + \int_{\bar{\bar{\eta}}(R_t)}^{\bar{\eta}} 1 dF(\eta) \\ &= 1 - \frac{R_t - \bar{R}}{R_t} F\left(\bar{\bar{\eta}}(R_t)\right) + \frac{\bar{R}}{R_t} \int_{-\bar{\eta}}^{\bar{\bar{\eta}}(R_t)} \eta dF(\eta) \end{aligned} \tag{2.30}$$

Notice that the default probability, $F\left(\bar{\bar{\eta}}(R_t)\right)$, is strictly positive (Resp. null) and that $\int_{-\bar{\eta}}^{\bar{\bar{\eta}}(R_t)} \eta dF(\eta)$ is strictly negative (Resp. null) if $\bar{\bar{\eta}}(R_t) > -\bar{\eta}$ (Resp. $\bar{\bar{\eta}}(R_t) \leq -\bar{\eta}$). One can conclude that the one-period expected recovery rate verifies: $E_t h_{t+1} < 1$ for $\bar{\bar{\eta}}(R_t) > -\bar{\eta}$ and $E_t h_{t+1} = 1$ otherwise. Starting from the "Tranquil Times" steady state, *i.e.* $R_t = \bar{R}$, we have $\bar{\bar{\eta}}\left(\bar{R}\right) = \left(\hat{R} + \left(\bar{\bar{R}} - \bar{R}\right)/\alpha\beta\right)^{-1} \bar{R} - 1 < 0$ and (2.30) can be simplified as:

$$E_t h_{t+1} = 1 + \int_{-\bar{\eta}}^{\bar{\bar{\eta}}(\bar{R})} \eta dF(\eta)$$

which then verifies $E_t h_{t+1} < 1$ for $\bar{\bar{\eta}}\left(\bar{R}\right) > -\bar{\eta}$ and $E_t h_{t+1} = 1$ otherwise.

2.5.2. Sovereign Risk Premium

From (2.8) and (2.9), the relative sovereign risk premium can be defined by:

$$\frac{R_t - R_t^f}{R_t^f} = \frac{\beta^{-1}\left[E_t \frac{h_{t+1}}{\pi_{t+1}}\right]^{-1}}{\beta^{-1}\left[E_t \frac{1}{\pi_{t+1}}\right]^{-1}} - 1 = \frac{E_t \frac{1}{\pi_{t+1}}}{E_t \frac{h_{t+1}}{\pi_{t+1}}} - 1$$

Using again the results in Table 1, this expression becomes:

$$\begin{aligned}
\frac{R_t - R_t^f}{R_t^f} &= \frac{\int_{-\bar{\eta}}^{\bar{\bar{\eta}}(R_t)} \left(\beta \bar{R}\right)^{-1} dF(\eta) + \int_{\bar{\bar{\eta}}(R_t)}^{\bar{\eta}} \left(\frac{\beta R_t}{1+\eta}\right)^{-1} dF(\eta)}{\int_{-\bar{\eta}}^{\bar{\eta}} \left(\frac{\beta R_t}{1+\eta}\right)^{-1} dF(\eta)} - 1 \\
&= \int_{-\bar{\eta}}^{\bar{\bar{\eta}}(R_t)} \frac{R_t}{\bar{R}} dF(\eta) + \int_{\bar{\bar{\eta}}(R_t)}^{\bar{\eta}} (1+\eta)\, dF(\eta) - 1 \\
&= \frac{R_t - \bar{R}}{\bar{R}} F\left(\bar{\bar{\eta}}(R_t)\right) + \int_{\bar{\bar{\eta}}(R_t)}^{\bar{\eta}} \eta dF(\eta) \qquad (2.31)
\end{aligned}$$

with $\int_{\bar{\bar{\eta}}(R_t)}^{\bar{\eta}} \eta dF(\eta) > 0$ when $\bar{\bar{\eta}}(R_t) > -\bar{\eta}$ and $\int_{\bar{\bar{\eta}}(R_t)}^{\bar{\eta}} \eta dF(\eta) = 0$ otherwise. One concludes that the relative sovereign risk premium is strictly positive for $\bar{\bar{\eta}}(R_t) > -\bar{\eta}$ and null otherwise. At the "Tranquil Times" steady state, *i.e.* $R_t = \bar{R}$, equation (2.31) simplifies to:

$$\frac{\bar{R} - R^f}{R^f} = \int_{\bar{\bar{\eta}}(\bar{R})}^{\bar{\eta}} \eta dF(\eta)$$

which is strictly positive for $-\bar{\eta} < \bar{\bar{\eta}}\left(\bar{R}\right)$ and null otherwise.

2.5.3. Calibration and Simulation

For sake of simplicity, we will assume that fiscal (relative) innovations are uniformly distributed: $F(\eta) = (\eta + \bar{\eta})/2\bar{\eta}$. The one-period Expected Recovery Rate is given by equation (2.30) which can be rewritten, for $-\bar{\eta} < \bar{\bar{\eta}}(R_t) < \bar{\eta}$:

$$\begin{aligned}
E_t h_{t+1} &= \frac{\bar{R}}{R_t}\left[\frac{\bar{\bar{\eta}}(R_t) + \bar{\eta}}{2\bar{\eta}} + \frac{1}{2}\left(\frac{\bar{\bar{\eta}}(R_t)^2 - \bar{\eta}^2}{2\bar{\eta}}\right)\right] + 1 - \frac{\bar{\bar{\eta}}(R_t) + \bar{\eta}}{2\bar{\eta}} \\
&= 1 - \left[\frac{R_t - \bar{R}}{R_t}\left(\frac{\bar{\bar{\eta}}(R_t) + \bar{\eta}}{2\bar{\eta}}\right) + \frac{\bar{R}}{R_t}\left(\frac{\bar{\eta}^2 - \bar{\bar{\eta}}(R_t)^2}{4\bar{\eta}}\right)\right]
\end{aligned}$$

and the one-period Sovereign Risk Premium is:

$$\frac{R_t - R_t^f}{R_t^f} = \frac{R_t - \bar{R}}{\bar{R}} \left(\frac{\bar{\bar{\eta}}(R_t) + \bar{\eta}}{2\bar{\eta}} \right) + \frac{\bar{\eta}^2 - \bar{\bar{\eta}}(R_t)^2}{4\bar{\eta}}$$

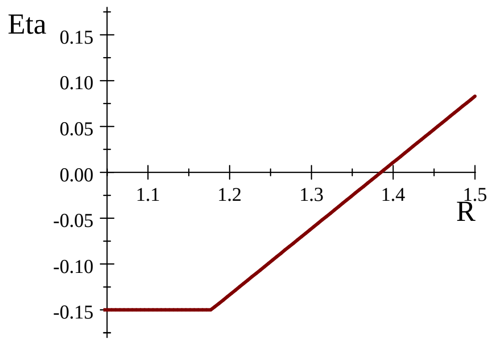
We can easily illustrate our results by adopting the following annual calibration for the model's parameters:

Table 2.3: Calibration

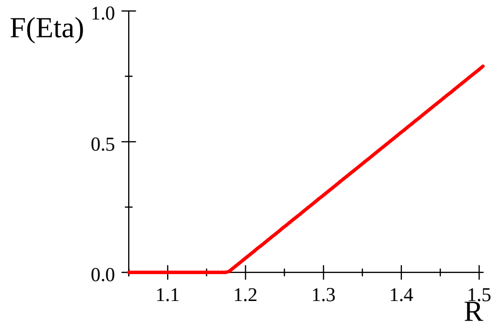
Definition	*Parameter*	*Value*
Discount factor:	β	0.95
Taylor coefficient:	α	1.5
Interest rate target:	$\bar{R}$	1.05
Monetary threshold:	$\hat{R}$	1.10
Fiscal threshold:	$\bar{\bar{R}}$	1.50
Upper bound of the distribution function:	$\bar{\eta}$	0.15

We can firstly calculate the lower threshold value of R_t for which $F\left(\bar{\bar{\eta}}(R_t)\right) \geq 0$. The solution is 1.177, which is superior to $\bar{R} = 1.05$ (and even superior to $\hat{R} = 1.10$). This implies that, starting from the "Tranquil Times" Steady State in period t, the probability for the Government to default on its debt in $t+1$ is always null. After this calibration, a Sovereign Default cannot be observed without a period of growing inflation. Consequently, an aggressive central bank fighting against inflation does not go without costs. It increases the fiscal burden of the government debt as well as the sovereign risk of default. A higher current interest rate increases the current probability of default which is captured by the current sovereign risk premium.

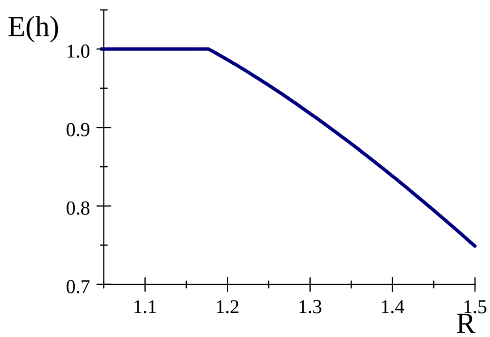
The resulting values for the fiscal default threshold, $\overline{\overline{\eta}}\left(R_t\right)$, the default probability $F\left(\overline{\overline{\eta}}\left(R_t\right)\right)$, the Expected Recovery Rate, $E_t h_{t+1}$, and the one-period Sovereign Risk Premium $\left(R_t - R_t^f\right)/R_t^f$ are represented as functions of the current interest rate R_t



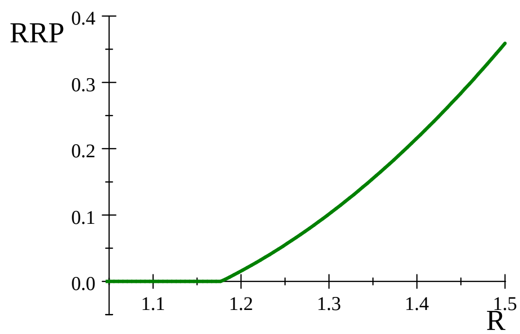
Graph 1: Default Threshold



Graph 2: Default Probability



Graph 3: Expected Recovery Rate



Graph 4: Relative Risk Premium

These Graphs show that when $R_t \leq 1.177$, even the hardest the negative fiscal shock –say $\bar{\eta} = -0,15$ –does not drive the economy into default. Thus, the Probability of Default is null, the Expected Recovery Rate is equal to one, and so the Relative Risk Premium is void. Otherwise, when $R_t > 1.177$ there are (negative) values for the fiscal shock that might drive the economy into default. Thus, the Probability of Default becomes positive, the Expected Recovery Rate becomes lower than the unity, and the Relative Risk Premium positive. The higher is R_t, the higher are both the Probability of Default and Relative Risk Premium and the lower the Expected Recovery Rate.

This finding contrasts with that of Uribe (2006)'s and is in line with the empirical evidence and estimates presented on Chapter 1.

2.6. Further Research and Discussion

This section presents a work in progress. It provides interesting findings and contributes to the discussion over the monetary policy on inflation as well as sovereign default dynamics.

As before, assume that the monetary policy takes the form of an interest-rate feedback rule whereby the short-term nominal interest rate is set as a function of inflation. But unlike the previous case, assume that the interest rate controlled by the central bank is the risk-free nominal interest rate, $R_t^f = 1/E_t Q_{t,t+1}$, and not the interest rate paid on government debt, R_t.[18]

Then, the central bank behavior can be expressed as,

$$R_t^f = \phi(\pi_t) = \begin{cases} \bar{R} & if \quad \pi_t \leq \hat{\pi} \\ \bar{R} + \alpha(\pi_t - \hat{\pi}) & \text{otherwise} \qquad \text{with} \quad \alpha > \beta^{-1} \end{cases} \tag{2.32}$$

where $\bar{R} = \beta^{-1}\bar{\pi}$ is the stationary value of the gross nominal interest rate associated to the inflation target $\bar{\pi}$, and $\hat{\pi}$ represents an inflation threshold. It will be useful to define: $\hat{R} = \beta^{-1}\hat{\pi}$, about which we make the same assumption as before: $\hat{R} > \bar{R}$, or, equivalently: $\hat{\pi} > \bar{\pi}$.

Therefore, the equilibrium can be defined as:

[18]This assumption seems to be more in accordance with the cashless economy framework that we have chosen. Indeed, this framework does not explicitly take into account the open market interventions by the central bank on the government securities market and does not facilitate an explaination of the control of the interest rate R_t by monetary authorities.

Definition 2. *A rational expectations competitive equilibrium is defined as a set of processes* $\left\{\pi_t, b_t, R_t, R_t^f, h_t\right\}_{t=0}^{\infty}$ *satisfying equations (2.8), (2.9), (2.10), (2.11), the monetary rules (2.32), the debt recovery rule (2.7), and the exogenous process for the primary surpluses* $\{\tau_t\}_{t=0}^{\infty}$ *where* $R_{-1}b_{-1}$ *are given and the recovery rate satisfies* $h_t \in (0,1)$ ॥

2.6.1. The Three Scenarios for this Economy

The asymmetric form of both equations (2.32) and (2.7) may potentially imply the existence of four regimes, but assumptions 1 and 2 permit to exclude the case where the central bank naturally[19] pegs the interest rate to $\bar{R}$, leading the fiscal authority to default on its outstanding debt. Three scenarios are left.

Both "Tranquil Times" and "Inflation Times" are characterized by the absence of sovereign default. Then, the equilibrium level of inflation and interest rates are given by equations (2.14) and (2.32) with $h_t = 1$:

$$\pi_t^{nd} = \frac{\beta R_{t-1}}{1+\eta_t} \tag{2.33a}$$

$$R_t^f = \phi\left(\pi_t^{nd}\right) = \begin{cases} \bar{R} & if \quad \pi_t^{nd} \leq \hat{\pi} \\ \bar{R} + \alpha\left(\pi_t^{nd} - \hat{\pi}\right) & \text{otherwise} \end{cases} \tag{2.33b}$$

The third one is the scenario of Sovereign Default – where $h_t < 1$. In this case, the fiscal authority finds that the potential cost of servicing its whole debt is unaffordable. Consequently, it defaults on its liabilities by honoring only a fraction of its financial obligations.

2.6.1.1. "Tranquil Times". When the value of the inflation rate (2.33a) satisfies the condition $\pi_t^{nd} \leq \hat{\pi}$, equation (2.33b) implies that the central bank pegs the risk-free interest rate to $\bar{R}$. Also, these periods are characterized by both low current

[19] By "naturally", we mean: "considering the inflation rate which would be realized in the case of No Default".

inflation and interest rates. We have:

$$\pi_t^T = \frac{\beta R_{t-1}}{1+\eta_t} \leq \hat{\pi} \tag{2.34a}$$

$$R_t^{f,T} = \bar{R} \tag{2.34b}$$

where $R_t^{f,T}$ denotes the current risk-free nominal interest rate in "Tranquil Times".

Both equations (2.34a) and (2.34b) are satisfied on condition that $\pi_t^T \leq \hat{\pi}$ which implies:

$$R_{t-1} \leq (1+\eta_t)\,\hat{R} \tag{2.35a}$$

remembering that $\hat{R} = \beta^{-1}\hat{\pi}$;or, equivalently:

$$\eta_t \geq \hat{\eta}\left(R_{t-1}\right) \tag{2.35b}$$

where $\hat{\eta}(R)$ is defined as:

$$\hat{\eta}(R) \equiv R/\hat{R} - 1 \tag{2.36}$$

2.6.1.2. "Inflation Times". Compared to the previous case, these periods are characterized by both higher current interest rates and inflation levels. And this is linked to the fact that the economy is hit by harder negative fiscal shocks. The current inflation remains defined like in the previous case but now it exceeds the inflation threshold $\hat{\pi}$ and the central bank behaves actively by increasing the current interest rate:

$$\pi_t^I = \frac{\beta R_{t-1}}{1+\eta_t} > \hat{\pi} \tag{2.37a}$$

$$R_t^{f,I} = \bar{R} + \alpha\left(\frac{\beta R_{t-1}}{1+\eta_t} - \hat{\pi}\right) < \overset{=}{R}{}^f \tag{2.37b}$$

where $R_t^{f,I}$ denotes the current risk-free nominal interest rate in "Inflation Times".

This equilibrium is satisfied on condition that $\pi_t^I > \hat{\pi}$ and $R_t^{f,I} < \bar{\bar{R}}^f$ which implies:

$$(1+\eta_t)\,\hat{R} < R_{t-1} < (1+\eta_t)\left(\hat{R}+\Gamma\right) \tag{2.38a}$$

using again $\hat{R} = \beta^{-1}\hat{\pi}$;or, equivalently:

$$\bar{\bar{\eta}}\left(R_{t-1}\right) < \eta_t < \hat{\eta}\left(R_{t-1}\right) \tag{2.38b}$$

with

$$\Gamma \equiv \frac{\bar{\bar{R}} - \bar{R}}{\alpha\beta} > 0 \tag{2.39}$$

and where the function $\bar{\bar{\eta}}(\cdot)$ is defined by:

$$\bar{\bar{\eta}}(R) \equiv \frac{R}{\hat{R}+\Gamma} - 1 < \hat{\eta}(R) \tag{2.40}$$

Condition (2.38b) expresses that a period of inflation is driven by a strictly negative shock which is no longer soft, given the level of R_{t-1}. The shock is rather hard but not enough to drive the economy into default.

2.6.1.3. "Sovereign Default Time". According to the fiscal authority, the potential cost of servicing the whole debt becomes too high when $R_t > \bar{\bar{R}}$, *i.e.*, $R_t^f > \bar{\bar{R}}^f$ which implies:

$$R_{t-1} > (1+\eta_t)\left(\hat{R}+\Gamma\right) \tag{2.41a}$$

or, equivalently,

$$\eta_t < \bar{\bar{\eta}}\left(R_{t-1}\right) \tag{2.41b}$$

This condition shows that for a given shock η_t, a scenario of Default can be triggered by a high level of the previous nominal interest rate or, for a given level of R_{t-1}, by a hard negative fiscal shock.

As a consequence, the fiscal authority defaults on its debt by honoring only a fraction $h_t < 1$ of its liabilities. From equations (2.14) and (2.32), current inflation and risk free interest rates become:

$$\pi_t^D = h_t \pi_t^{nd} \tag{2.42a}$$

$$R_t^{f,D} = \phi\left(h_t \pi_t^{nd}\right) \tag{2.42b}$$

where π_t^{nd} is always defined by (2.33a) as the equilibrium inflation rate in the no default case.

Note that without specifying the recovery rule –$h_t = h(\pi_t^{nd}) < 1$ –the equilibrium in period t remains undetermined and defined by equation (2.42a) and (2.42b).[20] There is a continuum of recovery rate determining the equilibrium inflation rate and so the nominal interest rate. This result is line with Buiter's critic.[21] In order to avoid this indeterminacy the fiscal authority has to specify a recovery rule. We now can make the following assumption about the recovery function $h(\pi_t^{nd})$:

$$h(\pi_t^{nd}) \equiv \frac{\pi^*}{\pi_t^{nd}} \tag{2.43}$$

where π^* verifies:

Assumption 4:: $\pi^* < \beta\left(\hat{R} + \Gamma\right) = \hat{\pi} + \left(\bar{\bar{R}}^f - \bar{R}\right)/\alpha.$

Equation (2.43) shows that, for a given value of π^*, the higher is the potential inflation rate π_t^{nd}, the smaller is the recovery rate. Using the recovery function

[20] We suppose that such a rule is a (non increasing) function of the nominal interest rate, denoted R_t^{nd}, to be determined by the monetary authority in the No-Default case. Then, $R_t^{nd} = \phi\left(\pi_t^{nd}\right)$ represents the potential cost of honoring the whole debt in the future.

[21] See Buiter (1999), pp. 50, Proposition 5.

(2.43) and the monetary rule (2.32) in equations (2.42a) and (2.42b), the equilibrium values of π_t^D and $R_t^{f,D}$ become:

$$\begin{aligned} \pi_t^D &= \pi^* \\ R_t^{f,D} &= \phi(\pi^*) \end{aligned}$$

Thus, the recovery rule (2.43) allows the economy, by defaulting on its financial obligations, to reach a less inflationary equilibrium in the same period t. Note that if $\pi^* \leq \hat{\pi}$, the monetary rule (2.32) implies $R_t^{f,D} = \bar{R}$.

Using (2.33a) in equation (2.43), the equilibrium value of the recovery rate is:

$$h_t = \frac{(1+\eta_t)\,\pi^*}{\beta R_{t-1}} \tag{2.44}$$

Assumption 4 ensures that this recovery rate is always inferior to unity.

2.6.2. Expected Recovery Rate, Sovereign Risk Premium and Interest Rates

It is possible to express R_t as an invertible function of R_t^f, and hence $\overset{=}{R}{}^f$ as a function of $\overset{=}{R}$. Let $\mathcal{P}_t = R_t/R_t^f$ denotes the gross sovereign risk premium. From (2.8) and (2.9), $\mathcal{P}_t$ can be defined by:

$$\mathcal{P}_t = \frac{R_t}{R_t^f} = \frac{E_t \frac{1}{\pi_{t+1}}}{E_t \frac{h_{t+1}}{\pi_{t+1}}} \tag{2.45}$$

Now lets make simplifying assumptions about the fiscal shock distribution and we will see that, once the Fiscal Default Rule is known - which is summarized by the choice of $\overset{=}{R}{}^f$ and R^* –the sovereign risk premium, $\mathcal{P}_t = R_t/R_t^f$, and the one-period expected recovery rate, $E_t h_{t+1}$, can be calculated. Let us begin by summarizing our results with the following table:

Table 2.4: the three scenarios

	Tranquil Times	**Inflation Times**	**Sovereign Default Time**
	$\hat{\eta}\left(R_{t-1}\right) < \eta_t$	$\bar{\bar{\eta}}\left(R_{t-1}\right) < \eta_t < \hat{\eta}\left(R_{t-1}\right)$	$\eta_t < \bar{\bar{\eta}}\left(R_{t-1}\right)$
h_t :	1	1	$\frac{(1+\eta_t)\pi^*}{\beta R_{t-1}}$
π_t :	$\frac{\beta R_{t-1}}{1+\eta_t}$	$\frac{\beta R_{t-1}}{1+\eta_t}$	π^*
R_t^f :	$\bar{R}$	$\bar{R} + \alpha\beta\left(\frac{R_{t-1}}{1+\eta_t} - \hat{R}\right)$	$\phi\left(\pi^*\right)$

where $\hat{\eta}(R) = R/\hat{R} - 1$ and $\bar{\bar{\eta}}(R) \equiv R/\left(\hat{R} + \frac{\bar{\bar{R}}^f - \bar{R}}{\alpha\beta}\right) - 1$ and with $\bar{R} < \hat{R} < \bar{\bar{R}}^f$ and $\phi\left(\pi^*\right) < \bar{\bar{R}}^f$.

2.6.2.1. Expected Recovery Rate. Using the results presented in the first row of Table 1, the one-period Expected Recovery Rate can be written:

$$
\begin{aligned}
E_t h_{t+1} &= \int_{-\bar{\eta}}^{\bar{\bar{\eta}}(R_t)} \frac{(1+\eta)\pi^*}{\beta R_t} dF(\eta) + \int_{\bar{\bar{\eta}}(R_t)}^{\bar{\eta}} 1 dF(\eta) \\
&= 1 - \int_{-\bar{\eta}}^{\bar{\bar{\eta}}(R_t)} \left(1 - \frac{(1+\eta)\pi^*}{\beta R_t}\right) dF(\eta) \qquad (2.46)
\end{aligned}
$$

where the last term after the sign of subtraction is positive under Assumption 4 for $\bar{\bar{\eta}}(R_t) > -\bar{\eta}$ and null otherwise.

One can conclude that the Expected Recovery Rate verifies $E_t h_{t+1} < 1$ for $\bar{\bar{\eta}}(R_t) > -\bar{\eta}$ and $E_t h_{t+1} = 1$ otherwise. Identically, let us define R_η such that $\bar{\bar{\eta}}(R_\eta) = -\bar{\eta}$. According to equation (2.38a), we have :

$$R_\eta = (1 - \bar{\eta})(R + \Gamma)$$

and we know that $E_t h_{t+1} < 1$ if $R_t > R_\eta$.

2.6.2.2. Sovereign Risk Premium. Using now the second row of Table 2.4 and equation (2.45), the gross sovereign risk premium - or country risk spread -

$\mathcal{P}_t = R_t/R_t^f = E_t \pi_{t+1}^{-1}/E_t\left(h_{t+1}/\pi_{t+1}\right)$, can be written:

$$\begin{aligned}\mathcal{P}_t &= \frac{\int_{-\bar{\eta}}^{\bar{\bar{\eta}}(R_t)} \left(\pi^*\right)^{-1} dF\left(\eta\right) + \int_{\bar{\bar{\eta}}(R_t)}^{\bar{\eta}} \left(\frac{\beta R_t}{1+\eta}\right)^{-1} dF\left(\eta\right)}{\int_{-\bar{\eta}}^{\bar{\eta}} \left(\frac{\beta R_t}{1+\eta}\right)^{-1} dF\left(\eta\right)} \\ &= 1 + \int_{-\bar{\eta}}^{\bar{\bar{\eta}}(R_t)} \left(\frac{\beta R_t}{\pi^*} - (1+\eta)\right) dF\left(\eta\right) \equiv \mathcal{P}\left(R_t\right) \qquad (2.47)\end{aligned}$$

where the last term after the sign of addition is positive under Assumption 4 for $\bar{\bar{\eta}}\left(R_t\right) > -\bar{\eta}$ and null otherwise . So, we can conclude that $\mathcal{P}_t > 1$ if $R_t > R_\eta$.

We can easily obtain the derivative of the function $\mathcal{P}\left(R_t\right)$ for $R_t > R_\eta$:

$$\mathcal{P}'\left(R_t\right) = \frac{\beta}{\pi^*} F\left(\bar{\bar{\eta}}\left(R_t\right)\right) + \left(\frac{\beta}{\pi^*} - \frac{1}{\left(\hat{R}+\Gamma\right)}\right) R_t F'\left(\bar{\bar{\eta}}\left(R_t\right)\right) > 0$$

where we have used equation (2.40) and (2.39). Assumption 4 insures that this derivative is always positive.

Using again the definition of the gross sovereign risk premium: $\mathcal{P}_t = R_t/R_t^f$ and equation (2.47), one can establish a link between R_t and R_t^f :

$$R_t^f = G\left(R_t\right) \equiv \frac{R_t}{\mathcal{P}\left(R_t\right)} \qquad (2.48)$$

where the function $G\left(R_t\right)$ has a derivative given by:

$$G'\left(R_t\right) = \frac{1}{\mathcal{P}\left(R_t\right)} - \frac{R_t \mathcal{P}'\left(R_t\right)}{\mathcal{P}\left(R_t\right)^2}$$

which verifies: $0 < G'\left(R_t\right) < 1$ if $R_t > R_\eta$ and $G'\left(R_t\right) = 1$ otherwise.

Equation (2.48) implicitly permits to determine the interest rate on government securities as a function of the riskless interest rate set by the central bank. By inverting the function $G\left(\cdot\right)$, one finds:

$$R_t = G^{-1}\left(R_t^f\right) \equiv g\left(R_t^f\right) \qquad (2.49)$$

where the function $g\left(R_t^f\right)$ verifies: $g'\left(R_t^f\right) = 1/G'\left(G^{-1}\left(R_t^f\right)\right) > 1$ if $R_t > R_\eta$ and $g'\left(R_t^f\right) = 1$ otherwise.

2.6.2.3. Riskless and Risky Interest Rates. Using finally the last row of Table 2.4 and equation (2.49), one can express the risky sovereign debt interest rate:
(2.50)

$$R_t = \begin{cases} g\left(\bar{R}\right) & \text{if} \quad R_{t-1} < (1+\eta_t)\,\hat{R} \\ g\left(\bar{R} + \alpha\beta\left(\frac{R_{t-1}}{1+\eta_t} - \hat{R}\right)\right) & \text{if} \quad (1+\eta_t)\,\hat{R} < R_{t-1} < (1+\eta_t)\left(\hat{R}+\Gamma\right) \\ g\left(\phi\left(\pi^*\right)\right) & \text{if} \quad R_{t-1} > (1+\eta_t)\left(\hat{R}+\Gamma\right) \end{cases}$$

Let us define $R^{f,I}$ such that: $R^{f,I} = g\left(\bar{R} + \alpha\beta\left(R^{f,I} - \hat{R}\right)\right)$ and suppose that $\hat{R} < R^{f,I} < \hat{R} + \Gamma$. By evaluating the derivative $\partial R_t / R_{t-1}$ for $R_{t-1} = R^{f,I}$ when $\eta_t = 0$, we obtain:

$$\left.\frac{\partial R_t}{\partial R_{t-1}}\right|_{R_{t-1}=R^{f,I};\eta_t=0} = \alpha\beta g'\left(R^{f,I}\right) > 1$$

We now can represent R_t^f and R_t as function of R_{t-1} in the case $\eta_t = 0$:

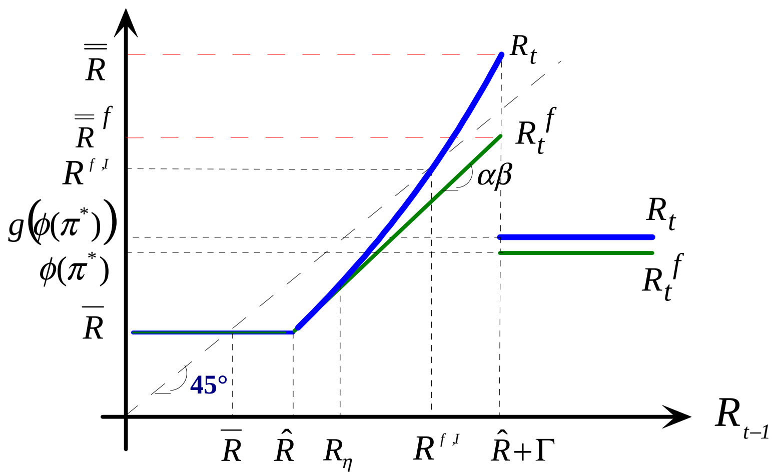


Figure 2.6: Risky and Riskless Interest Rates

Note that the assumption $\alpha\beta > 1$ is sufficient but unnecessary to guarantee $\alpha\beta g'\left(R^{f,I}\right) > 1$.

Corollary 3. *In presence of a default risk, the monetary policy can be active even in the case $\alpha\beta < 1$.*

2.7. Conclusion

The mail goal of this chapter is to characterize the way in which monetary policy affects the equilibrium behavior of recovery rate and sovereign risk premiums. This is an issue which has been fairly disregarded by recent monetary theory. The framework of analysis proposed in this chapter offers an additional perspective to discuss the possible interrelations between monetary and fiscal policy and provides supplementary advantages as regards other settings. It allows to overcome somes difficulties like the negative default rate which arises as a consequence of positive fiscal shocks –recall the 'super-solvency premium' in terms of Buiter. This model characterizes the way in which monetary policy affects the equilibrium behavior of price level, recovery rate and sovereign risk premiums. Indeed, in some cases, even a 'passive' interest rate rule might drive the economy to an unsustanable path without defaulting. It means that in presence of a default risk, the monetary policy can be active even in the case where $\alpha\beta < 1$.It turns out that monetary policy plays a significant role in shaping the equilibrium behavior of default and risk premiums. Both the Probability of Default and Sovereign Risk Premium are consistent with the empirical estimates presented in the previous chapter.

It also underlines the fact that the size of the equilibrium default rate matters for the post-equilibrium dynamics. The size of the equilibrium default rate must be higher enough in order to ensure a post-equilibrium dynamics without defaulting. This theoretical result is consistent with the argument presented on section 1.4.3 of the previous chapter as to the assesment of the Argentine Debt Haircut after the last event of default on December, 2001. The model explicitly emphasizes the role of the government (the fiscal authority) in resolving the financial crisis.

Even though the current framework can be extended in different directions, these have been left aside to simplify the exposition. For instance, it can be assumed that a fraction of the public debt is indexed. High inflation economies tend to develop an extensive system of indexed contracts. It is worth noticing that bonds linked to price indices are not 'real' bonds because sampling and computing price indices involve time. The nominal value of indexed bonds is typically adjusted according to lagged inflation rates. Othewise, it coud be assumed that public debt is denominated in foreign currency. These are important characteristics of actual emerging economies that would be worthwhile incorporating.

Appendix 2

2.7.1. Appendix 2. A.

Multiplying both sides of equation (2.5) by $R_t h_{t+1}$ as $B_t R_t h_{t+1} = B_{t-1} R_{t-1} h_t R_t h_{t+1} - \tau_t P_t R_t h_{t+1}$. Then, iterating the last expression j times, it results in:

$$R_{t+j} B_{t+j} h_{t+j+1} = R_{t-1} B_{t-1} h_t \left(\prod_{h=0}^{j} R_{t+h} h_{t+h+1} \right) - \sum_{h=0}^{j} P_{t+h} \tau_{t+h} \left(\prod_{k=h}^{j} R_{t+k} h_{t+k+1} \right) \tag{2.51}$$

Dividing both sides of equation (2.51) by P_{t+j+1} –see that P_{t+j+1} can also be written as $P_{t+j+1} = P_t \frac{P_{t+1}}{P_t} \frac{P_{t+2}}{P_{t+1}} \cdots \frac{P_{t+j}}{P_{t+j-1}} \frac{P_{t+j+1}}{P_{t+j}}$ –it turns out that,

$$\frac{R_{t+j} B_{t+j}}{P_{t+j+1}} h_{t+j+1} = \frac{R_{t-1} B_{t-1}}{P_t} h_t \left(\prod_{h=0}^{j} R_{t+h} h_{t+h+1} \frac{P_{t+h}}{P_{t+h+1}} \right) - \sum_{h=0}^{j} \tau_{t+h} \left(\prod_{k=h}^{j} R_{t+k} h_{t+k+1} \frac{P_{t+k}}{P_{t+k+1}} \right) \tag{2.52}$$

Applying the conditional expectations operator E_t, equation (2.52) becomes written,

$$E_t \frac{R_{t+j}B_{t+j}}{P_{t+j+1}} h_{t+j+1} = \frac{R_{t-1}B_{t-1}}{P_t} h_t E_t \left(\prod_{h=0}^{j} R_{t+h} h_{t+h+1} \frac{P_{t+h}}{P_{t+h+1}} \right) - E_t \sum_{h=0}^{j} \tau_{t+h} \left(\prod_{k=h}^{j} R_{t+k} h_{t+k+1} \frac{P_{t+k}}{P_{t+k+1}} \right) \tag{2.53}$$

Next, by applying the law of iterated expectations and using equation (2.9) equation (2.53) remains expressed as,

$$E_t \frac{R_{t+j}B_{t+j}}{P_{t+j+1}} h_{t+j+1} = \beta^{-j-1} \frac{R_{t-1}B_{t-1}}{P_t} h_t - \sum_{h=0}^{j} \beta^{-(j-h+1)} E_t \tau_{t+h} \tag{2.54}$$

Dividing both sides of equation (2.54) by β^{-j} and then taking the limit for $j \to \infty$, it turns out,

$$\lim_{j\to\infty} \beta^j E_t \frac{R_{t+j}B_{t+j}}{P_{t+j+1}} h_{t+j+1} = \beta^{-1} \frac{R_{t-1}B_{t-1}}{P_t} h_t - \sum_{h=0}^{\infty} \beta^{h-1} E_t \tau_{t+h} \tag{2.55}$$

See that defining $T = t + j + 1$, the left hand-side of equation (2.55) can be expressed as $\lim\limits_{T\to\infty} \beta^{T-j-1} E_t \frac{R_{T-1}B_{T-1}}{P_{T-1}} h_T = 0$. Then, multiplying this expression by β, it remains expressed as equation (2.10) which is equal to zero. So equation (2.55) results in,

$$\frac{R_{t-1}B_{t-1}}{P_t} h_t = \sum_{h=0}^{\infty} \beta^h E_t \tau_{t+h} \qquad \forall t$$

Part 2

Banking Regulation on Foreign Banks

CHAPTER 3

Literature Review on Foreign Banks and Financial Stability

3.1. Introduction

In the early 1980s, cross-border lending represented the main foreign banking activity in developing countries. From the second half of the 1990s, foreign banks have expanded their presence in several emerging market economies by establishing foreign branches and subsidiaries. However, multinational banking is not a new phenomenon. The first wave of multinational banking started at the beginning of the 19th century when British banks settled foreign offices in their colonies. The war and depression period marked the end of this first stage during which multinational banks concentrated in developing countries. The second wave of bank expansion began in the 1960s led by American banks. Japanese and British banks also played an important role. During this second expansion period, banks were mainly focused on developed countries. The third wave took place in the 1990s and this time multinational banks were more interested in expanding their activities into emerging market economies.

Early in the 1990s, deregulation and privatization of the Latin America's banking sector encouraged foreign direct investment in local banking industry. The preparations for EU membership and the efforts of Central and Eastern Europe policy makers to recapitalize and restructure their banking system –via privatization and liberalization in the transition period -allowed foreign control of the domestic banking sector in this region. As a consequence, foreign direct investment into the banking industry in Latin America and in Eastern Europe grew at an exceptional scale.

In Argentina, Chile, Czech Republic, Hungary and Poland, foreign control of banking assets is very high at present-foreign banks hold more than half of total banking assets. However, in Africa, Asia, and the Middle East and North Africa (MENA) foreign banks evolution has been slower due to the higher restrictions to foreign entry. More recently, since its accession to World Trade Organization in December 2001, China has agreed to gradually open up their domestic banking sector to foreign banks.

Despite the spectacular evolution of foreign bank entry, the debate on the merits of opening emerging market banking sectors to foreign competition still goes on and foreign bank entry remains a very sensitive issue in spite of its potential benefits. Evidence drawn from both cross-country samples and individual country studies shows that foreign bank entry is often associated with an increase in efficiency (Corvoisier and Gropp, 2002; Evanoff and Ors 2002; Demirgüç- Kunt *et al.,* 2003). Foreign banks seem to have higher profitability and lower overhead costs than state-owned and private domestic banks (Galindo *et al.,* 2004). Their technology and management practices are likely to improve the efficiency of the local banking sector (Levine, 1997). However, concerns arise around their increasing presence, such as lack of control by regulatory and monetary authorities in case of a massive foreign bank presence (e.g. information asymmetries between home and host country supervision authorities, banks acting in different jurisdictions).

The most controversial topic, though, refers to the risks to the banking system's stability and to a more volatile credit supply. The presence of foreign banks increases the amount of funding available in the local market by facilitating capital inflows and preventing capital flight in case of domestic shocks. Foreign banks have been a major source of funding following the Mexican, Brazilian or Argentine banking crises in the 1990s. During the Argentine crisis in 2001, however, some foreign banks (Scotiabank, Crédit Agricole) decided not to recapitalize their subsidiaries. In particular, foreign-owned banks may endanger the stability of local credit by withdrawing more rapidly from emerging markets in case of economic upheaval either in host or home country. A number of studies conclude that foreign bank penetration is beneficial to all firms and that there is no discrimination against small ones (Escudé *et al.*, 2001; Giannetti and Ongena, 2005). On the contrary, Detragiache *et al.*, 2006 argue that a strong foreign bank presence is associated with less credit to the private sector in poor countries. Evidence on small business lending is mixed (see Berger *et al.*, 2001).

Policy makers often debate about trade-offs between banking efficiency and banking stability. The latter has received less attention in empirical literature than the first. This chapter provides an overview of theoretical considerations and a review of empirical literature on the impact of foreign banks on stability focusing particularly on the case of developing countries. Section 3.2. analyses the theoretical background presenting major models to explain the link between foreign banks and credit stability. Section 3.3 presents a survey of empirical literature. And Section 3.4 concludes with an attempt to match theoretical and empirical literature.

3.2. Theoretical Background

Holmström and Tirole (HT) presented in 1997 a pioneer research introducing intermediaries (banks) capital constrained, which is the target sector of our subsequent analysis. The model is settled in a closed economy framework and is based on previous literature on capital-constrained lending.

In this model banks become an independent source of transmitting shocks due to the financing decision problem faced by firms. They have to choose between two sources of financing -bank capital or investors' capital- which are not perfectly substitutable. Bank capital becomes the most expensive of both because banks provide not only loans but also valuable monitoring services to mitigate the firms' managers moral hazard. Consequently, the HT approach helps to understand how a banking system may behave as a separate channel for transmitting shocks; independently from macroeconomic spillovers such as changes in the monetary or exchange rate policy. I then introduce Morgan *et al.* (2002, 2004) (MRS) as an extension of the HT model to a two-country framework. This research clears up how a multinational banking system may affect volatility within a nation compared to a national banking system. Moreover, conclusions as to how the multinational banking system transmits shocks cross-borderly can be drawn. On the basis of de Haas (2006), I also present an extension modeling an endogenous monitoring technology. The common element of these models is that it is focused on the short and medium-term effects of banking in transmitting capital shocks.

Finally, I present the Portfolio Model developed by Galindo *et al.*, (2004, 2005) (MGP) based on Pyle (1971), a useful model to analyze how a more diversified and so less riskier multinational bank may conversely increase credit volatility and introduce others types of risk.

3.2.1. A National Banking System in a Closed-Economy Model

The model has three sectors, each of them made up of firms, intermediaries (banks) and investors, where both firms and intermediaries are capital constrained. Firms can raise external capital from banks and investors to finance their project. The difference between both lenders is that banks monitor the firms while investors do not.

There are two periods. In the first one, financial contracts are signed and investment decisions are made. In the second one, investment returns are realized and claims are settled. The three parties are risk neutral and protected by limited liability, hence, none will end up cash-negative.

The Real Sector: This sector is constituted by a continuum of firms where the only difference among them is the initial amount of capital, A, assumed to be cash for simplicity. [1] The distribution of this asset across firms is given by the cumulative distribution function, denoted as $G(A)$. It indicates the fraction of firms with an amount of assets lower than A. The aggregate amount of firm capital is then given by $K_f = \int A.\partial G(A)$.

In period 1, according to the basic version of the model, each firm has only one project (or idea) economically viable to develop, which costs $I > 0$. But if $A < I$ then the firm needs at least $(I - A)$ in external funding to be able to invest. In period 2, the investment generates a verifiable (or public) financial return equal to zero in case of failure, or R in case of success.

Entrepreneurs are the main source of moral hazard. [2] As a consequence, in absence of either proper incentives or monitoring they may deliberately reduce the probability of project success and get a private profit -i.e. the opportunity cost of managing the project diligently. This moral hazard is formalized by assuming that there are three versions of the project and that the entrepreneur can privately choose between them. There is one good version of the project which probability of success is given by p_H and for the other two bad versions the probability of success is given by p_L. In addition, between both bad projects one yields a private benefit equal to b while the other does it equal to B where $B > b > 0$. Note that both B and b produce p_L so the entrepreneur will prefer the B-project to any other

[1]It could also be considered another asset to be used as collateral.

[2]There is no distinction between managers and entrepreneurs. The model assumes that managers are the owners of the firm -i.e. the entrepreneur.

financial contract. As it will be seen, considering three versions of the project leads to a richer way to model monitoring.

Note also that the value of R is equal for all projects, only the probability of being materialized differs between them. Obviously, it is assumed that: $\Delta p = p_H - p_L > 0$. So, it is the 'expected return' of the bad projects which is lower than that of good projects. Finally, only the good project is economically viable; that is:

$$p_H R - \gamma I > 0 > p_L R - \gamma I + B \tag{3.1}$$

where γ denotes the rate of return of the investors' capital. So through costly monitoring ($c > 0$), banks can prevent entrepreneurs from choosing B but not from opting for b -given that the amount of monitoring is fixed, banks will be able to control relatively evident mismanagement but not minor misconducts. Monitoring becomes economically valuable then -it will be clear at the time of analysing the 'incentive constraints,' they will depend on b instead of B.

The Financial Sector: This sector consists of many intermediaries. Their function is to monitor firm owners and therefore mitigate the moral hazard problem. As it was stated, the model assumes that monitoring can prevent a firm from undertaking the $B-$project by reducing the firm's opportunity cost of being diligent from B to b. It will be seen that an intermediary which monitors will allow a capital-constrained firm to invest or to raise even more external capital.

However, the key assumption is that bankers are subject to moral hazard as well because monitoring is privately costly; it means that intermediaries (bankers) have to pay a non verifiable amount ($c > 0$) to eliminate $B-$project.[3] In other words, intermediaries have incentives for working less and saving the amount of cash equal to c by not monitoring. As a consequence, to prove that banks really

[3]It means 'non verifiable' from the investors' perspective. It is non public information.

monitor and so induce investors to invest, banks must also invest a fraction of their own capital in each project.[4] This makes the aggregate intermediary capital (K_m) one of the most important capital constraints in the aggregate investment level.

The model assumes perfect correlation between projects. This extreme case simplifies the analysis. However, a certain degree of correlation between projects is needed in order to yield monitoring a useful activity. Otherwise, banks may diversify their portfolios in order to avoid this activity.

The Investors: Individual investors are small compared to intermediaries and we refer to them as uninformed investors, to distinguish them from intermediaries who monitor the firms where they have been invested. In contrast, we also make reference to intermediaries as informed investors. Uninformed investors demand an expected rate of return denoted by γ, assuming that the aggregate amount of uninformed capital invested in firms is determined by a standard increasing supply function $S(\gamma)$.[5] The market equilibrium will be described later on. Firms with excess of capital will have to invest their cash surplus in the open market at the uninformed rate of return.

The optimal three-party contract:

In the case of intermediation (indirect finance)[6] there are three participants in the financial contract to afford the project: the firm, the bank and the uninformed investors through the bank. All the equations are written by a unit of investment level. The two latter contribute to the external funds. The optimal three-party contract is set as follows: if the project fails, none of the parties is paid anything, in case of success, the whole profit R is shared so that

[4] The total amount of monitoring that will take place does not converge toward the infinity because each intermediary has a physical limited capacity for monitoring a certain amount of firms. This introduces a limit to the monitoring activity.

[5] Otherwise it should be assumed that γ is exogenous, given an infinity supply of outside investment opportunities that yield γ.

[6] Direct finance means that firms raise uninformed capital directly from investors. Intermediaries, like banks, do not participate.

$$R = R_f + R_u + R_m$$

where R_f, R_u and R_m denote the firm's, the uninformed investor's, and the bank's shares respectively.

Later on, it will be seen that the profit shares are determined endogenously and represent the opportunity costs of each of them -moreover, in the case of the firms and banks they are determined by their incentive constraints while to the uninformed investors is equal to the market value of γ.

As aforesaid, monitoring eliminates the $B-$project from the firm's options, then it is left to choose between the good project and the low benefit project (the $b-$project). After monitoring, the firm has to be paid at least:[7]

$$(IC_f) \qquad R_f \geq \frac{b}{\Delta p}$$

where $\Delta p = (p_H - p_L)$. This condition is called the 'firm incentive constraint' (IC_f). Notice that in absence of monitoring the IC_f is given by $R_f \geq B/\Delta p$ and thus a higher rate of return has to be promised to entrepreneurs to behave diligently. Thus, monitoring is economically valuable.

Then in order for banks to monitor, the following 'intermediary incentive constraint' (IC_m) must hold:[8]

$$(IC_m) \qquad R_m \geq \frac{c}{\Delta p}$$

[7]It implicitly assumes that the necessary condition for firms to behave diligently is $pH.R_f \geqslant pL.R_f + b$ which turns out from equation (3.1).

[8]It implicitly assumes that $pH.R_m - c \geqslant pL.R_m$. It means that it is more profitable to monitoring than not to. Later on, it will be seen that given that $c$is 'non verifiable' banks have to invest (at least part of) their own capital.

Both incentive constraints set a lower bound for their expected returns, respectively. These minimum thresholds are needed to enforce the three-party contract. Otherwise, given the moral hazard problem, firms or banks (or both) may commit fraud against the other participants. Thus the residual amount is the maximum return which can be promised to uninformed investors without destroying incentives.

Finally, it leaves at most R_u for investors. This amount results from $R - (R_f + R_m)$. As from both ICs it turns out that:

$$R_u = (R - \frac{(b+c)}{\Delta p})$$

Then the maximum return per unit of investment which can be promised to investors is called the 'pledgeable *expected* income' (PEI) and is given by:

$$(PEI) \qquad p_H(R - \frac{(b+c)}{\Delta p})$$

They must supply $I_u = (I - A - I_m)$ where I_m is the amount of capital that a bank invests in a firm which it monitors. Thus 'pledgeable expected income' should not be less than $\gamma I_u = \gamma(I - A - I_m)$, the opportunity cost of investing uninformed capital in the open market -recall that investors are also risk neutral.

It is assumed that monitoring capital is scarce and then it is entirely invested in it.[9] The amount of intermediary capital that a bank invests in a firm that it monitors is denoted as I_m. Then the bank expected rate of return is given by

$$\beta = \frac{p_H R_m}{I_m}$$

Replacing the IC_m in the last expression it turns out:

[9] IC_m implies that $(pH.R_m - c) > 0$; so monitoring earns positive net rate of return in the second period and this is linked to the fact that monitoring capital is scarce. Bank capital is then totally invested in firms.

$$I_m(\beta) = \frac{p_H c}{\Delta p \beta} \tag{3.2}$$

which represents the minimum investment level carried out by a bank in the firm that it monitors.

Considering that monitoring is costly, β must be higher than γ , then firms will prefer uninformed to informed capital. So each firm will demand the minimum level of capital from the bank. Demanding less than this minimum level would be inconsistent with the IC_m where the incentive is provided by R_m whereas β is taken as given. The demand of uninformed capital given by $I_m(\beta)$ regulates its rate of return and so it clears the market.

As aforesaid, uninformed investors provide the remainder of the funds to undertake the project. If this remaining amount is positive, its investment level becomes given by I_u. Uniformed investors will be willing to invest if the promised (or expected) rate of return equals at least the opportunity cost of investing in the open market, then we get:

$$p_H \left[R - \frac{(b+c)}{\Delta p} \right] \geq \gamma(I - A - I_m(\beta)) \tag{3.3}$$

This condition must hold for a firm to be financed. We could classify firms according to their capacity to raise external funds by rewriting this expression as a function of A :

$$A \geq \underline{A}(\gamma, \beta) = I - I_m(\beta) - \frac{p_H}{\gamma} \left[R - \frac{(b+c)}{\Delta p} \right] \tag{3.4}$$

According to this, there are 3 types of firms: the extremely rich (or well-capitalized) firms that invest directly without demanding informed capital; $A >$

$\overline{A}(\gamma)$;[10] the extremely poor that do not invest at all; $A < \underline{A}(\beta, \gamma)$;and in between these two groups are firms able to invest but only with the help of monitoring; $\overline{A}(\gamma) > A > \underline{A}(\beta, \gamma)$. In a typical case, they invest with a mix of external capital. However, if $A < \overline{A}(\gamma)$ but also $A + I_m(\beta) > I$ the firm only demands informed capital.

Notice that it could be assumed that uninformed investors invest in the firm in two alternative manners. In one case, they invest directly in the firm after the monitoring bank has invested enough resources so as to assure uninformed investors that the firm will behave diligently. Here, the intermediary looks like an investment bank (or a venture capitalist) where its investment is a sign that certifies the good quality of the borrower. In the other case, the investor invests in the firm through the informed investor who operates as an intermediary, such as a commercial bank. In this way, the investor deposits his funds in the bank for them to be invested in the firm together with the bank's capital. It could be checked that both arrangements are equivalent (see HT p. 675). But in addition to the latter case, investors will demand from intermediaries to satisfy a solvency condition based on their equity to total capital.

As from $p_H(R-(b+c)/\Delta p)$ and equation (3.4) we know that $\underline{A}(\beta, \gamma)$ is increased in both arguments; as it would be expected, as either β or γ increase more difficult is to rise funds. Notice that β must be high enough to prevent banks from choosing to invest in the open market instead of monitoring. The minimum β, say $\underline{\beta}$, must satisfy

$$\beta = \frac{p_H \gamma}{p_L} > \gamma$$

It turns out from the following condition: $p_H R_m - c = \gamma . I_m(\beta)$. The left-hand side is the second period net expected return of the bank and the right-hand side

[10] $\overline{A}(\gamma)$ is a maximum threshold -which value depends on γ. Firms with a collateral value higher than this threshold do not need to be monitored to avoid moral hazard. Worded differently, they are investing high enough capital to opt for a diligent behaviour than cheating.

the alternative return of investing in the open market. By replacing $I_m(\beta)$ for its expression, equation (3.2), we get that $(p_H.c/\Delta p) - c = \gamma.p_H.c/(\Delta p\beta)$. Finally, expressing β as a function of the rest of the variables: $\beta = p_H.\gamma/pL$ which has to be higher than γ.

The Equilibrium:

We continue analysing the most general assumption of the HT model: Investment can be afforded at any scale.[11] Then all variables are proportional to the level of the investment I. Private Benefit is $B(I) = BI$, the cost of monitoring is $c(I) = cI$, and the return of a successful investment is $R(I) = RI$ -it is assumed a technology with constant return to scale.

The Real Sector: The firm will choose the total investment level, I, its own capital investment level, A, and the values of R_f, R_m, R_u, I_m, I_u given the rates of return γ and β and the initial asset level, A_0. Each firm solves the same program but scaled by their initial level of assets. This greatly simplifies the analysis at the aggregate level whereas the parameters become independent from the initial condition, A_0. Each firm faces the following maximization program:

$$MaxU(A_0) = p_H RI - p_H R_m - p_H R_u + \gamma(A_0 - A)$$

subject to

[11]Instead of assuming fixed investment scale. The more general assumption also avoids problems linked to discontinuities in the in individual demand for capital.

$$\begin{array}{rcll} A & \leq & A_0 & (i) \\ A + I_m + I_u & \geq & I & (ii) \\ p_H R_m & \geq & \beta I_m & (iii) \\ p_H R_u & \geq & \gamma I_u & (iv) \\ R_m & \geq & \dfrac{cI}{\Delta p} & (v) \\ R_f & \geq & \dfrac{bI}{\Delta p} & (vi) \\ R_f + R_m + R_u & = & RI & (vii) \end{array}$$

The firm invests all its assets and is paid just enough to be diligent (in absence of monitoring it should be paid even more because $B > b$, see the firms' IC). The intermediary will be paid just enough to have the incentive to monitor and to invest up to the point where its capital return equals β , whereas the investor up to the point where its capital return equals γ. Thus the firm maximizes its debt level and its own asset return while in equilibrium all constraints bind.

First, the *maximum investment level* results from substituting (i) and (iii)-(vii) into (ii) so we get

$$I \leq \left\{ A_0 + \frac{I.p_H.c}{\beta \Delta p} + I \left(\frac{p_H}{\gamma} \right) \left[R - \left(\frac{b+c}{\Delta p} \right) \right] \right\} \tag{3.5}$$

then, I is expressed as a function of the rest of the variables, so we get

$$I(A_0) = \frac{A_0}{A_1(\gamma, \beta)} \tag{3.6}$$

where

$$A_1(\gamma, \beta) = 1 - \left(\frac{p_H.c}{\beta.\Delta p} \right) - \left(\frac{p_H}{\gamma} \right) \left[R - \left(\frac{b+c}{\Delta p} \right) \right] \tag{3.7}$$

Using equation (3.2) the second term of the right-hand side is equal to $I_m(\beta)$ whereas as of equation (3.3) the last term is equal to $(I - A - I_m(\beta))$ so it could be written as: $A_1(\gamma, \beta) = [1 - EF_1]$ where EF_1 denotes the amount of 'external funds' needed to finance one unit of investment; $EF_1 \equiv [I - A_1(\gamma, \beta)]$. Then $A_1(\gamma, \beta)$ represents the firm capital needed to undertake an investment of a unit size, $(I = 1)$. The lower is $A_1(\gamma, \beta)$ the higher is the leverage and the investment level. Note that both γ and β are positively related to $A_1(\bullet)$ so as the interest rates increase the maximum (possible) investment level, $I(A_0)$ decreases. Clearly, $A_1(\gamma, \beta) < 1$ because $A_1(\gamma, \beta) = [1 - (I - A)]$ and $A + I_m + I_u = I$ -recall that the used equations are expressed by a unit of investment level. Besides, in equilibrium, the interest rates must satisfy $A_1(\gamma, \beta) > 0$.

Finally,the *firm's maximum payoff* results from substituting equalities (i)-(vii) into the objective function and so getting

$$U(A_0) = \frac{p_H.b.I(A_0)}{\Delta p} \tag{3.8}$$

The net value of the firm's leverage is

$$\left[\frac{p_H.b}{(\Delta p.A_1(\gamma, \beta)} - \gamma\right] A_0$$

The term in brackets represents the difference between the internal and the market rate of return of the firm capital and thus it is positive.

The Capital Market (both financial sector and investors): The equilibrium is obtained by aggregating across firms given that they choose the same optimal policy scaled by their initial amount of capital, A_0. Let K_f be the aggregate amount of firm capital, K_m the aggregate amount of bank capital, and K_u the aggregate amount of invested uninformed capital. Total invested capital K is then $K_f + K_m + K_u$ and the total amount of bank credit equals $K_m + K_u$. The stock of both K_f and K_m is fixed. But K_u is determined endogenously; when the demand of uninformed capital (the sum of the pledgeable expected returns on individual firms discounted by γ) satisfies its supply function, $S(\gamma)$. Let $\gamma = \gamma(K_u)$ be the inverse supply function. The equilibrium for the uninformed capital must satisfy

$$p_H\left(K_f + K_m + K_u\right)\left[R - \frac{(b+c)}{\Delta p}\right] = (\gamma(K_u))K_u \tag{3.9}$$

By expressing K_u as a function of the rest of the variables we get the equilibrium quantity of uninformed capital raised by firms,

$$K_u = \varphi.\left(K_f + K_m\right) \tag{3.10}$$

and $\varphi = [p_H(R.\Delta p - b - c)] \,/\, [p_H(b + c - R.\Delta p) + (\Delta p)\gamma]$.

The equilibrium rate of return in both capital markets is:

$$\gamma = \frac{p_H.K}{K_u}\left[R - \frac{(b+c)}{\Delta p}\right] \tag{3.11}$$

$$\beta = \frac{p_H.c.K}{\Delta p K_m} \tag{3.12}$$

Equation (3.11) is obtained by simply dividing equation (3.9) by K_u -recalling that $K = (K_f + K_m + K_u)$ and $\gamma = \gamma(K_u)$. Equation (3.12) turns out by replacing $R_m = c.I./\Delta p$ into $\beta = p_H.R_m/I_m$, taking into account that $K_m/K = I_m/I$. Both equations (3.11) and (3.12) show that the equilibrium rate of return and the amount of capital are inversely related as it should be expected. However it is worth noticing that only uninformed capital responds to changes in its rate of return whereas the supply of the firm and intermediary capital are fixed and determine the aggregate investment level.

The Effect of Capital Shocks. Holmström and Tirole show how different types of shocks affect the equilibrium rates of return. They turn out as from equations (3.9)-(3.12). The most relevant results are summarized below:[12]

Credit Crunch (decrease in K_m):	(i) decreases γ	(ii) increases β
Firm Collateral Squeeze (decrease in K_f):	(i) decreases γ	(ii) decreases β
Savings Squeeze (decrease in K_u):	(i) increases γ	(ii) decreases β

Credit Crunch: According to the PEI (equation (3.9)), less expected return can be promised to the uninformed investors thus affecting negatively the total amount of uninformed capital. When dividing equation (3.9) by K_u , it can be noticed that given the fact that (K_f/K_u) increases and γ decreases it turns out that (K_m/K_u) decreased. This implies that bank capital is scarce in relation to uninformed capital, so β increases.

Collateral Squeeze: According to equation (3.12), β decreases -because both K_f and K_u decrease. Similarly to the previous case, if equation (3.9) is divided by K_u , it can be noticed that given the fact that (K_m/K_u) increases and γ decreases it turns out that (K_f/K_u) decreased; consequently, K_f becomes scarce in relation to K_u.

Saving Squeeze: Given the increase in the cost of the uninformed capital, γ, its demand is reduced. Bank capital becomes more abundant in relation to the uninformed capital –because bank and firm capital remains constant –and so β decreases.

As a corollary, it is worth noticing that, first, all types of capital tightening (a credit crunch, a firm collateral squeeze, and a savings squeeze) have a particular effect over interest rate hitting harder the poorest firms –they become deprived of

[12]HT also analyze their consequences over the firms' and intermediaries' solvency ratios which exceed the purpose of this paper.

investing. And second, that all sort of capital reduction leads to a lower amount of uninformed capital and a lower overall investment level, K.

It is also important to point out some limitations of this model.

First, the authors considered exogenous firm and intermediary capital supplies and then they performed comparative static exercises by considering each of them independent from one another. In fact, it should be taken into account the feedback impact of interest rates over the capital values. For this purpose, an explicit dynamic model is needed; to this, the authors suggest, for instance, that of Kiyotaki and Moore (1993).

Second, they assumed that firms and intermediaries are run by capital owners. In general they are run by managers instead of entrepreneurs.

Third, it was assumed that the intermediaries' projects are perfectly correlated -which is totally unrealistic. The issue of diversification, the degree of leverage, and the intensity of monitoring are closely linked. Later on, I present a model extension introducing endogenous monitoring intensity. It allows banks to control the extent to which entrepreneurs may swindle and to analyze the extent to which bank lending may affect the firms' decision and investment level.

However, as it has been suggested by MRS, this is a useful model to analyze how real and financial shocks may affect the availability of external funds and thus the firms' investment spending. Two reinforced effects apply. First, there is a direct effect due to the fact that capital crunch and collateral squeeze produce a reduction in the amount of capital that can be invested -by banks into firms and by firms, respectively. Second, there is an indirect effect due to the fact that the collateral squeeze and the capital crunch reduce the pledgeable expected income that can be promised to uninformed debtholders. The reduction in the pledgeable expected income affects negatively the firms' ability to raise uninformed capital.

The next section, based on MRS, presents an extension of this model to a two-country framework in order to compare this phenomenon in a National Banking System in relation to a Multinational Banking System.

3.2.2. A Multinational Banking System in a Two-Country Model

Morgan *et al.* (2004) (MRS) extend to a two-country setting the HT model. This model extension allows to study how bank capital shocks (financial shocks) and firm capital shocks (real or collateral shocks) separately affect the distribution of bank capital between countries. It also allows to compare the effects of bank capital shocks and firm capital shocks, respectively, in the country with the equilibrium derived from the closed economy model. However, both countries are symmetric -they do not discriminate between developing and developed countries. So capital shocks originated in the home country have the symmetric effects of those originated in the host country. The intuition of this model is that multinational banks transmit shocks simply because they are active in more than one country and so they rebalance their credit portfolios in reaction to country-specific shocks.[13]

The Additional Assumptions:

MRS extends the HT model by adding another physical country.[14] Keeping in mind the HT's framework, the two-country version of the model is completed as follows. Bank capital is mobile across borders, but the amount of bank capital in both countries is fixed. Firm capital is immobile across borders and the amount of firm capital in each individual country is fixed. Uninformed investors in both countries have access to one common securities market with a quasi-unlimited supply of investment opportunities. So the securities market rate of return, γ, is

[13] A model of this type is provided by Galindo *et al.* (2004) –and presented later on.

[14] They extend the model to analyse and test bank integration in U.S. States. However, the model fits better when analysing international bank integration, see Morgan and Strahan (2003).

exogenous, equal in both countries, and independent of country-specific shocks.[15] The bank capital moves across borders in reaction to shocks. On the contrary, firm capital is exogenous in each country and only changes under the impact of external shocks.

The Equilibrium:

Given that bank capital can move freely across countries and entails an endogenous reallocation between them, in the new equilibrium, bank capital is reallocated so that its rate of return is equalized between countries. This adjustment also influences the amount of deposits (uninformed capital) that firms attract.

Let π_2 be the share of informed capital in the host country (country two) and its complement, $\pi_1 = (1 - \pi_2)$, the share of informed capital in the home country (country one). When the share of informed capital invested in each country is endogenous, the equilibrium in the uninformed capital market in a multinational banking system is given by

$$p_H\left(K_{f2}^m + \pi_2\left(K_{m1}^m + K_{m2}^m\right) + K_{u2}^m\right)\left[R - \frac{(b+c)}{\Delta p}\right] = \gamma . K_{u2}^m \tag{3.13}$$

$$p_H\left(K_{f1}^m + \pi_1\left(K_{m1}^m + K_{m2}^m\right) + K_{u1}^m\right)\left[R - \frac{(b+c)}{\Delta p}\right] = \gamma . K_{u1}^m \tag{3.14}$$

where subscript 1 designates variables describing country one (home country) and subscript 2 those of country two (host country). The over-script m designates variables in a multinational banking system (the two-country model) and the over-script n, from now on, will designate those of a national banking system (the closed economy model). For instance, K_{u1}^m is the aggregated uninformed capital attracted by firms in a multinational banking system.

[15]They do not discriminate between countries where country risk may emerge and sovereign bond yields differ. It is then considered that γ is like a Treasury Bill which can be bought by investors from both countries.

The equilibrium rate of return on the informed capital market is:

$$\beta = \frac{p_H.c.K_2^m}{(\Delta p.\pi_2 (K_{m1}^m + K_{m2}^m))} = \frac{p_H.c.}{(\Delta p.\pi_1 (K_{m1}^m + K_{m2}^m))} \tag{3.15}$$

where $K_2^m = \left(K_{f2}^m + \pi_2 (K_{m1}^m + K_{m2}^m) + K_{u2}^m\right)$

and $K_1^m = \left(K_{f1}^m + \pi_1 (K_{m1}^m + K_{m2}^m) + K_{u1}^m\right)$.

Solving the system given by equations (3.13) -(3.15), we obtain the equilibrium amount of uninformed capital attracted by firms in each country and also the share of bank capital invested in each country:

$$K_{u1}^m = \frac{\varphi.K_{f1}^m.\left(K_{f1}^m + K_{f2}^m + K_{m1}^m + K_{m2}^m\right)}{\left(K_{f1}^m + K_{f2}^m\right)} \tag{3.16}$$

$$K_{u2}^m = \frac{\varphi.K_{f2}^m.\left(K_{f1}^m + K_{f2}^m + K_{m1}^m + K_{m2}^m\right)}{\left(K_{f1}^m + K_{f2}^m\right)} \tag{3.17}$$

where $\varphi = (p_H(R.\Delta p - b - c)) / (p_H(b{+}c{-}R.\Delta p){+}(\Delta p)\gamma)$, $\pi_2 = K_{f2}^m / \left(K_{f1}^m + K_{f2}^m\right)$, $\pi_1 = K_{f1}^m / \left(K_{f1}^m + K_{f2}^m\right)$ and $\pi_1 + \pi_2 = 1$.

Notice that the share of bank capital invested in each country is a proportion which equals the relative weight of the total firm capital in that country regarding the aggregate firm capital in both countries.

3.2.2.1. The Capital Shock Effects. Following MRS closely, this sub-section compares the effects of bank and firm capital shocks over the investment level in a multinational banking system (MBS) as to its effects in a national banking setting (NBS). The static comparative analysis assumes initial symmetry between countries so that $K_{m1}^m = K_{m2}^m$ and $K_{f1}^m = K_{f2}^m$. The dynamics and its intuition are described as follows.

1. Bank Capital Shocks:

In a MBS, the negative impact of a bank capital crunch on the amount of uninformed and informed capital invested in that country is smaller than in the case of a NBS. The availability of external financing is affected through the following two ways:

1.a: Effects over the Informed Capital Stock: Bank capital declines less in a MBS than in a NBS because after a negative bank capital shock beta increases, the bank capital moves from the unaffected country to the affected one diminishing the negative effect.

1.b: Effects over the Uninformed Capital Stock: Given that the amount lent by banks decreases less there is also a smaller increase in the bank capital rate of return and so a smaller reduction in the pledgeable income promised to uninformed capital -there is a smaller reduction in the amount of uninformed capital that firms may raise.

In a NBS, the reduction in the pledgeable income is proportional to the reduction of K^n_{m2}, by contrast, in a MBS the reduction in the pledgeable income is less than proportional to the reduction of K^m_{m2}, since π_2 is smaller than unity. Given that the pledgeable income decreases less within a MBS, then we also have a smaller reduction in the amount of uninformed capital that can be attracted by firms. Consequently, it turns out that multinational banking systems promote countercyclical effects regarding the total credit and investment level in the economy. Formally, it results that:

	National Banking		*Multinational Banking*
1.	**Bank Capital Shocks**		**Bank Capital Shocks**
1.a.	$\partial K^n_{m2}/\partial K^n_{m2} = 1$	$>$	$\partial \pi_2 \left(K^m_{m1} + K^m_{m2}\right)/\partial K^m_{m2} = 1/2$
1.b.	$\partial K^n_{u2}/\partial K^n_{m2} = \varphi > 0$	$>$	$\partial K^m_{u2}/\partial K^m_{m2} = (1/2)\,\varphi > 0$

2. Firm Capital Shocks:

Contrary to the previous case, the impact of a firm collateral shock is amplified in a MBS because banks in the affected country are able to move and lend their capital to another country where firms are backed by better collateral. Here again, aggregate credit and so investment level are affected through two ways:

2.a: Effects over the Informed Capital Stock: In a MBS the dynamics turns out as from equation (3.15) which shows that β decreases after a negative shock so banks move their capital to the unaffected country -where β is higher compared with that of the affected country. As a consequence, bank capital is reduced whereas in a NBS bank capital is not affected after a negative firm capital shock.

2.b: Effects over the Uninformed Capital Stock: Notice that according to equations (3.16) and (3.17), the demand of uninformed capital depends on the firms' ability to leverage this type of capital that is directly linked to the firm collateral value and bank capital stock. The intuition for this result is that firm collateral value is reduced by the shock, then a bank moves its capital abroad looking for well-capitalized firms. Then both effects (the lower collateral value and lower stock of bank capital) may lead to a worsening in the firms' ability to attract uninformed capital.[16] Notice that for a given firm capital shock, the ex-post bank and firm capital stock satisfies $\left(K^m_{m2} + Kf^m_{f2}\right) < \left(K^n_{m2} + Kf^n_{f2}\right)$ showing that firms' ability to leverage uninformed capital is highly affected under a MBS.

Similar to the previous shock, in the case of a NBS, the reduction in pledgeable income is proportional to the reduction of K^n_{f2}whereas in a MBS this reduction is more than proportional to that of K^m_{f2} , because the share of informed capital π_2 invested in country 2 –which depends on the amount of capital available in the two countries –also decreases following a decrease of K^m_{f2}. Given that the pledgeable income decreases more in multinational banking following a collateral squeeze, we also have a larger reduction in the amount of uninformed capital that can be attracted by firms. Consequently, a MBS promotes procyclical effects over bank credit and investment level in the economy. Formally,

	National Banking		*Multinational Banking*
2.	**Firm Capital Shocks**		**Firm Capital Shocks**
2.a.	$\partial\pi_2 K^n_{m2}/\partial K^n_{f2} = 0$	$<$	$\partial\pi_2 K^n_{m2}/\partial K^n_{f2} = K^m_{m2}/2K^m_{f2} > 0$
2.b.	$\partial K^n_{u2}/\partial Kf^n_{f2} = \varphi > 0$	$<$	$\partial K^m_{u2}/\partial K^m_{f2} = (2K^m_{f2} + K^m_{m2})\varphi/2K^m_{f2} > 0$

Note that $\left(\partial K^m_{u2}/\partial K^m_{f2}\right) - \left(\partial K^n_{u2}/\partial Kf^n_{f2}\right) = \varphi K^m_{m2}/2K^m_{f2} > 0$, so negative firm capital shocks end up in a larger decline of uninformed capital in a MBS than in a NBS.

As a corollary, the theory suggests that the net effect of foreign bank entrance on the economy stability is ambiguous. A MBS is more solid when the economy

[16]Recall that uninformed capital does not move from one country to the other; moreover, there exists a quasi-unlimited supply of investment opportunities that yield α.

faces a domestic bank capital crisis –because the banking system can be recapitalized by foreign banks importing resources from abroad. Thus shocks to the banking system itself become less important in an integrated environment. On the contrary, integration may amplify the impact of firm collateral shocks because integrated banks have the opportunity to shift their capital elsewhere during economic downturns.

In most cases, one shock entails the other often being simultaneous events. See Appendix 3.A. for an analysis of the effects of simultaneous bank and firm capital shocks over bank credit and investment level. Finally, the introduction of endogenous monitoring permits the model to better capture the effects that capital allocation may have on multinational bank lending and thus on real-economy activity. This extension is presented in Appendix 3.B.

3.2.3. A Portfolio Model

Galindo *et al., (*2004) present a model to investigate the behaviour of international banks across nations in case of shocks affecting one of the countries. The authors extend to J countries the model developed by Pyle (1971) focused on portfolio problems in intermediaries. More precisely, the management of deposit liabilities (*e.g.,* savings deposits), and the use of proceedings to purchase a given type of asset (*e.g.,* loans).

The authors assume that the representative international bank invests in a loan portfolio in each country according to a mean-variance analysis. The bank finances these investments using its own capital (normalised to the unity) and deposits raised on each local country at the cost of the market deposit rate. The loan portfolio is of a longer maturity than deposits and must be rolled over at the market rate.[17] Thus, deposit contracts are evaluated through its expected cost

[17]This means that deposit contracts are set at a variable rate of return.

and variance. Let ρ_d denotes the expected deposit rate and ρ_d the expected rate of return on loans.

For simplicity, it is assumed that both are normally distributed and that the standard deviation of both loans rate of return and deposit rates are equal to σ. The covariance between loan rates and deposit rates within a country equals $COVLD$. Finally, all covariances between countries are equal to COV –i.e., covariances between loan returns in country m and n, between funding costs in country m and n, and between loan rates of return in country m and funding costs in country n, where m and n are different countries satisfying $1 \leq m < n \leq J$.[18]

First, it is considered a symmetric case where the international bank invests the same amount of resources in each country. By letting D denote the total amount of deposits, the bank raises D/J deposits and invests $(1+D)/J$ in each country. The bank's expected return in each country can be written as

$$R_j = \frac{(1+D)}{J}\rho_l - \frac{D}{J}\rho_d \tag{3.18}$$

where the subscript j denotes country j and $j = 1, ..., J$. The variance of the bank's expected return in country j can be expressed as

$$Var(R_j) = \left(\frac{1+D}{J}\right)^2 \sigma^2 + \left(\frac{D}{J}\right)^2 \sigma^2 - 2\frac{D(1+D)}{J^2} COVLD \tag{3.19}$$

The total bank's expected return R can be expressed as

$$R = (1+D)\rho_l - D\rho_d \tag{3.20}$$

and the variance of the bank's return in the J countries becomes

[18] As in the model presented by MRS, MGP presents a general framework without distinguishing between developed and developing countries.

$$
\begin{aligned}
(3.21) \quad Var\,(R) &= Var(R_1, R_2, ..., R_J) \\
&= V(R_1) + V(R_2) + ... + V(R_J) \\
&\quad +2cov(R_1, R_2) + 2cov(R_1, R_3) + ... + 2cov(R_{J-1}, R_J)
\end{aligned}
$$

Given that $V(R_1) = V(R_2) = ... = V(R_J)$ and using equation (3.18) and (3.19), equation (3.21) becomes

$$
\begin{aligned}
(3.22) \quad Var\,(R) &= J\left[\left(\frac{1+D}{J}\right)^2\sigma^2 + \left(\frac{D}{J}\right)^2\sigma^2 - 2\frac{D(1+D)}{J^2}COVLD\right] \\
&\quad +2\sum_{1\leq m<n\leq J}^{J} cov(R_m, R_n)
\end{aligned}
$$

Given that all covariances between loan returns in country n and m are equal to COV, equation (3.22) remains expressed as

$$
(3.23) \qquad Var\,(R) = \frac{(1+D)^2}{J}\sigma^2 + \frac{D^2}{J}\sigma^2 - 2\frac{D(1+D)}{J}COVLD + \frac{J}{J-1}COV
$$

Equation (3.23) shows that the variance of a bank's portfolio decreases as the total number of countries J increases[19]. Moreover, as J tends to infinity, the variance of the bank's portfolio, $Var\,(R)$, tends to COV. This is in line with the standard result in portfolio theory. The risk of a well-diversified portfolio is the systematic risk represented by the correlations of asset returns.

In this symmetric case, we obtain the same result if we include the Base I capital constraint which might be written as

[19]Taking the derivative of $Var\,(R)$ with respect to J, results in $dVar\,(R)\,/dJ = C/J^2 + 1/\left(J-1\right)^2$ where $C = 2D(1+D)COVLD - \sigma^2 + 2D^2\sigma^2$. Consequently, as J increases $Var\,(R)$ decreases.

$$\sum_{j=1}^{J} \alpha_j (1 + D) \leq K = 1 \tag{3.24}$$

where α_j is the Basel risk weight [20] that is equal for each country j , and K denotes the capital normalised to unity. Given that the bank invests $(1 + D)/J$ in each country, equation (3.24) remains expressed as

$$\alpha(1 + D) \leq 1$$

Given that expected returns and variances are symmetric across countries, by maximising the mean-variance type utility function subject to the Base capital constraint, there results a portfolio of equal shares across countries. Consequently, it turns out the same standard result as in portfolio theory.

In order to analyse an international bank behaviour against different shocks, let's suppose that one of the countries, called "host" country, faces either a shock to the expected returns (an opportunity shock) or a shock to the deposit rate (a liquidity shock). In contrast to the symmetric case, let's assume now that the international bank invests θ in the $J - 1$ countries (excluding the host) and raises η deposits in all those countries (except the host). Thus, in the host country the bank invests $1 - \theta$ and raises $1 - \eta$ deposits satisfying $0 < \theta < 1$ and $0 < \eta < 1$. Let s_l denotes the expected return on loans in the host country and s_d the expected cost of deposits in that country satisfying ρ_l, $s_l > \rho_d$, s_d.

Then, the whole expected return of the international bank becomes

$$R = (1 + D)(\theta\rho_l + (1 - \theta)s_l) - D(\eta\rho_d + (1 - \eta)s_d) \tag{3.25}$$

And, the variance of its return can be written as

[20] This restriction refers to the minimum regulatory capital required by the Basel Committee on Banking Supervision.

$$(3.26)\ Var\,(R) = \sigma^2 \left\{ \begin{array}{c} (1+D)^2 \left[\dfrac{\theta^2}{J-1} + (1-\theta)^2\right] \\ +D^2 \left[\left(\dfrac{\eta^2}{J-1} + (1-\eta)^2\right)\right] \end{array} \right\}$$
$$+COV \left\{ \begin{array}{c} \dfrac{J-2}{J-1}\left[((1+D)\,\theta)^2 - (D\eta)^2\right] \\ +2\left[(1+D)^2\,\theta(1-\theta) + D^2\eta(1-\eta)\right] \end{array} \right\}$$
$$-2COVLD \left\{ \frac{D(1+D)\theta\eta}{J-1} + D(1+D)(1-\theta)(1-\eta) \right\}$$

The bank has mean-variance preferences maximizing the utility function $F(R, Var\,(R))$ subject to the Basel I constraint which remains expressed as $\alpha(1+D) \leq 1$. The maximization problem can be written as

$$(3.27) \qquad Max\left\{R - \frac{1}{2}\gamma VAR\right\} \text{ subject to } \alpha(1+D) \leq 1$$

where R and VAR are given by equations (3.25) and (3.26), respectively, and γ represents the relative risk aversion of the bank which satisfies $\gamma > 0$. Finally, the coefficient 1/2 is related to the Arrow-Pratt theory which estimates, for small risk, that the risk premium –the maximum amount that an agent is willing to pay to avoid risk –is equal to the half of risk aversion multiplied by the variance of the risk.

If the capital constraint is satisfied with equality, from the program given by expression (3.27) results the following solution for θ

$$(3.28) \qquad \theta = \frac{J-1}{J}\left[1 - \frac{\alpha\left((1-\beta)\,(s_r - \rho_r) - \beta_2\,(s_d - \rho_d)\right)}{\gamma\sigma^2\left((1-\beta)^2 - \beta_2^2\right)}\right]$$

where $\beta = COV/\sigma^2$ and $\beta_2 = COVLD/\sigma^2$.

Equation (3.28) provides intuitive results by assuming $\beta < 1$, $\beta_2 > 0$ and $(1-\beta)^2 > \beta_2^2$. An increase of s_l –the expected return in the host country – implies a decline of θ –the bank investments in $J-1$ countries –in favour of the investments in the host country. Thus, the bank takes profits from the opportunity presented in the host country. On the contrary, an increase of s_d –funding cost in the host country –implies an increase of θ. So, the international bank reallocates its resources withdrawing its investments from the host country and investing more in other countries.

Note that if $s_l = \rho_l$ and $s_d = \rho_d$ –loan rates of return and deposit rates between the host country and other countries are equal –then equation (3.28) drops to $\theta = (J-1)/J$ describing the previous symmetric case.[21]

Taking the derivative of θ with respect to s_l allows the study of the optimal portfolio changes when the the host country is confronted to a decrease of the expected return. It turns out

$$\frac{d\theta}{ds_l} = -\frac{J-1}{J}\frac{\alpha(1-\beta)}{\gamma\sigma^2\left[(1-\beta)^2-\beta_2^2\right]} \tag{3.29}$$

and taking the limit for $J \to \infty$, equation (3.29) becomes

$$\underset{j\to\infty}{Lim}\frac{d\theta}{ds_l} = -\frac{\alpha(1-\beta)}{\gamma\sigma^2\left[(1-\beta)^2-\beta_2^2\right]} \tag{3.30}$$

Equation (3.29) expresses that a well-diversified bank will withdraw its investments faster from the host country than a less diversified one if the host country

[21] Under the particular assumption that there is no covariance between the loan rate and the deposit rate within a country ($COVLD = 0$ and so, $\beta_2 = 0$), it turns out that θ does no longer depend on expected deposit rates. The investment decision is made independently from funding costs.

is hit by a negative shock to the local expected return, s_l. Besides, a higher positive correlation of loan returns and funding costs between countries –β increases –worsens the bank diversification impact on host country banking stability –the derivative becomes more negative.

From equation (3.30) note that as β increases the $Lim_{J\to\infty}$ becomes lower and so θ increases more for the same opportunity shock.[22] Thus, there is an interaction between globalization and positive return correlations.

Analogously, the derivative of θ with respect to s_d allows to study the lending behaviour of an international diversified bank in case of liquidity shock in the host country. It turns out

$$\frac{d\theta}{ds_d} = \frac{J-1}{J}\frac{\alpha COVLD}{\gamma\sigma^2\left(1-\beta^2\right)\left(1-\beta_2\right)} \tag{3.31}$$

and taking the limit for $J \to \infty$, equation (3.31) becomes

$$\underset{j\to\infty}{Lim}\frac{d\theta}{ds_d} = \frac{\alpha COVLD}{\gamma\sigma^2\left(1-\beta^2\right)\left(1-\beta_2\right)} \tag{3.32}$$

According to equation (3.31), in such a situation, an increase in funding costs in the host country will decrease bank lending in that country. Equation (3.32) shows that as J increases, the sensitivity of loans to funding costs increases too. In fact, as the limiting elasticity, given by

$$\underset{j\to\infty}{Lim}\frac{d\theta}{ds_d}\left(\frac{s_d}{1-\theta}\right)$$

becomes more positive, increases in funding cost would lead a well-diversified foreign bank to reduce assets in the host country –reducing $(1-\theta)$– more rapidly.

[22]The same reasoning could apply for η. A rise of the deposit rate in the host country leads the bank to reduce the amount of deposit raised in that country and the sensitivity of deposit to funding costs rises with globalization.

If funding costs rise, deposits in the host country, $(1-\eta)$, will be reduced –assets are cut aggressively. Note that if $COVLD = 0$ –loan rate and deposit rate within countries are uncorrelated –the increase in funding cost has no effect on bank lending behaviour.

Nevertheless, if $\beta < 1$ and $\beta_2 > 0$ are satisfied but $(1-\beta)^2 < \beta_2^2$, then the previous results are reversed.

In a later version of their work, Galindo *et at.*, (2005) relax the assumptions regarding the homogeneity of the covariances. In a more general case, results still rely on the specific assumptions on the value of the covariances.

The authors assume that $COVLD$ defines the covariance between the loan rate and the deposit rate within each country –as before –but, COV denotes covariances between loan returns in countries m and n and between funding costs in countries m and n where $1 \leq m < n \leq J$ and $COVLD_{m,n}$ denotes the covariance between the loan returns in country m and the deposit rates in country n. So, unlike the previous version of the paper, $COV \neq COVLD_{m,n}$.

As in the previous case, consider firstly the symmetric case. Under the new hypothesis, the equation expressing the bank's expected return does not change –recall that $R = (1+D)\rho_l - D\rho_d$. But the variance of the bank's return becomes

$$\begin{aligned} Var(R) &= \frac{(1+D)^2}{J}\sigma^2 + \frac{D^2}{J}\sigma^2 - 2COVLD\frac{(1+D)D}{J} \\ &\quad + COV\frac{(J-1)}{J} + 2(COV - COVLD_{m,n})(1+D)D\frac{(J-1)}{J} \end{aligned} \tag{3.33}$$

Equation (3.33) shows that as J increases, the variance decreases.[23] Moreover, as J tends to infinity, the variance of the portfolio tends to $COV + 2(COV - COVLD_{m,n})(1+D)D$, the covariance of returns on assets and liabilities across countries. If $COV = COVLD_{m,n}$ then the limit is simply COV. This result is

[23]Taking the derivative of $Var(R)$ with respect to J, results in $dVar(R)/dJ = C/J^2 + 2/(J-1)^2$ where $C = 2D(1+D)COVLD - \sigma^2 + 2D^2\sigma^2$. Consequently, as J increases $Var(R)$ decreases.

analogous to that of the initial version. The risk of a well-diversified portfolio is reduced to the systematic risk, represented by correlations rather than variances.

Maximising the mean-variance type utility function subject to $\alpha(1+D) \leq 1$, it results a portfolio of equal shares across countries. Then, it turns out the same standard result as in the portfolio theory. The more declining the risk, the greater the diversification across countries.

In the asymmetric case, the maximization problem is set under the same assumptions (all countries are symmetric in terms of variances and covariances) but the host country suffers from opportunity shocks and funding shocks. Thus the bank invests θ in the $J-1$ countries (excluding the host one) and $1-\theta$ in the host country and raises $1-\eta$ deposits in the host country and η in the others. The bank is subject to the same Basel I constraint. Then, the problem can be written as

$$Max\left\{R-\frac{1}{2}\gamma VAR\right\} \text{ subject to } \alpha(1+D) \leq 1 \tag{3.34}$$

where R remains given by equation (3.25) and

$$\begin{aligned}
VAR &= \sigma^2\left\{(1+D)^2\left[\frac{\theta^2}{J-1}+(1-\theta)^2\right]+D^2\left[\frac{\eta^2}{J-1}+(1-\eta)^2\right]\right\} \\
&\quad +2COV\left\{\begin{array}{c}\dfrac{(J-2)}{2(J-1)}\left[((1+D)\,\theta)^2-(D\eta)^2\right] \\ +\left[(1+D)^2\,\theta(1-\theta)+D^2\eta\,(1-\eta)\right]\end{array}\right\} \\
&\quad -2\,(1+D)\left\{\begin{array}{c}DCOVLD\left[\dfrac{\theta\eta}{(J-1)}+(1-\theta)\,(1-\eta)\right] \\ +COVLD_{m,n}\left[\dfrac{(J-1)\,\theta\eta}{2(J-2)}+\eta\,(1-\theta)+\theta\,(1-\eta)\right]\end{array}\right\}
\end{aligned}$$

The solution for θ is given by the following expression

$$\theta = \frac{J-1}{J}\left[1 - \frac{\alpha}{\gamma\sigma^2}\left(\frac{(s_l-\rho_l)(1-\beta)-(s_d-\rho_d)(\beta_2-\beta_3)}{(1-\beta)^2-(\beta_2-\beta_3)^2}\right)\right] \tag{3.35}$$

where $\beta = COV/\sigma^2$, $\beta_2 = COVLD/\sigma^2$, $\beta_3 = COVLD_{m,n}/\sigma^2$.

Given the arguments of equation (3.35) the authors assume $\beta < 1$, $\beta_3 < \beta_2$ and $(1-\beta)^2 > (\beta_2-\beta_3)^2$. The analysis that can be made by examining the expression for θ (equation (3.35)) is similar from that presented in the first version of the paper (when $COV = COVLD_{m,n}$). The derivatives are given by the following expressions:

$$\frac{d\theta}{ds_l} = -\frac{J-1}{J}\frac{\alpha(1-\beta)}{\gamma\sigma^2\left[(1-\beta)^2-(\beta_2-\beta_3)^2\right]} \tag{3.36}$$

$$\frac{d\theta}{ds_d} = \frac{J-1}{J}\frac{\alpha(\beta_2-\beta_3)}{\gamma\sigma^2\left[(1-\beta)^2-(\beta_2-\beta_3)^2\right]} \tag{3.37}$$

Considering the derivative of θ with respect to the expected returns (equation (3.36)) and the derivative of θ with respect to the deposit rate (equation (3.37)) in the host country, the study of the optimal portfolio changes in case of an opportunity shock or a liquidity shock points to analogous results to the first version of the Galindo *et al.*, (2004)'s paper.

It turns out that θ declines if the expected return in the host country increases (increase of investments in the host country) and θ increases when deposit rates raise (withdrawal of investments from the host country). Moreover, in the face of a negative opportunity shock, a more diversified bank may withdraw its investments more rapidly than a less diversified one and in case of liquidity shock the bank will reduce its assets in the host country unless $COVLD = COVLD_{m,n}$ –implying that $\beta_2 = \beta_3$ –the case in which the increase of deposit rate will have no effect on the optimal portfolio composition.

It is interesting to note that an increased correlation between loan returns –as well as between deposit rates – among countries –this means, that β increases – worsens the effect of multinational banks on banking stability in the host country (see equation (3.36)).

For the particular case $\beta_2 = \beta_3$, θ will no longer depend on funding costs. The raise of funding costs in the host country will have no effect on multinational bank assets.

However, if $\beta < 1$, $\beta_3 < \beta_2$ are still satisfied but $(1-\beta)^2 < (\beta_2 - \beta_3)^2$, it yields the opposite results to those presented above.

All in all, under specific assumptions regarding the value of the covariances, the model presented by GMP provides ambiguous results regarding international bank consequences over an affected country. On the one hand, the model suggests that credit from well diversified foreign banks will be more stable given a funding shock. On the other hand, international banks may react more aggressively than national banks in case of opportunity shock. The last effect worsens the impact of globalization on banking stability in the host country. This results are in line with those suggested by MRS.

Even so, both models are subject to the same criticism. Questions related to the dynamics of these models will probably remain unanswered.

3.3. The Empirical Literature

The empirical literature examining foreign banks' effect on credit stability is rather limited, especially if compared to that focusing on the relationship between foreign banks and banking efficiency. Foreign banks that have a physical presence in the host country seem to be less likely to reduce their credit or to withdraw their investments in case of economic problems compared to those only settled in their home country. Because the cost of a withdrawal is higher than the cost of pursuing activities. However, the empirical literature analysing the possible impact of foreign bank presence on financial stability is not based on a strong theoretical background. Empirical studies have shed light on the impact of foreign bank presence on credit volatility without taking into account the effect of different types of shock. The exception are Morgan *et al.*, (2002, 2004) (MRS); Morgan and Strahan (2003), and Galindo *et al.*, (2004, 2005) (GMP). MRS and GMP, both relatively recent studies, model foreign bank behaviour and its impact on credit stability in an attempt to explain the contradictory effects of foreign banks presence found in previous empirical research. However, identifying the shocks separately discussed above seems to be a very difficult task. In addition to data availability problems, the high correlation between bank capital and borrower collateral would require questionable assumptions. MRS are focused on bank integration in the United States after opening state borders to out-of-state banks. Rather than identifying the effects of bank capital shock and collateral shock separately, MRS try to examine whether the net effect of integration makes state economies more or less stable. The difficulty in sorting out the effects of different shocks is mainly due to unavailability of collateral shocks measures at a state level. MRS conclude that the net effect of US banking integration was stabilizing –without taking into account which type of shock prevailed. This setting results also useful for the study of cross-country financial integration. An analogy can be made between out-of-state banks and foreign banks since globalisation is just a larger scale version of national integration, even when the environments may differ substantially. Morgan and Strahan (2003) extended their research at an international level (to a panel of about 100 countries during 1990's) seeing that international evidence offers better possibilities to separate the effects of different shocks. Shocks to firm collateral can be measured by changes in the market value of traded equity in the stock market while bank capital shocks can be measured by changes in the capital of the country's banking system. The authors find no evidence that foreign entry has been stabilizing (contrary to US banking integration), foreign bank integration is either unrelated to volatility or positively linked to it. Indeed, this evidence is stronger for the set of developing countries.

GMP analyse the relative behaviour of foreign and domestic banks in four scenarios related to liquidity and opportunity shocks using a panel of 11 LAC countries. Aggregate movements in credit and deposits were chosen to identify the type of shock. The authors use the quarterly growth rates of bank's loans and indicators variables which capture whether deposits are growing faster or slower than credit (see Table 3.1).

Table 3.1: Matrix of opportunity and liquidity shocks:

	Aggregate credit growth greater than aggregate deposit growth	**Aggregate credit growth less than aggregate deposit growth**
Positive aggregate credit growth	Positive opportunity shock. Foreign banks' credit growth increase relative to domestic banks	Positive liquidity shock. Foreign banks' credit growth decrease relative to domestic banks
Negative aggregate credit growth	Negative liquidity shock (deposit crunch). Foreign banks' credit growth increase relative to domestic banks	Negative opportunity shock. Foreign banks' credit growth decrease relative to domestic banks

They find strong evidence in favour of theoretical hypothesis suggesting that foreign banks will increase (decrease) their market share as regards domestic banks when there is a negative (positive) liquidity shock or a positive (negative) opportunity shock. They conclude that foreign banks may bring rewards in terms of greater stability with respect to shocks that affect funding costs in a host country but potential costs in terms of instability in the face of host opportunity shocks.

Empirical literature suggests different mechanisms regarding the possible impact of foreign bank activities on a host country's economy. Foreign banks may affect domestic economies on the basis of changes in the home and/or host country conditions –called push and pull factors, respectively. Various variables have been used to capture the different nature of shocks (if they do) and factors over credit stability. Some authors choose GDP growth in either host or home country (Micco and Panizza, 2004; de Haas and van Lelyveld, 2006), lending rate (de Haas and van Lelyveld, 2006) and crisis indicators (Martinez Peria *et al.*, 2002; Dages *et al.*, 2000) among others. But, for instance, the impact of crises is often captured by changes in GDP growth which can be problematic. This proxy may suggest that crises are not perceived as different from any other recession (see Martinez Peria *et al.*, 2002). Even so, reported results from the existing literature remain ambiguous.

Foreign banks may affect domestic economies by changes in the home country conditions (push factors). On the one hand, economic turmoil in the home country can lead a parent bank to reduce foreign subsidiaries' activities suggesting positive relationship between the home country economic cycle and foreign bank's credit supply. Such a situation used to be explained by the deterioration of banks' financial condition due to a worsening economic environment. Jeanneau and Micu (2002) find that bank lending in largest countries in Asia and Latin America between 1995 and 2000 is positively correlated with the economic cycles in the major industrial countries. Peek and Rosengren (1997, 2000b) show that the sharp drop in Japanese stock prices beginning in 1990 led Japanese banks branches in the USA to reduce their credit supply (positive push relationship). van Rijckeghem and Weder (2001, 2003) test the role of bank lending in transmitting currency crises. The papers provide empirical evidence in support of the view that spillovers through common bank lenders across-countries were important in transferring Mexican, Thai, and Russian currency crises. Thus, foreign banks might well continue to be an important channel of contagion in scenarios of financial crisis. On the other hand, parent banks can expand their activities in the host country when they meet economic problems in their own market. This may be due to the lack of profit opportunities in the country of origin. Authors like Calvo and Coricelli (1993), Hernandez and Rudolph (1995), and Moshiriam

(2001) find that worsening home country conditions led banks to seek external lending opportunities supporting negative relationship between the home country economic cycle and foreign bank's credit supply. Martinez Peria *et al.*, (2002) find that, between 1985 and 2000, foreign banks (except Japanese ones) tended to increase their lending in ten host countries in Latin America when economic conditions in their home countries worsened. There is a negative relationship between US economic growth and foreign lending by US banks. De Haas and van Lelyveld (2006) also find a negative relationship between home country economic condition and greenfield foreign banks in 10 countries from Eastern and Central Europe between 1993 and 2000. Goldberg (2001) presents evidence that US banks' claims on emerging countries have been correlated with US GDP growth although the direction of causality in this push relationship differed between Asia (negative) and Latin America (positive).

Regarding the situation where foreign banks react to changes in the host country's economic environment (pull factors) empirical literature also points out opposing effects. Foreign banks -internationally diversified and more capitalized than local banks -may expand their credit in a host country with economic difficulties. Studies on foreign bank behaviour during times of financial crisis in the host country underline that foreign banks did not reduce their credit supply. Conversely, they viewed such adverse economic times as opportunities to expand. Thus, they contributed to greater stability of credit. Demirgüç-Kunt *et al* (1998) and Levine (1999) provide cross-country evidence that the presence of foreign banks reduce the likelihood of crises, control for other factors that are likely to produce banking crises, and have positive effects on growth. De Haas and van Lelyveld (2004, 2006) found that foreign banks reacted more procyclically to changing local economic conditions in 10 countries of Eastern Europe and Central Asia. Particularly, greenfield foreign banks have had a positive stability effect on total credit supply during both crises and normal times -in contrast with domestic banks which contract their credit during crises. Crystal *et al.*, (2002) show that in Chile, Colombia and Argentina, diversity of ownership had contributed to greater stability of credit during the second half on the 1990s as foreign banks showed significant credit growth during crisis period and thereafter. Dages *et al.*, (2000) do not find in Argentina and Mexico between 1994 and 1999 any support for the view that foreign banks contribute to instability or are excessively volatile in their response to local market signals. Finally, Goldberg (2001), Martinez- Peria *et al.,* (2002), Kraft (2002), and Detragiache and Gupta (2004) suggest that foreign banks look at economic problems as opportunities to expand. Such a reaction implies greater credit supply stability. However, foreign banks may reduce their activities in the host country and reallocate their capital over different markets which record better economic growth rates while local banks may not have such an option. Using annual bank level data over the period 1981-2000, Barajas and Steiner (2002) find that net foreign liabilities which are likely to be concentrated in MNB subsidiaries , contributed to an acceleration of credit expansion as well as sharpening of credit contraction in Bolivia, Peru and particularly Venezuela. Dahl and Shrieves (1999) analyse decisions made by 35 US banks as regard credit extended domestically and credit extended within 16 foreign countries, including international lending, during the period 1988 –1994. They provide evidence that foreign credit is positively related with US businesses. Moreover, they find that foreign credit is particularly greater in countries with expanding economies suggesting that banks do not trade off credit activities between domestically and abroad economic conditions. Buch (2000) analyses German bank lending in foreign countries (for both EU and non-EU membership) using panel data (disaggregated by region) between 1981 and 1998. The results show a strong and positive correlation between the foreign activities of German banks and the host countries' economic conditions and the foreign activities of German firms (like FDI in the non-banking sector or foreign trade activities). Jenneau and Micu (2002) investigate lending patterns across major lenders (using the BIS consolidated international banking statistics) to the largest Asian and Latin American countries. The procyclicality of lending behaviour to emerging economies which was found at the global level is mainly due to the procyclical behaviour of Japanese and European banks. Conversely, US banks exhibited a countercyclical lending pattern. De Haas and van Lelyved (2006) find that foreign banks, both greenfields and take-overs, react somewhat more procyclical to changing local economic conditions. Arena *et al.*, (2007) study bank behaviour across twenty Asian and Latin American countries from 1989 through 2001 to compare foreign and domestic owned bank activities; they find weak evidence of foreign bank entry into emerging markets contributing to credit market stability.

Nevertheless, a number of empirical studies on credit growth in emerging countries show that foreign bank entry may affect credit availability and distribution. For example, Detragiache *et al.*, (2006) find that, in poor countries, a stronger bank presence is strongly associated with less credit to the private sector. Besides, for countries with more bank entry, credit growth is slower and there is less access to credit. But there are no adverse effects on foreign bank presence in more advanced countries.

3.4. Discussion and Research Proposal

A review of theoretical and empirical literature suggests that foreign bank entry is a two-edged sword in terms of stability. It seems clear that the final effect of foreign financial institutions on macroeconomic volatility depends on the type of shocks hitting the economy.

The impact of multinational banking on a host country's volatility is ambiguous. The theoretical models presented suggest that multinational banks tend to dampen the effect of liquidity shocks (GMP model) or bank capital shocks (MRS model): support effect. However, foreign banks seem to amplify the impact of opportunity shocks (GMP model) or firm collateral shocks (MRS model) by exporting capital and lending away from the host country: substitution effect.

Of course, the overall impact of banking integration on volatility is an empirical question, not free from implementation difficulties. As such, it is very hard to identify and isolate the types of shocks discussed above. These caveats, coupled with problems concerning the availability of data, have led researchers to focus attention on the statistical significance of aggregate measures of foreign bank presence. If banking integration is not significant, this means that the stabilising and destabilising effects compensate each other, while if it is negatively signed and statistically significant at conventional statistical levels, stabilising effects predominate and foreign banks improve the buffer function of the financial system.

The empirical evidence also points to opposing results. Regarding pull factors, a number of empirical studies find that multinational banks tend to dampen host country shocks: contra-cyclical effect. On the contrary, other studies conclude that foreign bank lending seems to be positively correlated with changes in the host country conditions: pro-cyclical effect. Concerning push factors, we can also note contradictory findings within empirical studies: either home country financial shocks transmission or negative relationship between home-country business cycle and foreign bank lending.

Most of the applied papers stating that they study the link between foreign banks and stability of different macroeconomic aggregates are in fact grounded on econometric models that analyse only the first conditional moment, i.e. the level of the dependent variable (Micco and Panizza, 2006; Galindo *et al.*, 2005; Dages *et al.*, 2000). The only study that has tried to account for the second conditional moment of the data, i.e. volatility, has done so using two-step methods, which are known to be inefficient (Morgan and Strahan, 2003).

While there is a established body of theoretical knowledge, as well as some tentative results on the consequences of foreign banks over macroeconomic stability, further research efforts might accurately identify the effect of foreign banks over both the first and second conditional moments of the dependent variable. On the basis of the findings, governments will be able to design more effective policies aimed at curbing banking as well as macroeconomic volatility.

The proposal in this research consists in applying ARCH techniques to model jointly the first and the second conditional moments of real domestic credit as an innovation from the traditional empirical literature. In order to shed light on the issue of credit volatility, the ARCH equation is extended to include the degree of development of the banking sector and the internationalisation of the banking system among a broader set of regressors. To the knowledge of the author, this is the first time that such tools have been used to analyse the impact of foreign bank presence on macroeconomic volatility.

Appendix 3

Appendix 3.A: Simultaneous Bank and Firm Capital Shocks

This appendix analyses the effects of simultaneous bank capital shocks (S_m) and firm capital shocks (S_f) over the bank credit level and the investment level.

Let $S_m > 0$ and $S_f > 0$ denote positive capital shocks expressed in terms of amount of capital (and $S_m < 0$ and $S_f < 0$ negative capital shocks) whereas $s_f = S_f/K_f$ and $s_m = S_m/K_m$ denote the capital shocks expressed as a proportion of the capital stock. Then, for instance, $s_f > s_m$ implies that after both positive shocks, the firm shock is higher than the bank shock; or both negative shocks, the bank shock is higher than the firm shock. The opposite applies for $s_f < s_m$. This presentation follows de Haas (2006) closely.

A National Banking System:

Let's start by analyzing the simultaneous effects over β. Then, substitute equation (3.10) into equation (3.12) in order to express β as a function of K_f and K_m -taking into account that $K = K_f + K_m + K_u$- it turns out:

$$\beta_t = p_H c\,(1+\varphi)\,(K_f + K_m)\,/\,(\Delta p)\,K_m$$

and β_{t+1} can be expressed as

$$\beta_{t+1} = p_H c\,(1+\varphi)\,(K_f + S_f + K_m + S_m)\,/\,(\Delta p)\,(K_m + S_m)$$

Note that $\beta_{t+1} > \beta_t$ if $(K_f + S_f) / (K_m + S_m) > K_f/K_m$ which implies that the positive firm capital shock over its stock of capital is bigger than the positive shock over the stock of bank capital, $S_f/K_f > S_m/K_m$.

Now consider negative shocks where the bank shock is stronger than the firm shock. The following dynamics applies. As from the HT model's results, we know that a negative bank capital shock causes an increase in the return on bank capital but a negative firm shock decreases it. Dividing equation (3.9) by K_u it turns out that bank capital becomes more scarce than firm capital so its rate of return has to increase.[24] Regarding uninformed capital, its demand decreases after a decrease in the stock of banking capital and after a decrease in firm capital stock -then the equilibrium market of uninformed capital clears at a lower level.

As a corollary, the net effect of a simultaneous shock to firm capital and bank capital in a closed-economy depends on which shock affects the return on bank capital the most.

A Multinational Banking System :

The consequences of simultaneous (real and financial) shocks can also be analysed in a multinational banking setting. But recall that the amount bank credit (or lending) is compounded by both the stock of bank capital and deposits. As a consequence, the amount of the bank credit is also affected through the shock impact over deposits. The effect of bank capital reallocation over the bank credit stock is called 'first-round effect'. As opposed to the effect over the bank credit through deposits which is called a 'second round effect'.

Regarding the 'first-round effect' the net result of two opposite effects determines the bank capital reallocation. Both effects are driven by the multinational banks' objective to equalise the amount of bank capital per unit of firm capital and

[24]Either from equation (3.9) or (3.12) we know that $(K_m + K_f)/Ku$ increases so $(\Delta K_f + \Delta K_m) > \Delta K_u$. The shocks imply that $\Delta K_f < \Delta K_m$. Dividing the former expression by ΔK_u we get that $\Delta K_f/\Delta K_u < \Delta K_m/\Delta K_u$.

thus β between both countries. The first effect is called the 'support effect'. After a negative bank capital shock there is a bank capital inflow from abroad in order to profit from the higher rate of return in the affected country. The second effect is called the 'substitution effect'. After the firm capital shock, multinational banks reallocate their capital from the affected country to another. As a consequence, the enforcement of the 'first-round effect' depends on the net effect of the real and financial shocks; i.e., on the relative importance of the 'support effect' and the 'substitution effect'. In the case of simultaneous shocks, the proportion of bank capital in each country will depend on the proportion of (post-shock) firm capital stocks. Regarding the 'second-round effect', the redistribution of uninformed capital is given by a proportion φ of the sum of firm and bank capital.

Appendix 3.B: Endogenous Monitoring

This appendix expands the framework by modelling an endogenous monitoring cost. Remember that in the HT model, after a shock, the rate of return of the bank capital adjusts to equilibrate its market. In the MSR model, it adjusts to equalize its rate of return between both countries –a 'first-round effect' over bank lending, consequently, investment level. As regards the second component of bank credit, deposits, in both models, it depends linearly on bank sum and firm capital stock –a 'second-round effect' over bank lending. Then, when shocks take place simultaneously, the ex-post relative amount of bank and firm capital and its effect over β become the key element in determining the new equilibrium. This new technology affects the linear multiplication factor φ which at the same time affects K_u and β_t , and thus K_m –see equations (3.16), (3.17) and (3.15). Going internationally, this assumption does not change capital allocation between countries but bank lending by, for instance, changing the amount of deposits –the 'second-round effect'.

To model variable monitoring intensity, it must be considered that the opportunity cost b becomes a continuous variable (instead of a discrete one) and also that firms face a continuum of bad projects with alternative b level of private benefit. Monitoring at intensity level c -the cost of monitoring- eliminates all bad projects with a private benefit level higher than $b(c)$ which expresses the relationship between monitoring intensity and the firm's opportunity cost. Keeping p_H, Δp, R and γ equal in both countries, the two elements, b and c, are specified as follows:

$$c = \kappa + \varepsilon \left(\frac{K_m}{K_f}\right)^2 \text{ where } c, \varepsilon > 0 \text{ and } \kappa \geq 0 \tag{3.38}$$

$$b = \alpha - \lambda \left(\frac{K_m}{K_f}\right)^2 \text{ where } b, \alpha, \lambda > 0 \tag{3.39}$$

where ε, α and λ are equal in both countries assuming that $\kappa = 0$, so all monitoring cost is variable. Besides κ, equation (3.38) shows that monitoring cost comprises two elements. First, the monitoring intensity defined by the ratio between bank and firm capital. It expresses the amount of capital that the bank utilizes to monitor one unit of firm capital. The higher is the amount of bank capital invested in the firm, the higher is the monitoring intensity devoted by the intermediary. Moreover, monitoring cost is a convex function of monitoring intensity. It reflects the increasing marginal cost of this activity given the increasing difficulty for a bank to find out more and more about the firm.[25] Second, in line with de Haas (2006), the 'monitoring efficiency' is measured by the constant value of ε. The higher is ε, the higher is the monitoring cost for a given amount of bank capital for a unit of firm capital and, thus, less efficient is the bank to perform this activity. From now on, we assume that ε is equal across countries. Equation (3.39) shows that the higher is the monitoring intensity, the lower is b-value (the private benefits) of the available bad projects and so inducing the managers to behave more diligently.

As it is pointed out by de Haas, a higher monitoring intensity relaxes the IC_f. This means that the firm needs to be promised a smaller rate of return to ensure a diligent behaviour. Then the reduction in R_f implies that a higher rate of return could be promised to investors and this increases the amount of deposits and bank lending. However, notice that as R_f decreases, R_m increases; therefore, the positive impact over the rate of return which could be promised to investor is not evident.

Consider that λ has not been taken into account in this analysis. Moreover, we believe that it should be defined with regard to ε. These equations are interpreted considering that both λ and ε, in a different manner, express monitoring efficiency. First, ε represents the efficiency from the 'economic' point of view. It represents the cost of the monitoring technology plus the monitoring staff . Second, λ represents the efficiency from the 'expertise' point of view. It represents the

[25]This is a standard assumption used in a large number of papers.

know-how and professional skills in monitoring and an accurate use of technology. As a consequence, assuming $\kappa = 0$ and $\alpha = 0$, instead of defining 'monitoring efficiency' as the 'monitoring cost' –like de Haas –we prefer to define 'monitoring efficiency' as the (average) economic cost of eliminating each bad project; so monitoring efficiency is given by ε/λ. Then de Haas (2006)'s statement is true when $\left|\frac{\varepsilon}{\lambda}\right| < 1$.

Proof. Recall IC_f and IC_m which are binding constraints: $R_f = b.I./\Delta p$ and $R_m = c.I./\Delta p$. Then expressing R_m as a function of R_f we get: $R_m = \frac{c}{b}R_f$. From equation (3.38) and (3.39) we get that $(c/b) = -\left(\varepsilon/\lambda\right)$ so $R_m = -R_f\left(\varepsilon/\lambda\right)$. Then reduction in R_f is higher than the increase in R_m on condition that $\left|\frac{\varepsilon}{\lambda}\right| < 1$ –or $(c/b) < 1$. Conversely, if $\left|\frac{\varepsilon}{\lambda}\right| > 1$ the increase in R_m becomes higher than the reduction in R_f. Then the rate of return promised to investors will be lower, decreasing the amount of deposits and bank lending. The 'efficiency' of monitoring depends on the relation between its 'cost' and its 'effectiveness' in eliminating b-projects. $\square$

Note that the higher is λ, the more skillful is the professional staff and the more accurate the use of technology. And, the lower is ε, the cheaper is the professional staff and the technology. As a consequence, as $\left|\frac{\varepsilon}{\lambda}\right| \to 0$ monitoring is more and more efficient. The opposite is true when $\left|\frac{\varepsilon}{\lambda}\right| \to \infty$. If $\left|\frac{\varepsilon}{\lambda}\right| < 1$ then monitoring is efficient enough to be able to promise a higher rate of return to uninformed investors leading to a high bank lending. It follows that there is an efficiency limit given by $\left|\frac{\varepsilon}{\lambda}\right| = 1$.

Observe that higher monitoring intensity relaxes the IC_f which means that the firm needs to be promised a smaller rate of return to ensure a diligent behaviour on its part. Accordingly, if $\left|\frac{\varepsilon}{\lambda}\right| < 1$ then the reduction in R_f is higher that the increase in R_m , so a higher rate of return could be promised to investors. As a consequence, the amount of deposits increases as well as bank lending.

By substituting both equations (3.38) and (3.39) into equation (3.16) and (3.17) we obtain the expression for the amount of uninformed capital under endogenous monitoring:

$$\begin{aligned} K_{u2}^{m(en)} &= \varphi^{en}\left(K_{f1}^{m}+K_{f2}^{m}+K_{m1}^{m}+K_{m2}^{m}\right)\pi_2 \\ K_{u1}^{m(en)} &= \varphi^{en}\left(K_{f1}^{m}+K_{f2}^{m}+K_{m1}^{m}+K_{m2}^{m}\right)(1-\pi_2) \end{aligned}$$

where

$$\varphi^{(en)}=\frac{p_H\left[R.\Delta p-(\alpha+\kappa)+(\lambda-\varepsilon).\left(\frac{K_m}{K_f}\right)^2\right]}{p_H\left[R.\Delta p-(\alpha+\kappa)+(\varepsilon-\lambda).\left(\frac{K_m}{K_f}\right)^2-R.\Delta p\right]+(\Delta p)\gamma}$$

and $\pi_2 = K_{f2}^m/\left(K_{f1}^m+K_{f2}^m\right)$, $(1-\pi_2) = K_{f1}^m/\left(K_{f1}^m+K_{f2}^m\right)$ and the subscript (en) expresses *endogenous* monitoring .

From now on, we assume that $(\lambda-\varepsilon)>0$ and hence $\left|\frac{\varepsilon}{\lambda}\right|<1$.

Following De Haas' presentation closely, we compare the effects of endogenous and exogenous monitoring intensity under both national and multinational banking systems.

3.4.0.1. National Banking System in a Closed-economy Model. *Negative Bank Capital Shock:* In the case of endogenous monitoring, bank lending is reduced more than in the case of exogenous monitoring. A negative bank capital shock reduces the ratio (K_m/K_f) and assuming that $(\lambda-\varepsilon)>0$, then $\varphi^{en}<\varphi$ and so $K_u^{n(en)}$ is lower which at equilibrium become defined as

$$K_u^{n(en)}=\varphi^{(en)}.\left(K_f+K_m\right) \tag{3.40}$$

where

$$\varphi^{(en)} = \frac{p_H \left[R.\Delta p - (\alpha+\kappa) + (\lambda-\varepsilon).\left(\frac{K_m}{K_f}\right)^2 \right]}{p_H \left[R.\Delta p - (\alpha+\kappa) + (\varepsilon-\lambda).\left(\frac{K_m}{K_f}\right)^2 - R.\Delta p \right] + (\Delta p)\gamma}$$

Equation (3.40) expresses the equilibrium quantity of uninformed capital raised by firms under endogenous monitoring technology. This is coherent with the fact that given the increase in R_m, R_f decreases more under endogenous monitoring.[26] As a consequence, a higher R_u could be promised to uninformed investors. Obviously, the firm capital stock remains constant.

Negative Firm Capital Shock: Under endogenous monitoring, two opposite effects play a role. On the one hand, firm capital decreases and so less uninformed capital could be attracted; idem to exogenous monitoring. On the other hand, the higher ratio K_m/K_f leads to higher monitor intensity and to a higher φ^{en}-value. As a consequence, $K_u^{n(en)}$ decreases less with regard to the case of exogenous monitoring; or it even increases if $\left(\varphi_{t+1}^{(en)} - \varphi_t^{(en)}\right).(K_f + K_m) > \varphi_{t+1}^{(en)} |S_f|$ or $\left(\varphi_{t+1}^{(en)} - \varphi_t^{(en)}\right)(K_f + S_f + K_m) > \varphi_t^{(en)} |S_f|$.[27]

3.4.0.2. Multinational Banking System in a Two-country Model. Supposing that capital shocks hit the Host Country (Country 2), the following is observed:

Negative Bank Capital Shock: The final effect on bank capital stock in the host country is half lower compared to that of a national banking system. The burden of

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[26]Recall that $R_m = (c/b)\,R_f$. Under exogenous monitoring c/b is constant whereas under endogenous monitoring c/b decreases and thus R_f decreases less given the reduction in R_m. Because of this, a higher R_u could be promised to uninformed investors.

[27]$K_u^{n(en)}$ increases if $K_{u,t+1}^{n(en)} > K_{u,t}^{n(en)}$ which could be rewritten as $\varphi_{t+1}^{(en)}(K_f + S_f + K_m) > \varphi_t^{(en)}(K_f + K_m)$. Expressing the shock as a function of the other variables we get: $\left(\varphi_{t+1}^{(en)} - \varphi_t^{(en)}\right).(K_f + K_m) > \varphi_{t+1}^{(en)}(-S_f)$. Or $\varphi_{t+1}^{(en)}(K_f + S_f + K_m) > \varphi_t^{(en)}(K_f + K_m)$; $\varphi_{t+1}^{(en)}(K_f + S_f + K_m) - \varphi_t^{(en)}(K_f + K_m) > 0$ then adding and subtracting $\varphi_t^{(en)} S_f$ on the left-hand side we get $\left(\varphi_{t+1}^{(en)} - \varphi_t^{(en)}\right)(K_f + S_f + K_m) > \varphi_t^{(en)}(-S_f)$.

the shock is equally shared between countries –assuming that the initial conditions are the same in both countries. The international allocations of firm and bank capital are not affected under endogenous monitoring compared to endogenous monitoring (first-round effect). But it influences the amount of deposits that can be attracted in each country (second-round effect). Bank credit declines more under endogenous monitoring intensity than under exogenous monitoring in both countries. The lower $\varphi^{(en)}$-value implies that fewer deposits can be attracted per unit of bank and firm capital and bank credit in both countries is lower.

Negative Firm Capital Shock: There is a 'substitution effect'. Banks reallocate their capital from the host country (which suffered the shock) to the home country. Both exogenous and endogenous monitoring affect bank capital reallocation in the same manner. Neither plays a distinguishable role. However, the higher Bank to Firm Capital ratio in both countries implies that banks monitor more intensively in both countries. As a consequence, bank lending reduction in the host country is less severe under endogenous monitoring. This is because deposits decrease less due to the higher monitoring intensity. It partially compensates both the negative shock on firm capital and the consequently negative 'substitution effect' on bank capital. In the home country, the positive 'substitution effect' is amplified. Bank lending increases more because more deposits can be attracted.

As a corollary, total investment depends on the relative amount between firm and intermediary capital (and not only on each sum as before). Notice that endogenous monitoring intensity only makes a difference through bank credit level (and so bank lending) affecting both countries by an spillover effect. Bank and firm capital reallocation are the same under both exogenous or endogenous monitoring intensity.

Notice that endogenous monitoring in a variable investment model implies that all firms will be monitored with same intensity because the choice of b is independent of A_0 in the Program A_0.

To sum up, the theory suggests that the net effect of foreign bank entrance on the economy stability is ambiguous. A MBS is more solid when the economy faces a domestic bank capital crisis but conversely more exposed to 'external' bank capital crisis. Moreover, a MBS promotes a contagion effect of local financial crisis, hence, a positive correlation between crisis in different countries –it reduces aggregate credit and investment level in the other country. On the contrary, integration can amplify the impact of firm collateral shocks because integrated banks have the opportunity to shift their capital elsewhere during recession periods leading to higher credit and investment level in the other country. This positive spillover effect promotes a negative correlation between crisis in different countries.

The following table summarises the results assuming that the shock takes place in the home country –remember that countries are symmetric.

<table>
<tr><th colspan="3">Bank Credit Crunch (Financial Shock)</th></tr>
<tr><td rowspan="2">Home Country</td><td>REDUCING effect</td><td>Investment in Home Country</td></tr>
<tr><td>AMPLIFYING effect</td><td>Investment in Host Country</td></tr>
</table>

<table>
<tr><th colspan="3">Firm Collateral Squeeze (Real Shock)</th></tr>
<tr><td rowspan="2">Home Country</td><td>AMPLIFYING effect</td><td>Investment in Home Country</td></tr>
<tr><td>REDUCING effect</td><td>Investment in Host Country</td></tr>
</table>

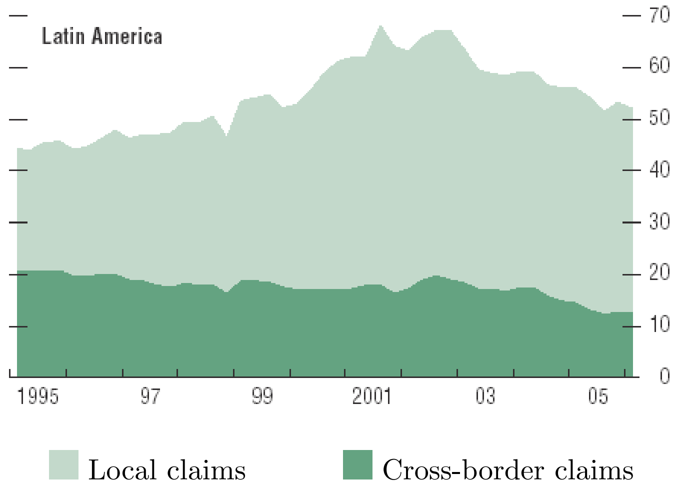
CHAPTER 4

Foreign Banks and Credit Volatility in Latin America

4.1. Introduction

Banking systems in Latin America during the 1990s witnessed a process of bank consolidation characterized by important changes in the ownership structure. In Argentina, Brazil, Colombia, Costa Rica, Peru and El Salvador, more than a quarter of all banks either closed or merged between 1996 and 2002. This important reduction in the number of banks lead the industry to a high level of concentration. However, by 2002, Latin America as a whole still showed a low level of concentration in this industry compared to other regions. At that time, foreign banks began to play a dominant role. In countries, like Argentina, Mexico and Peru, they became the most important players in the domestic financial system. The increased foreign bank presence in the region was coupled with the global phenomena of shifting banking activity from an international to a multinational strategy (see Graph 4.1).

Graph 4.1: Foreign Bank Presence LAC
(percent of total private sector credit)



Source: McGuire and Tarashev (2005a, 2005b) using BIS Statistics

Local claims define private sector local claims of foreign affiliates (in all currencies) as a percent of total private sector credit. Cross-border claims represent private sector cross-border claims of parent banks as a percent of total private sector credit (see McGuire and Tarashev 2005a and 2005b, for methodology and background analysis).

Foreign bank entry was mostly driven by financial deregulation but the main incentive to open up to international financial markets was the search of cheaper sources of capital not available in other countries of the region. As it was pointed out, financial resources in Latin American countries are scarce and costly. Maybe not surprisingly, the share of assets held by foreign banks coming from developed countries reached 98 percent, and only the remaining 2 percent was held by banks coming from other countries in the region.

Furthermore, the increase in foreign bank presence was associated with a decrease in public bank participation –a traditional big player in Latin American banking systems. Views on this issue are in a big contrast. Some economists argue that a strong public presence is needed in these economies where capital is scarce and costly. Public banks use to lend resources at low interest rates in order to encourage specific economic sectors and activities. Other economists suggest that the objectives of state-owned banks are mainly dictated by political incentives, there being little economic justification for their intervention in this industry.

All this transformation within the banking system raises crucial questions on how such changes affect both stability and access to credit (as well as costs). For instance, one source of concern is that the foreign bank presence in developing countries might lead to a more limited access to credit, particularly for the small and medium size firms which most depend on bank credit. In order to reduce and mitigate information asymmetries, small businesses tend to develop a long lasting and informal relationship with their banks. In contrast, foreign banks have difficulties (and maybe less incentive) in developing this type of relationship; therefore they mostly focus on large companies.

As already seen in the previous chapter, foreign banks are a double-edge sword and present both mixed evidence as well as theoretical support in terms of their effect on credit stability. They usually have access to additional sources of funding, being able to easily recapitalize after a crisis and even probably improving their market share. But they also face other opportunities and risks elsewhere, hence, capable of destabilizing domestic banking systems. Usually foreign banks face such alternatives and can cut credit by more than domestic banks can.

Based on this, in the current chapter, both the first and second conditional moments of the real banking credit –say, the media and the variance, respectively –are simultaneously estimated in order to shed light on foreign bank effect over real credit level and volatility.

The chapter is organized as follows. The next section details the data construction process. Section 4.2 presents the ARCH econometric model used in the estimation and Section 4.3 details the data construction process. Panel unit-root tests are outlined in Section 4.4, while Section 4.5 describes the estimation results. Section 4.6 draws the conclusions.

4.2. The econometric model

We are interested in identifying the impact of foreign banks on credit volatility, controlling for additional factors affecting the mean and conditional variance of credit. The ARCH family models are particularly suitable for this purpose, since they allow us to estimate jointly the determinants of both the first and second conditional moments of the data.

The econometric model to be estimated consists of the following equations:

$$y_{it} = \beta_0 + \phi y_{i,t-1} + X_{i,t}^{'}\beta_1 + \mu_i + u_{i,t}, \; i = 1, ..., N, t = 1, ..., T \tag{4.1}$$

$$u_{it} = \sigma_{it}\eta_{it} \tag{4.2}$$

$$\sigma_{it}^2 = \exp\left(\lambda_{0i} + z_{it}^{'}\lambda_1\right) + \alpha u_{it-1}^2 \tag{4.3}$$

$$\eta_{it} \sim N(0,1) \tag{4.4}$$

In the mean equation (4.1), y_{it} is the dependent variable, μ_i are the individual country-specific fixed effects, X_{it} is a vector of explanatory variables, $\beta_0$denotes the constant term, β_1 is a set of coefficients, u_{it} is a disturbance term, and N and T are the number of cross-sectional units and time periods in the panel respectively. Equation (4.2) states that the country-specific shock follows an ARCH process. In equation (4.3), the conditional variance, λ_{0i} is an individual, country-specific fixed effect, while Z_{it} is a vector of explanatory variables.[1] Together, equations

[1]As usual, country-specific fixed effects in the mean and conditional variance equation are intended to capture differences in institutions, regulations, culture and other economic factors not accounted for in the explanatory variables.

(4.1) to (4.4) constitute a panel ARMAX-ARCH model, which is estimated by quasi-maximum-likelihood techniques.[2]

4.2.1. The mean equation

Both macroeconomic and banking variables are assumed to affect the credit dynamics in the mean equation (see Dages *et al.*, 2000; Peek and Rosengren, 2000a; Crystal *et al.*, 2002; Goldberg, 2002; Morgan and Strahan, 2003; Detragiache *et al.,* 2006; and Micco and Panizza, 2006). The vector of macroeconomic explanatory variables includes real domestic GDP, the US GDP, the Federal Funds Rate, the domestic fiscal balance, the spread between lending and borrowing rates, the bilateral real exchange rate with the US, and a measure of currency crisis. The lagged dependent variable is introduced in the regression to control for persistence in the level of private credit.

We expect bank lending to be procyclical, both with respect to local and international economic activity.[3] A higher foreign GDP captures a more benign international financial environment, leading to greater credit in domestic markets. We also expect increases in the international cost of money, measured by the Federal Funds Rate, to lead to less buoyant credit activity. Real exchange rate depreciations should also have a detrimental effect on credit, since they can be considered as another component of international lending costs (Dornbusch, 1983). When the real exchange rate depreciates, the repayment of foreign loans becomes more expensive, making them less attractive. This may be potentially an important channel of credit contraction in domestic markets, since banks in

[2]Note that we estimate an ARCH(1), instead of a higher order or GARCH(p), in order to keep the model as parsimonious as possible. Of course, residual diagnostic tests will indicate whether this model specification is appropriate.
[3]See Horvath *et al.* (2002) and Goldberg (2007) for a revision of the theoretical literature on procyclical credit behaviour.

the region have been extensively issuing foreign debt as a way of funding domestic lending operations.

As regards the fiscal balance, the banking sector has proved to be an important provider of government funding in some of the countries under consideration. It would therefore be expected that better public finances would crowd-in private credit. A higher interest rate spread should negatively affect credit, by making fewer investment and personal projects economically viable. A priori, we might expect episodes of currency crisis in a particular country to be accompanied by a decline in bank lending, since they are associated with a general loss of confidence in the system and a retrenching of deposits.

The banking indicators that enter the mean equation are the degree of financial development, the presence of public and foreign banks in the system, and the level of concentration. The inclusion of financial development in the mean equation is intended to capture the extent of financial market imperfections (information asymmetries, monitoring capacity, etc.).[4] Regarding foreign banks, empirical evidence available to date is inconclusive as to their impact on credit dynamism. While Crystal *et al.* (2002) have found a positive effect (with foreign banks exhibiting a more strongly loan growth than their national counterparts in a sample of Latin American countries over the second half of the 1990s), Detragiache *et al.* (2006) show that in poorer countries a higher foreign bank presence is robustly associated with a slower growth in credit to the private sector. Finally, a more concentrated banking system is expected to reduce credit dynamism, because dominant players have much at stake in the event of negative shocks, and thus reduce risk-taking behaviour and credit growth (Morgan and Strahan, 2003).

[4]Aghion *et al.* (1999) develop a macroeconomic model, based on micro-foundations, which combines financial market imperfections and unequal access to investment opportunities. They show that economies with less developed financial systems will tend to be more volatile (justifying the inclusion of financial development in the variance equation – see below), and will experience slower growth.

Both theory and evidence highlight the importance of including interaction terms in equation (4.1) to account for the potential asymmetric behaviour of public and foreign banks in the event of currency and banking crisis, and internal and external shocks (domestic and foreign GDP and international interest rates). For example, Micco and Panizza (2006) find that state-owned banks may play a useful credit-smoothing role, because their lending is less responsive to macroeconomic shocks than lending by private banks. Regarding foreign banks, the empirical literature gives conflicting results as to whether or not they exacerbate credit cyclicality.[5] In periods of financial distress evidence seems to suggest that foreign banks did not reduce credit supply, though contributing to greater credit stability (Dages *et al.*, 2000; Peek and Rosengren, 2000a; Crystal *et al.*, 2002; and Goldberg, 2002).[6] Yet, foreign institutions may also change the way international interest rates and GDP shocks affect lending behaviour. In the event of a Federal Funds Rate increase they may exacerbate the "flight to quality" effect. And regarding foreign GDP, the literature also provides conflicting results as to whether or not foreign banks exacerbate the impact on domestic credit from international cycles.[7]

[5]Some empirical studies show a positive relationship between the host country's business cycles and international lending behaviour to developing countries (Dahl and Shrieves, 1999; Buch, 2000; Jenneau and Micu, 2002; Morgan and Strahan, 2003). However, Micco and Panizza (2006) find that foreign banks have not contributed to exacerbating lending in a pro-cyclical manner in a sample of developing and developed countries over the period 1995-2002.

[6]Foreign banks might view crises as an opportunity to expand, thereby maintaining or increasing their level of credit. Another way to gain market share consists in acquiring local private banks. See Cull and Martinez Peria (2007).

[7]A negative push relationship between the home country's economic cycle and cross-border and foreign bank lending in host countries was found by Moshiriam (2001), Martinez Peria *et al.* (2005) and De Haas and Van Lelyveld (2006). On the other hand, Dahl and Shrieves (1999) and Peek and Rosengren (1997, 2000b) find evidence of a positive push relationship between the home country's economic cycle and cross-border and foreign bank lending in host countries. Empirical evidence for the region seems to go in this direction, since Goldberg (2002) observes that US bank lending to Latin American countries increases as the US economy grows faster.

4.2.2. The potential determinants of credit volatility

As regards the variables in the conditional variance equation (4.3), we include banking and currency crises, the presence of foreign and state-owned banks, financial development and the degree of concentration in the banking system. While we expect crises to be positively related to credit volatility, the impact of the presence of foreign banks is uncertain: if stabilising effects predominate, then its coefficient should be negatively signed and statistically significant at conventional levels.

Regarding financial development and volatility the literature points at information asymmetries as one of the key elements that induce volatility. When markets are imperfect, firms must rely on internal rather than on external funding in order to finance investment, which will exacerbate output volatility as far as internal sources of finance are already procyclical. Also, supply and demand for credit may become more cyclical when the financial sector is not well developed. This is so because investors will be locked out of credit markets in bad times, only to be able to come back in good times (Aghion *et al.*, 1999). All in all, as far as the level of financial development can be related to the ability of economies to generate and process information, a negative relationship between financial market development and volatility would be expected (Dewatripoint and Maskin, 1995; Diamond, 1984).[8] As with foreign bank presence, banking concentration may either increase or reduce credit volatility. On the one hand, higher concentration may imply less competition, higher profits and franchise value (*i.e.*, the present value of the stream of profits that a firm is expected to earn). This renders concentrated banks more conservative –since they have much at stake –boosting incentives to make good

[8]Financial intermediaries also help lowering transaction costs, they improve corporate governance and risk management, and lead to better resource allocation and a smoother absorption of shocks. See Denizer *et al.* (2002) for a recent revision of the literature about financial development and volatility.

loans and contributing to the stability of the banking sector.[9] On the other hand, when market power increases, banking institutions have the possibility to charge higher interest rates, encouraging risk-taking behaviour and leading to greater vulnerabilities in the system (Boyd and De Nicoló, 2005). Also, more concentrated banking systems are likely to induce moral hazard, because concentrated banks are "too important to fail" (Mishkin, 1999). All in all, risk-taking behaviour increases, which results in more vulnerable banks.[10]

Morgan and Strahan (2003) have already tested the impact of foreign bank entry, financial development and concentration on economic volatility, measured by the squared and absolute value deviation of actual from expected GDP and investment growth.[11] For a full sample comprising developed and developing countries alike they find tentative evidence of a positive link between foreign banks and macroeconomic volatility. Concentration is not statistically significant, and financial development is found to increase economic volatility, which is puzzling both on theoretical and empirical grounds. Nevertheless, when they focus on a sample of Latin American countries, they report a negative coefficient in the GDP regression for both banking integration and financial development, although they are not statistically significant. Denizer *et al.* (2002) do find evidence that financial depth helps to reduce economic volatility using a panel of 70 developed and developing countries starting in the mid-1950s.

[9] Evidence that higher franchise values are associated with sounder banks was found by Keeley (1990), Demsetz *et al.* (1996) and Bergstresser (2001). These authors find that higher franchise values are systematically associated with higher bank capitalization, more lending diversification, and reduced bank failures,

[10] Empirical evidence along these lines is presented by Boyd and Graham (1991, 1996), De Nicoló and Kwast (2002), and De Nicoló *et al.* (2004).

[11] Expected GDP and investment growth is computed from a regression on time and fixed effects, banking integration, as well as a set of control variables. The sample consists of a panel of nearly 100 countries and spans the period 1990-97.

4.3. The data

Our sample of Latin American countries includes Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico and Peru. Country selection was based on the availability of data. Aggregate information is quarterly, spanning the period 1995:1-2001:4, for which a balanced panel is available.[12] As a result, we end up with 28 quarters and 8 countries (224 observations). Banking information is available from Central Banks and was gathered by the Inter-American Development Bank (IADB), while macroeconomic data are available from the IMF's International Financial Statistics and national sources (*i.e.*, central banks and national statistics agencies).

Banking sector indicators were constructed using balance sheets of financial institutions that report to the appropriate national regulatory agencies. The indicators of interest are measures of foreign and government-owned bank presence in the system, and a measure of banking concentration. Each bank is classified according to capital ownership, *i.e.* public or private, and domestic or foreign. Foreign banks are those with more than 50% of the capital owned by a G10 country.[13] State-owned banks are those with more than 50% of the capital in the hands of the government. Using this classification, the measure of foreign and government-owned banks in the system is defined as their respective share of credit in the whole system. The measure of credit considered is direct credit by banks to private and public non-financial institutions. Finally, the degree of concentration in the system is measured by the share of credit granted by the three largest banks as

[12]While for most of the countries, banking data were available monthly, for Chile and Mexico data were only available on a quarterly basis. Excluding these countries from the sample would have entailed a major loss, since these countries have been very active in attracting foreign banks.

[13]Some of the countries in the sample also host banks from other Latin American countries (regional banks). As in Galindo *et al.* (2005), we treat them as domestic banks because the authors find that they behave like domestic, rather than global well-diversified banks.

a proportion of total credit. As mentioned in the introduction to this chapter, foreign banks have been expanding their presence in Latin America during the sample period, which allows us to assess their impact on credit behaviour. Foreign direct investment (FDI) in the Latin American banking sector was mainly encouraged by the process of deregulation and privatisation of the industry that took place during the 1990s. As a result, foreign banks' share of total credit more than doubled in Argentina, Brazil, Chile, Mexico and Peru between 1995 and 2001 (Figure 4.1).[14] This is against a slight increase in banking concentration throughout the region, with the exception of Brazil and Chile, where concentration was reduced (Figure 4.2).

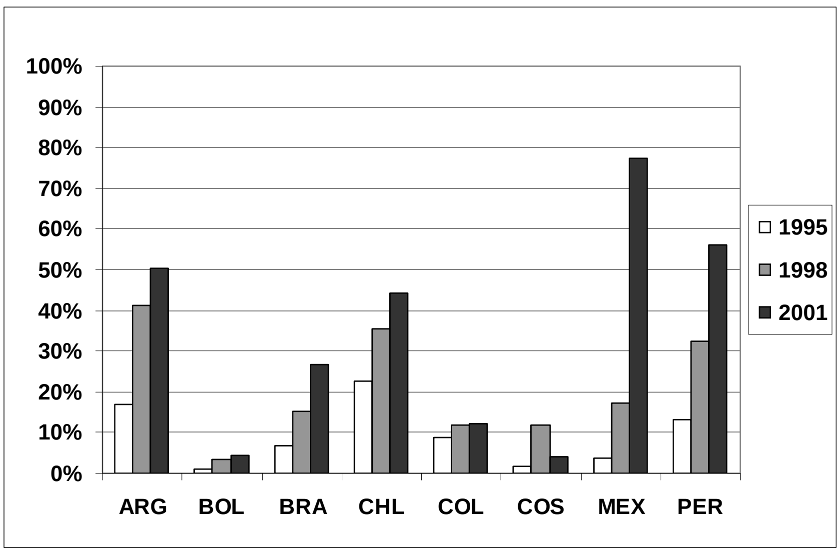
The macroeconomic variables included in the estimating equations are: real credit to the private sector by banking institutions (the dependent variable), seasonally-adjusted real domestic GDP, seasonally-adjusted real US GDP, the Federal Funds Rate, the domestic fiscal balance, the spread between lending and borrowing rates, the degree of financial development, the bilateral real exchange rate with the US, and a chronology of banking and currency crises.

Real credit is computed as the nominal credit stock averaged over the quarter and deflated by the seasonally-adjusted CPI. The Federal Funds Rate is expressed as per cent per annum, while the fiscal balance is computed as the four-quarter rolling sum of the headline central government balances, then defined as a per cent of nominal GDP. The interest rate spread focuses on local-currency operations and is computed as the difference between the lending and deposit rates in per cent of the deposit rate. Financial development is measured as total (public plus private) credit in percent of GDP. The bilateral real exchange rate with respect to the US dollar is computed using market-based nominal exchange rates (in national currency per US dollar) and seasonally-adjusted consumer price indices. The banking

[14] A similar pattern emerges when assets, instead of credit, are used to measure foreign participation.

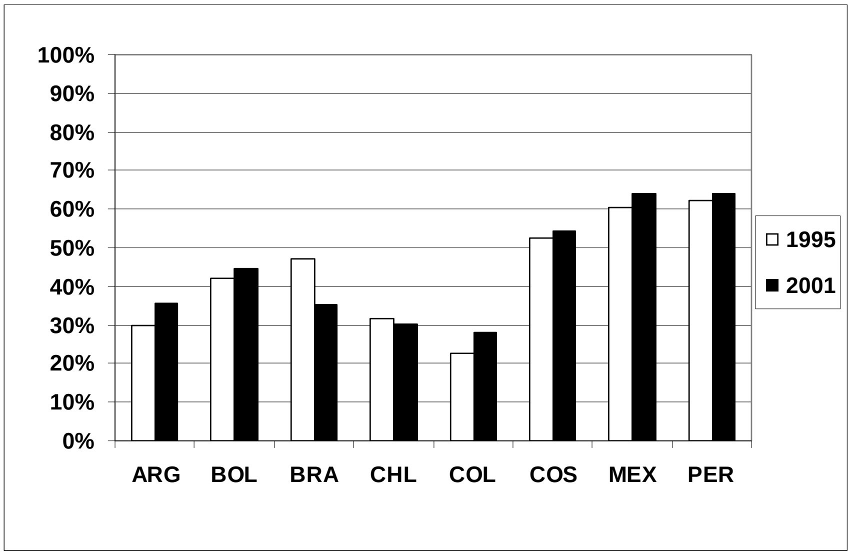
crisis indicator is a dummy that takes the value of one for each quarter in which there was a banking crisis according to the chronology reported by Caprio *et al.* (2005) over the period 1970-2000, and extended to 2001 by Carstens *et al.* (2004). Finally, a currency crisis indicator was constructed based on Frankel and Rose (1996), taking the value of one if an exchange rate depreciation in a given quarter is higher than 10% and is at the same time at least five percentage points higher than the depreciation of the previous quarter (Table 4.1).

Figure 4.1. Foreign bank presence
(share over total credit)



Source: Author's calculations.

Figure 4.2. Banking Concentration
(top 3 banks' share of total credit)



Source: Author's calculations.

Table 4.1: Currency and Banking Crisis in Latin America (1995:1 – 2001:4)

Country	Currency crises	Banking crises
Argentina		1995:1-1995:4
		2001:1-2001:4
Bolivia		1995:1-1995:4
Brazil	1999:01:00	1995:1-1996:4
	2001:02:00	
Colombia	1999:01:00	1998:1-1998:4
Costa Rica		1995:1-1998:1
Mexico	1995:01:00	1995:1-1996:4
	1995:04:00	

Source: Author's calculations, Carstens *et al.* (2004) and Caprio *et al.* (2005).

4.4. Panel unit-root tests

Financial sector foreign direct investment in Latin America is a relatively new phenomenon, which means that data are less readily available and the use of time series techniques for individual countries is difficult. The use of panel data that pools together information for different cross-sectional units increases the amount of information and the power of econometric estimations. Nevertheless, the usual concerns about spurious regressions and misleading statistical inferences still arise when using potential non-stationary panels, in which the time dimension greatly exceeds the number of cross-sectional units. Indeed, checking the panel unit-root properties of the variables will be a first step in disentangling the effect that foreign banks may have on credit volatility in our sample of Latin American countries.

The number of tests to detect the presence of unit-roots in panels has been growing rapidly. First generation techniques have ignored the possibility that unobserved common factors can affect the cross-sectional units simultaneously.

This possibility can easily arise in macroeconomic applications that use country or regional data, substantially biasing the estimated coefficients and distorting the size of the test statistics.[15] Recognising this deficiency, a second group of panel tests have been proposed to successfully address this issue (see Breitung and Pesaran, 2006, for a literature review). Nevertheless, the unwarranted application of these techniques is not without difficulties. If panel unit-root tests that allow for cross-sectional dependence are used inappropriately, tests might result in a loss of power.

Therefore, before deriving any inference on the statistical properties of the data it is necessary to establish whether or not the variables in the panel are subject to a significant degree of error cross-sectional dependence. This can be achieved by conducting first generation panel unit-root tests, obtaining the residuals of each equation, and then computing the Lagrange Multiplier (LM) test suggested by Breusch and Pagan (1980). The LM statistics tests the null hypothesis of zero cross-equation error correlations, and is based on the average of the squared pair-wise sample correlation of the residuals ($\hat{\rho}_{i,j}$).[16] The test is given by:

$$CD_{lm} = T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{i,j}^2$$

Under the null hypothesis of zero cross-sectional dependence, the statistics converges to a chi-squared distribution with $N(N-1)/2$ degrees of freedom. This test has been shown to be particularly suitable for cases in which N is sufficiently small relative to T, as in our case.[17]

[15]In particular, Pesaran (2007) shows that in the presence of high cross-sectional dependence, the bias is such that the empirical size is higher than the nominal size. The extent of over rejection increases with the degree of cross-sectional dependence, and with N and T.

[16]Specifically, $\hat{\rho}_{i,j} = \hat{\rho}_{j,i} = \left(\sum_{t=1}^{T} e_{i,t}e_{j,t}\right) \Big/ \left(\sum_{t=1}^{T} e_{i,t}^2\right)^{1/2} \left(\sum_{t=1}^{T} e_{j,t}^2\right)^{1/2}$, where $e_{i,t}$ is the Ordinary Least Squares (OLS) estimate of the error equation used to test for unit-roots for each i separately.

[17]Pesaran (2004) has proposed another test for cross-sectional dependence, using the level rather than the squared values of the pair-wise correlation coefficients. By using Pesaran's test, we

Choi's (2001) test is used to determine the existence of panel unit-roots, assuming that the individual time series are cross-sectionally independent. While the test can be constructed by applying any unit-root test to the individual series, here we estimate standard ADF regressions for each cross-sectional unit and combine the *p-values* associated with each lagged dependent variable so as to form the following statistics:

$$Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}(p_i)$$

where Φ is the standard normal cumulative distribution function, and p_i is the asymptotic *p-value* for the ADF unit-root test of cross section i. The null hypothesis is that all times series have a unit-root, while under the alternative hypothesis some of the variables are stationary. Choi (2001) shows that under the null hypothesis, Z converges to a standard normal distribution. A main advantage is its improved finite sample power over other traditional techniques, such as Levin *et al.* (2002) and Im *et al.* (2003).

The panel unit-root test that allows for cross-sectional dependence is constructed along the same lines as before, the only difference being the ADF regression used to obtain the *p-values* and the fact that the Z statistics no longer converges to a standard normal distribution, even for large T and N. In such a case, stochastically simulated critical values have to be used instead.[18] Pesaran (2007) proposed an easy way to deal with the problem of cross-sectional correlation arising from an unobserved common factor, which consists in simply augmenting the standard ADF regression with cross-sectional averages of lagged levels and first-differences of the individual series. In particular, the Z test will now be constructed using the OLS *p-values* associated to coefficient β_i in the following p^{th}

cannot rule out the possibility that positive and negative correlations compensate each other, leading to the erroneous inference that no cross-sectional dependence is present in the data.

[18]These depend on the sample size (T and N), and on the deterministic components included in the regressions.

order regression:

$$\Delta y_{it} = \alpha_{mi} d_{mt} + \beta_i y_{i,t-1} + \varsigma_i \bar{y}_{t-1} + \sum_{j=0}^{p_i} \delta_{ij} \Delta \bar{y}_{t-j} + \sum_{j=1}^{p_i} \rho_{ij} \Delta y_{i,t-j} + e_{it}$$

where $\bar{y}_t$ is the cross-sectional mean of y_{it} given by $\bar{y}_t = N^{-1} \sum_{i=1}^{N} y_{it}$, and $m = 1, 2, 3$, with $d_{1t} = \{\phi\}$, $d_{2t} = \{1\}$ and $d_{3t} = \{1, t\}$.[19] Simulations performed by Pesaran show that the cross-sectionally augmented version of Choi's test has quite satisfactory power and size, even for small values of T and N.

Table 4.2 shows the cross-sectional dependence and panel unit-root test results for the above-mentioned set of variables over the period 1995:1-2001:4. Recognising that potential biases may arise when including different deterministic components in the estimative unit-root equations, we have adopted the following strategy. Country variables that do not exhibit a trend were centred, and no deterministics were included in the analysis, which allows for testing the null of a random walk without drift against the alternative of level stationarity. When country variables do exhibit a trend, models were estimated with a constant, and with and without a linear time trend. Only if the null hypothesis is not rejected in both cases, can we be confident that a unit-root is present in the data. Indeed, column 1 contains the names of variables, column 2 indicates the cases in which some of the equations include a constant only, while column 3 presents those in which the same set of equations was extended to include a linear trend.

The test of cross-sectional dependence performed on the residuals of the ADF estimations that do not contain averages of the dependent variable are reported in column 4. As expected, significant dependence was found across countries in macroeconomic variables, such as real GDP, the fiscal balance, real private lending

[19]The augmentation order p is selected here on account of the Schwartz Information Criterion applied to each cross-sectional ADF equation, without the cross-sectional variables $\bar{y}_{t-1}$ and $\Delta \bar{y}_{t-j}, j = 1, \ldots, p_i$.

and real exchange rates. By contrast, most of the banking variables are free of common factors that may make them highly correlated. The last column of Table 4.2 presents the Z statistics, with or without cross-sectional dependence according to the results obtained by the LM test (CD_{lm}) statistics presented above.[20] It is possible to reject the null hypothesis of unit roots for almost all variables, while for real GDP the test provides conflicting results. Individual unit-root tests results for real US GDP and the Federal Funds Rate (not reported) do not allow us to reject the presence of a unit-root in the series.

Based on these results, the variables of interest are defined as follows. When the presence of unit roots is rejected and the variables are expressed as ratios (foreign bank presence, concentration, etc.), the level difference with respect to the Hodrick-Prescott (HP) trend is considered. Otherwise, the percentage deviation with respect to the trend is used instead. Of course, when a unit-root is present, the variables are first-differenced.[21] Finally, in the case of real GDP, for which results are not conclusive, estimations are carried out for both transformations to ensure the robustness of the econometric results.

[20]Accordingly, when the CD_{lm}statistics does not reject the null, the unit-root test that excludes cross-sectional averages was used.

[21]Panel unit-root tests (not reported) performed on the transformed variables reject the unit-root null in each case.

Table 4.2. Cross-sectional dependence and panel unit-root tests

Variable	Constant[1]	Constant plus trend[2]	CD_{lm} [3]	*Z* statistics[4]
Real GDP	X		121.5***	1.5
		X	115.9***	-5.9***
Fiscal balance	X		42.6**	-2.5**
		X	45.3**	-4.1***
Financial development	X		27.4	-6.4***
		X	29.8	-7.1***
Real private lending	X		63.8***	-3.7***
		X	66.6***	-6.4***
Banking spread	X		34.1	-2.9***
		X	27.6	-5.8***
Real exchange rate	X		64.6***	-3.0**
		X	70.9***	-8.1***
Foreign bank presence	X		29.1	-1.3*
		X	29.0	-4.1***
Public bank presence	X		17.7	-2.9***
		X	21.6	-3.8***
Banking concentration	X		27.8	-1.5*
		X	30.2	-3.0***

1. Some variables contain a constant term. The remaining do not contain deterministics and are centered.

2. Some variables contain a constant term plus a trend. The remaining do not contain deterministics and are cantered.

3. Breusch and Pagan's test for the null hypothesis of zero cross-sectional dependence. (***), (**) and (*) denote, respectively, statistical significance at the 1%, 5% and 10%

4. Choi's panel unit-root test, with and without cross-sectional dependence according to the *CDlm* test result. The null is rejected at a significance level alpha when $Z<c_{z,alpha}$, where $c_{z,alpha}$ is the lower tail of the standard normal distribution or the simulated critical value, for the cases without and with cross-sectional dependence, respectively. The optimal number of lags included in each cross-sectional ADF equation was determined using the Schwarz Information Criterion (SIC).

4.5. Estimation results

4.5.1. The econometric methodology

This section presents the steps followed to estimate the model, selecting among a set of variables those significant at conventional statistical levels, while a more detailed analysis of the role played by interaction terms in the mean equation is presented in the annex, following a particular-to-general strategy.[22] To choose the

[22]Results presented in the annex are also used as a guide to choose the most general model estimated in this section.

final specification for the model, we preliminarily identify the presence of fixed effects in the mean and variance equation, we test for poolability of the data (*i.e.*, that coefficients in the mean equation are the same across countries), and we identify the presence of ARCH effects in the conditional covariance equation.

Indeed, we begin by estimating the mean equation by OLS and testing for the presence of fixed effects using a Chow test, assuming that the data are poolable. In particular, we test for the null hypothesis that all the individual fixed dummy variables included in equation (4.1) are zero: $H_0 : \mu_1 = \mu_2 = \cdots = \mu_{N-1} = 0$. The Chow test is just an F test for the joint significance of these dummies and is computed as:

$$F_0 = \frac{(RRSS - URSS)/(N-1)}{URSS/(NT-N-K)} \sim F_{N-1,N(T-1)-K}$$

where N and T are the cross and time series dimensions respectively, K is the number of coefficients, excluding the dummy variables and the constant, $RRSS$ is the residual sum of squares of the restricted model (*i.e.*, the pooled OLS), and $URSS$ is the residual sum of squares of the unrestricted model (*i.e.*, the OLS model that includes the fixed effects dummy variables).

Once we have decided on the inclusion of fixed effects dummy variables, we proceeded to test for poolability of the data in the estimated equation. Again, this is performed using a Chow test to check the null hypothesis that all the coefficients are equal among the cross-sectional units. The statistic is defined as:

$$F_0 = \frac{(RRSS - URSS)/(N-1)K'}{URSS/N(T-K')} \sim F_{(N-1)K',N(T-K')}$$

where$K' = K+1$. The $RRSS$ is given by the OLS estimation performed on the pooled model (*i.e.*, assuming homogenous coefficients), whereas the unrestricted residual sum of squares ($URSS$) is the sum of the residual squares performed on each separate country-specific OLS regression (*i.e.*, assuming a different coefficient for each country equation).

The next step consisted in using the residuals of the previously estimated mean equation to test for the presence of fixed effects in the conditional variance. In particular, we ran a regression of the form:

$$u_{it}^2 = \beta_0 + \mu_i + \sum_{j=1}^{p} \alpha_j u_{it-j}^2$$

and tested for the joint significance of μ_i using the same Chow test as before, for a given value, p. Once we have decided on the inclusion of fixed effects in the conditional variance, we proceeded to test for the presence of ARCH effects (*i.e.*, the significance of α_j's). The null hypothesis is then that no ARCH effects are present in the model.

Once the model's specification has been determined, equations (4.1)-(4.4) were estimated jointly using maximum likelihood techniques, including different sets of explanatory variables in the variance equation. To avoid potential endogeneity problems, lagged domestic variables are introduced in both the mean and variance equations. Indeed, we measure the impact of previous values of the variables on subsequent credit behaviour. The exceptions are the currency and banking crises dummies and the foreign variables (US GDP and the Federal Funds Rate), which are included in contemporaneous form.

4.5.2. The determinants of credit behaviour: the mean equation

Model (1) in Table 4.3 presents the results for the most general estimation performed on the mean equation, while Model (2) excludes the insignificant variables at conventional statistical levels.[23] In both estimations, the null hypothesis of absence of fixed effects in the mean equation is not rejected, suggesting that fixed effects are not present in the data. The same results hold true for the null of poolability, suggesting that coefficients are significantly equal across countries, justifying the standard homogeneity assumption. Models (3) to (10) present the same estimation as Model (2), the only difference being the inclusion of explanatory variables in the variance equation (Table 4.4).

As reported in that table, tests of fixed effects in the conditional variance allow for rejecting the null hypothesis for Models (1) and (2). This is due to the dummy for Mexico which is highly significant, while the rest are not statistically different from zero. Absence of ARCH effects of order one is rejected at the 10% level, while absence of ARCH(4) effects is rejected even at the 1% level in Model (2). To keep the specifications as parsimonious as possible, all the models are estimated including only an ARCH(1) effect in the conditional variance equation, while testing whether higher order ARCH effects are present in the residuals.[24]

The results for the mean equation show that the autoregressive coefficient is highly significant, suggesting considerable persistence in the dependent variable.[25] Persistence in credit behaviour has also been found by Detragiache *et al.* (2006) for a panel of 89 low-income and lower middle-income countries over the second half of the 1990s. Our estimations also point to a high degree of lending procyclicality,

[23]Giving that macro variables are very likely to be correlated, thus reducing individual significance, a larger 10% level was used as a threshold instead of the traditional 5%.

[24]Including a dummy for Mexico in this equation makes the algorithm not converge. The dummy was then not included in the estimations.

[25]Model (2) was re-estimated adding an autoregressive component up to the order four, given that quarterly data is being used in the econometric analysis. Results (not reported) show that only the first autoregressive coefficient is statistically significant.

a result that has also been found by Barajas and Steiner (2002) and Arena *et al.* (2007) for Latin American countries.[26] Results presented in Annex 1 also suggest that foreign banks do not contribute to amplify credit cycles in the region, given that the interaction between domestic GDP and foreign banks is not significant. This finding is consistent with Micco and Panizza (2006).

Push factors, like the US GDP and the Federal Funds Rate, though signed correctly, are insignificant at standard statistical levels. This indicates that mainly pull factors play a role in shaping credit behaviour in the second half of the 1990s in our sample of Latin American countries.[27] Interaction terms between these variables and foreign banks are neither significant (see Annex 1). As with the push variables, the fiscal balance, the interest rate spread, the presence of foreign and public banks, and the degree of concentration in the banking sector are not significant at conventional statistical levels.

As hypothesised, the lagged degree of financial development is highly significant, pointing to the fact that deeper financial systems (proxying for a lower degree of financial imperfections) help to foster real private credit in subsequent periods. As expected, the real exchange rate is also significant, showing that depreciations reduce credit, because it makes the repayment of loans in foreign currency more expensive. This finding is similar to that of Arena *et al.* (2007) for the same region.

Both banking and currency crises are expected to have a negative effect on credit behaviour. During banking crises generally involving bank runs, deposits are depleted putting a burden on the granting of loans. Currency crises may trigger balance sheet effects, leading the banking sector to experience bankruptcy problems. As mentioned before, they also tend to be associated with general losses of confidence in the system and a retrenching of deposits. Only the currency crisis

[26] Similar results are found when the domestic GDP growth is used instead of the HP-filtered series.

[27] Since Spanish-owned banks account for almost half of total foreign bank lending in the region, the American GDP was replaced by the Spanish GDP, but results remained unchanged.

dummy was found to have the expected negative sign while banking crises do not have a statistically distinguishable effect on credit behaviour.[28] This might be due to the fact that banking crises tend to coincide with deterioration in economic fundamentals, making their impact indistinguishable from other cyclical downturns. Regarding interaction terms, foreign banks do not seem to behave differently from national institutions, both in banking and currency crises (see Annex 1). Nevertheless, government-owned banks do seem to play a stabilising role on credit during banking crises. A similar result reported by Micco and Panizza (2006) states that public-owned banks may play a useful credit-smoothing role, because their lending is less responsive to macroeconomic shocks than the lending of private banks.

4.5.3. The impact of foreign banks on credit volatility

The estimation of the variance equation is presented in Table 4.4, where different sets of explanatory variables are included in the analysis. This is one of the main differences from previous work on the issue of disentangling the impact of foreign banks and financial development on macroeconomic (and credit) volatility, since we modelled together the first and second conditional moments of the data, instead of using two-step estimators which are known to be inefficient.

Indeed, in Models (1) and (2) of Table 4.4, the variance equation only includes an ARCH(1) process, which is significant at the 10% level. Model (3) also includes a dummy variable for banking crises, which is highly significant. Also, while periods of banking crises do not seem to have a statistically significant effect on the level of credit, they do increase the volatility of credit to the private sector. Next, we test for a differential behaviour of foreign and state-owned banks during periods of financial stress, by including, in turn, interaction terms between the dummies

[28] Note that the banking crisis dummy variable was not included in the general estimation performed in Table 3, since it was found not to be significant in spite of having an expected negative sign in the exercise reported in the annex.

for banking crises, and foreign and public bank presence. If either one or the other exacerbates credit volatility, the coefficient should be positive and statistically significant at conventional levels. In the present case, there does not seem to be such a difference in behaviour. In the case of state-owned banks, the conclusion seems to support the idea that they have a stabilising effect during periods of stress, but only on the level of credit (*i.e.*, the first moment of the data). While banking crises increase credit volatility, this does not seem to be true for currency crises, as shown by Model (6).

As mentioned above, the literature on the internationalisation of the banking sector and the implications for banking and macroeconomic stability showed that there is no definite answer to the question of whether or not foreign banks raise or reduce credit volatility. To test for the impact of foreign banks on macroeconomic volatility empirical studies have included an aggregate measure for the presence of foreign banks in the econometric estimations. If stabilising effects predominate, then the coefficient should be negatively signed and statistically significant at conventional levels. The opposite is of course true when foreign banks increase credit volatility. As gauged by the empirical evidence presented under Model (7) in Table 4.4, foreign banks do seem to have contributed to reducing real credit volatility in our sample of Latin American countries over the period 1995-2001. The coefficient for foreign banks is negative and statistically significant at the 5% level, which is consistent with Dages *et al.* (2000) for Argentina and Mexico, who find that foreign banks exhibit lower volatility of lending than their domestically-owned counterparts, contributing to lower overall credit volatility.

Of course, it can be argued that the presence of foreign banks could just be capturing the degree of development of the financial sector, or a more concentrated banking system. Foreign direct investment may help develop the banking sector because they tend to introduce better risk management practices and information technologies, improving the efficiency and diversification of the banking system

(Goldberg, 2007). They also tend to exhibit higher average loan growth rates and greater loss-absorption capacity, because of easier access to international capital markets and parent bank's resources (Crystal *et al.*, 2002). As mentioned before, a deeper financial sector is expected to lead to a more stable macroeconomy. Also, foreign bank entry often consists in buying and merging local banks, which may result in more concentrated banking systems. Evidence reported under Model (8) shows that deeper banking systems indeed result in lower credit volatility, a finding coherent with Denizer *et al.* (2002) for other macroeconomic variables, like GDP, consumption and investment.[29] Including concentration among the explanatory variables in the conditional variance does not modify the previous findings, both in terms of signs and statistical significance, but shows that concentration has no role to play in shaping credit volatility patterns. This result is in line with Morgan and Strahan (2003), who found that banking concentration did not affect GDP and investment growth volatility in a sample of Latin American countries over the period 1990-97.

In a last specification, state-owned banks were included in the regression, but was not found to be significant. Indeed, the final specification retained for the conditional variance equation is Model (8), in which banking crises increase real credit volatility, while foreign bank entry and banking development reduce such volatility.[30] The diagnostic tests performed on this and the other models show that we can be confident about the specification of the econometric equations. We cannot reject the null hypothesis that the standardised residuals are normal, as stated by equation (4.4). Also, we test for the correct specification of the

[29]Note that, due to the positive correlation between foreign bank presence and banking sector development, the coefficient for foreign bank penetration is slightly reduced in absolute terms, while remaining significant at conventional statistical levels.

[30]To rule out the possibility of reverse causality between foreign bank presence and credit volatility, the conditional variance estimated using Model (2) was included as a regressor in an equation having foreign bank presence as the dependent variable. Credit volatility proved not to be significant at conventional statistical levels.

mean and variance equations by testing for the presence of autocorrelation and conditional heteroscedasticity in the standardised residuals. Actually, we never reject the hypothesis of absence of low and high orders of ARCH effects, and while autocorrelation of order four seems to be present in Models (1) to (7), it disappears once financial development is included among the regressors of the conditional variance equation.

Table 4.3. The determinants of credit dynamics –period: 1995:1 -2001:4 (Dependent variable: HP-adjusted real credit to the private sector)[1]

Mean equation	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
AR(1)	**0.26**	**0.47*** **	**0.49*** **	**0.36** **	**0.49*** **	**0.48*** **	**0.45*** **	**0.47*** **	**0.46*** **	**0.47*** **
	[1.30]	[3.47]	[4.02]	[2.43]	[4.07]	[3.98]	[3.62]	[3.72]	[3.70]	[3.74]
Real GDP (t-1)	**0.88*** **	**0.68*** **	**0.74*** **	**0.79*** **	**0.72*** **	**0.70*** **	**0.84*** **	**0.77*** **	**0.77*** **	**0.77*** **
	[3.56]	[3.11]	[3.28]	[3.81]	[3.21]	[3.15]	[3.96]	[3.81]	[3.85]	[3.78]
US GDP (t)	**0.37**									
	[0.53]									
Fed. Rate (t)	**-1.44**									
	[-1.64]									
Fiscal balance (t-1)	**0.80**									
	[0.75]									
Spread (t-1)	**-2.63**									
	[-0.99]									
Financial dev. (t-1)	**1.28** **	**1.17** **	**0.83* **	**1.24** **	**0.84** **	**0.89** **	**1.13** **	**1.30*** **	**1.30*** **	**1.30*** **
	[2.06]	[2.36]	[1.89]	[2.67]	[1.94]	[2.05]	[2.67]	[3.55]	[3.62]	[3.55]
RER (t-1)[2]	**-0.25** **	**-0.20** **	**-0.19** **	**-0.20** **	**-0.18** **	**-0.20** **	**-0.19** **	**-0.20** **	**-0.20** **	**-0.20** **
	[-2.44]	[-2.10]	[-2.40]	[-2.76]	[-2.39]	[-2.63]	[-2.12]	[-2.30]	[-2.38]	[-2.29]
Public banks (t-1)	**-0.39**									
	[-1.22]									
Foreign banks (t-1)	**0.23**									
	[0.65]									
Banking conc. (t-1)	**0.55**									
	[1.61]									
BC*PB (t)[3]	**1.70*** **	**1.18** **	**1.17* **	**1.70** **	**1.18* **	**1.21* **	**1.54* **	**1.51** **	**1.53** **	**1.49** **
	[3.56]	[2.72]	[1.79]	[2.64]	[1.70]	[1.86]	[1.99]	[2.11]	[2.19]	[2.10]
Currency crisis (t)	**-5.45* **	**-4.59** **	**-4.99**	**-5.16**	**-4.95**	**-5.22*** **	**-5.47* **	**-5.71** **	**-5.59** **	**-5.76** **
	[-1.76]	[-2.03]	[-1.61]	[-1.63]	[-1.60]	[-4.15]	[-1.92]	[-2.18]	[-2.15]	[-2.17]
Chow test for absence of FE in mean equation[4]										
F test	**1.68**	**1.56**								
(p-value)	*0.15*	*0.18*								
Chow test for poolability of the data[5]										
F test	**1.62**	**2.64**								
(p-value)	*0.95*	*0.99*								

1. Robust *t-statistics* are reported between brackets. (*), (**) and (***) denote statistical significance at the 10%, 5% and 1% levels, respectively.
2. RER = real exchange rate.
3. BC = banking crisis; PB = public banks.
4. The null hypothesis is absence of fixed effects in a mean equation estimated by OLS.
5. The null hypothesis is that the data are poolable in a mean equation estimated by OLS.

Table 4.4 The determinants of credit dynamics –period: 1995:1 -2001:4
(Dependent variable: credit volatility)[1]

Variance equation	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	**9.64*** **	**10.89*** **	**2.01*** **	**2.07*** **	**2.01*** **	**2.03*** **	**2.03*** **	**2.06*** **	**2.08*** **	**2.06*** **
	[5.72]	[6.59]	[12.07]	[12.03]	[12.04]	[12.01]	[11.01]	[12.08]	[11.55]	[11.80]
ARCH(1)	**0.28***	**0.21***	**0.14**	**0.10**	**0.15**	**0.14**	**0.13**	**0.04**	**0.03**	**0.04**
	[1.87]	[1.71]	[1.08]	[0.84]	[1.11]	[1.07]	[1.22]	[0.75]	[0.52]	[0.68]
BC (t)			**1.18*** **	**1.07*** **	**1.17*** **	**1.17*** **	**1.22*** **	**1.06*** **	**1.02****	**1.06*** **
			[3.26]	[2.88]	[3.14]	[3.19]	[3.03]	[2.86]	[2.72]	[2.85]
BC*FB (t)[2]				**-0.33**						
				[-1.40]						
BC*Public banks (t)					**0.07**					
					[0.32]					
Currency crisis (t)						**-2.91**				
						[-0.45]				
Foreign banks (t-1)							**-0.24****	**-0.20****	**-0.20****	**-0.19****
							[-2.49]	[-2.22]	[-2.14]	[-2.10]
Financial dev. (t-1)								**-0.26****	**-0.25****	**-0.26****
								[-2.07]	[-2.05]	[-2.08]
Banking conc. (t-1)									**-0.03**	
									[-0.34]	
Public banks (t-1)										**0.02**
										[0.20]
Chow test for absence of FE in conditional variance equation [3]										
F test	**2.47**	**3.51**								
(p-value)	*0.04*	*0.01*								
F test for ARCH(1) effects in conditional variance [4]										
F test	**13.25**	**2.76**								
(p-value)	*0.00*	*0.099*								
F test for ARCH(4) effects in conditional variance [4]										
F test	**10.21**	**6.33**								
(p-value)	*0.00*	*0.00*								
Diagnostics										
Log-likelihood	-338.5	-363.2	-356.3	-355.2	-356.2	-354.3	-353.3	-349.4	-349.3	-349.4
Normality test (KS)										
(*p-value*)[5]	0.72	0.50	0.89	1.00	0.88	0.98	0.93	0.98	0.98	0.97
BG(1) *(p-value)* [6]	0.84	0.59	0.47	0.70	0.53	0.45	0.70	0.14	0.18	0.15
BG(4) *(p-value)*	0.00	0.02	0.07	0.06	0.06	0.08	0.01	0.15	0.16	0.16
ARCH(1) *(p-value)* [7]	0.29	0.51	0.54	0.45	0.53	0.45	0.70	1.00	0.98	0.98
ARCH(4) *(p-value)*	0.61	0.82	0.98	0.95	0.97	0.93	0.97	0.97	0.96	0.97

1. Robust *t-statistics* are reported between brackets. (*), (**) and (***) denote statistical significance at the 10%, 5% and 1% levels, respectively.
2. BC = banking crisis; FB = foreign banks.
3. The null hypothesis is absence of fixed effects in the variance equation. The model considered is an ARCH(1).
4. The null hypothesis is the absence of ARCH effects.
5. Kolmogorov-Smirnov normality test computed on the standardised residuals.
6. Breusch-Godfrey test for serial correlation computed on the standardised residuals.
7. Autoregressive conditional heteroscedasticity test computed on the standardised residuals.

4.6. Conclusion

Foreign bank entry into developing countries has risen sharply since the 1990s, favoured by the liberalisation of external sectors and the embracement of a series of market-friendly policy reforms, including deregulation and privatisation of the banking sector. One region that has attracted considerable foreign direct investment into the banking industry has been Latin America. This unprecedented internationalisation of the region's banking sector has motivated a debate on the potential consequences for the recipient countries in terms of efficiency and diversification of the banking sector, the quality of the regulatory environment and competition and access to banking services by small and medium-sized enterprises.

Against this background, the present paper has investigated the impact of foreign banks on real credit creation and volatility in a panel of eight Latin American countries, using quarterly data over the period 1995:1-2001:4. We have tried to disentangle the effects of a rising presence of foreign banks on credit volatility by using ARCH techniques to model jointly the first and second conditional moments of real domestic credit. To do so, the conditional volatility equation is extended to include the degree of development of the banking sector and the internationalisation of the banking system, among other regressors. To the knowledge of the author, this is the first time that such tools have been used to analyse the impact of foreign bank presence on macroeconomic volatility.

The theoretical literature examining the link between foreign direct investment in the banking sector and macroeconomic stability is rather limited and does not provide a clear answer to this issue. The overall impact of banking integration on volatility is then an empirical question. Potential explanations of why foreign banks may contribute to credit stability are the following. Foreign banks are typically well-diversified institutions with access to a broader set of liquidity sources than domestic banks. They may also contribute to a faster recapitalisation of local banks after a crisis, and they may have superior risk management systems and better credit quality screening devices, thus improving the quality of their assets. Finally, they have the potential to prevent capital flight in the case of domestic shocks, since people may prefer to redirect deposits towards foreign-owned institutions, instead of withdrawing the money out of the system altogether. This contributes to higher funding and lending stability.

The main findings of the paper regarding credit volatility are as follows. First, banking crises increase real credit volatility. Public and foreign banks do not have a discernible effect (positive or negative) during these stressful periods. Second, the evidence reported in this chapter shows that deeper banking systems result in lower credit volatility, a result consistent with the findings of Denizer *et al.* (2002) for volatility in other macroeconomic variables. Finally, stabilising effects predominate in such a way that the presence of foreign banks reduced credit volatility in our panel of eight Latin American countries over the period 1995:1-2001:4.

Appendix 4

Appendix 4.A: Assesing the impact of interaction terms on credit dynamics

This Annex presents a particular-to-general econometric analysis that evaluates the importance of interaction terms in shaping the dynamics of the level of real credit (mean equation). Variables are introduced one by one in the mean equation and kept in the next round of estimations only when they are significant in the previous step. This allows us to keep the model as parsimonious as possible, which is of paramount importance in guaranteeing convergence of the estimating algorithm.

Estimation results are presented in Table A.1 and Table A.2. The most parsimonious model estimated includes only an autoregressive term, which proves to be highly significant (Model 1). The next model includes domestic GDP to capture procyclicality in credit behaviour. This variable also proves to be highly significant and positively signed across all the estimated models. In Model (3) we test for the impact that the presence of foreign banks may have on amplifying or reducing procyclicality in lending behaviour. If the hypothesis that international banking institutions exacerbate procyclicality is not rejected, then an interaction term between domestic GDP and the presence of foreign banks should be positively signed and statistically significant at conventional levels. Empirical evidence presented in Table A.1 shows that foreign banks cannot be blamed for having amplified credit cycles in the region, a finding that is in line with that of Micco and Panizza (2006) and Arena *et al.* (2007).

In Models (4) to (7) we include external or push factors that may have an effect on domestic lending patterns. In particular, we include the US GDP and the Federal Funds Rate, as well as their interactions with foreign banks, to test the hypothesis that these institutions amplify foreign shocks. It is found that, while US GDP has a positive impact on credit, neither the Federal Funds Rate nor the interaction terms are statistically significant. The finding of a positive coefficient for US GDP is consistent with Goldberg (2002), who observes that US bank lending to Latin American countries increase as the US economy grows. It should be noted, however, that while the US GDP is kept in the estimations because it is significant in this round, it loses its explanatory power in subsequent models.

Next we include the fiscal balance, the spread between the lending and deposit rates, the degree of financial development, and the bilateral real exchange rate with the US (Models 8 to 11). From this set of variables, only the last two appear to be significant and were consequently kept in subsequent estimations. In Models (12) to (14) of Table A.2 we added banking variables to the econometric regressions: public and foreign bank presence, and the concentration of the banking system. None of these proved to be significant. Empirical evidence to date is inconclusive as regards the impact of foreign banks on credit dynamism (Detragiache *et al.*, 2006). The next six models (15 to 20) include banking and currency crises and their interactions with foreign and state-owned banks, but only the latter is positive and statistically significant, meaning that state-owned banks help stabilise credit levels during periods of banking crisis. Including a currency crisis dummy among the regressors gives a negative and statistically significant coefficient, while foreign and state-owned banks do not seem to exacerbate or buffer the impact of such events on credit behaviour.

Table A.1. The determinants of credit dynamics (1995:1-2001:4)

(Dependent variable: HP-adjusted real credit to the private sector)[1]

Mean equation	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
AR(1)	**0.80*** **	**0.74*** **	**0.75*** **	**0.76*** **	**0.76*** **	**0.74*** **	**0.74*** **	**0.75*** **	**0.74*** **	**0.59*** **
	[23.94]	[18.14]	[17.89]	[18.36]	[18.66]	[18.10]	[18.00]	[18.56]	[17.39]	[7.39]
Real GDP (t-1)		**0.55*** **	**0.55*** **	**0.47*** **	**0.43*** **	**0.48*** **	**0.48*** **	**0.49*** **	**0.48*** **	**0.58*** **
		[3.71]	[3.62]	[3.36]	[3.08]	[3.16]	[3.21]	[3.33]	[3.07]	[3.93]
GDP*FB (t-1)			**0.02**							
			[0.57]							
US GDP (t)				**0.81***	**0.86***	**0.80***	**0.85***	**0.80***	**0.77***	**1.09** **
				[1.80]	[1.90]	[1.75]	[1.89]	[1.76]	[1.66]	[2.42]
US GDP*FB (t)					**0.05**					
					[0.48]					
Fed Rate (t)						**0.34**	**0.40**			
						[0.47]	[0.54]			
Fed Rate*FB (t)							**-0.07**			
							[-0.37]			
Fiscal bal. (t-1)								**-0.39**		
								[-0.73]		
Spread (t-1)									**0.32**	
									[0.20]	
Fin. dev. (t-1)										**1.16*** **
										[3.27]
Variance equation										
Constant	**8.78*** **	**11.47*** **	**11.46*** **	**10.56*** **	**10.22*** **	**10.61*** **	**10.46*** **	**10.64*** **	**10.97*** **	**10.41*** **
	[8.52]	[10.11]	[10.03]	[9.89]	[9.44]	[9.88]	[9.73]	[9.84]	[9.61]	[9.86]
ARCH(1)	**1.10*** **	**0.29*** **	**0.29*** **	**0.37*** **	**0.41*** **	**0.36*** **	**0.38*** **	**0.37*** **	**0.36*** **	**0.30*** **
	[7.62]	[2.65]	[2.65]	[2.82]	[2.84]	[2.79]	[2.83]	[2.77]	[2.74]	[2.61]
Chow test for absence of FE in mean equation[2]										
F test	**0.40**	**0.46**	**0.43**	**0.44**	**0.43**	**0.44**	**0.51**	**0.36**	**0.60**	**0.34**
(p-value)	*0.90*	*0.86*	*0.88*	*0.87*	*0.88*	*0.88*	*0.82*	*0.92*	*0.75*	*0.93*
Chow test for poolability of the data[3]										
F test	**1.63**	**1.58**	**1.36**	**1.26**	**1.12**	**1.15**	**1.00**	**1.15**	**1.40**	**1.17**
(p-value)	*0.93*	*0.94*	*0.88*	*0.81*	*0.69*	*0.73*	*0.51*	*0.72*	*0.92*	*0.75*
Chow test for absence of FE in conditional variance equation[4]										
F test	**3.36**	**2.88**	**2.86**	**2.96**	**2.96**	**2.98**	**2.98**	**3.73**	**2.69**	**3.06**
(p-value)	*0.00*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.00*	*0.01*	*0.00*
F test for ARCH(1) effects in conditional variance[5]										
F test	**3.13**	**4.85**	**5.49**	**8.45**	**8.54**	**9.57**	**8.62**	**0.97**	**11.70**	**7.05**
(p-value)	*0.08*	*0.03*	*0.02*	*0.00*	*0.00*	*0.00*	*0.00*	*0.33*	*0.00*	*0.01*
Diagnostics										
Log-likelihood	-648.7	-586.5	-586.5	-584.3	-584.1	-584.2	-584.0	-557.3	-565.4	-569.0
Normality test[6]	0.07	0.20	0.25	0.40	0.34	0.36	0.38	0.31	0.43	0.28
BG(1) *(p-value)*[7]	0.17	0.40	0.42	0.34	0.29	0.35	0.33	0.37	0.33	0.43
BG(4) *(p-value)*	0.33	0.19	0.19	0.18	0.18	0.19	0.20	0.25	0.16	0.08
ARCH(1) *(p-value)*[8]	0.25	0.15	0.15	0.13	0.16	0.12	0.14	0.12	0.17	0.88
ARCH(4) *(p-value)*	0.61	0.28	0.27	0.22	0.26	0.24	0.24	0.22	0.27	0.25

1. Robust *t-statistics* are reported between brackets. (*), (**) and (***) denote statistical significance at the 10%, 5% and 1% levels, respectively.
2. The null hypothesis is absence of fixed effects in a mean equation estimated by OLS.
3. The null hypothesis is that the data are poolable in a mean equation estimated by OLS.
4. The null hypothesis is absence of fixed effects in the variance equation. The model considered is an ARCH(1).
5. The null hypothesis is the absence of ARCH effects.
6. Kolmogorov-Smirnov normality test computed on the standardised residuals.
7. Breusch-Godfrey test for serial correlation computed on the standardised residuals.
8. Autoregressive conditional heteroscedasticity test computed on the standardised residuals.

Table A.2. The determinants of credit dynamics (1995:1-2001:4)

(Dependent variable: HP-adjusted real credit to the private sector)

Mean equation	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
AR (1)	**0.45*** **	**0.46*** **	**0.45*** **	**0.43*** **	**0.49*** **	**0.52*** **	**0.49*** **	**0.50*** **	**0.50*** **	**0.51*** **
	[4.63]	[3.59]	[4.63]	[4.23]	[5.15]	[5.44]	[4.02]	[4.07]	[4.18]	[4.31]
Real GDP (t-1)	**0.70*** **	**0.71*** **	**0.71*** **	**0.70*** **	**0.62*** **	**0.58*** **	**0.69*** **	**0.65*** **	**0.64*** **	**0.65*** **
	[4.85]	[3.90]	[4.91]	[4.87]	[4.07]	[3.80]	[3.28]	[3.13]	[3.11]	[3.19]
US GDP (t)	**0.97*** **	**0.67**	**0.98*** **	**0.97*** **	**1.04*** **	**1.02**	**0.78**	**0.69**	**0.68**	**0.76**
	[2.06]	[1.04]	[2.06]	[2.03]	[2.22]	[2.18]	[1.31]	[1.21]	[1.20]	[1.33]
Fin. dev. (t-1)	**1.52*** **	**1.03*** **	**1.54*** **	**1.60*** **	**1.52*** **	**1.42*** **	**1.05*** **	**1.16*** **	**1.15*** **	**1.10*** **
	[4.32]	[2.51]	[4.47]	[4.83]	[4.33]	[3.72]	[2.59]	[2.56]	[2.59]	[2.46]
RER (t-1)	**-0.22*** **	**-0.16** **	**-0.22*** **	**-0.23*** **	**-0.20*** **	**-0.20*** **	**-0.08**	**-0.18* **	**-0.19* **	**-0.16**
	[-3.33]	[-1.94]	[-3.35]	[-3.51]	[-2.87]	[-2.71]	[-0.93]	[-1.78]	[-1.81]	[-1.54]
PB (t-1)		**-0.28**								
		[-1.07]								
FB (t-1)			**-0.05**							
			[-0.40]							
Banking conc. (t-1)				**-0.18**						
				[-1.32]						
BC (t)					**-0.62**	**-0.51**	**-1.23**			
					[-0.72]	[-0.57]	[-1.10]			
BC*FB (t)						**0.26**				
						[0.58]				
BC*PB (t)							**1.21*** **	**1.14*** **	**1.13*** **	**1.13*** **
							[2.89]	[2.62]	[2.59]	[2.61]
Currency crisis (t)								**-4.36** **	**-4.49**	**-3.80* **
								[-2.05]	[-0.85]	[-1.88]
CC*FB (t)									**0.18**	
									[0.10]	
CC*PB (t)										**0.52**
										[0.43]
Variance equation										
Constant	**10.36*** **	**11.51*** **	**10.33*** **	**10.44*** **	**10.28*** **	**10.18*** **	**10.85*** **	**10.67*** **	**10.61*** **	**10.48*** **
	[9.63]	[7.21]	[9.59]	[9.62]	[9.43]	[9.39]	[5.74]	[6.21]	[6.16]	[6.05]
ARCH(1)	**0.25*** **	**0.28** **	**0.25*** **	**0.24*** **	**0.26*** **	**0.27*** **	**0.23**	**0.22* **	**0.22* **	**0.23* **
	[2.55]	[2.03]	[2.55]	[2.46]	[2.54]	[2.56]	[1.52]	[1.75]	[1.77]	[1.76]
Chow test for absence of FE in mean equation										
F test	**0.34**	**0.76**	**0.34**	**0.33**	**0.47**	**0.52**	**1.41**	**1.60**	**1.55**	**1.61**
(p-value)	*0.94*	*0.58*	*0.93*	*0.94*	*0.86*	*0.82*	*0.23*	*0.16*	*0.18*	*0.16*
Chow test for poolability of the data										
F test	**1.44**	**1.43**	**1.55**	**1.23**	**2.15**	**2.62**	**46.63**	**2.33**	**1.92**	**1.92**
(p-value)	*0.94*	*0.91*	*0.98*	*0.83*	*1.00*	*1.00*	*1.00*	*1.00*	*0.99*	*0.99*
Chow test for absence of FE in conditional variance equation										
F test	**2.92**	**6.59**	**2.87**	**2.91**	**3.12**	**2.80**	**3.46**	**3.65**	**3.62**	**3.65**
(p-value)	*0.01*	*0.00*	*0.01*	*0.01*	*0.00*	*0.01*	*0.01*	*0.00*	*0.00*	*0.00*
F test for ARCH effects in conditional variance										
F test	**12.73**	**8.90**	**11.88**	**17.63**	**0.11**	**0.51**	**0.00**	**3.24**	**3.23**	**3.25**
(p-value)	*0.00*	*0.00*	*0.00*	*0.00*	*0.74*	*0.48*	*0.95*	*0.07*	*0.07*	*0.07*
Diagnostics										
Log-likelihood	-564.4	-384.6	-564.2	-564.0	-542.8	-543.63	-364.4	-362.5	-362.4	-362.1
Normality test	0.32	0.52	0.35	0.41	0.31	0.39	0.72	0.51	0.54	0.62
BG(1) *(p-value)*	0.43	0.71	0.43	0.46	0.47	0.46	0.54	0.63	0.60	0.62
BG(4) *(p-value)*	0.02	0.84	0.02	0.01	0.00	0.01	0.24	0.03	0.04	0.05
ARCH(1) *(p-value)*	0.72	0.27	0.69	0.61	0.84	0.85	0.74	0.51	0.50	0.49
ARCH(4) *(p-value)*	0.42	0.49	0.44	0.47	0.33	0.30	0.83	0.78	0.76	0.86

General Conclusion

In emerging market economies, monetary economy and the banking sector as a whole remain difficult to track given the vulnerability of the countries involved and the volatility of the scenario. International evidence on sovereign debt crises shows that the years preceding a crisis are generally characterized by widening fiscal deficits, and easy access to market financing that delays the implementation of fiscal reforms. Such circumstances lead to a rise of borrowing costs that soon prove to be inconsistent with a country's servicing ability (as well as willingness) to pay. In addition, the combination of a weak economy and poor public finances gives rise to a circular policy dilemma, as high interest rates are necessary to finance budget deficits, but further dampen economic activity and lead to a weaker budgetary performance. In this context, the specification of the central bank's monetary policy plays a highly relevant role over the following key variables: nominal interest rate, price level, sovereign risk premium, probability of default and recovery value. Without timely recourse to fiscal rectitude, a debt crisis inevitably ensues and the government is forced to default or inflate the debt away, both of which entail larger banking instability and economic costs. Such scenario would potentially involve a compulsorily rollover of government bonds -in general, short-dated securities into longer-dated paper - at lower yields. Naturally, with banks' asset bases reflecting high concentrations in government securities, this possibility introduces considerable pricing risk to the banking system. Given these factors, the banking sector in Latin American countries has faced very challenging periods, linking to the need of re-capitalization of their balance sheets.

The challenges that remain are substantial. However, as result of this thesis, the discussion has been limited to the most relevant developments and concerns - at least in my point of view. Therefore, I conclude with a few comments on some of the broader policy questions that central bank policymakers have faced in designing and implementing reforms.

This research stresses the benefits of prudent fiscal policy as well as the role of the monetary policy. Emerging economies will suffer less constraint if there is thorough cooperation between fiscal authorities (i.e., treasurers) and monetary authorities (i.e., central bankers). The model applied on Chapter 1 can be used to estimate both the recovery rate and the probability of default arising from other scenarios of financial distress in emerging countries. However, the model described on Chapter 2 is sufficiently tractable and thus more results can be obtained by modifying certain aspects of the baseline specification. I hope that this model suggests other approaches to the same problem.

As regards the role of foreign bank entry, Part 2 of this thesis has shown the exponential increase of foreign bank presence in Latin American countries. Besides, this research has also shown that the banking system in Latin America and the Caribbean is characterized by high credit volatility when it is compared with other regions around the world. Consequently, this trend has presented both opportunities in terms of modernization of the region's banking system and challenges in terms of possible additional volatility and less access to credit for small firms. The empirical findings presented on Chapter 4 seem to show that the benefits of foreign bank entry greatly outweigh its potential costs. Foreign banks have access to a broader set of liquidity sources than domestic banks, and consequently they may contribute to a faster recapitalization of local banks after a crisis. Moreover, they also have the potential to prevent capital flight in the case of domestic shocks, thus contributing to higher funding and lending stability.

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