

**Three Essays on the Credit Dimension of Monetary
Policy**

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ABSTRACT

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This thesis focus on the credit dimensions of monetary policy. The topic has been an area of active research since the financial crisis of 2008 and 2009. The chapters can be grouped in terms of the questions that motivated them. For the first and the second, it was "Why do Central Banks in emerging market economies intervene in credit markets in response to external shocks?", while for the third the question is more general "Why do Central Banks intervene in credit markets?".

In Chapter 1, we describe that, during the financial crisis of 2008-2009, to respond to a sudden stop in capital flows, many central banks in emerging market economies relied on credit policies. We build a quantitative small open economy model to study these credit policies. The main innovation of our setup is the presence of two imperfect credit markets, one domestic and the other international, and of two types of firms. The exporter is assumed to have access to both credit markets, while the wholesale firm can only borrow in the domestic market. During a sudden stop, exporters, faced with higher spreads for international credit lines, repay part of their foreign debt, tap the local

market for funds and cause spreads to increase in the domestic market. This increases financing costs for all firms, causes a deterioration of the balance of payments and depresses output. Calibrating the model to match Brazilian data, we assess the effects of two policies implemented by the Central Bank of Brazil: (i) lending to exporters using previously accumulated foreign-exchange reserves and (ii) expanding credit in order to reduce spreads in the domestic market. The model suggests that both policies probably raised GDP, but that the latter may well have decreased welfare. Moreover, had the central bank not been able to use foreign reserves as the source of funding, lending to exporters would also have reduced welfare.

In Chapter 2, we expand our focus to the fact that, during the crisis, the emerging markets economies faced a large decline in their terms of trade and an increase in the interest rate they could borrow from abroad. As their counterparts in developed economies, policymakers intervened in credit markets. A common ground behind the interventions seems to be failures in the banking system. We build a quantitative small open economy model with domestic financial intermediation to study these credit policies. The main innovation of our setup is the presence of a domestic banking system. In this structure, four main channels link external shocks to the financial sector: (1) the profitability of the export sector, (2) asset prices, (3) bank's borrowing cost and (4) the balance sheet position of banks as they hold foreign currency denominated debt. For the calibration we consider, based on Brazilian data, the domestic financial sector has the largest amplification effect in response to an increase in the international interest rate and the corresponding decline in assets price is the main channel. Hence credit interventions are most powerful in response to this type of a shock, reducing by 30

In Chapter 3, we first note that a number of recent theoretical papers show that margins can affect asset prices. Such results are important, for example, to understand the unconventional policies implemented by the Fed during the great recession of 2007-

2010. However, empirical evidence is still scarce. We contribute to fill this gap. We show that an aggregate margin-related factor is able to predict future excess returns of the SP 500 and that stocks with high exposures to the cost of buying on margin pay on average higher returns.

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To Felícia e Tiago

Chapter 1

The Credit Dimension of Monetary Policy: Lessons from Developing Economies under Sudden Stops

1.1 Introduction

The¹ financial crisis of 2007-2009 pushed monetary authorities far beyond the traditional management of interest rates. Central banks around the world felt the need to supplement their conventional policies with strategies designed to alleviate adverse

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conditions in credit markets. Emerging market economies, in particular, buffeted as they were by large reversals in foreign credit flows, engaged in a variety of specifically targeted credit policies (see Ishi, Stone, and Yehoue 2009). The case for these types of policies, however, remains contentious among practitioners. And there is even more controversy about the justification, in terms of economic theory, for the exceptional measures undertaken by so many central banks. Here, we aim to contribute to this debate by building a quantitative small open economy model to study the credit policies adopted by developing countries in response to sudden stops in capital inflows.

The main innovation of our model is the presence of two imperfect credit markets, one domestic and the other international. This allows us to capture an important financial market segmentation present in many emerging economies: while most firms can borrow domestically, only some types of firms have access to foreign credit. Moreover, shocks to the foreign supply of credit affect not only international spreads but domestic spreads as well, as firms that previously relied on credit from abroad are forced to tap the local market to a greater extent. The increase in both spreads raises financing costs for all borrowers in the economy and depresses output.

In this economic environment, we use our model to assess the implications of two common types of credit policies that were embraced across emerging market economies, during the crisis. The first was the liquidity provision to the export sector. The fact that in the data, as well as in our model, exporters are the main class of firms that have access to foreign borrowing is crucial in an analysis of this type of measure. The second policy adopted was an expansion of credit by central banks intended to lower domestic spreads across the board. This latter type of intervention was also common in advanced economies. What is special about emerging economies is that the policy was implemented in response to a major tightening in international credit conditions that generated a sudden stop in capital inflows. Acknowledging the link between the

external shock and conditions in the domestic credit market turns out to be essential for both policies.

In order to clarify this, we posit an economy populated by households, a financial sector and four types of firms: wholesale, trading companies, retail and capital producing. The key aspects of the model are related to the financing of firms in the wholesale and trading sectors. Wholesale firms combine physical capital and labor to produce home goods. Since they own the physical capital, wholesalers require funds to operate. Trading companies instead specialize in the export market: they acquire goods from domestic producers and sell them abroad, at no additional cost, to foreign consumers. They also require funding because they receive the corresponding payments only with a delay. In the same vein as the financial accelerator literature (Bernanke, Gertler, and Gilchrist 1999), the financial frictions in our model imply that firms rely mostly on debt contracts to adjust their capital structure. The main difference here is that they can, at least in principle, borrow either domestically or from abroad.

In the domestic market, which we model, like Cúrdia and Woodford (2010c) and Goodfriend and McCallum (2007), through a costly loan production technology, both firms can borrow at the same rate. However, in the international market, as is common in developing countries, some firms face more favorable foreign credit supply conditions than other firms operating in the same economy. To simplify the model, we assume that only the trading firms have access to foreign credit markets at all.

A variety of observations support our assumption that exporters have access to foreign credit at more favorable terms, at least in emerging market economies². First,

²A number of market participants in Latin America also point out that trade finance offers better terms because the essentiality of international trade shields the repayments of trade-related lines from being blocked by exchange rate centralizations and other heterodox measures. This widespread view is based on the history of past currency crises in Latin America, where local governments always made efforts to guarantee that trade credit obligations were honored. We would like to thank those who took the time to explain to us this aspect and other features of trade finance related products.

in the banking literature, Berger, Klapper, and Udell (2001), Stein (2002), Mian (2006), Gormley (2010), among others, show that foreign-owned financial institutions, as well as large banks, tend to finance only the largest and most profitable firms. Combined with the well-established view in the modern trade literature that firms operating in the export-import sector tend to be larger, better organized and more sophisticated (Melitz 2003), these papers suggest that lending to firms engaged in international trade is usually viewed as a safer market, which foreign banks can supply more easily, either directly or through local banks³.

Second, in our model, trading firms require funding because exports require additional working capital, as foreign customers make payments with a one-period delay. Therefore, in the model, we associate international borrowing with trade finance credit lines. The literature on the topic (for example, Amiti and Weinstein 2009) has emphasized, among other aspects, the higher working capital requirements associated with international transactions. A recent theory of trade finance by Ahn (2010) suggests that, due to screening advantages, foreign lenders of working capital to firms in developing economies should specialize in providing trade finance to exporters⁴.

Finally, banks do not take on currency mismatch risk when lending to exporters in emerging economies. This explains the existence, in normal times, of a highly competitive credit market, with many specialized players, in which trade finance becomes a low-risk, low-reward proposition (Korinek, Le Cocguic, and Sourdin 2010).

With asymmetric access to international credit, a sudden stop of capital flows

³Cho, Krishnan, and Nigh (1993), for instance, show that foreign banks operating in the US tend to specialize in trade finance.

⁴In addition, according to the World Bank Global Development Finance Report (2004), "Participation in international trade can help less creditworthy countries and firms expand their access to finance. Banks are more willing to lend when traded goods are available as security." Cetorelli and Goldberg (2010) show the importance of trade finance as a transmission mechanism of the 2007-2009 crisis. For a more complete discussion of bank structuring of trade finance, see Manova (2010).

impacts different agents through different channels. The exporters are directly affected as they can no longer obtain the cheap trade finance credit lines from abroad, and hence see a significant deterioration in the terms at which they can borrow. As a consequence, they reduce their activity, decrease their foreign debt, and tap the domestic market for funds. The wholesale firms are indirectly affected, because the additional demand for funds from exporters increases domestic spreads and interest rates. In response to a higher borrowing cost, these firms reduce production and cut back investments. Finally, as exporters repay their foreign debt, the exchange rate depreciates, further reducing domestic consumption and investment.

In light of the importance of these financial channels, credit policies are arguably important tools for central banks dealing with sudden stops. Given that the Central Bank of Brazil has been a prominent example of the use of unconventional policies⁵, we calibrate our model using Brazilian data, and offer a (simplified) case study of the recent crisis in this country⁶. We start by establishing that the model's mechanism is able to capture the dynamics of key macroeconomic variables during the crisis of 2008-2009. In particular, the model can replicate the rise in both international and domestic spreads, as observed in the data. Then we perform a series of counterfactual analyses to assess the importance of the credit policies implemented by the Central Bank of Brazil.

Our main findings are the following. First, providing credit to exporters is an effective tool. Our simulations indicate that it reduced spreads and that both GDP and

⁵Calvo (2006), for example, suggests that some of these alternative policies, especially the central bank involvement in the credit market for exports first implemented by Brazil in 2002, and then again in 2008-2009, have had significant effects in terms of reducing the economic and social costs of these crises.

⁶As shall be further explained below, we assume away some important aspects of the crisis. In particular, Brazil, as most emerging economies, was also hit by a large terms of trade shock. Abstracting from this shock affects the ability of the model to match some aspects of the crisis, but allows us to focus on the role of credit policies in response to a sudden stop.

welfare were higher as a result of the credit policy. Essential to this conclusion is the fact that the central bank funded its intervention entirely from previously accumulated foreign reserves. The economic intuition supporting the effectiveness of the policy is, then, straightforward: the credit facility provides a cheaper alternative of foreign credit to the exporters during the crisis. It should be emphasized, however, that in our analysis the central bank provides credit at the prevailing market price. Therefore, any benefits come from the general equilibrium effects on spreads, as exporters reduce the amount of debt contracted with the private sector.

To be able to provide an alternative line of credit, the central bank needs to have foreign-exchange reserves available at the time of the intervention⁷. Had they not been fully-funded out of reserves, credit facilities to exporters would reduce welfare in our model. In this case, targeting credit to exporters would still provide them with the incentive to repay their foreign debt. But, without the use of foreign reserves, this movement would also accelerate the exchange rate depreciation and, hence, inflation. When the central bank cares about these variables, as they most likely do – after all, many emerging market economies adopt an inflation targeting regime – the policy ends up reducing welfare.

Second, with respect to the policy aimed at the domestic market more generally, our results are not as favorable. Even though the intervention is effective in reducing domestic spreads due to general equilibrium effects, the impact on welfare can be negative. By reducing domestic spreads, the central bank distorts the incentives of agents in favor of domestic debt. This increases, for instance, the repayment of foreign debt by exporters. Similarly to the case without the use reserves described above, when nom-

⁷To be precise: the central bank has to have access to foreign resources that are not subject to the same spreads available to private agents. Previously accumulated foreign reserves, IMF loans or currency swaps with the US Federal Reserve are examples of funding. In our model, all of these sources of funding would have the same effect.

inal rigidities are taken into account, the resulting capital outflow can reduce welfare through their effects on the exchange rate and, consequently, on the inflation rate⁸.

Finally, we show that, in the absence of domestic financial frictions, the central bank has no reason to implement any credit policy. In this case, the only factor that matters is the use of foreign-exchange reserves. To make this point clear, we compare two policies: one in which extending credit to exporters is fully-funded out of foreign reserves and another in which the central bank sells foreign reserves in the spot market, with the proceeds transferred to households (through a reduction in the government debt or an immediate tax rebate). If we consider an economy with perfect domestic financial markets, the two policies are equivalent. Moreover, even when we assume that domestic spreads are positive, but constant, the two policies have almost identical effects. The intuition is a simple one: without frictions, it does not matter where in the economy the central bank injects resources, because they will always end-up where they are most needed. These results underline that we need to take account of key institutional features of the economy, such as the observed increase in domestic spreads during crises, to correctly consider the implementation of credit policies.

These findings suggest two broader lessons for credit policies in emerging economies. The first is that *domestic frictions matter for the design of credit policies*. Although it should be obvious, this is a relevant point to make for the case of emerging markets, where policies were implemented in response to a negative shock to the international

⁸There are other reasons to intervene in the domestic market, such as releasing liquidity to avoid potential bank runs. These, however, are beyond the scope of our model. The banking literature - as well as the Lehman bankruptcy experience - has illustrated the importance of acting conscientiously in that dimension. Implicitly, we assume that the banking system is not directly impacted by the sudden stop. We understand this can be a strong assumption, but one that allows us to highlight the importance of the credit policies in dealing with sudden stops, regardless of the specific secondary effects of the crisis on domestic financial systems. It is also important to point out that there were no major bankruptcies in developing economies' financial sectors.

borrowing conditions faced by these economies. Furthermore, with few exceptions, most of the literature on sudden stops (see references below) has focused exclusively on this international dimension of credit market frictions and ignored the empirically observed presence of domestic frictions. Our results show that such a narrow focus can be misleading, as one could erroneously conclude that there is no need at all for credit policy and only the use of foreign-exchange reserves matters.

The second broader lesson says that *the mere fact of an increase in credit frictions does not necessarily imply that central bank credit policy will raise welfare*. In fact, our simulations suggest that intervening only in domestic credit markets, or engaging in more general credit policies without the necessary backing of foreign-exchange reserves, is not a good recipe for dealing with sudden stops in capital flows. Note that in both cases, the policies are successful in achieving their goal of reducing credits spreads. Nevertheless, they reduce welfare because of their negative impact on the exchange rate and inflation.

This point is worth emphasizing because policies designed to act exclusively upon the inefficiencies of the domestic financial markets are exactly the ones recommended in most works focused, for example, in the case of the US economy⁹. Cúrdia and Woodford (2010a) show that if the condition that "all investors can purchase arbitrary quantities of the same assets at the same market price" is violated then credit policy can improve welfare. That condition is violated in our model, but still credit interventions to reduce domestic spreads can reduce welfare. What our results show is that those policy recommendations depend further on the details of the financial structure that is assumed. For many developing countries suffering from sudden stops in capital inflows, given the structure of their economies, the most effective credit policies are of a different

⁹Some examples are Geanakoplos (2010), Gertler and Karadi (2011) and Cúrdia and Woodford (2010a).

type. Credit targeted at the more affected sectors in a developing economy – mainly the export-import firms, which use more foreign borrowing to fund their operations – can be quite helpful during a crisis, as long as the central bank funds these loans with reserves hoarded before the crisis.

The remaining sections of the paper are organized as follows. After relating our work to the literature in the final part of this introduction, we review Brazil's crisis experience through the lens of its key macroeconomic variables. Section 3 presents the details of the model and its baseline calibration. In Section 4, we perform a crisis experiment, first using the baseline calibration and taking as given the credit policies implemented in Brazil. Then, in the same section, we perform a series of experiments, under different assumptions, to discuss the mechanism of the crisis, the importance of the policies and provide two broader lessons for credit policies in emerging markets. Section 5 concludes.

Relation to the Literature

Our work contributes to three branches of the literature. First, our approach, which allows financial intermediation to play a fundamental role in the macroeconomy, is part of a renewed effort by monetary economists to integrate the insights of financial economics into their policy evaluation frameworks (Brunnermeier 2009). Until recently, it had become common to consider monetary policy as consisting solely of interest rate policy, and to analyze alternative policies in models that abstracted from the allocative role of financial intermediation. Woodford (2003) stresses that, by the time his manuscript was published, few central banks still used credit controls or other methods to "directly regulate the flow of funds through financial markets and institutions" (p.15). Such controls would, it was believed, distort the relative cost of funds to different parts of the economy in ways that would negatively impact the central banks'

overall objectives¹⁰.

Recent events have brought a renewed focus on unconventional monetary policies. This in turn has required renewed attention to credit market imperfections. Cúrdia and Woodford (2010b) raise this point clearly, stating that the usual policy prescriptions, based on concern for stabilization of inflation and real GDP alone, may "be inadequate to circumstances of the kind recently faced". Important recent contributions to this literature include Gertler and Karadi (2011), Gertler and Kiyotaki (2009), Cúrdia and Woodford (2010a, 2010b, 2010c), Reis (2010), Del Negro, Eggertsson, Ferrero, and Kiyotaki (2010), Geanakoplos (2010) and Ashcraft, Garleanu, and Pedersen (2010).

Our results confirm that taking credit frictions into account can be important. Credit interventions seem to have been an effective countercyclical, welfare-improving policy during the financial crisis of 2008-09, in emerging economies. However, our analysis also suggests that some interventions can reduce welfare. Therefore, the implication of our work to this literature is that the desirability or undesirability of credit policies depends crucially on detail of their implementation.

Second, we contribute to the literature on sudden stops in emerging economies. Even though the use of credit policies in the most recent episode can be considered a novelty, sudden stops in international capital flows have been a fixture in the history of developing economies. And, following Calvo (1998), much has been said about how countries handle the existence of such an exogenous shock. However, most of the literature has focused exclusively on the financial frictions related to the foreign financing of economic activity in emerging markets. Some examples are Cook (2004), Céspedes, Chang, and Velasco (2004), Elekdag, Justiniano, and Tchakarov (2006), Devereux, Lane, and Xu (2006), Cúrdia (2008) and Braggion, Christiano, and Roldos (2009).

¹⁰Cúrdia and Woodford (2010a) discuss conditions under which central bank credit policy would have no useful role to play.

Gertler, Gilchrist, and Natalucci (2007) develop one of the few models that incorporates financial frictions in the domestic credit markets. Despite such an extensive body of work, the policy instruments considered for counteracting credit market driven crises have, nevertheless, remained quite restrained, with the interest rate instrument and active management (or not) of exchange rates as the central elements of most analyses.

Moreover, as domestic financial markets in many developing economies deepen and central banks expand their policy options, such a narrow focus on the international dimension of credit markets – arguably, one of the fundamental issues over the 1990’s – ends up limiting the usefulness of these models. In particular, few connections have been made between the frictions in both domestic and foreign financial markets and their role as a channel for the transmission of sudden stops (one important exception is Caballero and Krishnamurthy 2001). Here, we highlight this link.

Finally, we also contribute to the large literature on the accumulation and management of foreign-exchange reserves by developing economies. Some recent examples are Calvo (2006), Jeanne and Ranciere (2006), Aizenman and Lee (2007), Jeanne (2007) and Obstfeld, Shambaugh, and Taylor (2010). To the best of our knowledge, we are the first to show in a quantitative macro model that using foreign reserves to provide credit to exporters during a sudden stop can improve welfare.

1.2 The Crisis in Brazil

Despite some early signs of tightening in the international capital markets in the first quarter of 2008, reflected in the growing spreads on foreign loans to Brazil, the country continued its course of economic expansion as GDP, investments and consumption growth sustained their fast pace (figure 1a). The beginnings of a global meltdown,

even with the first few bank failures in the UK and the US, were not enough to change the outlook for the economy, as was emphasized by the Brookings Institution panel on Brazil (2009). Economic decoupling dominated the news. Perhaps even more telling, in hindsight, was the Brazilian Central Bank's decision to keep raising overnight interest rates to control demand-driven inflation (figure 1b).

The reigning chaos in global financial markets, strengthened by the bankruptcy of Lehman Brothers in September, completely changed the prevailing scenario. Brazil was, once again, coupled with the world. International spreads more than doubled in a single quarter, while the domestic credit spreads increased by 400 basis points over the same period (figure 1b). GDP started falling over the fourth quarter, as real investments collapsed and aggregate consumption reversed course¹¹.

The most common diagnostic suggests that the crisis reached Brazil through two main channels (Pastore and Pinotti 2008, Stone, Walker, and Yasui 2009). The first of these was the negative impact of worldwide financial crisis, which pushed the country towards an unexpected sudden stop on incoming international funding, including trade-related lines of credit. The second conduit was the global recession itself, in particular the slowdown in China, which reduced the demand for commodity exports and, hence, commodity prices. As a consequence, Brazil was subject to a terms-of-trade shock that limited the use of exports as an exit strategy for the crisis.

Faced with the prospect of disruption in the economy, the Brazilian Central Bank aggressively cut the economy's short-term interest rate in response to the declines in activity and inflation. In addition, it elected three main lines of defense, which were established concomitantly and implemented in several steps throughout the duration of

¹¹Many emerging market economies went through the same process, as highlighted by Ishi, Stone, and Yehoue (2009), Yehoue (2009) and several references cited therein. Brazil is a very representative member of this group.

the crisis¹².

First, the monetary authority decided to reduce banking reserves' requirements across the board, in order to infuse the domestic banking system with liquidity and reduce the lending rates charged by banks. It also designed some targeted reductions in reserves requirements geared towards small and medium-sized banks. These were carried out through government-incentivized acquisitions of the loan portfolios of smaller banks by the five largest privately-owned financial institutions in the country. In total, these measures¹³ amounted to about 142 billion reais (about 75 billion US dollars at the time).

The second line of defense was established to deal with the shortage of external funding. Through the sale of dollars with repurchase agreements starting in late September and auctions of US dollars (USD) against dollar-denominated collateral, which began in October of 2008, the central bank announced the provision of USD 34 billion to the Brazilian firms operating in the international markets. The total amount actually sold was closer to USD 25 billion and involved mainly exporting companies.

The third announced objective of the Brazilian Central Bank was to reduce the volatility of the exchange rate. To achieve this goal, the monetary authority acted directly in the spot market for foreign currency, selling over USD 14.5 billion of its massive stock of foreign-exchange reserves. It also intervened in the derivatives market, announcing the auction of swaps, in which the central bank took the short position

¹²The Treasury also put into practice a hefty agenda of countercyclical fiscal policies. While these may have been important, we choose not to include them in our experiments in order to better frame our credit policy analysis.

¹³The government-owned banks also aggressively increased their loan portfolios during the crisis. The Brazilian development bank, BNDES, was particularly active, providing long-term lending to the corporate sector. Although in line with the credit policies we study here, proceedings governing the lending decisions by these government-owned banks lack transparency and include some subsidies – especially in the case of the BNDES – that we don't consider in our model, as they do not generalize to other economies.

against the dollar, of over USD 50 billion – but actually implementing only around USD 12 billion.

As figures 1a and 1b show, the final toll of the crisis can be viewed as moderate and short lived. The economy presented negative growth rates for two quarters, but GDP, consumption and investment had already begun to recover by the second quarter of 2009. Domestic and international spreads remained high throughout most of the first half of 2009, but below their peak levels. In the second half of that year, the spreads started to decline and, in the domestic case, returned to their previous levels. It is nevertheless important to point out that international spreads remain above their pre-crisis levels.

Overall, the actions of the Brazilian Central Bank were viewed as successful, even if empirically reliable evidence to support this view remains scarce. Our paper contributes to the debate about the impact and importance of some of the policies implemented. However, it is important to highlight that our main focus is to study credit policies and its implications in the general context of an emerging economy facing a sudden stop. Therefore, we abstract from some of the particularities, like the terms-of-trade shock and the intervention in the exchange rate spot and forward markets, and focus on the followings stylized facts of the crisis in Brazil:

1. An exogenous shock reduced the supply of foreign credit and increased international and domestic spreads;
2. Real activity declined and remained below trend during a few quarters following the shock; and
3. The central bank intervened in the trade finance market (the second line of defense above) and in the domestic credit market (part of the first line of defense above).

1.3 Model

1.3.1 Outline of the Model

The core of the model is a standard small open economy with financial frictions and nominal price rigidities along the lines of Cúrdia (2008), Elekdag, Justiniano, and Tchakarov (2006), and Devereux, Lane, and Xu (2006). A key financial friction in these models is that firms can borrow abroad subject to constraints as in Bernanke, Gertler, and Gilchrist (1999) (henceforth, BGG). To deal with the dynamics of the crises of interest and the policy responses, we extend these models in two key dimensions, both related to financial aspects.

First, we allow firms to also contract domestic debt by introducing – through the simple, but effective mechanism of a costly loan production technology – a local financial sector that, by its imperfection, generates credit spreads in the domestic market. The existence of firms with access to both domestic and foreign financial sectors is an important feature of economies in which both credit markets are relevant. In addition, the fact that financial markets are imperfect in emerging economies should not come as a surprise. The data also shows that these frictions become more important during sudden stop episodes. In Section 1.2, we show that the domestic spreads in Brazil increased significantly during the financial crisis of 2008-09. Gertler, Gilchrist, and Natalucci (2007) document similar behavior for South Korea during the Asian crisis of 1997-98. In a qualitative model of collateral constraints, Caballero and Krishnamurthy (2001) focus on the domestic financial frictions during emerging crisis. In the quantitative model presented here, the domestic frictions are essential to understand the design and implications of credit policies, in addition to helping us to match important features of the data.

By considering a single loan production technology in the domestic financial system, we are implicitly assuming that all firms are homogenous from the point of view of a domestic bank. Hence, the domestic spreads are unique and depend only on the total volume of domestic financial intermediation. As a consequence, the demand by firms for domestic and foreign credit depends mostly on the conditions they face in the international markets.

This last observation brings us to the second key innovation in our model: exporters are assumed to obtain loans from abroad at better financial terms than the ones that are available to other firms in the economy. This is a fundamental characteristic of many developing economies. As discussed in the introduction, there are three main reasons as to why exporters might have better access to foreign financial markets. First, international lenders may have a better understanding of the business of exporters, which are usually larger and more transparent companies, than of firms who mostly attend to domestic consumers. Second, foreign lenders may also prefer to specialize in trade finance credit in emerging markets. Finally, the assets of exporters are linked to the foreign currency and since foreign debt in developing economies is almost always denominated in foreign currency, there is a smaller degree of currency risk in lending to exporters.

Moreover, at least in normal times, exporters can obtain better funding abroad than in the domestic credit markets¹⁴. For instance, Figure 2 shows the actual spreads on loans provided by a number of Brazilian Banks through different lines of credit. Noticeably, in periods of small spreads, the cost of credit to exporters, mostly through trade lines, is considerably lower than the working capital lines available to equivalent

¹⁴Chapter 5 of the World Bank Global Development Finance Report (2004) shows that, for a set of developing economies in which trade lines can be matched to comparable domestic finance loans, the spreads on trade finance were (marginally) lower than their domestic counterparts. This is consistent with the evidence we obtain from Brazilian banks.

companies in non-exporting sectors.

Except for these two points, the underlying framework proposed remains fairly standard. We construct a small open economy with identical households, which are divided between workers and managers, a simple domestic financial sector (or the market for "domestic loans"), a market for loans from abroad (which we also label as the "trade finance" market) and four types of firms: wholesale, retail, trading and capital producing companies. We close the model with a government entity that combines the roles of both Treasury and Central Bank, and the usual resource constraint on home goods. The balance of payments, as always, reflects the budget constraints of all the actors. The details of the economy are spelled-out below.

Households

We assume that the households are composed of a constant fraction $(1 - f)$ of workers and a fraction f of managers¹⁵. A worker provides labor to the wholesale firms and returns her wage to the household, while a manager, as the name suggests, manages one of the household's firms and also returns her earnings – ie, the profit of the firm she manages – to the family unit. The managers are further segmented according to the type of firm they oversee. A fraction $f - f_e$ of the individuals within the household, called "wholesalers", is responsible for running the wholesale firms, while a fraction f_e , of "exporters", takes care of the trading companies. Individuals can move between the worker and manager groups. In particular, every period, a random fraction $(1 - \theta_w)$ of the wholesalers and a fraction $(1 - \theta_e)$ of the exporters become workers. To keep the fractions of each type constant, a number of individuals, also randomly selected,

¹⁵Our structure is similar to the one developed in Gertler and Karadi (2011), where the two types are workers and bankers.

become managers. Note that, even though the manager operates it, the household is the actual owner of all the firms.

Within the household there is perfect insurance and, hence, all consumption decisions are taken at the household level. However, all the professional transactions between a manager and other agents in the economy, including those within the same household, are done at arms-length. In the case of the financial decisions of a firm, the manager is considered an insider, while the household is an outside investor. This approach allows us to include a rich variety of financial frictions in the model while keeping the convenience of having a representative consumer. In particular, the model has two types of firms that rely on debt to fund their activities. The traditional "financial accelerator" approach (ie, BGG) would require three types of individuals, each with different consumption and labor decisions. Here, we also have three agents, but only the household consumes and works.

When an individual becomes a manager, she receives a start-up equity (or net worth) to initialize the operation of the firm. The size of the initial net worth and the fact that a manager has a finite expected life implies that the firms always borrow debt to finance their investments. All of the relevant decisions by the managers, such as the financing decision, the initial equity, the evolution of the firm's net worth, and the aggregate per period net cash flow payments to the households, shall become clear when we discuss the problem of the wholesale and the trading companies. At this juncture, it suffices to say that a manager, when exiting the group, returns all remaining net worth to the households.

There are two types of consumption goods in the economy: home goods ($C_{H,t}$) and foreign goods ($C_{F,t}$). Both goods are internationally traded and preferences between

them are Cobb-Douglas

$$C_t = \left(\frac{C_{H,t}}{\gamma} \right)^\gamma \left(\frac{C_{F,t}}{1-\gamma} \right)^{1-\gamma}. \quad (1.1)$$

These preferences imply that the aggregate price index P_t , and the demands for domestic and foreign goods are, respectively, given by

$$P_t = P_{H,t}^\gamma S_t^{1-\gamma} \quad (1.2)$$

$$C_{H,t} = \gamma \frac{P_t C_t}{P_{H,t}} \quad (1.3)$$

$$C_{F,t} = (1-\gamma) \frac{P_t C_t}{S_t} \quad (1.4)$$

where S_t is the nominal exchange rate, defined as the domestic price of the foreign currency, $P_{H,t}$ is the aggregate domestic price of the home good, and we normalize the foreign price level to 1.

Besides the wholesale firms and trading companies, the households also own retail firms, capital producers and financial intermediaries. None of these last three types of firms require capital to operate. In addition, households can buy government bonds and make deposits with a financial intermediary. These two financial assets are both risk free and, in equilibrium, perfect substitutes. We aggregate them into a single variable B_t .

The consumption (C_t), bond holdings (B_t) and labor (L_t) decisions are given by maximizing the discounted expected future flow of utility

$$E_t \sum_{t=0}^{\infty} \beta^t \left[\left(C_t - \tilde{L} \frac{L_t^{1+\psi}}{1+\psi} \right)^{1-\sigma} / (1-\sigma) \right] \quad (1.5)$$

with respect to $\{C_t, L_t, B_t\}$, subject to the budget constraint

$$P_t C_t + P_t B_t \leq W_t L_t + R_{t-1} P_{t-1} B_{t-1} + \Pi_{f,t} - T_t \quad (1.6)$$

where W_t is the wage, R_t is the interest rate received from holding one period bonds, $\Pi_{f,t}$ is the aggregate net cash flow from all types of firms owned by the household and T_t is a lump sum tax. Following a common practice in the emerging market literature, utility is defined as in Greenwood, Hercowitz, and Huffman (1988). This assumption eliminates the wealth effect on labor supply by making the marginal rate of substitution between consumption and labor independent of consumption.

The Euler equation and labor supply are given by

$$E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} \frac{1}{\Pi_{t+1}} R_t \right] = 1 \quad (1.7)$$

$$\frac{W_t}{P_t} = \tilde{L} L_t^\psi \quad (1.8)$$

where Π_t is the gross inflation rate and

$$\lambda_t = \left(C_t - \tilde{L} \frac{L_t^{1+\psi}}{1+\psi} \right)^{-\sigma}. \quad (1.9)$$

Wholesale Firms

A continuum of identical wholesale firms, indexed by j , hire domestic labor (L_t) and acquire capital (K_t) to produce the home good (Y_t) using a Cobb-Douglas production function

$$Y_t = \left(\frac{L_t}{\alpha} \right)^\alpha \left(\frac{K_{t-1}}{1-\alpha} \right)^{1-\alpha}. \quad (1.10)$$

For simplicity, we assume that capital completely depreciates in one period and, hence, that investment at t is equal to the next period level of capital times the price of the capital good: $K_{t+1} P_{K,t}$. Capital is acquired from the capital producers. Their production function and the determination of the price $P_{K,t}$ are described in the subsection 1.3.1.

The wholesale firms are owned by the households and operated by the managers within them (the wholesalers). A specific firm has two sources of funds: the internal accumulation of profits and the debt contracted with the domestic financial sector.

Let $N_{w,t}(j)$ be a given net worth level of a wholesale firm j at period t . The balance sheet constraint imposes that

$$P_{K,t}K_{t+1}(j) = P_t N_{w,t}(j) + P_t D_{w,t}(j) \quad (1.11)$$

where $D_{w,t}(j)$ is the amount of debt contracted specifically by wholesale firm j . For a given net worth, the maximization of the value of the firm described below and an aggregate version of this balance sheet constraint determine the level of capital in the wholesale sector.

The net worth of a previously existing firm is given by

$$P_t N_{w,t}(j) = P_{w,t} Y_t(j) - W_t L_t(j) - R_{b,t-1} P_{t-1} D_{w,t-1}(j) \quad (1.12)$$

where $P_{w,t}$ is the wholesale price of the home good and $R_{b,t}$ is the gross interest rate available to borrowers in the domestic market.

In any period, the demand for labor is a static decision given by

$$L_t = \frac{\alpha}{(1-\alpha)} \left(\frac{P_{w,t}}{W_t} \right)^{\frac{1}{1-\alpha}} K_t. \quad (1.13)$$

Substituting this demand curve and the production function (1.10) into (1.12), we get

$$P_t N_{w,t}(j) = (R_{K,t} - R_{b,t-1}) P_{K,t-1} K_t(j) + R_{b,t-1} P_{t-1} N_{w,t-1}(j) \quad (1.14)$$

where

$$R_{K,t} = \frac{P_{w,t}}{P_{K,t-1}} \left(\frac{W_t}{P_{w,t}} \right)^{-\frac{\alpha}{1-\alpha}} \quad (1.15)$$

is the return of investing in capital, which depends only on aggregate conditions. This last property implies that the size of the firm does not matter and therefore, from this point forward, we drop the index j .

The wholesaler keeps accumulating assets in the firm until exiting the sector, when all of the remaining net worth returns to the household. Therefore, an operating firm chooses the path $\{K_{t+1}\}$ to maximize the expected terminal net worth. The value of the firm (in real terms) is then given by

$$V_w(N_{w,t}) = \max_{\{K_{t+1}\}} E_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} [(1 - \theta_w)N_{w,t+1} + \theta_w V_w(N_{w,t+1})] \right\} \quad (1.16)$$

where $N_{w,t}$ evolves according to (1.14) and the manager uses the stochastic discount factor of the shareholder of the firm, the household. Note that the value of the firm is a weighted average of the value when the firm ceases to exist, the first term above, and the value if it remains in operation. Moreover, it is straightforward to show that the value of the firm is a linear function of its net worth

$$V_{w,t}(N_{w,t}) = \eta_{w,t} N_{w,t} \quad (1.17)$$

where

$$\eta_{w,t} = E_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} \frac{R_{b,t}}{\Pi_{t+1}} ((1 - \theta_w) + \theta_w \eta_{w,t+1}) \right\} \quad (1.18)$$

The solution to this maximization problem yields one of the two main equations for the wholesale sector. Since the wholesalers take the time paths of the prices $R_{K,t}$ and $R_{b,t}$ as given, in equilibrium, the risk adjusted excess return provided by leverage is zero:

$$E_t \left[\mu_{w,t+1} \frac{1}{\Pi_{t+1}} (R_{K,t+1} - R_{b,t}) \right] = 0 \quad (1.19)$$

where μ_{t+1} defines the current marginal value, in real terms, of one additional unit of net worth in period t+1

$$\mu_{w,t+1} = \beta \frac{\lambda_{t+1}}{\lambda_t} ((1 - \theta_w) + \theta_w \eta_{w,t+1}) \quad (1.20)$$

The second main equation describes the evolution of the net worth in the wholesaler sector. We make two assumptions. First, a manager who exits the sector returns

all the remaining cash to the households. That is, at period t , all of the firm's net worth (1.14) is paid out as dividends. Second, the household provides a small fraction κ_w of total assets in the sector to the new start-ups. The aggregate evolution of the net worth in the sector is then given by

$$P_t N_{w,t} = \theta_w [(R_{K,t} - R_{b,t-1}) P_{K,t-1} K_t + R_{b,t-1} P_{t-1} N_{w,t-1}] + \kappa_w P_{K,t} K_{t+1} \quad (1.21)$$

Equations (1.19) (together with the specification of the domestic financial sector) and (1.21) determine the consolidated debt level and the aggregate evolution of the net worth in the wholesale sector.

Retail Firms

A continuum of retail firms, owned by the households, indexed by $i \in [0, 1]$, buy the home good from the representative wholesale firm and transform it, with a linear technology and at no additional cost, into their own variety. Firms operate in a monopolistically competitive environment and prices are sticky à la Calvo. Every period, firms reset their price with probability $(1 - \alpha_p)$.

The total aggregate demand for the domestic good is given by

$$Y_{H,t} = C_{H,t} + K_{H,t+1} + C_{H,t}^* + \Xi_{H,t} \quad (1.22)$$

where $C_{H,t}$ is the demand from the domestic consumers, $K_{H,t+1}$ is the investment demand (determined at t), $C_{H,t}^*$ is the demand from foreign consumers and $\Xi_{H,t}$ is the resource cost, denominated in terms of the home good, of financial intermediation. The demand from foreign consumers is given by

$$C_{H,t}^* = C^* (P_{H,t}^*)^{-v^*} \quad (1.23)$$

where C^* is an exogenous shifter of the foreign demand for home goods, which here, for simplicity, we assume is constant. The remaining two components of the aggregate demand, $K_{H,t+1}$ and $\Xi_{H,t}$, are described below.

The final home good is assumed to be a composite made of the continuum of differentiated goods, $Y_{H,t}(i)$, produced by the retail firms via the aggregator

$$Y_{H,t} = \left(\int_0^1 Y_{H,t}(i)^{\frac{\eta-1}{\eta}} di \right)^{\frac{\eta}{\eta-1}}. \quad (1.24)$$

The demand for each variety is then given by

$$Y_{H,t}(i) = Y_{H,t} \left(\frac{P_{H,t}(i)}{P_{H,t}} \right)^{-\eta}. \quad (1.25)$$

A firm i that can reset its price at t chooses $\bar{P}_{H,t}(i)$ that solves¹⁶

$$\underset{\bar{P}_{H,t}(i)}{\text{Max}} E_t \sum_{j \geq 0} \alpha_p^j \beta^j \frac{\lambda_{t+i}}{\lambda_t} \frac{P_t}{P_{t+j}} Y_{H,t+T} \left(\frac{\bar{P}_{H,t}(i)}{P_{H,t+j}} \right)^{-\eta} ((1-\tau)\bar{P}_{H,t}(i) - P_{w,t+j}) \quad (1.26)$$

where we use the stochastic discount factor of the household.

The optimal price, which is the same for all firms that reset their price, is given by

$$\bar{P}_{H,t} = \frac{E_t \sum_{j \geq 0} \alpha_p^j \beta^j \frac{\lambda_{t+j}}{P_{t+j}} Y_{H,t+j} P_{H,t+j}^\eta P_{w,t+j}}{E_t \sum_{j \geq 0} \alpha_p^j \beta^j \frac{\lambda_{t+j}}{P_{t+j}} Y_{H,t+j} P_{H,t+j}^\eta}. \quad (1.27)$$

Finally, the aggregate domestic price index is given by

$$P_{H,t} = [(1-\alpha_p)(\bar{P}_{H,t})^{1-\eta} + \alpha_p(P_{H,t-1})^{1-\eta}]^{\frac{1}{1-\eta}}. \quad (1.28)$$

¹⁶The term $(1-\tau)$ allows for a subsidy that we set to eliminate the monopoly distortion at the steady state $\left(\frac{\eta}{\eta-1} \frac{1}{1-\tau} = 1 \right)$

Trading Companies

The differentiated retail goods are sold in domestic and international markets. In the case of exports, we assume that the goods take one period to arrive in the customers markets: a good sold and shipped in the current period arrives at its international destination only in the next period. More importantly, foreign consumers pay for the good only when they receive it.

Given this structure, we consider the case in which the trading companies specialize in the export market. In period t , they buy, sell and ship to international markets, at no additional cost, each variety of the home good demanded by foreign consumers. The price of the good they sell is determined at period t and is denominated in foreign currency. Since they receive payments for their sale only at period $t+1$, trading firms require capital to operate.

To support its activities, a trading firm has access to three sources of funding: internal cash flow, debt in the domestic market and debt from abroad. The most important characteristic of these firms is that they have access to credit from abroad on favorable terms compared with other domestic firms. Here we make the assumption that they are actually the only firms that have access to the international credit markets.

Trading companies are managed by individuals – the exporters – within the household. Let $N_{e,t}$ be a given net worth level of a trading company at period t . Since, as in the case of the wholesale firm, size does not matter, we already omit an index to differentiate each exporter. The balance sheet constraint imposes that

$$P_{H,t}C_{H,t}^* = P_t N_{e,t} + P_t D_{e,t} + S_t D_{e,t}^* \quad (1.29)$$

where $P_{H,t}^*$ is the aggregate export price, $C_{H,t}^*$ is the aggregate quantity exported, $D_{e,t}^*$ is the foreign debt, which is denominated in foreign currency, contracted by the exporter, $D_{e,t}$ is the domestic debt. For a given net worth, the maximization of the value of the

trading company and the aggregate balance sheet determine the demand for $C_{H,t}^*$ (the equivalent to investing in "capital" for the exporter).

The net worth of a previously existing firm is given by¹⁷

$$P_t N_{e,t} = S_t P_{H,t-1}^* C_{H,t-1}^* - S_t \psi_{e,t-1}^* R^* D_{e,t-1}^* - R_{b,t-1} P_{t-1} D_{e,t-1} \quad (1.30)$$

where $\psi_{e,t}^*$ is the spread the trading firm pays in international markets and R^* is the world risk free interest rate, which, to simplify the model, is assumed to be constant.

The value of the trading company (in real terms) is then given by

$$V_e(N_{e,t}) = \max_{\{C_{H,t}^*, D_{e,t}^*, D_{e,t}\}} E_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} [(1 - \theta_e) N_{e,t+1} + \theta_e V_e(N_{e,t+1})] \right\} \quad (1.31)$$

where the maximization is subject to the balance sheet constraint (1.29) and the transition equation (1.30). The value of the trading company is given by an expression equivalent to (1.17), with the time-varying coefficient on the net worth now given by

$$\eta_{e,t} = E_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} \frac{s_{t+1}}{s_t} \psi_{e,t}^* R^* ((1 - \theta_e) + \theta_e \eta_{e,t+1}) \right\} \quad (1.32)$$

where s_t is the real exchange rate.

The setup above results in three main equations for the export sector. First, exporters take prices and the interest rates as given. In the equilibrium we consider here, and in line with our discussion above, they always borrow in the international market. However, they may decide not to access the domestic market. As a consequence, their optimal borrowing decision implies that

$$E_t \left[\mu_{e,t+1} \frac{1}{\Pi_{t+1}} \frac{S_{t+1}}{S_t} \psi_{e,t}^* R^* \right] \leq E_t \left[\mu_{e,t+1} \frac{1}{\Pi_{t+1}} R_{b,t} \right] \quad (1.33)$$

¹⁷The trading company buys and sells each variety of the home good. Optimization implies that the return, as given by expression (1.34), of selling one extra unit is the same for each variety i . Therefore, we already write the profit function in terms of the aggregate variables: $P_{H,t}^* C_{H,t}^* = \int P_{H,t}^*(i) C_{H,t}^*(i) di$ and $P_{H,t} C_{H,t}^* = \int P_{H,t}(i) C_{H,t}^*(i) di$

where $\mu_{e,t+1}$ is defined as in (1.20).

The left hand side of the equation above is the risk-adjusted cost of borrowing from abroad, while the right hand side is the correspondent measure for domestic debt. When the cost of domestic debt is too high compared with what the exporter can get abroad, condition (1.33) holds as an inequality and the domestic debt $D_{e,t} = 0$. We consider that this is the "normal" case in the economy. However, during a crisis, when there is a negative shock to the supply of credit from abroad, equation (1.33) will hold as an equality and the exporter will also borrow domestically.

Second, the leverage decision of the exporter implies that the return, in terms of foreign currency, of selling one extra unit of $C_{H,t}^*$ – the left hand side in the expression below – must equal the borrowing cost:

$$\frac{P_{H,t}^*}{P_{H,t}/S_t} = \psi_{e,t}^* R^*. \quad (1.34)$$

Finally, as with the wholesalers, we assume that the exporter who exits the sector returns all the remaining cash to the households, who provide a small fraction κ_e of the total "assets" in the sector to the new start-ups. These assumptions imply that the evolution of the aggregate net worth in the trading sector is given by

$$P_t N_{e,t} = \theta_e (S_t P_{H,t-1}^* C_{H,t-1}^* - S_t \psi_{e,t-1}^* R^* D_{e,t-1}^* - R_{b,t-1} P_{t-1} D_{e,t-1}) + \kappa_e P_{H,t} C_{H,t}^*. \quad (1.35)$$

Capital Producing Firms

Another important characteristic of developing economies is the use of imported (capital and intermediary) goods as essential inputs for production. Capital goods and inputs usually represent a substantial fraction of the overall imports in these economies. Cúrdia (2008) and Fraga, Goldfajn, and Minella (2003) provide a large amount of

evidence and discuss the importance of this characteristic. When we calibrate the model to match the data from Brazil, we allow for the composition of the (composite) consumption goods to be quite different from that of the capital goods, which have a larger share of imported inputs. Hence, changes to the prevailing exchange rate can affect investments much more significantly than overall consumption.

To capture this effect, we follow Gertler, Gilchrist, and Natalucci (2007) and assume that capital goods are produced from domestic and foreign goods using a CES production function:

$$K_{t+1} = \left[(\gamma_k)^{\frac{1}{\rho_k}} (K_{H,t+1})^{\frac{\rho_k-1}{\rho_k}} + (1 - \gamma_k)^{\frac{1}{\rho_k}} (K_{F,t+1})^{\frac{\rho_k-1}{\rho_k}} \right]^{\frac{\rho_k}{\rho_k-1}}. \quad (1.36)$$

The price index for capital goods and the breakdown into domestic and foreign components are, respectively, given by

$$P_{K,t} = [\gamma_k (P_{H,t})^{1-\rho_k} + (1 - \gamma_k) (S_t)^{1-\rho_k}]^{\frac{1}{1-\rho_k}} \quad (1.37)$$

$$K_{H,t+1} = \gamma_k K_{t+1} \left(\frac{P_{H,t}}{P_{K,t}} \right)^{-\rho_k} \quad (1.38)$$

$$K_{F,t+1} = (1 - \gamma_k) K_{t+1} \left(\frac{S_t}{P_{K,t}} \right)^{-\rho_k}. \quad (1.39)$$

Financial Intermediation

International Market

The international credit market is open (only) to exporters. Even though they take prices as given, the premium $\psi_{e,t}^*$ is a function of the overall leverage in the export sector

$$\psi_{e,t}^* = 1 + \tilde{\psi}_{e,t}^* (d_{e,t}^*)^{\eta_e} \quad (1.40)$$

where $d_{e,t}^* = S_t D_{e,t}^* / P_{H,t} C_{H,t}^*$ and $\tilde{\psi}_{e,t}^*$ is an exogenous shock.

In a model with asymmetric information between inside and outside investors and costly verification, as in the BGG framework, the optimal decisions would imply a positive relation between leverage and spread as in the equation above. Note also that information frictions, and the heterogeneity in this aspect among sectors, is an essential feature of our discussion about the different access of exporters and other firms to international credit. In Cúrdia (2008), Elekdag, Justiniano, and Tchakarov (2006), and Devereux, Lane, and Xu (2006) the authors follow the BGG approach and include the information frictions explicitly in the model. Here, we simplify along that dimension in order to focus on the sectorial heterogeneity and the interaction between international and domestic credit markets (features that are absent in those works). Therefore we follow a common practice in the real business cycle literature on emerging markets with international financial frictions¹⁸ and directly assume a functional form for the international spread.

Domestic Market

The role of the domestic financial system is to raise one-period, interest-rate-bearing deposits from households and to make loans to firms that need funding – the trading companies and the wholesale firms. We assume that the market is imperfect and, as a consequence, there is a spread between borrowing and lending rates. Following similar approaches in Cúrdia and Woodford (2010c) and Goodfriend and McCallum (2007), we consider a loan production technology that can capture monitoring and management efforts in the financial sector. In particular, to make a total real amount of loans equal to D_t , banks consume, in the period the loan is originated, $\Xi(D_t)$ units of real resources, measured in consumption goods. The function Ξ represents a specific

¹⁸See, for example, Garcia-Cicco, Pancrazi, and Uribe (2010) and Neumeyer and Perri (2005).

loan technology and is assumed to be equal to

$$\Xi(D_t) = \tilde{\Xi}(D_t)^\xi \quad (1.41)$$

where $\tilde{\Xi}$ and ξ are parameters.

Note that we are implicitly assuming that all firms are homogenous from the point of view of a domestic bank, and, hence, the domestic spreads are unique and depend only on the total volume of domestic financial intermediation. In our model, the important sectorial heterogeneity is related to information aspects, in particular, in the relation between foreign lenders and domestic firms. Our assumption here is that domestic banks can equally assess the quality of all type of borrowers.

For the households, deposits in the banking system and government bonds are perfect substitutes: one-period, nominal, risk-free bonds. Therefore, the deposit rate equals the rate on government bonds R_t . The real profit of a representative financial intermediary is given by

$$\Pi_{fi,t} = R_{b,t}D_t - R_tD_{h,t} \quad (1.42)$$

where $R_{b,t}$ is the interest charged to borrowers in the domestic market; $D_t = D_{w,t} + D_{e,t}$ is the total amount of loans made to the wholesale and trading companies; and $D_{h,t}$ is the total amount of deposits raised from the households.

A flow of funds restriction imposes that the value of total deposits has to equal the loan portfolio plus the resource costs associated with the loan origination

$$D_{h,t} = D_t + \Xi_t(D_t). \quad (1.43)$$

Maximization of equation (1.42) subject to (1.43) implies that

$$R_{b,t} = (1 + \Xi'_t)R_t. \quad (1.44)$$

The structure presented here allows us to incorporate, in a simple manner, a spread between the domestic borrowing and lending rates. Moreover, this spread depends on the volume of financial intermediation. Finally, we also note that the spread is the same for all types of firms. As a consequence, firms with favorable access to external credit lines – the exporters in our model – will prefer to borrow from foreign lenders, while the remaining firms will mostly use the domestic financial system.

Government

The government is a single entity composed by the Treasury and the Central Bank. Together, they control five variables in the model: the nominal interest rate (R_t), a lump-sum tax on households (T_t), the supply of domestic government bonds held by households ($B_{g,t}$), the amount of foreign reserves (FA_t) – held as US Treasury Bonds, for example – and loans made to domestic firms as part of a credit policy ($D_{g,t}$). We include foreign reserves in the model because some of the credit policies implemented by emerging market central banks were coordinated with the management of their holdings of foreign currency reserves.

We impose two restrictions on the government. The first is a standard intertemporal budget constraint

$$T_t = D_{g,t} + S_t FA_t - P_t B_{g,t} + (R_{t-1} P_{t-1} B_{g,t-1} - R_{g,t-1} D_{g,t-1} - R^* S_t FA_{t-1}) \quad (1.45)$$

where $R_{g,t}$ is the interest rate received by the Central Bank on its domestic credit interventions.

The second condition restricts the interventions in the credit and bond markets to be sterilized. That is, any change in the volume held of a specific asset on the consolidated government balance sheet requires an equivalent change in the holdings of

another asset or in the amount of government bonds on the liability side:

$$D_{g,t} + S_t F A_t = P_t B_{g,t}. \quad (1.46)$$

Imposing this last condition allows us to abstract from money in the model. It is also a close description of the actual policies we study in this paper.

Taken together, these restrictions imply that the government has, at least in the case of a flexible exchange rate regime, three independent instruments: R_t , $F A_t$ and $D_{g,t}$.

For the interest rate, we assume that the Central Bank follows a Taylor Rule type of policy

$$\frac{R_t}{R} = (\Pi_t)^{\phi_\pi} \left(\frac{Y_t}{\bar{Y}} \right)^{\phi_y} \quad (1.47)$$

where R and \bar{Y} are the steady levels of, respectively, the gross domestic interest rate and output. The credit policies and the management of reserves are the topic of Section 1.4.

Exogenous Shocks

The only exogenous shock in the model is the $\tilde{\psi}_{e,t}^*$ term in the foreign credit supply curve (equation 1.40). Movements in this variable capture changes in the conditions available to exporters in the international credit markets. A sudden stop is a large positive increase in $\tilde{\psi}_{e,t}^*$ such that, for any given level of leverage, the spread on the foreign debt is higher. We assume that $\tilde{\psi}_{e,t}^*$ follows an AR(1) process in logs.

Equilibrium

We close the model with the home good resource constraint and the balance of payments. In the case of the former, we have that

$$Y_{H,t}\Delta_t = \left(\frac{L_t}{\alpha}\right)^\alpha \left(\frac{K_t}{1-\alpha}\right)^{1-\alpha} \quad (1.48)$$

where Δ_t is a measure of the price dispersion¹⁹ in the retail sector:

$$\Delta_t = \int_i \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\eta} di. \quad (1.49)$$

Aggregating the budget constraints of households and the government, and replacing the profit functions as necessary, one can derive the balance of payments (in terms of the foreign currency)

$$P_{H,t-1}^* C_{H,t-1}^* - C_{F,t} - K_{F,t+1} = D_{e,t-1}^* \psi_{e,t-1}^* R^* - D_{e,t}^* + FA_t - R^* FA_{t-1} \quad (1.50)$$

In the appendix A.1, we list all the equations that determine the dynamic equilibrium of the economy. Of the fundamental equations, many are standard: consumer Euler equation, labor supply, resource constraint and balance of payment. The core of our model is given by the equations related to the financial aspects of firms in the wholesale and export sectors: equation (1.33) guides the exporters' decision about how much to borrow domestically and abroad; equations (1.19) and (1.34) determine the leverage (and, given the level of net worth, investment) in each sector; while equations (1.21) and (1.35) present the evolution of each aggregate sectorial net worth. Together with the characteristics of the financial intermediation, equations (1.40) and (1.44), these equations drive the propagation of the sudden shock in the economy.

¹⁹The resource constraint includes the price dispersion term because we use non linear methods to solve the model. See the discussion in the expanded version of Schmitt-Grohé and Uribe (2005).

Eliminating the Financial Frictions

In this subsection we show how to eliminate the financial frictions from the model. This is particular important for the case of the domestic frictions because it highlights exactly the additional assumptions of our model, when compared to the no-domestic-friction standard in the previous papers of the literature. More importantly, in the simulations of Section 1.4, we use the frictionless case presented here to show how important the domestic frictions are to understand the role of credit policies.

We start by briefly pointing out that one can eliminate the international financial friction by setting the debt-elasticity (η_e) of the spread in the foreign credit supply curve (equation 1.40) close to zero²⁰. This allows the domestic rate to differ from the international interest rate but this difference would be independent of the leverage conditions in the export sector.

The economy has no domestic friction if we set $\tilde{\Xi} = 0$ in equation (1.41) and replace equations (1.21) and (1.35), describing, respectively, the evolution of the net worth in the wholesale and export sectors, with two equations imposing that $\eta_{w,t} = \eta_{e,t} = 1$. The first condition eliminates any spread in the domestic debt market, while the latter equations allow the firms to adjust their equity at any time.

In this case, the two following Euler equations, which can be derived from (1.18) and (1.32) when $\eta_{w,t} = \eta_{e,t} = 1$, drive the investment decisions in the wholesale and export sectors

$$E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} \frac{R_{b,t}}{\Pi_{t+1}} \right] = 1 \quad (1.51)$$

$$E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} \frac{s_{t+1}}{s_t} \psi_{e,t}^* R^* \right] = 1. \quad (1.52)$$

²⁰Setting η_e equal to a small positive value instead of zero ensures the independence of the deterministic steady state from initial conditions (see Schmitt-Grohé and Uribe 2003).

Finally, note that in the absence of frictions, the composition of domestic debt and equity is not determined and is completely irrelevant. In the simulations below with a perfect domestic market, we simply assume the steady-state level.

1.3.2 Solution Method and Calibration

A crisis in the model begins with an abrupt and unexpected increase in the cost of foreign credit. Starting from the non-stochastic steady state, at period t_0 , agents learn about the current realization and the future (deterministic) path of the exogenous processes. To capture the occurrence of a sudden stop event, we consider a large increase to the exogenous process $\tilde{\psi}_{e,t}^*$ in equation (1.40). This implies that, for the same leverage at the firm level, the spread practiced on the foreign credit market rises substantially.

To solve for the dynamic equilibrium, we use a shooting algorithm under the assumption that the economy will return to its steady state after T periods. At every period, one must check if the exporters' debt condition (1.33) holds as an equality or as a strict inequality. In the parametrization we consider here, the latter holds in the steady state and, therefore, the exporters contract only foreign debt at that point. However, when the shock hits the economy, the cost of international debt increases and exporters start to borrow in the domestic market as well. In other words, the condition will hold as an equality upon impact and will typically continue to hold as such for a few periods after the initial shock.

We use an algorithm designed to control for just such an "occasionally binding constraint". We first guess that equation (1.33) holds as an equality from the period t_I to t_N and solve the model. Then we check whether $d_{e,t} \geq 0$ for all $t \in [t_I, t_N]$ and if (1.33) holds as inequality for $t \notin [t_I, t_N]$ (where $d_{e,t} = 0$). If not, we adjust the interval

$[t_I, t_N]$ and start over.

The method described also captures the nonlinearity present in the model quite well. Given that our stated objective is to study the effects of large financial shocks, taking into account the nonlinearities is absolutely fundamental. Several recent papers, including Gertler, Gilchrist, and Natalucci (2007), Braggion, Christiano, and Roldos (2009) and Christiano, Eichenbaum, and Rebelo (2009), have also studied crisis experiments under perfect foresight using methods similar to the one we apply here.

A period in the model is a quarter and there are 22 parameters to calibrate. Table 1 lists all of them and their calibrated values. For those parameters that we can directly match to moments in the data, we use figures from Brazil, which is the focus of our simplified case study.

First, we start with the description of the more conventional parameters, whose values we take from the literature on nominal DSGE models calibrated or estimated for emerging economies. We set the inverse of the intertemporal elasticity of substitution (σ) to 1 and the inverse of the labor supply elasticity (ψ) equal to 2. The value of the export price elasticity (v^*) commonly varies from the fairly inelastic 0.6 in Cúrdia (2008) and Cook (2004) to perfectly elastic in Devereux, Lane, and Xu (2006) and Braggion, Christiano, and Roldos (2009). Perfect elasticity is also true for most of the papers in the emerging market real business cycle literature, where the world is assumed to absorb any quantity exported at the international price. Here we follow Céspedes, Chang, and Velasco (2004), Gertler, Gilchrist, and Natalucci (2007) and Elekdag, Justiniano, and Tchakarov (2006) and choose a median value of 1. With respect to the nominal part of the model, in line with the estimations in Elekdag, Justiniano, and Tchakarov (2006), we use 2/3 for the degree of price stickiness (α_p) and 8 for the elasticity of substitution across the different varieties of home goods (η).

To calibrate the labor coefficient in the production function (α), the preference

bias for home goods (δ) and the share of home goods in the production of capital goods (δ_k), we use the Brazilian national accounts. These coefficients are set, respectively, to 0.80, 0.967 and 0.50 to match the GDP share of investment expenditures (0.20), of imported consumption goods (0.02) and of imported capital and inputs (0.10). All these shares were computed from post-1995 data, after the economy was stabilized by the Real Plan. For the elasticity of substitution in the production of capital goods, we follow Gertler, Gilchrist, and Natalucci (2007) and consider a small degree of substitutability (0.25). This is particularly important in the short time horizon of the crisis that we consider here.

To obtain the leverage ratio of firms for the steady-state debt-to-assets ratio of the wholesale firm (d_w), we first consider Brazilian firm level studies²¹ that have computed an average ratio of debt-to-assets of about 0.35. These studies are, however, somewhat outdated, with the most recent one covering firms only up to 2004. Since then, the volume of corporate credit as percentage of GDP in the country has almost doubled. Therefore, we consider a rate of 0.5, a number close to the value used by Devereux, Lane, and Xu (2006), which is itself based on firm-level studies for Asian economies. In the case of trading companies, we set the steady state foreign debt-to-assets ratio (d_e^*) to 0.97, which implies that the steady-state amount of export-related trade finance credit lines equals 0.12 of the quarterly GDP. This is consistent with the average value of trade finance debt in the data ranging from 2006 to 2010 and represents approximately 1/5 of the total amount of foreign debt in Brazil. Note that, in the steady state, exporters do not borrow in the domestic market ($d_e = 0$).

We now turn to the less traditional parameters regarding the financial portion of the model. The leverage ratios d_w and d_e^* determined in the previous paragraph

²¹Terra (2003) and Bonacim, Ambrozini, and Nagano (2006).

pin-down, respectively, the coefficients κ_w and κ_e to 0.0047 and 0.00034. The fraction of managers who stay in their group (θ_w and θ_e) are set such that the average life of a firm is 10 years.

For given values of ξ and η_e , calibrating the two steady state-values for the domestic and international spreads sets, respectively, the $\tilde{\Xi}$ term in the domestic credit supply curve (1.6) and the $\tilde{\psi}_e^*$ coefficient in the international credit supply curve (1.5). For both rates, we consider proprietary data – provided by four large cap banks operating in Brazil – on the spreads charged on loans to top rated companies in the country. In the case of the international spread, we use the main short term, foreign currency denominated, trade finance credit line available to exporters. A firm can access this credit line only if it provides – not necessarily at the beginning of the loan – proof that they have performed an international trade transaction. For the domestic rate, we compute the average spreads of working capital credit lines that are denominated in domestic currency and have short term maturity similar to that of the trade finance line. The average domestic and international spreads in the data set are, respectively, 2.4% and 1.6% in annual terms, in the 2004 to 2007 period. This was a financially and economically stable time in Brazil and we use it as a proxy for a "non-crisis" steady-state measure.

For the curvature of the international credit supplies, η_e , we set it to 1, a conservative level of spread-debt elasticity. This value implies that at the steady-state, an increase of 1pp (percentage point) in foreign debt as a share of GDP raises the international spread by 0.16pp. Garcia-Cicco, Pancrazi, and Uribe (2010) estimate this number to be around 0.5pp. By assuming a smaller number, we are being conservative about how much a decrease in the leverage of exporters against the international private sector reduces the spread on its foreign debt. In the case of the domestic market (ξ), we assume in our baseline calibration that $\xi = 22$. This replicates the observed initial

increase in the domestic spread during the crisis.

In terms of the Taylor Rule followed by the monetary authority in setting the policy rate, we fix $\phi_\pi = 2$ and $\phi_y = 0.75$. These values are common in the literature and provide a good description of the flexible inflation target rule currently in place in Brazil.

Furthermore, we choose to normalize, without loss of generality, the steady-state value of output and the terms of trade to 1. The first assumption determines the household disutility of labor \tilde{L} , and the second sets the steady-state value of the exogenous component in the foreign demand for domestic goods (C_t^*). Finally, the household time discounting (β) is set to equal 0.99. This results in a 4% annual domestic policy (or saving) real interest rate, which, for simplicity, we also assume to be the international interest rate.

Finally, for the exogenous process $\tilde{\psi}_{e,t}^*$, estimating a simple AR(1) process for the international spread statistics collected by the Central Bank results in an autocorrelation coefficient of 0.93. This value is consistent with the more elaborate law of motion of sovereign spreads in Latin American countries estimated by Fernández-Villaverde, Guerrón-Quintana, Rubio-Ramirez, and Uribe (2010). Therefore, we set the autocorrelation of the shock to 0.9.

1.4 Crisis Experiment and Credit Policies

In this section, we conduct crisis experiments and study the scope for credit policies by central banks. A crisis in the model begins with a large shock to the exogenous process $\psi_{e,t}^*$ in the foreign credit supply curve (equation (1.40)). This shock is able to produce a reversal on credit flows to an emerging market economy. We start with simulations under the baseline calibration and with the implemented credit

policies.

The initial shock to the foreign credit supply implies an increase, before any adjustments in the economy, of 10 percentage points (pp) in the international spread. In equilibrium, which take into account the variations in leverages and the implemented credit policies, this implies an increase of 7pp in the international spreads in the first period of the crisis. This jump from a steady-state level of 1.6% is within the range observed in Brazilian data during the financial crisis of 2008-2009. The average rate of trade finance credit lines to exporters, compiled by the Central Bank of Brazil, shows that the spread peaked, in December of 2008, at 7.9%, or 6.4pp above the average of 1.5% that prevailed over 2006 and 2007. Similar measures using the data from privately-owned institutions further illustrate that, for firms with high credit ratings, the maximum increase was 5.7pp, while it reached 8pp for firms with intermediate ratings.

The main goal here is to assess the impact of the unconventional credit policies on the evolution of the main variables in the economy and evaluate their welfare implications. As described in Section 2, there were two main types of policies used in Brazil, and these are representative of most of what was done in developing economies. One was directed to exporters and denominated in US dollars, and the other provided liquidity to the domestic banking sector to support their lending to firms. In our model, we associate the former with a policy targeted to the trading companies and linked to their trade finance borrowing, and the latter with a policy aimed at all firms borrowing in the domestic credit market. More specifically, the two types of policies above are implemented in the model as follows:

Credit to Exporters: The central bank offers a fixed amount of a one period loan, which is denominated in foreign currency and with the interest rate set in a

competitive auction where *only* the exporters can bid. The auction process implies that the interest rate will be the market rate of the trade finance credit lines available to exporters ($R^*\psi_{e,t}^*$). In our base case, we assume that these US dollar interventions are fully funded by previously accumulated foreign exchange reserves. The importance of the source of funding will become clear below, as we relax this last assumption²².

Domestic Credit: The central bank offers a fixed amount of a one-period loan, denominated in domestic currency. The interest rate is set in a competitive auction in which *all* firms can bid. In this case, the interest rate will be the borrowing rate in the domestic credit market ($R_{b,t}$).

In determining the importance of this second policy we convert the total central bank-sponsored loans to the domestic market, $D_{g,t}$, into a reaction function to the prevailing spreads, as follows:

$$D_{g,t} = \left(\frac{1 + \Xi'_t}{1 + \bar{\Xi}'} \right)^\phi \quad (1.53)$$

with $\phi = 0.10$. This number falls, based on microeconomic evidence for the Brazilian economy, within the range of our best estimates for the impact of the domestic credit policy on prevailing spreads²³.

²²In defining the size of these interventions, we focus on the Central Bank's balance-sheet and, from it, approximate the volume of trade credit extended, measured as a percentage of quarterly GDP. Starting in the last quarter of 2008, the estimated quantities are: 3%, 2.5%, 2%, 1%, and 0.15% of quarterly GDP.

²³To calibrate for the effect of domestic credit facilities on prevailing spreads, we start by looking at evidence from microeconomic studies on the total effect of central bank reserve requirements on the average domestic spreads in Brazil. Costa (2004), in a comprehensive investigation of the Brazilian banking sector, estimates that reserve requirements account for about 10.66% of average spreads. Combining this with the 39% reduction – compared to the pre-crisis rules – in reserve requirements during the crisis, as shown by Mesquita and Torós (2010), we construct a range for the total impact of the domestic credit policy on the prevailing, post-crisis, average domestic spreads implied by our model (the model-based spreads with no credit policy can be found in figure 5a).

1.4.1 Understanding the Mechanism

The main mechanisms in the model can be understood by looking at the export and wholesale sectors during a crisis. This is done in figures 3a and 3b, where we plot the dynamics of selected variables in our baseline scenario and with credit policies. When faced with the higher cost of borrowing abroad (1st graph on the left in figure 3a), trading companies start to repay their foreign debt (3rd graph on the left of figure 3a) and switching to other sources of funding. Their alternative is to contract debt with banks in the domestic market (2nd graph on the left of figure 3a). In terms of the model, this means that the Euler equation (1.33) now holds as an equality.

The exporters' transition into domestic debt financing propagates the shock to other sectors in the economy through two channels. First, it puts pressure on both lending (3rd graph on the left in figure 3b) and borrowing rates (1st graph on the right in figure 3a). With higher rates, the demand for goods from borrowers – investments by the wholesale firms (2nd graph on the left of figure 3b) – and lenders – consumption by the households (1st graph on the right of figure 3b) – decreases. The second transmission conduit comes from the balance of payments: the repayment of foreign debt stresses the exchange rate (3rd graph on the right of figure 3a). Given the high share of imported capital goods, that mainly causes a further decline in investments.

Firms in the wholesale sector are affected by both channels, as figures 3a and 3b clearly demonstrate. The higher borrowing rate increases the required future return on capital. More importantly, the fall in the demand for domestic goods, coming from higher rates and the adjustment to the balance of payments, decreases the current return on capital and, as a consequence, the net worth of wholesale firms. This last effect amplifies the initial shock because the wholesale firms now need to borrow more in the domestic market as well, further increasing the local rates and reducing domestic

demand. It also disseminates the shock, as in the "financial accelerator" literature, because the net worth of these firms takes several periods to recover.

Overall, the initial declines in output, consumption and investment can be significant. In the quarter of the impact, they fall, at annualized rates, in the range of about 4% to 6%. Moreover, even though they start to recover in the next few quarters, these variables remain below their steady-state levels for a significant period. These facts, together with the increase in net exports, are robust empirical effects of shocks to the external supply of credit that our model, as well as most previous models in the literature, can replicate.

There is, however, something fundamentally different about our model: it accounts for the domestic credit frictions that characterize most developing economies. In figure 4, we highlight the importance of this through the behavior of a set of basic economic variables under three separate situations: (i) our baseline case, already seen in figures 3a and 3b, which assumes the highest level of spread-debt elasticity; (ii) a case where there is no distortion in the domestic market, as described in Section 1.3.1; and (iii) an inelastic spread-debt relation ($\xi = 1$), which represents an environment with low distortion. A comparison between the domestic spreads' schedules for the baseline scenario and the no-distortion setting shows that the borrowing rates can increase significantly with the financial frictions (2nd graph on the right of figure 4).

Because of this feature, our setup, unlike most existing models, can ease the effects of the crisis on both the economy's base interest rate and CPI inflation, despite the fact that it does not account for the full size of the Brazilian credit market²⁴ or for the demand reducing terms of trade of shock. In most emerging market economies, both

²⁴The full size of the Brazilian credit market was 120% of the quarterly GDP in 2008. Our model, which looks only at a specific part of the corporate sector debt accounts for a credit volume of 22% of GDP.

the policy rate (lending rate) and inflation declined during the financial crisis of 2008-2009. In the traditional framework, without domestic credit frictions, this simply cannot happen: the unique interest rate rises with the increase in the international spread. In our model, the lending rate also increases when the financial frictions are low (inelastic spread-debt case). However, the higher the value of ξ , the smaller is the increase. If the domestic financial system can only increase lending with sizeable increases in spreads, as one might suspect to be true in the short run in emerging economies with less developed financial markets, the policy rate might actually decrease. Our baseline scenario does not introduce enough distortions to generate this behavior for longer periods, but the rate decrease in the first period of the crisis and comparison across schedules clearly demonstrates that it goes in the right (data defined) direction.

The intuition for the above result is simple. The policy rate reacts to inflation and output. The drop in GDP pushes the interest rate down. The exchange rate depreciation, however, increases inflation and, hence, requires a higher interest rate. But larger spreads decrease the demand for goods from borrowers, reducing inflation and, as a consequence, lowering interest rates. If this last effect is strong enough, the policy rate will fall. In terms of inflation, our model goes in the same direction, with smaller increases for higher values of ξ . It is important to note that the increase in net exports follows immediately from the depreciation of the nominal (and real) exchange rate in the model, whereas it has more of a J-curve behavior in the data. This is to be expected, given that we are not controlling for the setup (adjustment) costs of international trade and that we assume away the significant terms of trade shock suffered concomitantly by the Brazilian economy. The instantaneous jump in net exports and the lack of deflationary pressures, in the model, from a drop in commodity prices (a demand shock for a commodity exporter) can partially account for this deviation of inflation from the data.

Finally, with a more detailed description of how the initial credit shock propagates into the economy, we can address the question of why targeting credit to exporter or to the domestic credit market in general, as implemented by various central banks, might be important or not. This is the main question of the paper, which will be addressed in the next section, and the framework of previous models in literature could not deal with it.

1.4.2 Discussion of the Credit Policies

We now turn our attention to the main question of the paper and evaluate the effectiveness of credit policies in the context of sudden stops. The aim of these policies is to alleviate conditions in credit markets: the credit facilities to exporters target the market for foreign loans and the domestic credit auctions aim at the market for domestic loans. A first observation is that, as mentioned before, in both cases, the central bank provides credit at the market rate. The only operating channel of any intervention is its general equilibrium effect on spreads as the volume of intermediation by the private sector varies.

We also point out that abstract from direct costs associated with the credit procedures of the central bank. An underlying assumption is that the central bank doesn't need to impose these costs on the borrowers. To the extent that, as it will become clear, some of our results are that certain policies would reduce welfare, the presence of central bank costs should only strength those conclusions. The absence of these costs are also less important for questions about the different benefits of different policies, another point that we emphasize in the discussion below.

A final important consideration is that our analysis is restricted to the periods during and after the crisis. For example, we ignore the effects that the knowledge that a

sudden stop can occur would have on the behavior of agents before it happens. This is true, even though the implementation of some of the policies might depend on actions (for example, the accumulation of foreign reserves by the central bank) taken prior to the crisis. A complete assessment of the policies should consider these aspects. We leave those issues for future research, but one should keep in mind this caveat while reading the results below.

Credit to Exporters

Figure 5 presents the counterfactual implications of removing each of the two policies, one at a time ("no domestic credit" and "no credit to exporters") and, then, of eliminating all interventions in the credit markets ("no credit policy"). In the case of credit to exporters, one can see that by providing an alternative source of funding, the central bank allows exporters to repay a larger fraction of their foreign debt. In equilibrium, this reduces the international spread. Since previously accumulated foreign reserves are used to fund the central bank loans, the repayment of external debt does not, however, put pressure on the exchange rate.

The wholesale firms also benefit from the credit to exporters policy through two channels. First, exporters contract less debt in the domestic market, and, as a result, they do not generate as much strain on local spreads. Second, a lower international spread reduces the costs of exports for any given level of exchange rate depreciation, and, as a consequence, increases the overall demand for the home good. The profits and the net worth of the wholesale firms also rise accordingly. This last effect improves their balance sheets and, hence, their capacity to invest. This further increases the demand for home goods and helps reduce local spreads.

On the whole, the policy has significant impacts. Aggregate variables such as real GDP, consumption, and investment improve (figure 5b) by as much as 0.5% in

the first quarter of the shock when compared to the "no credit to exporters" case. In terms of welfare, measured as the steady state consumption equivalent and presented in Table 2, the policy reduces the negative impact of the crisis by 36% (from -0.0293% to -0.0187%). It should not come as a surprise that providing credit to exporters is an effective countercyclical tool in the case of a sudden stop in the trade finance credit lines. The initial shock is a negative shift in the supply of external credit to domestic firms. By offering its previously accumulated foreign exchange reserves, the central bank is effectively replacing part of the more expensive external credit lines.

To assess the key role played by foreign reserves, Figure 6 shows what would have happened had the central bank provided credit to exporters by issuing domestic bonds to households, instead of using foreign reserves to fully fund its operation. Exporters would still have repaid a significant fraction of their foreign debt, but, without being compensated by a reduction in the central bank holdings of foreign reserves, this movement would have resulted in a net negative outflow of capital. As a consequence, both the real interest and the exchange rate depreciation would have risen further to decrease the domestic absorption (consumption and investment). In addition, the exchange rate depreciation would have caused higher inflation. Under the baseline calibration, these combined effects reduce welfare (Table 2), when compared with the case with no policy intervention. Note that with flexible prices, the policy would improve welfare. However, given that in most emerging economies inflation stabilization is the most important objective of the central bank (in fact, as noted in the introduction, many countries adopt an "inflation targeting" regime), we consider the baseline calibration to be the more relevant case.

To show how crucial is the correct assessment of the behavior of domestic credit spread is for the design of credit policies, we consider the case where there are no domestic frictions, as defined in section 1.3.1, and the case in which the domestic

spread is debt inelastic ($\xi = 1$). The most interesting conclusion from this exercise is that in both cases only the use of foreign exchange reserves matters. The intuition is straightforward: in the absence of domestic frictions, it doesn't matter where in the economy the central bank injects resources, as funds will always end up where they are most needed.

We highlight this point by comparing two policies: (i) credit to exporters funded with foreign reserves ("credit to exporters"), as in the baseline scenario, and (ii) selling foreign reserves in the spot market and transferring the proceeds to the households as a tax rebate ("tax rebate")²⁵. To make the analysis more straightforward, we also include the case without any credit policy. As can be seen in Figures 7a and 7b, the only difference between the policies is that, with a "tax rebate", the financial liabilities the trading companies sustain against the domestic private sector are higher in comparison to the case where the central bank provides credit to exporters. However, this difference is irrelevant in the absence of domestic frictions or in the debt inelastic case. In both situations, the spreads remain constant (at zero in the case of the former). As a consequence, the equilibrium paths of all the relevant variables – foreign borrowing, international spreads, GDP, exchange rate, as well as all other variables in the model – are the same for both policies.

Finally, these results also indicate a specific reason for central banks to accumulate foreign reserves in "normal" times (i.e., prior to the crisis): to be able to lend to exporters during the crisis. Note also that the social benefit of reserves accumulation would be higher than the private one because by providing credit directly to exporters during the crisis, the central bank can avoid the inefficiencies in the domestic financial intermediation. This result goes along the lines of the precautionary argument for for-

²⁵If, instead of a tax rebate, we consider a reduction in the government domestic debt, the results are the same.

eign reserves accumulation (see, for example, Jeanne and Ranciere (2006), Aizenman and Lee (2007) and Jeanne (2007)).

Domestic Credit

The goal of the intervention in the domestic market ("domestic credit") is to improve the allocation of funds between domestic savers and borrowers. In our economy, the domestic spread is the result of the private financial system's inefficiencies in coordinating this allocation. In that sense, comparing, for example, the plotted lines for "no domestic credit" and for the "baseline" scenario in Figure 4a, we can see that the policy achieves its objective. However, we find no impact at all in the volume and spread of foreign debt, and only modest implications for GDP, consumption and investment.

Moreover, our results indicate that providing domestic credit might reduce welfare. The first reason for this is that the policy can conflict with other objectives of the central bank. More specifically, by improving the local financial intermediation, the central induces a higher level of domestic borrowing, which facilitates the repayment of the foreign debt. As a consequence, net capital outflow increases, putting pressure on the exchange rate and, due to the pass-through effects of currency depreciation, raises inflation. In the baseline calibration, the nominal frictions imply that this chain of events reduces welfare from -0.01767%, with no domestic credit, to -0.01867% with both policies (Table 2).

The impact is smaller if we assume flexible prices, but the policy still reduces welfare because exchange rate movements can have effects beyond their impact on inflation. For example, as discussed above, capital goods contain a larger share of imports and, hence, their real price index is more affected by currency depreciations. The last column in Table 2 shows that if the consumption and capital composites

contained the same weight of imports, domestic credit would improve welfare.

Finally, it is important to point out that all these welfare results are similar when we consider a larger volume of intervention in the domestic credit market, as can be seen in the last row of Table 2.

Two Broader Lessons for Credit Policies in Emerging Markets

Domestic frictions matter for the design of credit policies.

This statement comes as no surprise: credit policies play a role because of financial frictions in the private sector. The interesting aspect is that, in emerging markets, the policies were implemented in response to a shock in the foreign supply of credit, where international financial frictions faced by the economy are usually viewed as being the central ones. These international imperfections are the focus of a vast literature on the importance of financial frictions in emerging market economies. In fact, in most cases, the domestic market is assumed to be perfect (or irrelevant) and, hence, can be completely ignored. That approach is justified when the focus is not on credit policy, for economies with insignificant domestic financial markets.

But, as we showed above, ignoring the empirically observed domestic frictions can be misleading when considering credit policies. In particular, one could erroneously conclude that there is *no need for credit policy* at all as the central bank could achieve the same results by simply selling foreign exchange reserves in the spot market and transferring the proceeds of the auction to the households. Given how cautious some countries are in their use of international reserves (Aizenman and Sun 2009), it is clear that considerations of the type we study here are significant to the problem.

We are not, of course, the first to note that domestic financial frictions matter to understand policies in the presence of sudden stops. Caballero and Krishnamurthy (2001) point out that a financial crisis in emerging economies can be originally caused

by a shock to the quality of their international collateral. But it is the scarcity of domestic collateral that justifies the precautionary accumulation of foreign exchange reserves by the central bank, as well as its use during a crisis. More closely related to our conclusions, Calvo (2006) suggests that “for the success of this surgical operation [central bank directly channel international reserves to sectors which, on net, display a positive marginal social return to the use of international reserves], it is necessary for the central bank to be well on top of developments in domestic credit markets”.

The mere fact of an increase in credit frictions does not necessarily imply that central bank credit policy will raise welfare

We saw two examples where credit policies (credit to exporters partially funded with reserves, and domestic credit) facilitated the allocation of funds between domestic borrowers and savers, but did not improve welfare – they actually did the opposite. This happened because the policies increased – each in their own way – the pressure on the balance of payments, as exporters could more easily borrow in the domestic market to repay their foreign debt. If foreign exchange reserves are not used to counterbalance the strain on currency markets, the resulting exchange rate depreciation and higher inflation decrease welfare.

Similar effects have been previously emphasized in the literature. For example, Obstfeld, Shambaugh, and Taylor (2010) consider a model in which the provision of domestic liquidity by the monetary authority to support the domestic financial system during a bank run “...magnifies the potential claims on official foreign exchange reserves, and hence magnifies the currency depreciation...”. In their model, this observation justifies the hoarding of large sums of foreign exchange reserves by emerging economies.

This point is worth emphasizing because policies designed to act exclusively upon the inefficiencies of the domestic financial markets are exactly the ones recommended

in most works for closed economies – or at least for developed economies. In particular, this is the case of the recent literature addressing the responses of the US Federal Reserve during the great recession of 2008-09. For instance, Geanakoplos (2010) argues that, in a model of margins requirement and collateralized debt, "[t]he Fed must step around the banks and lend directly to investors, at more generous collateral levels than the private markets are willing to provide". Gertler and Karadi (2011) use their "model to evaluate the effect of expanding central bank credit intermediation to combat a simulated financial crisis ", and conclude "that the welfare benefits may be substantial if the efficiency costs of government intervention are modest". Cúrdia and Woodford (2010a) also describe assumptions under which a disturbance that increases credit spreads would justify central bank lending to private non-financial borrowers.

What our results show is that those policy recommendations depend on the financial structure that is assumed. For many emerging markets, given the structure of their economies and how the crisis reached them, the most effective credit policies are of a different type. They must be funded out of previously accumulated foreign exchange reserves and are most appropriately targeted to the export sector.

1.5 Conclusion

Crises have long been fertile ground for economic theory. The last global installment, over 2007-2009, was certainly no exception. Macroeconomics, in particular, benefited not only from the emergence of a new set of questions searching for answers, but also from the resurgence a whole repository of controversies that many believed to have been pacified: “what should the instruments of monetary policy be?”, “do credit policies have a role to play in the management of economic crises?”, “do we really un-

derstand all the functions of foreign-exchange reserves' accumulation?", "what financial frictions should be taken into account when dealing with sudden stops?". These are but a few topics that have either resurfaced or gained centrality in academic research agendas as a direct consequence of the latest crisis.

Our paper belongs to this broader agenda. More specifically, we have tried to answer the following important question: were the credit policies implemented, during the recent crisis, by several developing economies useful in dealing with the economic effects of the sudden stop in international credit flows?

To answer this question, we've built a quantitative small open model with two imperfect credit markets, one domestic and the other international. This innovation delivers a financial market entrance differentiation that exists in many developing economies: while domestic credit markets are open to most firms, only some specific companies (trading companies or exporters) have access to foreign borrowing. It also allows shocks to the foreign supply of credit to affect domestic spreads through a simple mechanism: firms that previously borrowed abroad turn to the local credit market for funding to a great extent and, hence, increase the cost of domestic loanable funds. This works as a clear, but seldom highlighted, transmission mechanism for the external crisis, as the jump in spreads in both markets raises financing costs for all borrowers in the economy and depresses output.

Our main findings suggest, first, that it can make sense for the central bank to provide credit directly to exporters, (even) at the prevailing market price. Not only does this restrain spreads, increasing GDP, but it also generates an unambiguous welfare improvement, as long as the intervention is funded out of previously accumulated foreign-exchange reserves. After all, by providing a cheaper alternative of foreign credit to exporters during the crisis, the credit facility generates positive general equilibrium effects on spreads as exporters reduce the amount of debt contracted with the private

sector, without having a government in search of new funding to fill that gap.

Without the use of reserves to fund the operation, however, credit facilities to exporters would have reduced welfare in our model, as the incentive to repay their foreign debt would pressure the exchange rate, without providing much relief for domestic spreads. Inflation would, consequently, creep up to undesirable levels. This result shines a new light in the large literature on the accumulation and management of foreign-exchange reserves, as it is the first to demonstrate, in a quantitative macroeconomic model, that using foreign reserves to provide credit to exporters during a sudden stop can improve welfare.

Our second finding deals with policies aimed more generally at the domestic market, and it suggests that, even though they are effective in reducing domestic spreads, their upshot on welfare will be negative. Much like in the case without the use of reserves, the incentives towards repaying foreign debt are distorted and the resulting capital outflow weights on the exchange rate and, consequently, on inflation. As was pointed out before, however, this result should be viewed with caution. There are many – potentially good – reasons to intervene in the domestic credit markets, such as avoiding possible bank runs. These have been thoroughly studied in the literature and are not the subject of our investigation here. With this caveat in mind, nevertheless, one can clearly understand the importance of this negative result, as some developing economies engaged in domestic credit market interventions with the unmistakable (and apparently wrong-headed) objective of reducing spreads to all firms.

Finally, we highlight the importance of accounting for domestic financial frictions by showing that, in their absence, the central bank has no reason to engage in any kind of credit policy. Comparing a policy of direct credit to exporters, funded with foreign-exchange reserves, with a policy of selling foreign reserves in the spot market and rebating the proceeds to the households, we find that both approaches are equivalent in

an economy with perfect domestic financial markets. Without frictions or if domestic spreads are positive but remain constant during the crisis, it does not matter where in the economy the central bank injects resources, because they will always end-up where they are most needed.

Overall, our findings suggest that intervening only in domestic credit markets, or engaging in more general credit policies without the necessary backing of foreign-exchange reserves, is not a good recipe for dealing with sudden stops in capital flows. Credit focused at the more affected sectors in a developing economy – mainly the export-import firms, which use more borrowing to fund their operations – can be quite helpful during a crisis, as long as the central bank funds its actions with reserves hoarded before the crisis. In designing these policies, however, one needs to account for the fundamental aspects in the economy, like the observed, crisis-induced increase in domestic spreads.

Major revisions in the pre-established consensus are, obviously, important. Credit interventions seem to have been an effective countercyclical, welfare-improving policy during the financial crisis of 2008-09, in emerging economies. However, this general statement does not apply to all cases, and some misguided interventions can clearly reduce welfare. The one fundamental lesson that comes out of our analysis is that the desirability or not of engaging in credit policies depends crucially on their implementation. A deep understanding of the economy's fundamental characteristics should, therefore, be an absolute requirement before considering any deviation from the usual, time-established economic policies.

1.6 Tables and Figures

Table 1.1: Parameters in the Model

The table describes all the parameters in the model and their baseline calibration

Parameter	Value	Description
<i>Conventional parameters calibrated from the literature in emerging market economies</i>		
σ	1	inverse of the intertemporal elasticity of substitution
ψ	2	inverse of the labor supply elasticity
ν^*	1	exports price elasticity
η	8	elasticity of substitution across the different varieties of home goods
α_p	2/3	probability of a retail firm not being able to adjust its price
ρ_k	0.25	elasticity of substitution in the production of capital goods
ϕ_π	2	response of the policy rate to inflation
ϕ_y	0.75	response of the policy rate to output
<i>Parameters calibrated to match moments of the Brazilian data in the steady state</i>		
α	0.80	share of labor (set to match the GDP share of investment expenditures: 0.20)
δ	0.967	home good bias (share of imported consumption goods: 0.02)
δ_k	0.50	home good bias in capital goods (share of imported capital and input: 0.10)
Ξ	-	domestic credit supply curve (domestic spread at 2.4% in annual terms)
Ψ_e	-	foreign credit supply curve (international spread at 1.6% in annual terms)
κ_w	0.0047	start-up in the wholesale sector (net worth – assets ratio at sector at 0.5)
κ_e	0.00034	start-up in the export sector (net worth – assets ratio at sector at 0.03)
<i>Less Conventional Parameters</i>		
ξ	22	domestic spread volume elasticity
η_e	1	international spread leverage elasticity
θ_w	0.975	fraction of wholesaler staying in their group (average firm life: 10 years)
θ_e	0.975	fraction of exporters who stay in their group (average firm life: 10 years)
<i>Other parameters</i>		
L	1.552	disutility of working (normalizes the steady-state output to 1)
C*	0.12	foreign demand (normalizes the steady-state terms of trade to 1)
β	0.99	time discounting (steady-state policy rate to 4% annual terms)

The figure shows the performance of selected variables from 2007 to 2010. The vertical line mark the jump in the international spread faced by Brazilians firms that occurred when Lehman Brothers went bankrupt.

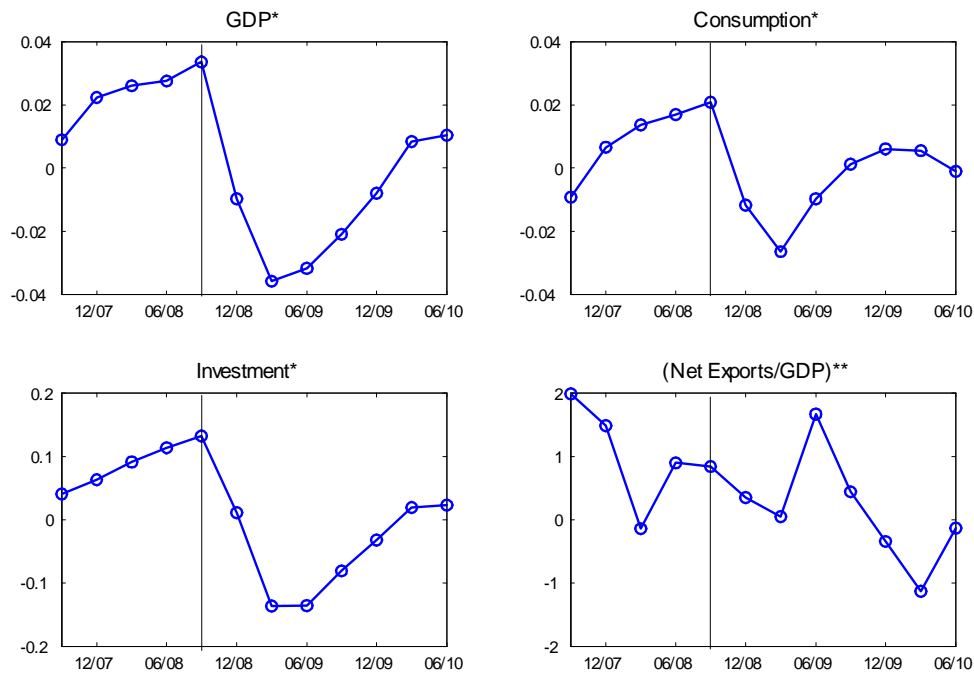


Figure 1.1: Figure 1a - The Financial Crisis of 2008-09 in Brazil

*Quarterly data, log scale and detrended. ** Quarterly data.

The figure shows the performance of selected variables from 2007 to 2010. The two vertical lines mark two jumps in the international spread faced by Brazilians firms. The second and larger one, occurred when Lehman Brothers went bankrupt

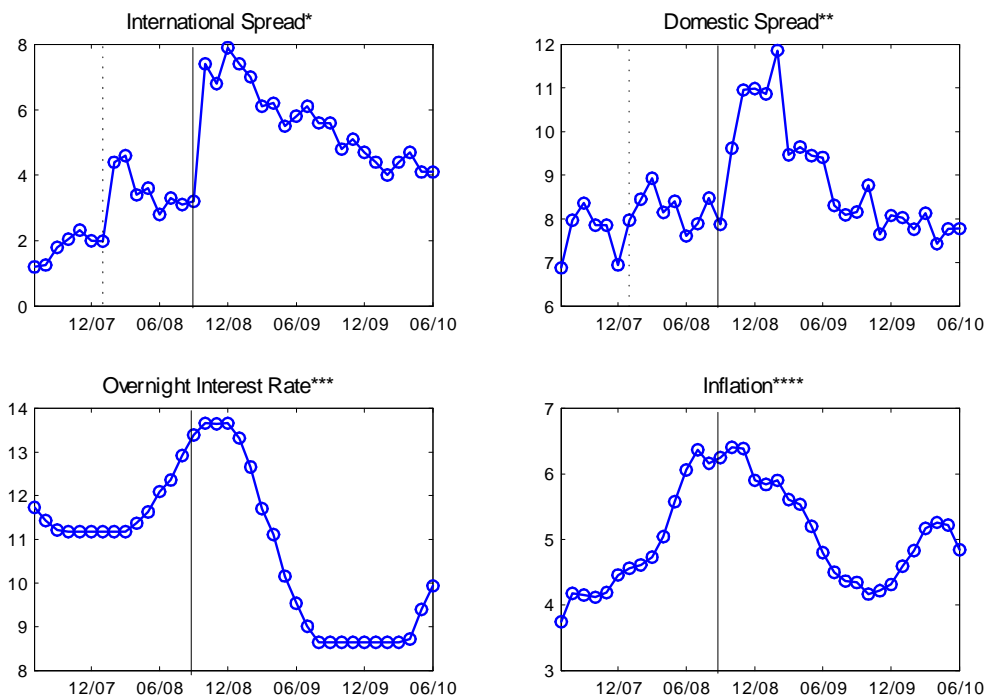


Figure 1.2: Figure 1b - The Financial Crisis of 2008-09 in Brazil (continued)

* Monthly average. Trade finance credit lines available to exporters. Spread over libor. ** Monthly average. Average of short term working capital credit lines compute by the BCB. Spread is over banks fundings costs. *** Monthly average. Policy rate controled by the BCB (minus the Fed Fund Rate). **** CPI inflation, year over year

The graph shows the spreads on trade finance (short term and denominated US\$) and domestic (short term and denominated in domestic currency) credit lines for top rating firms in Brazil. The data was provided by Brazilian banks.

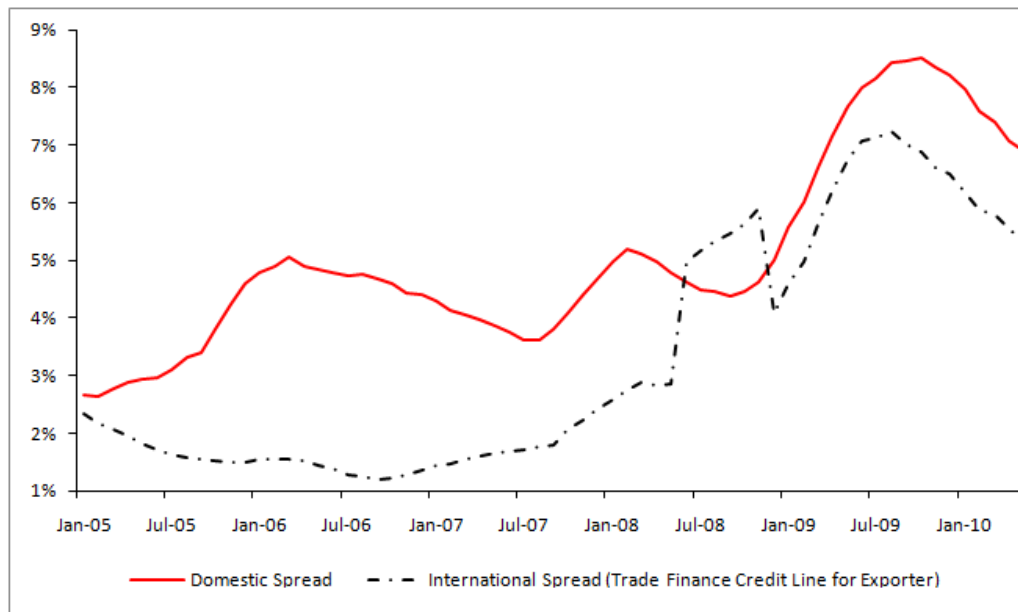


Figure 1.3: Figure 2 - Trade Finance and Domestic Working Capital Lines

Annualized spread.

The figure reports the dynamics of selected variables under the baseline calibration, including the implemented policies

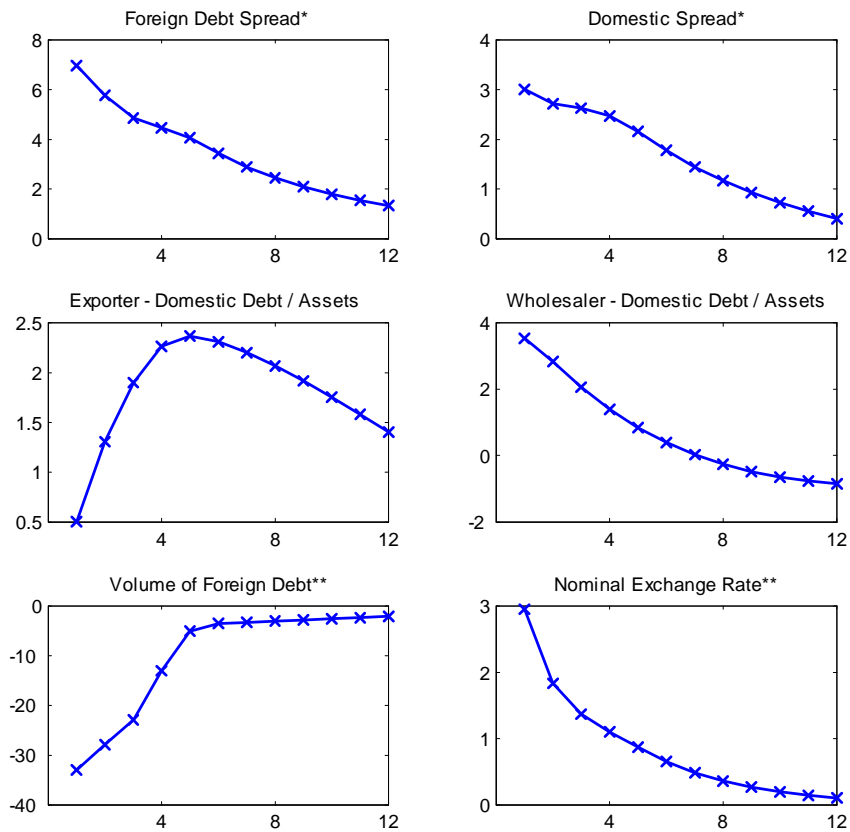


Figure 1.4: Figure 3a - Crisis Experiment - Baseline Calibration

All variables are deviations from the steady state. *Annualized(pp). ** Log deviation (%)

Same as figure 3a

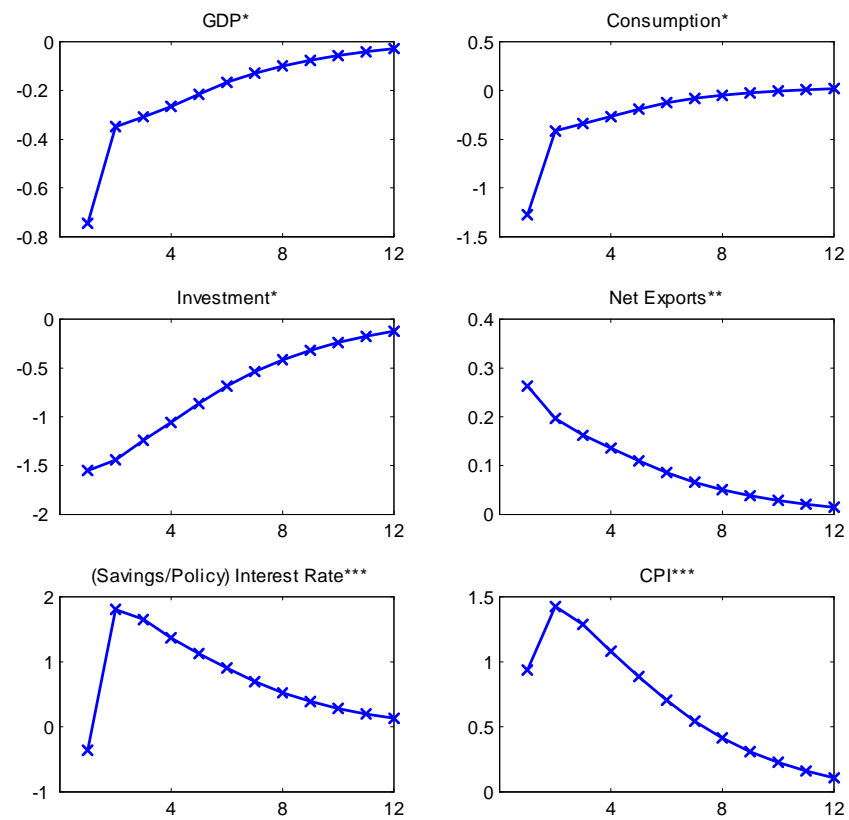


Figure 1.5: Figure 3b - Crisis Experiment - Baseline Calibration (continued)

All variables are deviations from the steady state. * Log deviation (%). ** Share of GDP (pp).

*** Annualized (pp).

"Baseline" includes the frictions, in the "no domestic friction" case the domestic market is complete and in the "debt inelastic spread" the domestic spread is inelastic with respect to the volume of intermediation.

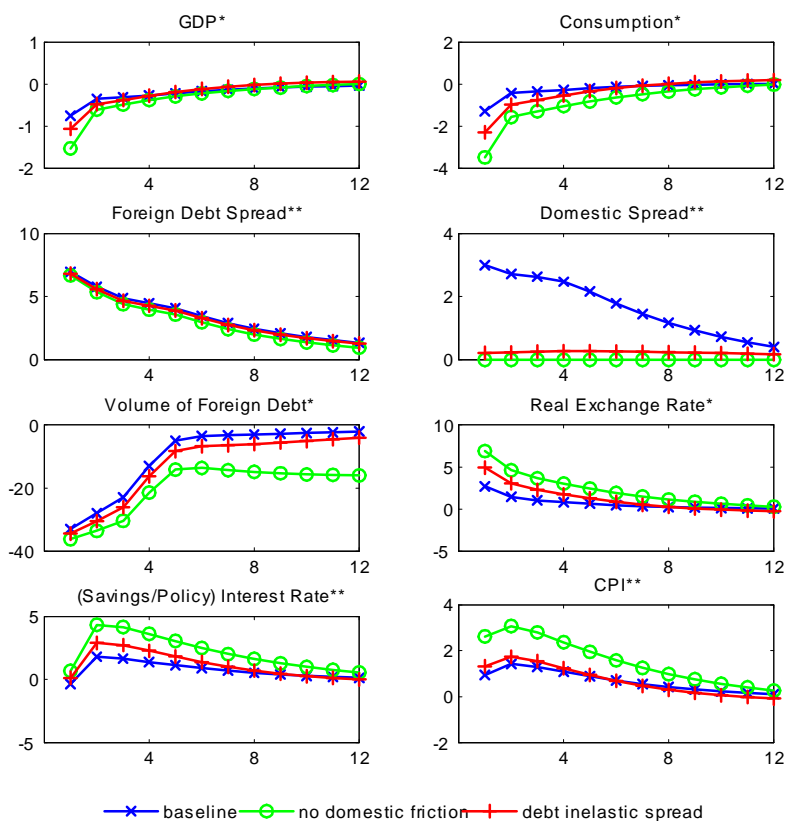


Figure 1.6: Figure 4 - Crisis Experiment without Frictions in the Domestic Financial Market

All variables are deviations from the steady state. * Log deviation (%). ** Annualized (pp).

The figure reports the dynamics of selected variables under the baseline calibration, but assumes different scenarios with respect to which credit policy is implemented.

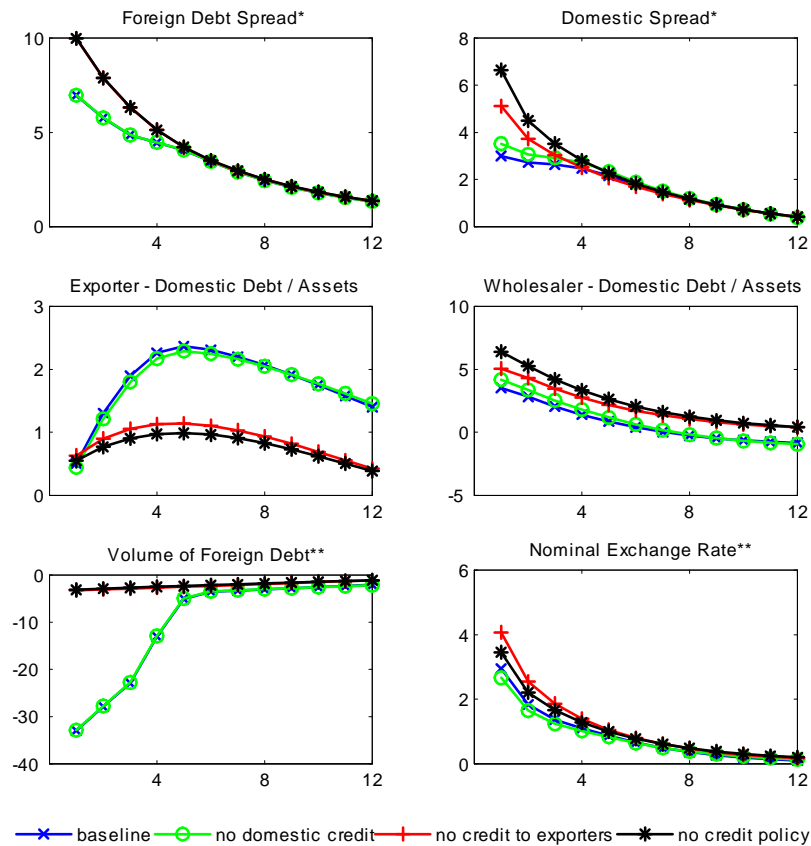


Figure 1.7: Figure 5a - Counterfactual Analysis

All variables are deviations from the steady state. * Annualized (pp). ** Log deviation (%).

Same as figure 5a

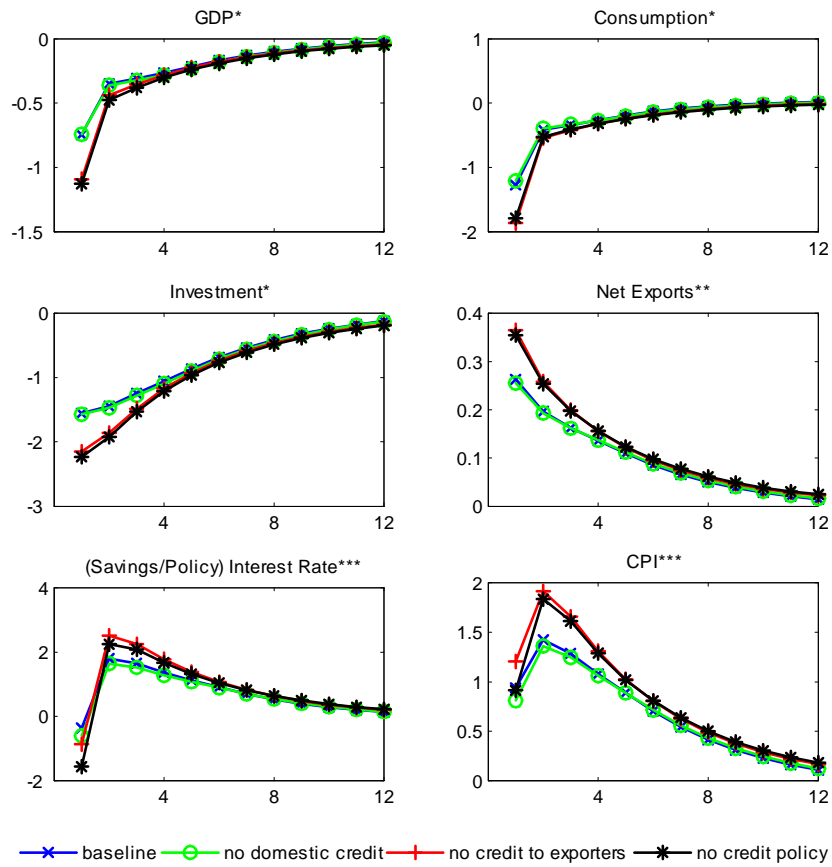


Figure 1.8: Figure 5b - Counterfactual Analysis (continued)

All variables are deviations from the steady state. * Annualized (pp). ** Log deviation (%).

In the "fully funded" case foreign reserves cover 100% of the amount of credit provided by the Central Bank, while in the "partially funded case" they cover at most 80%.

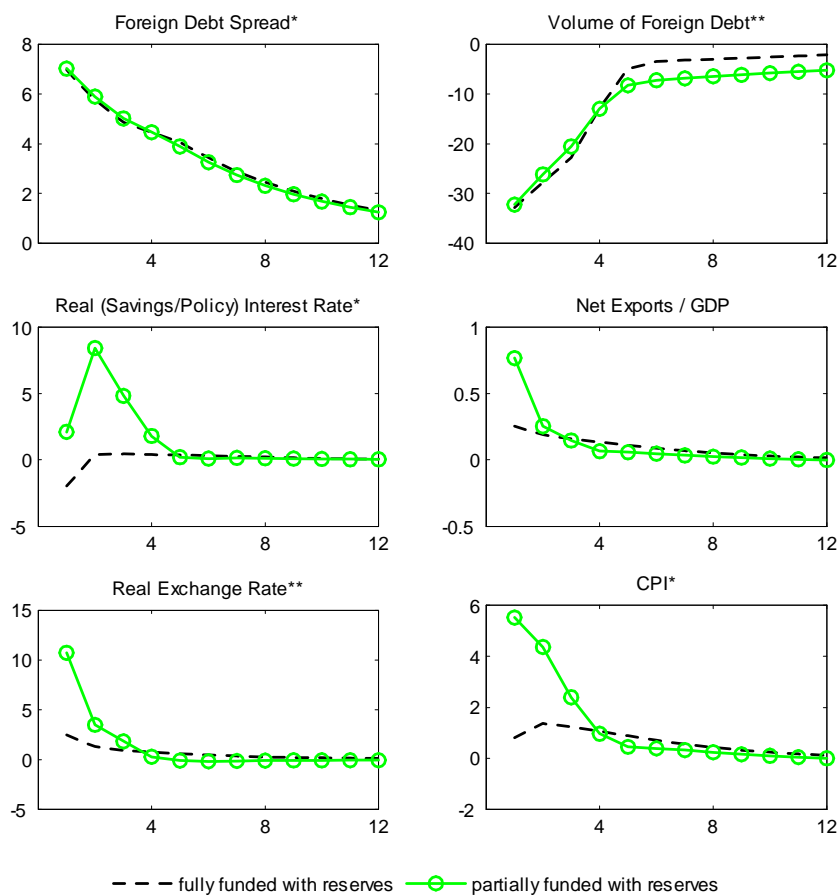


Figure 1.9: Figure 6 -Credit to Exporters and the Role of Foreign Reserves

All variables are deviations from the steady state. * Annualized (pp). ** Log deviation (%).

Three assumptions with respect to the use of foreign reserves: no change ("no policy"), lend foreign reserves to exporters ("credit to exporters"), sell reserves in the spot market and transfer the proceeds to the households as a lump sum transfer ("tax rebate").

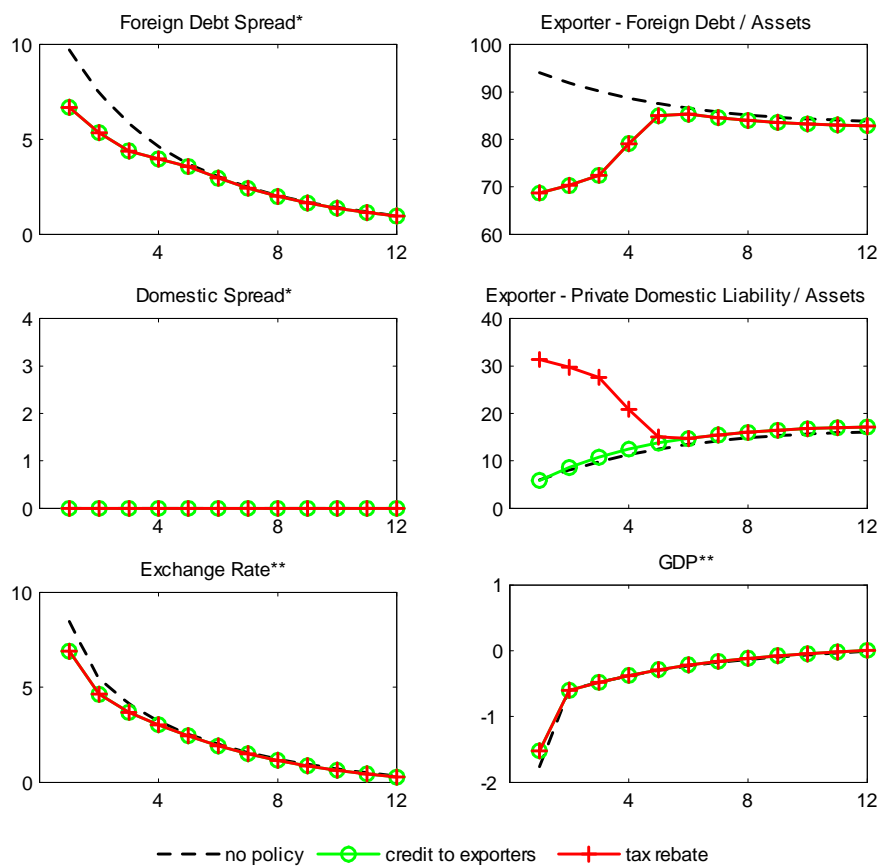


Figure 1.10: Figure 7a - Policies without Domestic Frictions

All variables are deviations from the steady state. * Annualized (pp). ** Log deviation (%).

Three assumptions with respect to the use of foreign reserves: no change ("no policy"), lend foreign reserves to exporters ("credit to exporters"), sell reserves in the spot market and transfer the proceeds to the households as a lump sum transfer ("tax rebate").

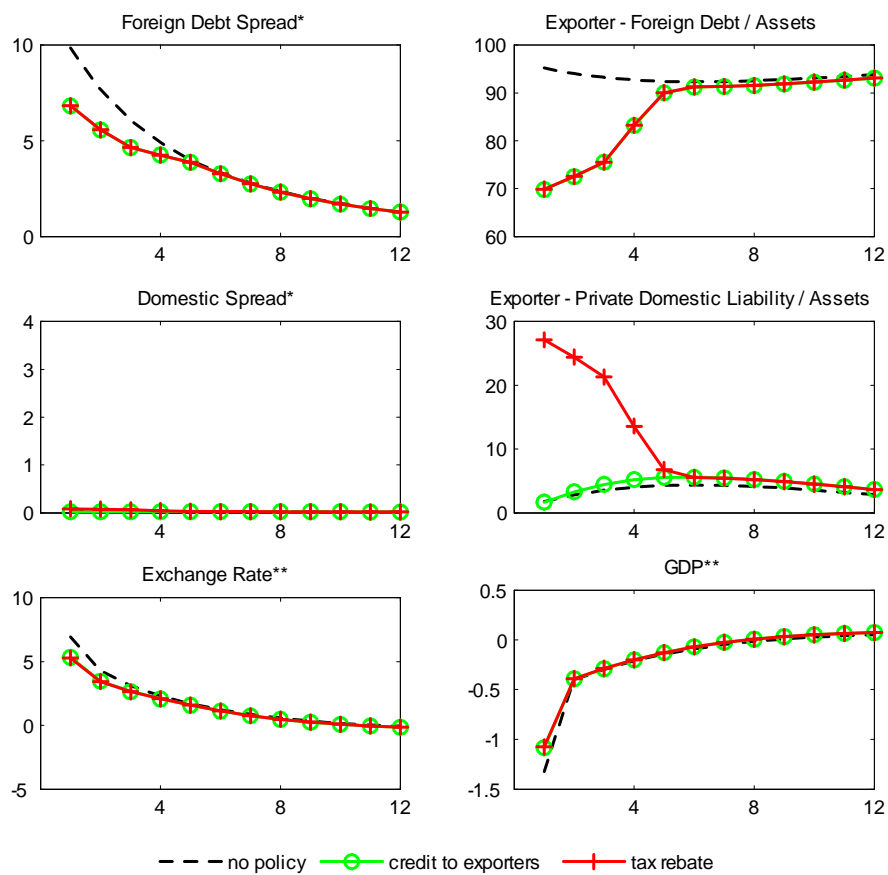


Figure 1.11: Figure 7b - Policies with Debt Inelastic Domestic Spread

All variables are deviations from the steady state. * Annualized (pp). ** Log deviation (%).

Table 1.2: Welfare Loss
 Consumption equivalent (pp). *Foreign reserves cover at most 80% of the credit to
 exporters. ** $\phi = 5$ (see equation 1.53)

	Baseline Calibration	Flexible Prices	Flexible Prices & Same Price Index
Both Credit Policies	-0.01867	-0.01318	-0.01622
No Domestic Credit	-0.01767	-0.01310	-0.01625
No Credit to Exporter	-0.02927	-0.02233	-0.02491
No Credit Policy	-0.02695	-0.02226	-0.02494
Credit to Exporter - Partially Funded*	-0.04920	-0.01296	-0.01710
Larger Domestic Credit Intervention**	-0.04050	-0.02282	-0.02393

Chapter 2

The Domestic Financial Intermediation Channel of External Shocks and Credit Policies in Emerging Market Economies

2.1 Introduction

In¹ the financial crisis of 2008 and 2009, as world output collapsed and international credit markets became dysfunctional, most emerging markets economies faced a large decline in their terms of trade (in particular commodity exporter countries), an increase in the interest rate they could borrow from abroad and a reduction in capital inflows (see Blanchard, Faruqee, and Das 2010). These shocks were no novelties for

¹I would like to thank Michael Woodford, Ricardo Reis and seminar participants in the Macroeconomics Colloquium at Columbia University for their comments

developing economies. In fact, the business cycle literature has highlighted the importance of terms of trade and international borrowing rates to developing economies (e.g, Mendoza 1995, Kose 2002, Broda 2004, Neumeyer and Perri 2005, and García-Cicco, Pancrazi, and Uribe 2010). And a large literature has studied episodes of strong reversals in financial flows (e.g, Calvo 1998, Cook 2004, Céspedes, Chang, and Velasco 2004, Calvo, Izquierdo, and Talvi 2006, Devereux, Lane, and Xu 2006, Cúrdia 2008, Braggion, Christiano, and Roldos 2009 and Mendoza 2010).

However, there were some important new developments in terms of policy reaction as policymakers in several emerging markets adopted, in most cases for the first time, a variety of specially targeted credit interventions (Ishi, Stone, and Yehoue 2009). Examples include direct acquisition of private sector securities in Korea; provision of liquidity against trade finance securities collateral in Brazil; transfer of funds from the treasury to government-owned banks so that they could increase their loan portfolios in Brazil; broadening of the list of eligible collateral for monetary operations to include commercial papers in Chile; and government guarantee programs for commercial paper in Mexico.

Central banks in developed countries also intervened in credit markets. For example, the US Fed directly injected credit into private markets (see Cúrdia and Woodford 2010a and Gertler and Karadi 2011). A common ground behind the interventions in both developing and developed economies seems to be failures in the banking system or more generally in financial intermediation. As Gertler and Karadi (2011) states “we interpret unconventional monetary policy as expanding central bank credit intermediation to offset a disruption of private financial intermediation”.

Therefore the first goal of this paper is to develop a quantitative small open economy DSGE model (SOEM) with *domestic* financial intermediation. I can then calibrate the model to emerging economies data and use it to quantify how the *external*

shocks mentioned above interact with the domestic financial sector. The final objective is then to evaluate the impact of the implemented credit policies in mitigating the initial shocks.

Note that the emphasis here is on the *domestic* part. Several SOEM incorporate financial frictions on the relation between domestic agents (households, firms or government) and foreign investors, while at the same time assume no frictions in the relation between domestic lenders and borrowers². But the credit policies we study aim to improve the intermediation among domestic lenders and borrowers.

Our domestic financial sector is an adaptation of the one in the closed economy model of Gertler and Karadi (2011). Local intermediaries take interest-rate bearing deposits from domestic and foreign savers to provide funds to firms, which use the resources to finance their investment and working capital needs. Because of a moral hazard with a costly enforcement problem, the leverage of banks depends on the spread between the expected return on its assets and the interest rate paid on deposits. Since the central bank doesn't face the same constraint, it might be able to improve the efficiency of the financial intermediation in periods of financial stress.

Even though the policies were a response to domestic frictions, the original shocks faced by emerging economies during the crisis 2008-2009 were, as mentioned above, international ones. Therefore our second goal is to identify and quantify the main channels linking terms of trade and international financial conditions to the domestic banking system³.

²See, for example, Cook (2004), Céspedes, Chang, and Velasco (2004), Neumeier and Perri (2005), Elekdag, Justiniano, and Tchakarov (2006), Devereux, Lane, and Xu (2006), Cúrdia (2008), Braggion, Christiano, and Roldos (2009), Mendoza (2010) and García-Cicco, Pancrazi, and Uribe (2010). Two exceptions are Gertler, Gilchrist, and Natalucci (2007) and Martins and Salles (2011). However, the former has frictions a la Bernanke, Gertler, and Gilchrist (1999) but no financial intermediation, while the latter doesn't focus on the balance sheet of financial intermediaries as we do here.

³Banks account for most of the financial intermediation in developing economies. Therefore we use

We consider four main channels linking these shocks to the financial sector. First, terms of trade affect the profitability of the corporate sector and hence bank's return on assets. Second, an increase in the international interest rate depresses asset prices and reduces the profit of banks. Third, international rates also affects bank's borrowing cost. And for last, exchange rate depreciations associated with both types shocks weakens the balance sheet position of banks. This effect arises from the well documented fact that most of the foreign debt in emerging economies is denominated in foreign currency. Here we assume that banks are the domestic agent borrowing from abroad. Therefore, the negative balance sheet effects occurs in the financial sector. Once the banking sector is hit by the shocks, it propagates and amplifies the initial effects.

The quantitative importance of these channels and the amplification caused by the domestic financial sector depends on the economy under consideration. In our case, we calibrate the model with data from Brazil, which has a medium size export sector (exports represent roughly 12% of GDP in our sample) and holds modest levels of foreign debt (18% of annual GDP). In this case, the domestic financial sector has the largest amplification effect in response to an increase in the international interest rate and the corresponding decline in assets price is the main channel. Within our baseline calibration, the fall in output is twice as large in the model with domestic financial frictions when compared to a model without domestic banks. But we also show that if the economy is more indebted in the international markets or has a larger export sector, the domestic financial sector can also cause a significant amplification in response to a terms of trade shock.

To quantify the importance of the intervention in credit markets we assume that central bank acquires the securities issued by the wholesale firms at the prevailing

terms like financial intermediaries and banks interchangeably.

market prices. Hence the only operating channel of any intervention is its general equilibrium effect on spreads as the volume of intermediation by the private sector varies. The reduction in spreads is possible because the central bank is not subject to the same information and enforcement frictions affecting banks. There might be other costs associated with the credit procedures of the central bank. For example, central banks are most likely less efficient than the private sector in allocating credit because of a lack of expertise and/or political reasons. The underlying assumptions here are then that these costs are high enough to discourage interventions outside crises episodes and that the central bank doesn't need to impose these costs on the borrowers. A welfare analysis needs to take those into considerations. However, at this point, we focus on the positive approach of describing the dynamics under alternative policies and abstract from a normative discussion based on welfare evaluation.

Our simulations show that the intervention can reduce by almost 30% the initial GDP fall in response to a large increase in international rates. By reducing domestic spreads, the policy increases asset prices, improve the net worth of banks, the volume of the credit and, as consequence, minimizes the impact of the shock. In the case of a negative shock to exports, the benefits of the policies are smaller. This is the other side of the small amplification role played by the domestic financial markets in response to this type of shock, under the baseline calibration considered here.

Credit interventions are most powerful against shocks that have large impact on banks balance sheets. A purely financial shock that directly affects the net worth of banks is another case in which credit interventions is effective. An example of this type of shock occurs when banks suffer heavy loss in some of its assets. In an international context, this loss could come from assets held abroad and uncorrelated with the domestic economy. During the financial crisis of 2008-09, this was an important channel propagating the US subprime mortgage crisis to Europe, as European banks suffered

large losses from their holdings in the US. The model presented here is suitable to study these transmissions mechanisms.

To further illustrate these results we perform a brief case study of Brazil in the financial crisis of 2008-09. The country faced an increase of 6% in the international spreads and a decline of 40% in the foreign currency value of exports. As a result, output, at its troughs, was -6.86% below the previous trend. Among other policies, the government transferred funds to the government-owned development bank, BNDES, so that it could increase its loans to companies. In 2009, the transfers totalled 3% of the GDP or close to 7% of the total volume of credit in the economy at the time. When we use our model to study the impact of this policy, our conclusions are mixed. We estimate that, in the first quarter of the crisis, the policy improved output (the main policy goal) by 23%, but in the second quarter, at the trough of the recession, the improvement was of only 8.7%. From then onward the impact is negligible. Initially, the interest rate was the main shock hitting the economy. But from the beginning of 2009 the decline in exports was the most important factor behind the recession. The comments above indicate that, at least in the case of Brazil, the domestic financial sector is less important in propagating this type of shock. As a consequence, the credit policy was less beneficial.

Finally, we point out that the model presented here is general and can be used to address other questions. We illustrate that by showing that it can replicate standard business cycle properties of emerging market economies with just three types of shocks: the terms of trade, the international interest rate and a domestic stationary technology shock. The model is also appropriate to discuss conventional monetary policy (interest rate setting) in the context, for example, of a strong reversal in external capital inflows (i.e. a sudden stops episodes) because it explicitly includes a domestic banking system, which is often at the epicenter of these episodes (see, for example, Kaminsky and

Reinhart 1999). Even though banks are crucial to explain the severity of sudden stops, so far, the literature has dealt with this issue only indirectly by incorporating financial frictions at the firm level. According to our experiments, the baseline Taylor rule dominates other policies in terms of GDP performance. For last, even though we calibrate the model with emerging markets economies, the structure of the model applies to any small open economy where the domestic financial sector is also important.

The rest of the paper is organized as follow. In section 2, we present the model in detail. Section 3 explores the role of the domestic financial sector. Section 4 contains the analysis of the unconventional polices, while the more conventional, interest-rate-setting policies are the topic of section 5. Section 6 is devoted to a brief case study of Brazil. We conclude in section 7.

2.2 Model

2.2.1 Outline of the Model

The model is a small open economy version of Gertler and Karadi (2011). The main feature is the presence of financial intermediaries that take interest-rate bearing deposits from domestic households and international lenders to provide capital to domestic firms. They also engage in maturity transformation as they fund themselves with one-period deposits but hold, among other assets, infinite lived securities (equity). Moreover, because of a moral hazard with costly enforcement problem, the leverage of banks depends on the spread between the expected return on its assets and the interest rate paid on deposits.

The remaining parts of the model are fairly standard. There are two tradeable goods, a domestic and foreign one, and four agents in the economy: Households choose

consumption, supply , and hold domestic bonds; wholesale firms hire capital and labor to produce the domestic good; a continuum of retailers differentiate the home good at not cost and face price stickiness à la Calvo; and capital producing companies produce new capital goods and refurbish depreciated units. The wholesale firms require capital to fund their intraperiod working capital and the investment in physical capital.

We close the model with a government entity that combines the roles of both treasury and central bank, and the usual resource constraint on home goods. The balance of payments, as always, reflects the budget constraints of all the actors. The details of the economy are spelled-out below.

Households

The households are composed of a constant fraction $(1 - f)$ of workers and a fraction f of bankers. A worker provides labor to the wholesale firms and returns her wage to the household, while a banker manages one bank and also returns her earnings – i.e, the profit of the bank she manages – to the family unit. Individuals move between the worker and banker groups. In particular, every period, a random fraction $(1 - \theta)$ of bankers become workers. To keep the fractions of each type constant, the same number of individuals, also randomly selected, become bankers. Note that, even though bankers are responsible for the operation of the banks, the household is the actual owner.

Within the household there is perfect insurance and, hence, all consumption decisions are taken at the household level. However, all the professional transactions between bankers and other agents in the economy, including those within the same household, are done at arms-length. In the case of the financial decisions of a bank, the banker is considered an insider, while the household is an outside investor.

When an individual becomes a banker, she receives a start-up equity to initialize

operations. The size of the initial net worth and the fact that a banker has a finite expected life implies that the banks always borrow to finance their investments. All of the relevant decisions relating the banks, such as the financing decision, the initial equity, the evolution of its net worth, and the aggregate per period net cash flow payments to the households, shall become clear when we discuss their problem in the next subsection. At this juncture, it suffices to say that a banker, when exiting the group, returns all remaining net worth to the households.

There are two types of consumption goods in the economy: home goods ($C_{H,t}$) and foreign goods ($C_{F,t}$). Both goods are internationally traded and preferences between them are Cobb-Douglas

$$C_t = \left(\frac{C_{H,t}}{\gamma} \right)^\gamma \left(\frac{C_{F,t}}{1-\gamma} \right)^{1-\gamma}. \quad (2.1)$$

These preferences imply that the aggregate price index P_t , and the demands for domestic and foreign goods are, respectively, given by

$$P_t = P_{H,t}^\gamma S_t^{1-\gamma} \quad (2.2)$$

$$C_{H,t} = \gamma \frac{P_t C_t}{P_{H,t}} \quad (2.3)$$

$$C_{F,t} = (1-\gamma) \frac{P_t C_t}{S_t} \quad (2.4)$$

where S_t is the nominal exchange rate, defined as the domestic price of the foreign currency, $P_{H,t}$ is the aggregate domestic price of the home good, and we normalize the foreign price level to 1.

Households can trade real government bonds and make deposits with a domestic financial intermediary. These two financial assets are both risk free and perfect substitutes. We aggregate them into a single variable B_t . The consumption (C_t), bond holdings and labor (L_t) decisions are given by maximizing the discounted expected

future flow of utility

$$Max E_0 \sum_{t=0}^{\infty} \beta^t \left[\left(C_t - \tilde{L} \frac{L_t^{1+\psi}}{1+\psi} \right)^{1-\sigma} / (1-\sigma) \right] \quad (2.5)$$

with respect to $\{C_t, L_t, B_t\}$, subject to the budget constraint

$$P_t C_t + P_t B_t \leq W_t L_t + P_t R_{t-1} B_{t-1} + \Pi_{f,t} - T_t \quad (2.6)$$

where W_t is the wage, R_t is the real interest rate received from holding one period bonds, $\Pi_{f,t}$ is the aggregate net cash flow from all the financial and non-financial firms owned by the household and T_t is a lump sum tax. Following a common practice in the emerging market literature, utility is defined as in Greenwood, Hercowitz, and Huffman (1988). This assumption eliminates the wealth effect on labor supply by making the marginal rate of substitution between consumption and labor independent of consumption.

The Euler equation and labor supply are given by

$$E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} R_t \right] = 1 \quad (2.7)$$

$$\frac{W_t}{P_t} = \tilde{L} L_t^\psi \quad (2.8)$$

where

$$\lambda_t = \left(C_t - \tilde{L} \frac{L_t^{1+\psi}}{1+\psi} \right)^{-\sigma} \quad (2.9)$$

is the marginal utility of consumption.

Domestic Financial Intermediation

A continuum of identical banks, indexed by j , raise one-period, interest-rate-bearing deposits (i.e. short term debt contracts) from domestic households and/or

international investors to fund the wholesale firms. The financial intermediaries are owned by the households and operated by the bankers within them. A specific bank has two sources of funds: the internal accumulation of profits and the debt contracts issued to households and foreign investors.

Let $N_t(j)$ be a given net worth level of a bank j at period t . The balance sheet constraint imposes that

$$S_{K,t}(j) = N_t(j) + D_t(j) \quad (2.10)$$

where $S_{K,t}(j)$ is the value of the securities issued by wholesale firms acquired by bank j and $D_t(j)$ is the total amount of debt issued by bank j .

The next period net worth of a currently existing bank is given by

$$N_{t+1}(j) = (R_{S,t+1} - R_{D,t+1}) S_{K,t}(j) + R_{D,t+1} N_t(j) \quad (2.11)$$

where $R_{S,t+1}$ is the real rate of return on assets and $R_{D,t+1}$ is the average real rate paid on deposits.

As long as $E_t(R_{S,t+1} - R_{D,t+1})$ is positive, the banker will keep accumulating assets and will return the profits to the household only when she exits the sector. As consequence, the value of the bank is giving by

$$V_t(j) = E_t \left\{ \sum_{i=0}^{\infty} \beta^{1+i} \theta^i (1 - \theta) \frac{\lambda_{t+1+i}}{\lambda_t} N_{t+1+i}(j) \right\} \quad (2.12)$$

or, using equation (2.11),

$$V_t(j) = \kappa_t S_{K,t}(j) + \eta_t N_t(j) \quad (2.13)$$

where and

$$\kappa_t = E_t \left\{ \beta (1 - \theta) \frac{\lambda_{t+1}}{\lambda_t} (R_{S,t+1} - R_{D,t+1}) + \theta \beta \Lambda_{t,t+1} x_{t+1} \kappa_{t+1} \right\} \quad (2.14)$$

$$\eta_t = E_t \left\{ (1 - \theta) + \theta \beta \Lambda_{t,t+1} z_{t+1} \eta_{t+1} \right\} \quad (2.15)$$

with $x_{t+1} = S_{K,t+1}(j)/S_{K,t}(j)$ and $z_{t+1} = N_{t+1}(j)/N_t(j)$. Note that constant returns to scale imply that the growth rate of assets and net worth are independent of the size of the bank (i.e, independent of j).

A moral hazard problem with costly enforcement imposes a participation constraint on the banker. Each period the banker can divert a fraction λ of its assets. If this happens, the depositors can immediately force the intermediary into bankruptcy. However, because it is too costly, depositors can recover only a fraction $(1 - \lambda)$ of the assets. To ensure that the banker doesn't deviate funds from the bank the following incentive constraint must hold

$$V_t(j) = \kappa_t S_{K,t}(j) + \eta_t N_t(j) \geq \lambda S_{K,t}(j) \quad (2.16)$$

The problem of a banker is to maximize (2.13) subject to (2.16). With $E_t(R_{S,t+1} - R_{D,t+1}) > 0$, κ_t is positive and the banker wants to accumulated assets. If $\lambda \leq \kappa_t$ there is no restriction on leverage and the banker keeps accumulating assets. This accumulation will eventually drive the spread $R_{S,t+1} - R_{D,t+1}$ and κ_t to zero. Therefore, for a positive λ this is not a general equilibrium. If $\lambda > \kappa_t$, the participation constraint binds and imposes a limit on leverage. In that case

$$S_{K,t}(j) = \frac{\eta_t}{\lambda - \kappa_t} N_t(j) = \phi_t N_t(j) \quad (2.17)$$

where $\phi_t \equiv \eta_t / (\lambda - \kappa_t)$ measures the bank leverage.

Equation (2.17) determines the size of the assets of a bank as a function of its net worth. This relation is the same for all banks so we can drop the j index. Note also that κ_t is increasing in $E_t(R_{S,t+1} - R_{D,t+1})$ and, as a consequence, ϕ_t is positive related to the spread in the financial sector.

Banks can borrow by issuing debt contracts to the domestic households and to foreign investors. In equilibrium, the cost of the former is the real interest rate paid by

government bonds because households are indifferent between these bonds and bank deposits. The foreign debt is denominated in foreign currency, as is the typical case in emerging markets economies, and its gross interest rate (Ψ_t^*) is taken as given by bankers. The next subsection discusses the factors that determine the cost of foreign debt.

As long as their expected costs are equal, banks are indifferent between domestic and foreign debt. In the calibration we consider here, banks always hold domestic and foreign debt. Therefore

$$E_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} [(1 - \theta) + \theta \eta_{t+1}] \left(R_t - \frac{s_{t+1}}{s_t} \Psi_t^* \right) \right\} = 0 \quad (2.18)$$

Note that equation (2.18) is the uncovered interest rate parity in the model. Furthermore, we impose a symmetric equilibrium where the liabilities of all banks have the same composition between domestic and foreign debt. The average real rate each bank pay on their total debt ($R_{D,t+1}$) is then given by

$$R_{D,t} = \frac{s_t}{s_{t-1}} \Psi_{t-1}^* \phi_{t-1}^* + R_{t-1} (1 - \phi_{t-1}^*) \quad (2.19)$$

where ϕ_t^* is the ratio between foreign and total debt in the banking sector and s_t is the real (in terms of the consumption composite good) exchange rate.

Aggregating the net worth of existing banks (equation 2.11) and adding the start-up capital of new banks gives the evolution of the aggregate net worth of the banking sector

$$N_t = \theta [(R_{S,t} - R_{D,t}) \phi_{t-1} + R_{D,t}] N_{t-1} + \xi S_{K,t} \quad (2.20)$$

where ξ is the fraction of total assets distributed as start up capital.

Finally, using (2.11) and (2.17), we can obtain expressions for x_t and z_t

$$z_t = \frac{N_t(j)}{N_{t-1}(j)} = (R_{S,t} - R_{D,t}) \phi_{t-1} + R_{D,t} \quad (2.21)$$

$$x_t = \frac{S_{K,t}(j)}{S_{K,t-1}(j)} = \frac{\phi_t}{\phi_{t-1}} z_t \quad (2.22)$$

International Credit Markets

International lenders to domestic agents face the risk of not being repaid and hence require a premium to make loans. Following Neumeyer and Perri (2005) and García-Cicco, Pancrazi, and Uribe (2010), the international rate can be broken into two components: one that reflects global factors (R_t^*) and another the captures local ones (Φ_t^*)

$$\Psi_t^* = R_t^* \Phi_t^* \quad (2.23)$$

The rate R_t^* is required by global investors to invest in risky assets in general, or at least, in those related to emerging market economies. This rate depends on factors that are orthogonal to local conditions. The empirical evidence suggests that these global factors explain a large fraction of the variation in the international interest rate faced by borrowers in emerging economies (see, for instance, Uribe and Yue 2006 and Longstaff, Pan, Pedersen, and Singleton 2011)

Three examples of factors that can increase R_t^* are a rise in global risky aversion, a tightening on the portfolio or capital constraints of agents that are the natural buyers of risky assets and an increase in the perceived uncertainty associated with investing in emerging markets.

In the first example, an increase in global risk aversion, which can be caused by a worldwide recession, is associated with "flight to quality" episodes. This was a key factor during the Great Recession of 2007-09 and according to Blanchard, Faruqee, and Das (2010) an important channel through which the crisis was propagated to emerging economies.

For the case of capital constraints, the second example above, Garleanu and Pedersen (2011) shows that when leverage risk tolerant agents⁴ face tighter liquidity constraints, the required rate of return on all risky assets increases. If these agents are also the lenders to emerging economies, the rate R_t^* is also affected. Along a similar line of argument, Fostel and Geanakoplos (2008) show that if emerging market assets are not mature enough to be attractive to the general public, then their marginal buyers are liquidity constrained investors who also hold other risky assets. As a consequence, a fall in the price of some risky assets in a large developed economy increase the yields on emerging market bonds partially because of a portfolio effect: investor will want to sell the latter securities to buy the former⁵. In the sudden stop literature, margin requirements and portfolio considerations, combined with imperfect information aspects, have also been used to explain contagion from a crisis in particular country to others (see, for example, Calvo 1999 and Calvo and Mendoza 2000).

The last explanation for the global component of country spreads involves investors' Knightian uncertainty. If a financial asset is relative new, as might be the case of emerging market assets for international investors due to a lack of knowledge about their underlying economies, they might be subject to this type of uncertainty. Krishnamurthy (2010) provides a good description of how this effect might take place: "...crisis occurs when the new financial assets behave in unexpected ways. Lacking a historical record to refer to, market participants are faced with risks they don't understand, and treat these risks as Knightian (Frank H. Knight 1921). Investors' response in this case is to disengage from risks...". According to this channel, the 1998 Russia

⁴According to the authors: "One can think of these [risk tolerant] leveraged investors as banks or the financial sector more broadly, including hedge funds."

⁵In the words of the authors: "We will use our theory to argue that the periodic problems faced by emerging asset classes are sometimes symptoms of what we call a global anxious economy rather than of their own fundamental weaknesses."

default caused a jump in the spreads of Brazilian bonds, two countries that had little economic relationship with each other but were both labeled as emerging economies, because investors become uncertain about the fundamentals of the whole class of emerging market assets and made decisions based on worst-case scenarios. Cúrdia (2008) uses a mechanism of this type to generate a sudden stop in his work about optimal monetary policy in emerging economies.

The international loan to a domestic borrower is risky because foreign investors face the possibility of default. We follow the same simple approach as Neumeyer and Perri (2005) and assume that private domestic borrowers always repay their debt. Note that this is consistent with the model presented here as long as the net worth of banks remain positive⁶. However, each period there is a probability that the local government confiscates payments going from local borrowers to foreign investors. Variations in this probability generates movements in the domestic factor Φ_t^* .

Instead of modeling this confiscation probability, we directly map Φ_t^* into domestic variables. In particular, we follow García-Cicco, Pancrazi, and Uribe (2010) and assume that Φ_t^* depends on the net foreign asset position of the country⁷:

$$\Phi_t^* = (-B_t^*)^{\eta_\Psi} \quad (2.24)$$

where $-B_t^*$ is the net foreign debt of the country and the parameter η_Ψ determines the degree of financial imperfection. This equation implies that the spread over the international rate is increasing with the aggregate indebtedness of the economy.

⁶There is no idiosyncratic shocks and hence the net worth of an individual bank would become negative only if the net worth of the whole banking system is wiped-out. This doesn't occurs in of our simulations.

⁷This dependence reflects financial frictions and is beyond what is necessary to close an open economy as suggest by Schmitt-Grohé and Uribe (2003)

Wholesale Firms

At each period, identical wholesale firms start with a given level of physical capital (K_{t-1}), hire labor (L_t) to produce the home good ($Y_{H,t}$) and sell their production to the retailers for a wholesale price of $P_{w,t}$. The production function is Cobb-Douglas

$$Y_{H,t} = A_t L_t^\alpha K_{t-1}^{1-\alpha} \quad (2.25)$$

where A_t is the total factor productivity.

After production takes place, the firm can sell its depreciated level of capital back to the capital producers at the market price level Q_t . Since it costs one unit of the consumption good to repair a unit of depreciated capital, the wholesale firm receives $(Q_t - \delta) K_{t-1}$ from this sale.

The last operational activity of the firm is to acquire capital from capital producers to be used next period. To fund this investment, the firms sell securities to financial intermediaries. By assumption, they issue only equity claims to fund their investment in physical capital. For example, at the end of period t , wholesale firms sell a total value of $Q_t K_t$ securities to buy an identical value of physical capital. The abstraction from debt contracts here is a simplification. In the presence of default, debt contracts would also be state contingent. The assumption of equity-financing allows us to capture the fact that the return on the assets of banks depend on the profitability of firms and asset prices. Finally, given that the market is competitive, wholesale firms earn zero profit state by state and simply return all the profits to the buyers (banks) of these equity securities

All these decisions and transactions take place at the beginning of the period. However, a friction in the payments technology implies that wholesale firms receive a fraction θ_w of their revenues only at the end of the period. As a consequence, wholesale firms need working capital from banks to operate. For that purpose, firms issue bonds

at the beginning of the period and repay them at the end. The interest rate on these bonds ($R_{w,t}$) is risk free because they are intraperiod without repayment uncertainty.

Profit maximization in the presence of working capital implies that the demand for labor is given by

$$(1 - \theta_w (1 - R_{w,t}^{-1}))\alpha p_{w,t} Y_{H,t} = L_t w_t \quad (2.26)$$

where $p_{w,t}$ is the real wholesale price of the home good, and w_t is the real wage.

Finally, the rate of return on the equities issued by the firms is

$$R_{K,t} = \frac{(1 - \theta_w (1 - R_{w,t}^{-1}))(1 - \alpha)p_{w,t} Y_{H,t} + (Q_t - \delta) K_{t-1}}{Q_{t-1} K_{t-1}} \quad (2.27)$$

Retail Firms

A continuum of retail firms, owned by the households, indexed by $i \in [0, 1]$, buy the home good from the wholesale firms and transform it, with a linear technology at no additional cost, into their own variety. Firms operate in a monopolistically competitive environment and prices are sticky à la Calvo. Every period, firms reset their price with probability $(1 - \alpha_p)$.

The total aggregate demand for the domestic good is given by

$$Y_{H,t} = C_{H,t} + I_{H,t} + C_{H,t}^* \quad (2.28)$$

where $C_{H,t}$ is the demand from the domestic consumers, $I_{H,t}$ is the investment demand, which is described below, and $C_{H,t}^*$ is the demand from foreign consumers, which is given by

$$C_{H,t}^* = C_t^* (P_{H,t}^*)^{-v^*} \quad (2.29)$$

where $P_{H,t}^*$ is the foreign price of the domestic good and C_t^* is an exogenous shifter in the foreign demand for home goods. The law of one price holds and hence $P_{H,t}^* = P_{H,t}/S_t$.

The final home good is assumed to be a composite made of a continuum of differentiated goods, $Y_{H,t}(i)$, produced by the retail firms via the Dixit-Stiglitz aggregator

$$Y_{H,t} = \left(\int_0^1 Y_{H,t}(i)^{\frac{\eta-1}{\eta}} di \right)^{\frac{\eta}{\eta-1}}. \quad (2.30)$$

The demand for each variety is then given by

$$Y_{H,t}(i) = Y_{H,t} \left(\frac{P_{H,t}(i)}{P_{H,t}} \right)^{-\eta}. \quad (2.31)$$

When a firm i can reset its price at t , it chooses $\bar{P}_{H,t}(i)$ that solves⁸

$$\underset{\bar{P}_{H,t}(i)}{\text{Max}} E_t \sum_{j \geq 0} \alpha_p^j \beta^j \frac{\lambda_{t+i}}{\lambda_t} \frac{P_t}{P_{t+j}} Y_{H,t+T} \left(\frac{\bar{P}_{H,t}(i)}{P_{H,t+j}} \right)^{-\eta} ((1-\tau)\bar{P}_{H,t}(i) - P_{w,t+j}) \quad (2.32)$$

where we use the stochastic discount factor of the household.

The optimal price, which is the same for all firms that reset their price, is given by

$$\bar{P}_{H,t} = \frac{E_t \sum_{j \geq 0} \alpha_p^j \beta^j \frac{\lambda_{t+j}}{P_{t+j}} Y_{H,t+j} P_{H,t+j}^\eta P_{w,t+j}}{E_t \sum_{j \geq 0} \alpha_p^j \beta^j \frac{\lambda_{t+j}}{P_{t+j}} Y_{H,t+j} P_{H,t+j}^\eta} \quad (2.33)$$

Finally, the aggregate domestic price index is given by

$$P_{H,t} = [(1 - \alpha_p)(\bar{P}_{H,t})^{1-\eta} + \alpha_p(P_{H,t-1})^{1-\eta}]^{\frac{1}{1-\eta}}. \quad (2.34)$$

2.2.2 Capital Producing Firms

Capital producers buy used capital from the intermediate producers, repair the depreciated capital and build new capital. The cost of refurbishing used capital is a unit of the consumption good, but to build new units, in addition to a unit consumption cost, the capital producers incur on an adjustment cost.

⁸The term $(1 - \tau)$ allows for a subsidy to eliminate the monopoly distortion at the steady state.

The real profit maximization problem is then given by

$$Max E_t \left\{ \sum_{j \geq 0}^{\infty} \beta^j \frac{\lambda_{t+j}}{\lambda_t} \left[(Q_t - 1) I_{n,t} - p_{k,t} f \left(\frac{I_{n,t} + I_{ss}}{I_{n,t-1} + I_{ss}} \right) (I_{n,t} + I_{ss}) \right] \right\} \quad (2.35)$$

where $I_{n,t} = I_t - \delta K_{t-1}$ is the net investment (i.e new capital), and I_{ss} is the steady state level of investment. The function $f()$ provides the cost of adjusting the capital level and has the following properties: $f(1) = f'(1) = 0$ and $f''(1) > 0$.

The solution to this problem yields the Q price of capital

$$Q_t = 1 + f() + f'() \frac{I_{n,t} + I_{ss}}{I_{n,t-1} + I_{ss}} - E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} f'() \left(\frac{I_{n,t+1} + I_{ss}}{I_{n,t} + I_{ss}} \right)^2 \right] \quad (2.36)$$

2.2.3 Government

The government is a single entity composed by the treasury and the central bank. Together, they control four variables: the nominal interest rate (i_t), a lump-sum tax on households (T_t), the supply of government bonds ($B_{g,t}$) and the credit interventions ($D_{g,t}$).

We impose two restrictions on the government. The first is a standard budget constraint

$$T_t = D_{g,t} - B_{g,t} + (R_{t-1} B_{g,t-1} - R_{g,t-1} D_{g,t-1}) \quad (2.37)$$

where is $R_{g,t}$ is the real interest rate received by the central bank on its credit interventions.

A second condition restricts the interventions in credit markets to be sterilized. As a consequence, any change in the volume of assets on the consolidated government balance sheet requires an equivalent change in the amount of government bonds on the liability side:

$$D_{g,t} = B_{g,t} \quad (2.38)$$

Taken together, these restrictions imply that the government has two independent instruments: the nominal interest rate i_t and the credit interventions. We discuss in details the credit intervention in section 2.4.

For the interest rate, we assume that the Central Bank follows a Taylor Rule type of policy

$$(1 + i_t) = (1 + i_t^n) (\Pi_{H,t})^{\phi_\pi} \left(\frac{Y_t}{Y_t^n} \right)^{\phi_y}$$

where i_t is the nominal interest rate, Y_t^n is the flexible price level of product, i_t^n is the flexible price (real) interest rate and $\Pi_{H,t}$ is the inflation of the home good.

Exogenous Shocks

There are three exogenous shocks in the model: one domestic and two international. The former is a stationary productivity shock A_t . We include this mainly to show that the response of the economy is similar to the ones in closed economy models with a financial accelerator mechanism.

The external shocks are the term R_t^* in the international interest (2.23) and the variable C_t^* in the foreign demand (2.29). The former represents an external financial shock while the latter is a simple way to capture exogenous movements in the terms of trade.

We assume that these three shocks are independent of each other and follow an AR(1) process. Section 2.2.4 discusses their calibration.

Equilibrium

Market clearing in the domestic financial market imposes that

$$S_{K,t} = Q_t K_t + \theta_w p_{w,t} Y_{H,t} \tag{2.39}$$

where $S_{K,t}$ is the value of the securities issued by the wholesale firms. The right hand side of the equation gives the total amount of resources required by wholesale firms to fund their investment and working capital needs.

In equilibrium, firms always need the two types of capital⁹. Banks are willing to hold both types of assets as long their rate of return are equivalent. Hence, in equilibrium,

$$E_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} [(1 - \theta) + \theta \eta_{t+1}] (R_{K,t+1} - R_{w,t}) \right\} = 0 \quad (2.40)$$

The resource constraint of the home good is given by

$$C_{H,t} + I_{H,t} + C_{H,t}^* = A_t L_t^\alpha K_{t-1}^{1-\alpha} \quad (2.41)$$

Aggregating the budget constraints of households and the government, and replacing the profit functions as necessary, one can derive the balance of payments (in terms of the foreign currency)

$$P_{H,t}^* C_{H,t}^* - C_{F,t} - I_{F,t} = B_t^* - \Psi_{t-1}^* B_{t-1}^* \quad (2.42)$$

where $I_{F,t}$ is the imported foreign good component of investments.

Appendix B.1 lists all the equations that determine the dynamic equilibrium of the economy.

2.2.4 Solution Method and Calibration

We solve for the dynamic rational expectations equilibrium using standard first order perturbation methods. A period in the model is a quarter and there are 22

⁹There is one important technicality regarding the working capital funding. As described in section 2.2.1, firms repay banks at the end of the period. We assume that from the end of one period to the beginning of the next, banks hold the total amount of this repayment as a non-interest rate asset (for example, money issued by the central bank). This assumption justifies the payment of interest rate on intraperiod loans and is compatible with the balance sheet constraint of banks.

parameters to calibrate. Table 1 lists all of them and their calibrated values. For those parameters that we can directly match to moments in the data, we use figures from Brazil.

First, we start with the description of the more conventional parameters, whose values we take from the literature on nominal DSGE models calibrated or estimated for emerging economies. We set the inverse of the intertemporal elasticity of substitution (σ) to 1, the inverse of the labor supply elasticity (ψ) equal to 1 and the inverse elasticity of net investment to the price of capital to 1.728. The value of the export price elasticity (v^*) commonly varies from the fairly inelastic 0.6 in Cúrdia (2008) and Cook (2004) to perfectly elastic in Devereux, Lane, and Xu (2006) and Braggion, Christiano, and Roldos (2009). Perfect elasticity is also true for most of the papers in the emerging market real business cycle literature, where the world is assumed to absorb any quantity exported at the international price. Here we follow Céspedes, Chang, and Velasco (2004), Gertler, Gilchrist, and Natalucci (2007) and Elekdag, Justiniano, and Tchakarov (2006) and choose a median value of 1. With respect to the nominal part of the model, in line with the estimations in Elekdag, Justiniano, and Tchakarov (2006), we use $2/3$ for the degree of price stickiness (α_p) and 8 for the elasticity of substitution across the different varieties of home goods (η).

To calibrate the labor coefficient in the production function (α), the depreciation of capital (δ) and the preference bias for home goods (γ) we use the Brazilian national accounts. These coefficients are set, respectively, to 0.611, 0.0149 and 0.861 to match the share of labor on total output (0.60), investment expenditures (0.17) and the GDP share of imports (0.11). All these shares were computed from post-1995 data, after the economy was stabilized by the Real Plan.

We now turn to the parameters regarding the domestic financial portion of the model: the fraction of assets the banker can successfully divert (λ), the fraction of the

total amount of assets in the economy transferred to new bankers as start-up capital (ξ) and the random fraction of the bankers who become workers in each period ($1 - \theta$). These parameters are set to match three steady values. First, commercial and investment banks in Brazil hold assets that are on average 9 times the size of their net worth. Leverage in the corporate sector is much smaller and gravitates around¹⁰. However, most of the credit flow to companies, as well as consumers, is provided by banks, while the domestic capital markets remains largely devoted to government related securities. To capture this high dependence on the banking system, a feature that is also common in other emerging market economies, we target a steady state ratio of assets to capital of 6.

Second, the average domestic corporate spread from 2004 to 2007, a financially and economically stable period in Brazil, was 13.7% in annual terms. However, a large fraction of this rate might be attributed to other factors than the theory presented in section 2.2.1. Indeed, Costa (2004) estimates that profits accounts for between 9% and 34% of the spreads charged by banks in Brazil, while the remaining fraction can be attributed to taxation, reserves requirement, default rates and operational costs. Therefore, we set the steady state "inefficient" spread, which is the one explained by our model, to 3.4% in annual terms, or 25% of the total spread observed in the data.

The third and last value we target with the parameters of the domestic financial sector is the average life of banks. The main economic role of this average life in the model is to limit the ability of banks to adjust their capital level. As a consequence, we should not directly associate it with actual average life of banks in data. In lack of better

¹⁰Brazilian firm level studies (Terra (2003) and Bonacim, Ambrozini, and Nagano (2006)) have computed an average ratio of debt-to-assets of about 0.35. These studies are, however, somewhat outdated, with the most recent one covering firms only up to 2004. Since then, the volume of corporate credit as percentage of GDP in the country has almost doubled. Therefore, we consider a rate of 0.5, a number close to the value used by Devereux, Lane, and Xu (2006), which is itself based on firm-level studies for Asian economies

guidance, at this point, we set the average bank life to 10 quarters in order to keep the fraction of assets the banker can successfully divert (λ) at a not too high level¹¹.

For the curvature of the international credit supply curve, η_Ψ , we set it such that, as estimated in García-Cicco, Pancrazi, and Uribe (2010), at the steady-state, an increase of 1pp (percentage point) in foreign debt as a share of GDP raises the international spread by around 0.5pp. In addition, we also set the steady state level of foreign debt to match the ratio of foreign to total liabilities in the Brazilian banking sector. This ratio has varied from almost 0.15 in the late 90s to 0.03 in 2009. Here we set it at 0.06, which is the value at the end 2007.

In terms of the Taylor Rule followed by the monetary authority in setting the policy rate, we fix $\phi_\pi = 2$ and $\phi_y = 0.75$. These values are common in the literature and provide a good description of the flexible inflation target rule currently in place in Brazil.

Furthermore, we choose to normalize, without loss of generality, the steady-state value of output and the terms of trade to 1. The first assumption determines the household disutility of labor \tilde{L} , and the second sets the steady-state value of the exogenous component in the foreign demand for domestic goods (C_t^*). Finally, the household time discounting (β) is set to equal 0.99. This results in a 4% annual domestic policy (or saving) real interest rate, which, for simplicity, we also assume to be the international interest rate.

Finally, for the exogenous processes, estimating a simple AR(1) process for the international spread statistics collected by the Central Bank results in an autocorrelation coefficient of 0.93. This value is consistent with the more elaborate law of motion

¹¹With the choice of parameters above, we have that $\lambda = 0.32378$, meaning that the banker can deviate almost 32% of the banks assets. See Gertler and Karadi (2011) for a discussion about this issue.

of sovereign spreads in Latin American countries estimated by Fernández-Villaverde, Guerrón-Quintana, Rubio-Ramirez, and Uribe (2010). Therefore, we set the autocorrelation of R_t^* to 0.9. For C_t^* in the foreign demand (2.29), first note that with $\nu^* = 1$, $P_{H,t}^* C_{H,t}^* = C_t^*$. Hence we can use the value of exports in foreign currency to fit a process for C_t^* . Using quarterly data for Brazilian exports since 1960 yields a autocorrelation of 0.898. In the case of the stationary productivity shock A_t , we just assume that the autocorrelation is 0.9.

2.3 Understanding the Role of the Domestic Financial Sector

Figures 1 and 2 show the dynamics of selected variables in response to exogenous shocks. The case of a negative a domestic technology shock, displayed in Figure 1, illustrates the basic mechanism of the model. Without frictions in the domestic financial sector, an 25 basis point decrease in A_t has the negative impact in the economy through well-know channels. These impacts are shown in the graphs by the line labelled "Standard DSGE", which is a version of model without the domestic financial frictions described in Section 2.2.1.

As one can see in the graphs, the presence of domestic financial frictions (baseline model labelled as "Financial Decelerator") propagates the initial shock. The mechanism is straightforward, the initial negative performance of the economy affects the balance sheet of banks, increasing their leverage ratio and, hence, impacting the domestic spreads . This increase in spreads further depress the demand by firms for labor and investment. The first because firms require working capital to pay workers and the second because firms issue securities to fund their capital expenditures. As can be seen

in the top graph on the left, these factor amplifies the output fall.

For the purposes of this paper, however, it is more important to understand and quantify the amplification effects of the domestic financial sector when the economy is hit by external shocks. In the case of an increase in the international rates available to domestic borrowers the impacts are significant. As Figure 2a shows, an 1% (annualized) rise in the R_t^* depress GDP by about 0.1% in quarterly terms in the Standard DSGE model, compared to a fall of over 0.2% when frictions in the domestic banking system are included. For the same reasons as before, most of the fall comes from increase in the financial costs associated with investing and hiring workers. Note that, in the case of consumption, the difference between the two models is small.

One can also observe in the graphs of Figure 2a, that the decline in the net worth of banks come mostly from the negative impact of the fall in assets prices on the return on the assets held by banks (the second graph on the third row). Indeed, banks hold stocks issued by the firms. Log-linearizing equation (2.27), which gives the gross return of investing on firms, results in the following expression

$$R_K \hat{r}_{K,t} = (1 - \alpha) k_y^{-1} \left(\hat{p}_{w,t} + \hat{y}_t - \hat{k}_{t-1} - \hat{q}_{t-1} - \hat{r}_{w,t} \right) + (\hat{q}_t - (1 - \delta) \hat{q}_{t-1}) \quad (2.43)$$

where \hat{x} denotes log-deviation from steady state, R_K the value of $R_{k,t}$ in steady state and k_y is the capital to output ratio, also in the steady state. Under the baseline calibration, k_y equals to 11.4 and, as consequence, most of the movement in $\hat{r}_{K,t}$ comes from the second term on the right hand side of the above equation. With $\hat{q}_{t-1} = 0$ in the initial period of the shock, the decline in \hat{q}_t translates into a direct impact¹² on $\hat{r}_{K,t}$, which has a large effect on the balance sheet of banks. This interaction between asset prices and balance sheet has been highlighted by many economist as an important

¹²Note that in the Figure 2a, the return on bank's assets is annualized. Therefore the fall of 1% in q_t reflects into a $r_{k,t}$ close to -4% *a.a.* in the first period of the shock.

aspect to understand the role played by the financial sector during recessions.

In the case of a decline in the foreign demand for the domestic good the domestic financial sector has a somewhat smaller role in propagating the initial shock. This can be seen in Figure 2b, which reports impulse response function to a decline of 2.2% in C_t^* . With this value the initial recession cause by a shock to the international spread is the same as the originated for the foreign demand under the Standard DSGE model. However, the fall in output is much latter case compared to the former under the Financial Accelerator model. It is in this sense (same effect without domestic friction but smaller with frictions) that we consider that the domestic banking system plays a reduced role in propagating exogenous shocks to the terms of trade (which, as mentioned before, is captured by C_t^* in the model).

This less important role is not a structural feature of the model as it depends on the characteristics of the economy given by its calibration. For example, a deterioration in the terms of trade causes a large exchange depreciation. If domestic banks rely significantly on foreign debt, which are denominated in foreign currency, this depreciation has a larger impact on the banks balance sheet. In the baseline calibration, foreign debt accounts for only 6% of bank's liabilities. But this figure reached 15% in Brazil in the past and may also be larger in other countries. Figure 2c, compares the results when this ratio in the steady state is 6% (Baseline Calibration) with the case when it is equal to 30% (Larger Foreign Liabilities). As can be seen, the domestic banking system in the latter amplifies significantly the initial shock. The main difference is that, even with a similar levels of exchange rate depreciations in both cases, with higher levels of foreign debt the ex-post cost of the banks debt (graphs at the bottom) is higher. Amplification might also be larger in economies that are more exported oriented, as is the case of, for example, some countries in Asia.

Observations on Business Cycles

This paper is not a complete description of business cycles in emerging market economies. However, simulating the economy and generating some basic business cycle statistics further highlights the main properties of the model. In addition, it also demonstrates that the model captures well important characteristics of these economies.

Two important properties of business cycle in emerging market economies are the higher volatility of consumption growth when compared to output growth and the negative correlation between the trade balance-to-output ratio ("tby") and output growth. Table 2 shows that this is the case not just of Brazil, but also of other countries in Latin America¹³.

The same table contains the real business cycle statistics generated by the Standard DSGE and Financial Accelerator models. The reported values come from 500000 simulations using the baseline calibration presented in section 2.2.4. The only exception is that we shut down the nominal parts of the model. We set the standard deviations of the exogenous technology, foreign demand for the home good and international spread shocks to match, respectively, the standard deviations of output, terms of trade and international spread in the quarterly data for Brazil in the period from 1991 to 2010.

The statistics from simulating the baseline model (second column in the table) are in line with the data. In particular, the standard deviation of consumption growth is higher than the one for output growth and the tby-output growth correlation is negative. The domestic frictions are not essential to generate the former. In fact, the standard model without domestic financial intermediation (first column) already matches this aspect of the data. However, the inclusion of the domestic financial system improves significantly the performance of the model with respect to tby-output growth correla-

¹³The only exception is Chile, which has positive correlation between tby and output.

tion by taking this measure into the negative territory (-0.06 compared to 0.01 in the Standard DSGE version). As discussed above, the presence of domestic frictions have a higher amplification effect in response to shocks to the international borrowing rate. Since this shock generates a strong negative tby-output growth correlation (compare the paths of net exports and output in figures 2a and 2b), amplifying the effects of international spreads shocks result on average negative value for this statistics. Finally, note that the domestic frictions also increases the investment volatility, bringing it closer to the values observed in the data.

The model presented here is not the first to be able to match the mentioned main features of business cycle in emerging economies. But its reassuring that it does. Moreover, by improving upon the more standard model, it provides an alternative explanation for these characteristics¹⁴.

2.4 Unconventional Monetary Policies

In this section, we study the effects of unconventional policies. These involve direct interventions in credit or securities markets. At this point, we focus on the positive approach of describing the dynamics under alternative policies and abstract from a normative discussion based on welfare evaluation

The central bank intervenes in credit markets by acquiring the securities issued by the wholesale firms. The aim is to alleviate conditions in financial markets: the short term working capital facilities and the long term contracts to fund investment. A first observation is that in both cases the central bank acts at the prevailing market

¹⁴See, for example, Aguiar and Gopinath (2007), Neumeyer and Perri (2005) and García-Cicco, Pancrazi, and Uribe (2010) for discussions about the data and the driving forces behind them.

prices. The only operating channel of any intervention is its general equilibrium effect on spreads as the volume of intermediation by the private sector varies.

The reduction in spreads is possible because the central bank is not subject to the same information and enforcement frictions affecting banks. There might be direct costs associated with the credit procedures of the central bank. The assumption is that these costs are different than the ones associated with market intermediation. Two other underlying assumptions are that these costs are high enough to discourage interventions outside crises episodes and that the central bank doesn't need to impose these costs on the borrowers. The absence of these costs in the model are less important for the positive questions considered here.

To incorporate credit interventions, assume that the central bank acquires a total value $S_{cb,t}$ of securities. These assets are composed by the two types of assets held by banks, in the same proportion as they are available in the economy. Government bonds issued to households fund these acquisitions.

The the value of banks' assets is now given by $S_{K,t} - S_{cb,t}$. Denote by $\phi_{cb,t}$ the fraction of the securities in the economy held by the central bank (i.e. $\phi_{cb,t}S_{K,t} = S_{cb,t}$). Then, equation (2.17) becomes

$$S_{K,t} = \frac{\phi_t}{1 - \phi_{cb,t}} N_t \quad (2.44)$$

Note that "total leverage" and "private leverage" in the economy can differ. The latter is provided by financial intermediaries and is equal to ϕ_t . The former includes the official interventions and, when these occur, it increases the total amount of leverage ($\phi_t/(1 - \phi_{cb,t}) > \phi_t$ if $\phi_{cb,t} > 0$).

We assume that the central bank set $\phi_{cb,t}$ to zero in "normal" times. However, when the domestic spreads are high, it chooses a positive value. In determining the importance of this policy in "crisis", we convert the total central bank-sponsored loans

into a reaction function to the prevailing spreads, as follows:

$$\phi_{cb,t} = E_t \left[\frac{R_{S,t+1}/R_{D,t+1}}{R_S/R_D} \right] \quad (2.45)$$

where R_S/R_D is the steady state spread.

Figure 3 shows the impact of the credit interventions. In all experiments, we set $\eta_{cb} = 20$, which, as pointed below, generates limited interventions in the economy.

In the case of external shocks, first consider an increase of 6% (annualized rate) on the international borrowing rate available to domestic banks. This is an increase of the size observable in some emerging market economies during the global financial crisis of 2007-2009. This shock can also be associated with the surge in capital outflows emphasized by the sudden stops literature, although an increase of 6% in international spreads is smaller than the jumps observed during these episodes in the 90s and early 2000s.

The intervention significantly mitigates the negative effects of the shock. As can be seen in figure 3a, it reduces the initial GDP fall by almost 30%. As mentioned before, the policy works through the general equilibrium effects on domestic spreads. The fall on these spreads increase asset prices, improve the net worth of banks, the volume of the credit and, as consequence, amplify the benefits. Note that, at its maximum, official credit correspond to 5% of the volume of credit.

Two interesting observations can also be made. First, among the two variables that depend on credit, the intervention benefits more employment than investment. This suggests that short term credit markets to finance working capital is an important channel through each the policy affects the economy. Second, many important variables, like the real exchange rate, interest rates and inflation, are not significantly affected. This result indicates that the central bank can affect conditions in credit markets without distorting other prices.

In the case of a negative shock to exports, figure 3b shows that the benefits of the policies are smaller. This is the other side of the small propagation role played by the domestic financial markets in response to this type of shock, as discussed in section 2.3.

Given the important role played by domestic banks, credit interventions are most powerful against shocks that have large impact on their balance sheets. This explains the differences discussed above. A purely financial shock that directly affects the net worth of banks is another case in which credit interventions is effective. An example of this type of shock occurs when banks suffer heavy loss in some of its assets. In an international context, this loss could come from assets held abroad and uncorrelated with the domestic economy. During the financial crisis of 2007-09, this was an important channel propagating the US subprime mortgage crisis to Europe, as European banks suffered large losses from their holdings in the US. The model presented here is suitable to study these transmissions mechanisms.

2.5 Conventional Monetary Policies

A complete discussion of conventional monetary policy, including optimal welfare-based analysis, is beyond the goals of this paper. Nevertheless, it is interesting to ask what the model has to say about the adoption of different interest rate rules. In the context of external shocks, there is a large debate in the literature and among policymakers about what is the best policy during periods of strong reversal in external capital inflows (i.e. a sudden stops episodes).

The model presented here is adequate to re-address this debate because it explicitly includes a domestic banking system, which are often at the epicenter of these

episodes (see, for example, Kaminsky and Reinhart 1999). Moreover, in the model, external borrowing is done by banks. This is also the usual picture in the data. As a consequence when international interest rates rise significantly and/or the exchange rate depreciates (foreign-currency denomination of external debt is usual case in developing countries) the health of domestic banks is strongly jeopardized. These balance sheet effects have been documented as been extremely important (see, Calvo 1998 and Calvo, Izquierdo, and Mejía 2007). Even though banks are crucial to explain the severity of sudden stops, so far, the literature has dealt with this issue only indirectly by incorporating financial frictions at the firm level.

In addition to the baseline Taylor rule, we consider two types of policies: a fixed nominal exchange rate (or hard peg) and an inflation targeting regime. In the case of the former, Calvo Guillermo and Reinhart (2002) discusses why countries might want to smooth exchange rate movements. Blanchard, Faruqee, and Das (2010) is an evidence that such views remain popular. Among other reasons, fixing the nominal exchange rate has been defended on the grounds that the foreign-currency denomination of the external debt creates recessionary balance sheet effects when the currency depreciates. Most of the literature using DSGE type of models has not favored this view and usually concludes that a more flexible exchange rate regimes is preferable (see discussions in Cúrdia 2008). But as mentioned before, contrary to our paper, these works don't include a domestic banking system.

Inflation targeting regimes have been adopted by many emerging market economies. Fraga, Goldfajn, and Minella (2004) discusses the adoption and challenges of inflation targeting in these economies while Gonçalves and Salles (2008) find empirical evidence in favour of this type of regime. However, during a sudden stop, large exchange rate depreciation and the associated pass-through to domestic prices have led some countries to be more flexible with respect to their inflation target (see discussions in Fraga, Gold-

fajn, and Minella 2004 and Caballero and Krishnamurthy 2004). Here we re-address the effects of inflation target during sudden stops with a focus on its effects in the domestic financial system.

According to our experiments, during a sudden stop, the baseline Taylor rule dominates other policies in terms of GDP performance. The first column of figure 4 shows the impulse responses to a large shock to the international borrowing rate R_t^* that generates a large capital outflow. This is an easy way to generate a sudden stop in the model.

Both the inflation targeting and fixed exchange rate regimes imply higher real interest rate. The former because the exchange rate devaluation generates a higher domestic inflation and hence forces the central bank to push rates up to keep inflation at its target. The latter because to defend the nominal exchange rate the central bank has also to increase rates to attract capital or contain its outflow.

Higher interest rate causes a recession without frictions in the domestic banking system. In the presence of these, the effects are larger. The higher rates depress asset prices and harm firms profits. Both effects, in particular the former, produce negative returns on the assets of banks, reduce their net worth, decrease the volume of credit and increase spreads.

Note that in the hard peg regime the central bank is able to contain the real exchange rate depreciation. This decreases the ex-post real cost of bank's debt and, hence, provide some relief. This is exactly the goal of those who defend the control of the exchange rate. However, the negative effects on the asset side are stronger and the net effect is a decline in the net worth of banks.

The effects just described can be stronger under alternative functional assumptions. For example, the second column in figure 4 shows the case of CRRA preferences. With a fixed exchange rate regime the declines in assets prices and in the net worth

of banks are twice as large as they fall under the baseline Taylor rule. This difference explains most of the larger fall in output under these regimes.

The conclusions with respect to the fixed exchange rate regime hold even if foreign debt represents a larger fraction of bank's liabilities. In the last column of figure 4, foreign debt represents 30% of the total debt (against 6% in the baseline calibration). In this case, exchange rate depreciation has a stronger impact on the liabilities. Nonetheless, pegging the nominal exchange rate still generates a larger recession. The associated larger capital outflow demands higher interest rate to defend the exchange rate. These higher rates produce even sharper falls in assets prices. Again, the negative effects suppress the benefits of lowering the real exchange rate depreciation.

Finally, we also consider a Taylor rule responding to both inflation and the nominal exchange rate. This specification allows some room for both variables to increase during crisis. In all cases considered in figure 4, the baseline Taylor rule still delivers a higher output dynamics.

The results above clearly point in the direction that not allowing the exchange rate to depreciate during periods of large capital outflows is a mistake. This was also the conclusion, as already mentioned, in some of the previous literature. There are, however, two important qualifications to be made. First, the usual recommendation is actually to try to control for very large depreciations and stabilize the exchange rate at some level rather than simply keep it constant (see again Blanchard, Faruquee, and Das (2010)). Here the exchange rate depreciation is not as large as observed during some of the crises in during the 90s and early 2000s. Therefore it is still possible that after some level it becomes desirable to control the exchange rate. Second, here, increasing the nominal interest rate is the only instrument available to the central bank. And this is exactly what causes the decline on the value of the assets held by banks. However, in practice, central bank also use other instruments like intervention in

exchange rate markets (using, for example, their holdings of foreign reserves) or impose capital controls. In any case, the general message remains. Policymakers must not just focus on the liabilities or assets of banks. All effects must be simultaneously considered.

2.6 Crisis Experiment - Brazil in the Great Recession of 2008-09

Starting in the last quarter of 2008, as most emerging market economies, Brazil faced a combination of a financial shock, which increased the interest rates available to domestic borrowers in international markets, and a negative terms of trade shock. The international spreads available to private borrowers surged as much as 6% in annual terms while the US dollar value of exports declined by 40% in two quarters (see the first two graphs in the top row of figure 5). This mix of negative shocks had a large impact on growth. At its trough in the 1st quarter of 2009, output was -6.86% below the previous trend.

The government was also very active in reacting to the crisis. Most interesting for our purposes, it adopted a series of measures to alleviate conditions in credit markets¹⁵. In one of these policies the treasury transferred funds to the government-owned development bank, BNDES, so that it could increase its loans to companies. In 2009, the transfers totalled 3% of the GDP or close to 7% of the total volume of credit in the economy at the time.

We use our model to study the impact of this policy. First we plug into the model shocks to the terms of trade and to the international rates that reproduce the

¹⁵The Treasury also put into practice a hefty agenda of countercyclical fiscal policies and the central bank did a series of interventions in the spot and forward exchange rate markets. We choose not to include them in our experiments in order to better frame the credit policy analysis.

paths of exports (measured in US dollar) and foreign spreads in the data. Then we consider a version of the model with credit policy as described in 2.4 such that, at its peak, 7% of the total credit in the economy is intermediated by the central bank. To compare, we also considered a version of the model without credit policy.

As can be seen in figure 5, the model roughly replicates the behavior of the main variables in the data. It performs well, in particular, in the financial variables (i.e. the domestic spread), but relatively poorly in the nominal ones like inflation. But given the complexity of the shocks and policies at the time, the overall performance is quite good.

The conclusions about the credit policy are mixed. We judge its impact by looking at the output performance, the main goal of the Brazilian authorities at the time. Comparing the GDP paths generated by the model with and without the policy, we reckon that, in the first quarter of the crisis, the policy improved output by 23%. But in the second quarter, at the trough of the recession, the improvement was of only 8.7%: an increase in GDP from -7.72% below the steady state to -7.05%. From then onward the impact is negligible.

Initially, the interest rate was the main shock hitting the economy. But since the beginning of 2009 the decline in exports was the most important factor behind the recession. The results from the previous sections indicate that, at least in the case of Brazil, the domestic financial sector is less important in propagating this type of shock. As a consequence the credit policy is less beneficial.

It could be the case that the domestic banks were hit by other channels than the ones considered here (profitability of the exporting sector, asset prices movements, bank's borrowing cost and balance sheet position of banks). But we included the ones that most economists considered relevant during the time. Therefore, we end this case study with a word of caution about the desirability of credit policy in Brazil in response

to international shocks that are predominantly related to the terms of trade.

2.7 Conclusion

In this paper, we constructed a small open economy model with a domestic banking system. The model is general and can be used to address several questions that involves a significant role for the financial sector. We gave some examples of that by addressing some questions relating to monetary policy. In this sense the paper belongs to a broader agenda in macroeconomics that aim to incorporate financial intermediation in quantitative models.

The main question we answer can be stated as following: “do credit policies have a role to play in the management of economic crises originated outside the country? And if yes, how important are these policies?” To answer the first part, we argued that interventions might make sense if the external shocks have large impact on the balance sheets of domestic banks and if the central bank is not restricted in the same way that private agents are. A banking sector a la Gertler and Karadi (2011) is a case where such features occur. Once the basic rationale for the intervention is understood, the main effort is to quantify its importance.

In this aspect we highlight four main channels linking the external shocks to the domestic financial sector. First, terms of trade affect the profitability of the corporate sector and hence bank’s return on assets. Second, an increase in the international interest rate depresses asset prices and reduces the profit of banks. Third, international rates also affect bank’s borrowing cost. And for last, exchange rate depreciations associated with both types shocks weakens the balance sheet position of banks because they usually are the domestic agent who borrows from abroad.

According to our calibration, the main channel is the second one: an increase in the international interest rate depresses asset prices and reduces the profit of banks. The simulations show that the fall in output is twice as large in the model with domestic financial frictions when compared to a model without domestic banks.

Given that the amplification is higher for this type of shock, it is not surprising that credit policies are more effective in this case. To quantify the importance of the intervention we assume that central bank acquires the securities issued by the wholesale firms at the prevailing market prices. By reducing domestic spreads, the policy also increases asset prices, improves the net worth of banks, the volume of the credit and further minimizes the impact of the shock. Our simulations show that the intervention can reduce by almost 30% the GDP fall in response to a large increase in international rates. In the case of a negative shock to exports, the benefits are smaller.

The final exercise, a case study of Brazil during the crisis, shows that some of the policies implemented in the country had limited impact in improving output because the decline in terms of trade was the main shock for the economy and this has not a large impact on its domestic banks. This should be read as a warning to policymakers: account qualitatively and quantitatively for the domestic financial frictions before engaging in credit interventions.

2.8 Tables and Figures

Table 2.1: Parameters in the Model

The table describes all the parameters in the model and their baseline calibration

Parameter	Value	Description
<i>Conventional parameters calibrated from the literature in emerging market economies</i>		
σ	1	inverse of the intertemporal elasticity of substitution
ψ	1	inverse of the labor supply elasticity
v^*	1	exports price elasticity
η	8	elasticity of substitution across the different varieties of home goods
$f'(1)$	1.728	Inverse elasticity of net investment to the price of capital
α_p	2/3	probability of a retail firm not being able to adjust its price
η_Φ	0.1675	+1% in $D^*/Y \Rightarrow +0.5\%$ in the country spread
ϕ_π	2	response of the policy rate to inflation
ϕ_y	0.75	response of the policy rate to output
<i>Parameters calibrated to match moments of the Brazilian data in the steady state</i>		
α	0.611	labor coefficient in the production functions (set to match the GDP share of labor: 0.60)
δ	0.01492	depreciation (GDP share of investment expenditures: 0.17)
γ	0.861	home good bias (share of imports: 0.11)
β	0.99	time discounting (international spread of 4% over world risk free rate, which was normalized to 0)
B^*/Y	-0.887	foreign assets position as a share of quarterly GDP (ratio of foreign to total liabilities in the Brazilian banking sector)
ξ	0.00066	start-up capital (assets / net worth = 6)
λ	0.32378	fraction of assets a banker can deviate (annual spread: 3.4%)
θ	0.90	fraction of bankers who stay in their group (average firm life: 10 years)
<i>Other parameters</i>		
L	0.21	disutility of working (normalizes the steady-state output to 1)
C^*	0.114	foreign demand (normalizes the steady-state terms of trade to 1)
ρ_{R^*}	0.9	autocorrelation of the international interest rate R^*
ρ_{C^*}	0.9	autocorrelation of the foreign currency value of Brazilian exports
ρ_A	0.9	autocorrelation of the stationary productivity shock

Table 2.2: Real business cycle statistics

* Brazil (1950-2010). ** Brazil (1947-2010); Chile (1967-2006). The model-based figures are drawn from 500000 simulations. Data sources. Brazil - Ipea Data; Argentina and Mexico: statistics are taken directly from Garcia-Cicco, Pancrazi, and Uribe (2010); Chile: gdp and tby from Garcia-Cicco, Pancrazi, and Uribe (2010), consumption from

http://www.economics.harvard.edu/faculty/barro/data_sets_barro.

	Standard	Financial	Brazil	Brazil	Argentina	Chile	Mexico
	DSGE Model	Frictions Model	1991-2011	1945-2010	1900-2005	1900-2006	1900-2005
	Quarterly	Quarterly	Quarterly	Annually	Annually	Annually	Annually
std gdp	1.40	1.40	1.40	3.49	5.30	6.23	4.09
std cons / std gdp	1.22	1.37	1.30	1.42	1.42	1.49	1.50
std inv / std gdp*	1.44	1.98	3.34	2.93	3.77	-	4.86
corr(gdp, cons)	0.91	0.92	0.48	0.54	0.72	0.63	0.66
corr(gdp, inv)*	0.67	0.71	0.65	0.66	0.67	-	0.55
corr(gdp, tby)**	0.02	-0.06	-	-0.15	-0.03	0.02	-0.20
corr(cons, tby)**	0.01	-0.05	-	-0.29	-0.27	-0.08	-0.29
corr(inv, tby)*	-0.13	-0.25	-	-0.10	-0.19	-	-0.07

The figure shows the performance of selected variables in response to a 0.25% decrease in A_t . The Financial Accelerator line corresponds to the baseline model, while the Standard DSGE has the same structure of baseline model but *without* the domestic frictions (i.e. no domestic financial intermediation). The units in the vertical axis are % deviations from the steady state. In the case of variables marked with an *, the units are annualized percentage points deviation from the steady state. The horizontal axis are the numbers of quarters after the initial shock.

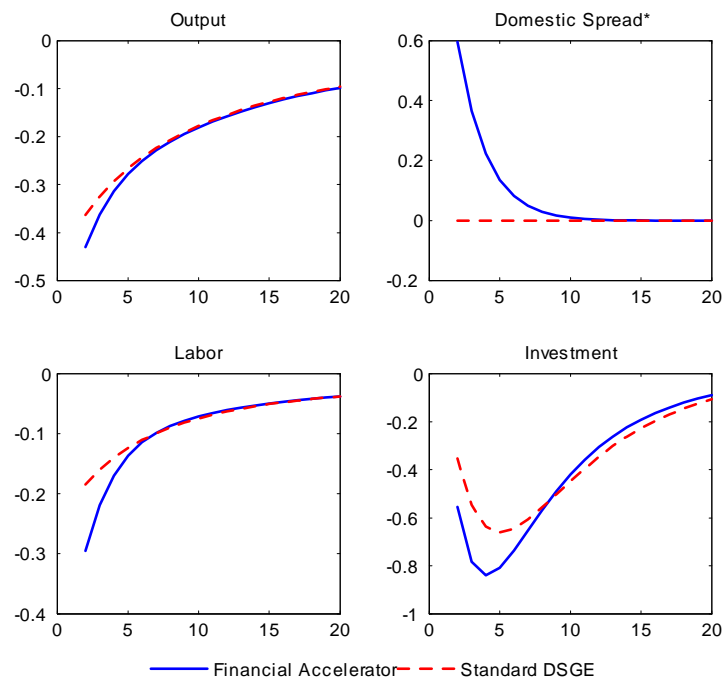


Figure 2.1: Figure 1 - Dynamics after a domestic technology shock

Figure 2a - Dynamics after a shock to the international spreads

The figure shows the performance of selected variables in response to an 1% (annualized) increase in R_t^* . The Financial Accelerator line corresponds to the baseline model, while the Standard DSGE has the same structure of baseline model but *without* the domestic frictions (i.e. no domestic financial intermediation). The units in the vertical axis are % deviations from the steady state. In the case of variables marked with an *, the units are annualized percentage points deviation from the steady state. The horizontal axis are the numbers of quarters after the initial shock.

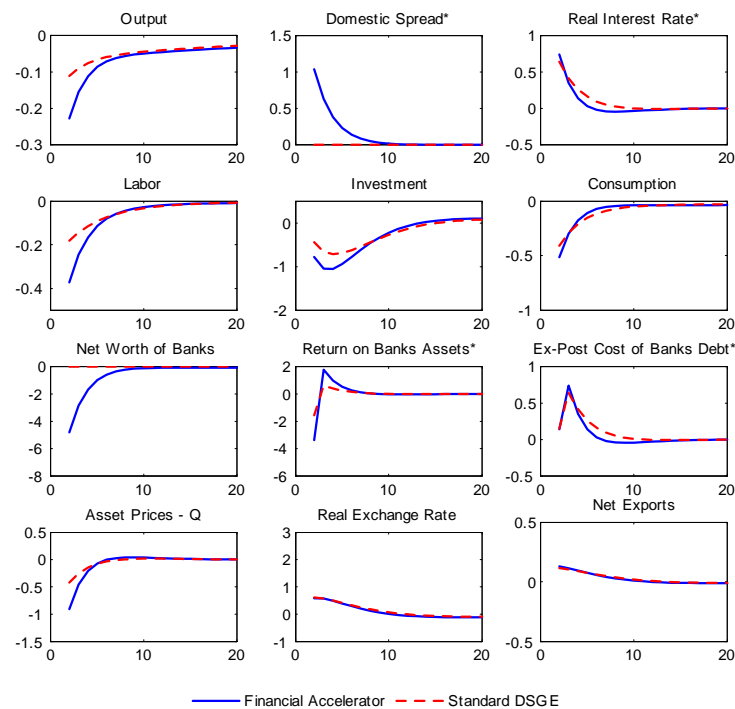


Figure 2.2: Figure 2a - Dynamics after a shock to the international spreads

The figure shows the performance of selected variables in response to a decrease of 3.7% in C_t^* . In the case of the Standard DSGE model, this fall has the same impact in output as the shock to international spreads displayed in figure 2a. The units in the vertical axis are % deviations from the steady state. In the case of variables marked with an *, the units are annualized percentage points deviation from the steady state. The horizontal axis are the numbers of quarters after the initial shock.

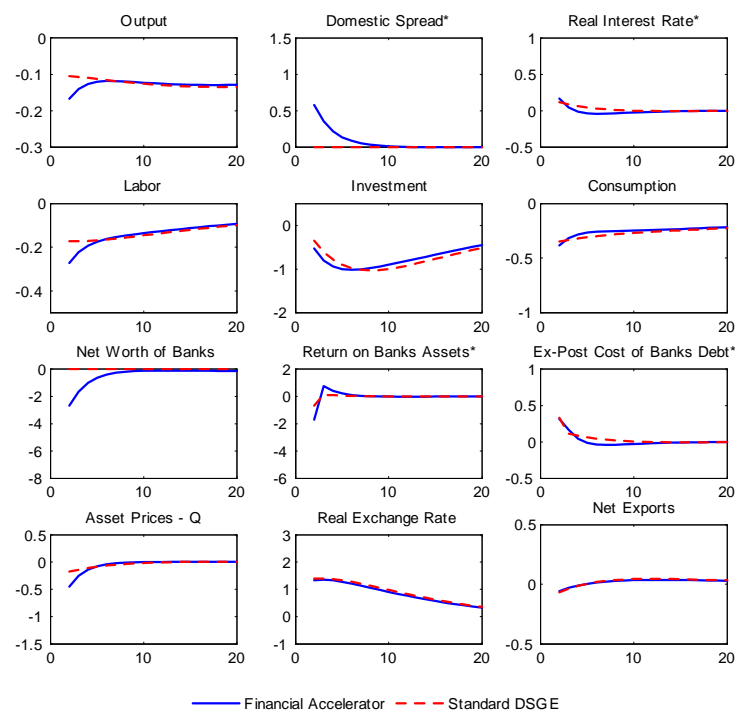


Figure 2.3: Figure 2b - Dynamics after a shock to the foreign demand for the home good

The figure shows the performance of selected variables in response to a shock to C_t^* . The graphs on the left correspond to the Baseline calibration, while the ones on the right, labeled Larger Foreign Liabilities, relate to a version in which foreign debt represent 30% of the liabilities of domestic banks (compared to 6% in baseline calibration). In both cases the shock is adjusted to generate the same initial impact of output in the Standard DSGE model. The units in the vertical axis are % deviations from the steady state. In the case of variables marked with an *, the units are annualized percentage points deviation from the steady state. The horizontal axis are the numbers of quarters after the initial shock.

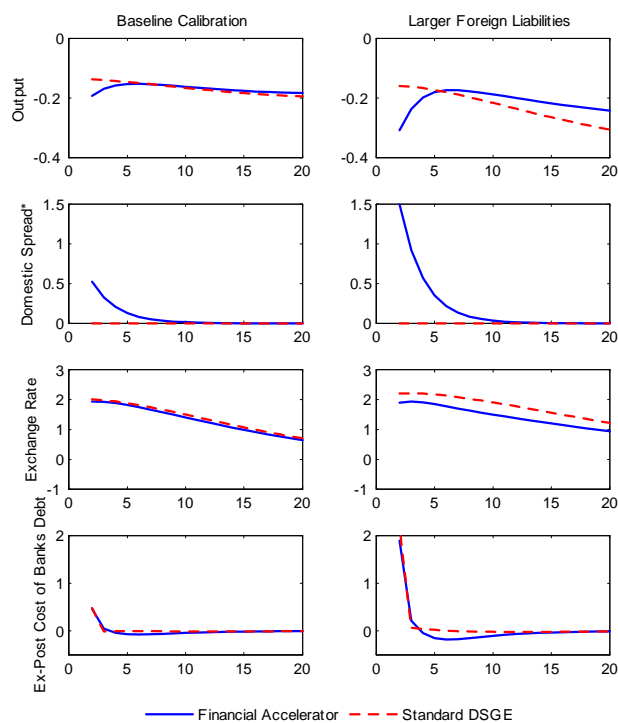


Figure 2.4: Figure 2c - Dynamics after a shock to the foreign demand for the home good

The figure shows the performance of selected variables in response to an 6% (annualized) increase in R_t^* , with and without intervention in credit markets. The units in the vertical axis are % deviations from the steady state. In the case of variables marked with an *, the units are annualized percentage points deviation from the steady state. The horizontal axis are the numbers of quarters after the initial shock.

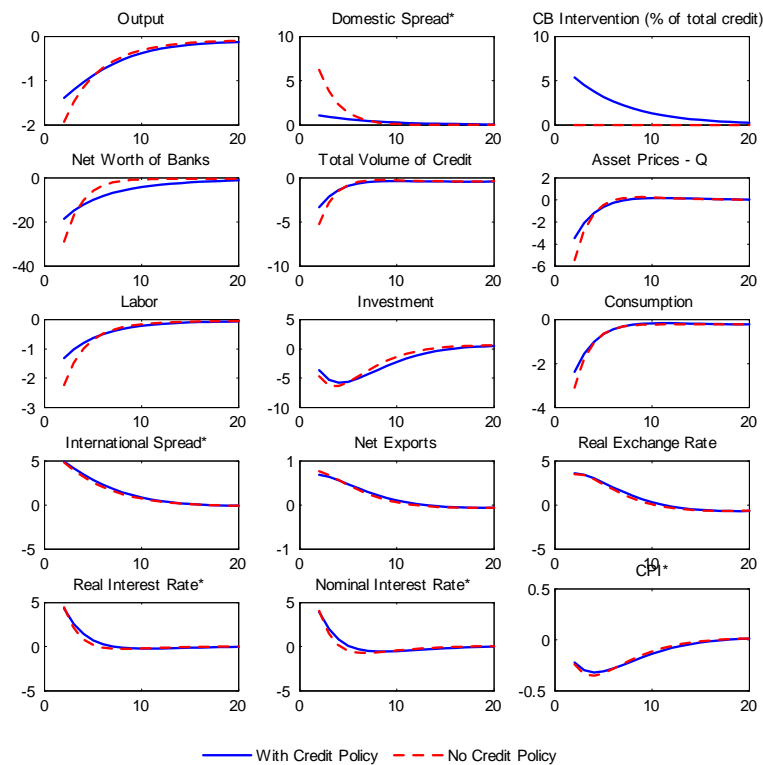


Figure 2.5: Figure 3a - Unconventional policies in response to a shock to the international spreads

The figure shows the performance of selected variables in response to a decrease of 40% in C_t^* , with and without intervention in credit markets. The units in the vertical axis are % deviations from the steady state. In the case of variables marked with an *, the units are annualized percentage points deviation from the steady state. The horizontal axis are the numbers of quarters after the initial shock.

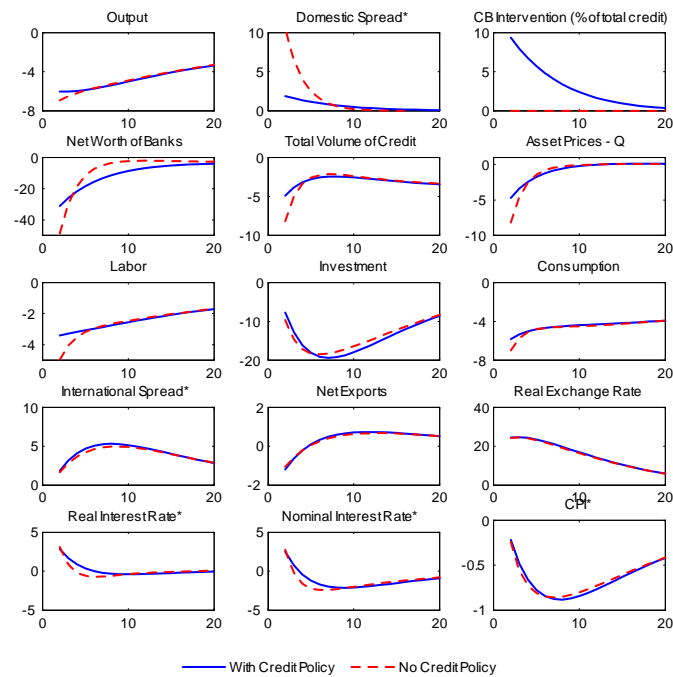


Figure 2.6: Figure 3b - Unconventional policies in response to a shock to the foreign demand for the home good

The figure shows the performance of selected variables in response to an 6% (annualized) increase in R_t^* , with and without intervention in credit markets. The units in the vertical axis are log deviations from the steady state. In the case of variables marked with an *, the units are annualized percentage points deviation from the steady state. The horizontal axis are the numbers of quarters after the initial shock.

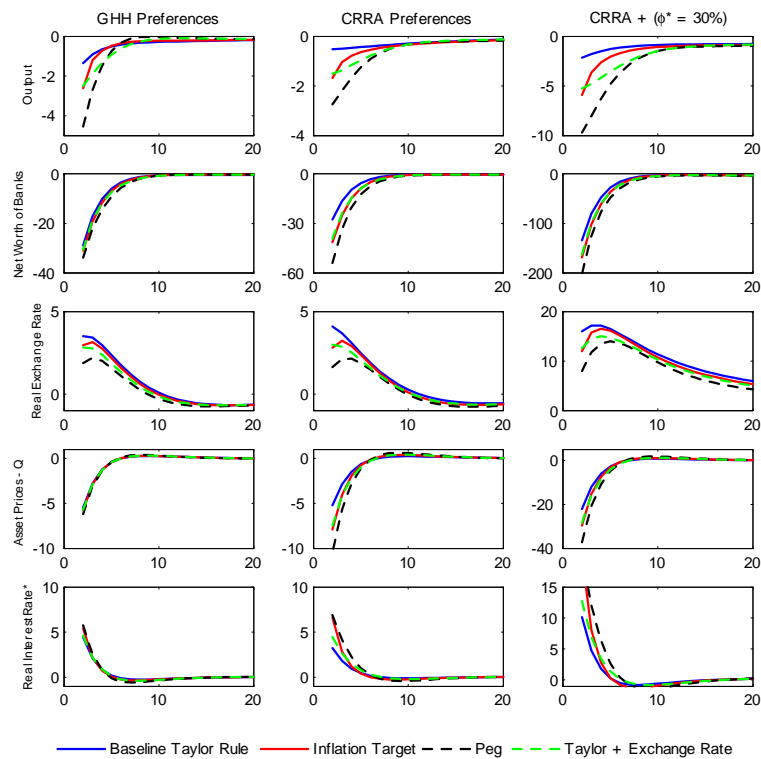


Figure 2.7: Figure 4 - Conventional policies in response to a sudden stop in capital inflows

The figure shows the performance of selected variables during the financial crisis of 2008-2009 in Brazil. The black line represents realized data, while the others are generated by the model (the green line is the financial accelerator model with credit policies and the blue one is the same model but without policies). The exogenous variables (exports and shock to the international spread) are set such the model with policy is close to the data.

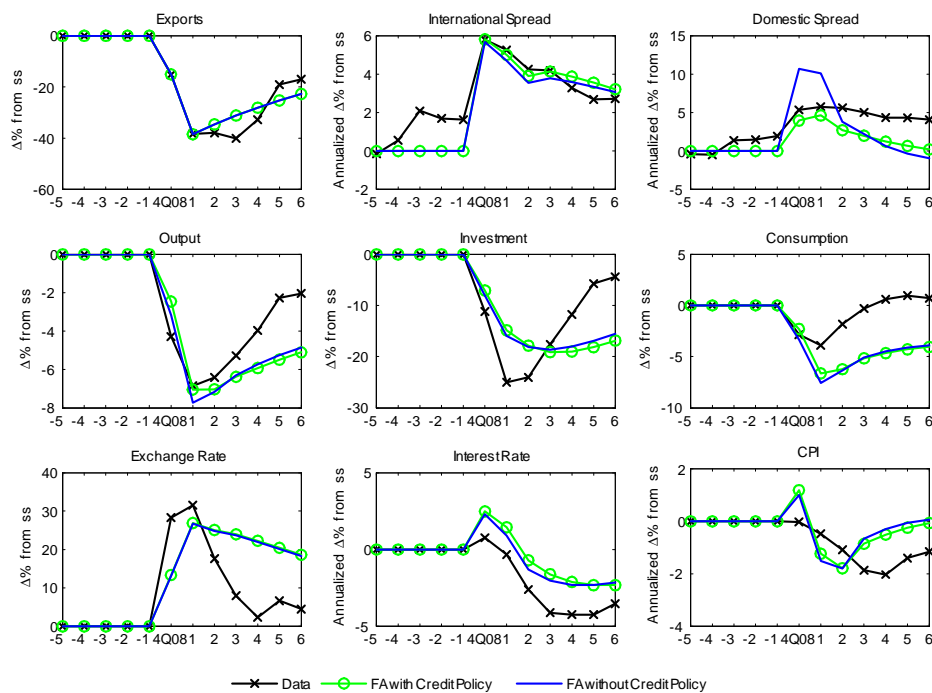


Figure 2.8: Figure 5 - Crisis Experiment - The case of Brazil

Chapter 3

Do Margin Requirements Affect Asset Prices?

3.1 Introduction

A¹ number of recent theoretical works show that margin requirements may impact asset prices. Some examples are Brunnermeier and Pedersen (2009), Gromb and Vayanos (2009), Geanakoplos (2010) and Garleanu and Pedersen (2011). The key feature of these models is the consideration of leveraged positions which depend on margin requirements. If in some periods a significant fraction of agents are credit constrained, that is, it is harder to buy assets on margin, an additional premium may be required when investing.

The implication of these results are important not only to understand asset

¹This Chapter was co-authored with Bruno C. Giovannetti. This study was initiated while the authors were affiliated to Columbia University as Ph.D. students. The authors thank Andrew Ang, Dennis Kristensen and Rodrigo Bueno for valuable comments. In addition, this paper has benefited from suggestions received from the Columbia University Finance Colloquium. All possible errors are our own responsibility.

prices. Some authors, such as Geanakoplos (2010) and Ashcraft, Garleanu, and Pedersen (2010), have been using these models to analyze the unconventional policies implemented by the Fed during the 2007-2010 financial crisis, when the size and composition of the Fed's balance sheet have suffered major changes. In January 2007, the Fed carried basically US Treasury bills (\$ 780 billion). During the great recession, however, a variety of assets were included in the balance sheet in significant amounts. For example, commercial papers (\$ 350 billion), repurchase agreements (\$ 150 billion), mortgage-backed securities (\$ 1 trillion), Federal agency debt securities (\$ 150 billion) and others (\$ 100 billion).

As Geanakoplos (2010) argues, the negative effect of margins on prices, together with the fact that these elements feed back one each other, could justify such a radical change in the Fed's policy. According to him, during some periods, "the Fed must step around the banks and lend directly to investors, at more generous collateral levels than the private markets are willing to provide."

Moreover, the margin related premium may break the usual non arbitrage link between the Fed fund rate and the rate of returns of other assets, affecting the ability of the monetary authority to promote an expansionary policy. This is noted by Ashcraft, Garleanu, and Pedersen (2010). As we shall see below, the margin premium is the product of the margin requirement and the cost of margin (weighted by the importance of the leveraged agents in aggregate consumption). The cost of margin is equal to the shadow cost of capital, which can be measured by the difference between the uncollateralized and the collateralized short term rates. The latter is closely related to the Fed fund rate, while the former depends on the liquidity and credit conditions in the interbank market. Hence, during a financial crisis, when the margin constraints are binding, a reduction in the Fed fund rate may not translate into a fall on the rate of returns of other assets. The reason is that the consequently higher shadow cost of capital steep-

ens the margin-return relation, and this increases the required return on assets with high margin requirements. Since in bad periods margins are significantly higher across assets, the interest rate reduction can then have small effect on the required return of other assets in the economy.

In despite of the relevance of these theoretical results, there is still very few empirical evidence supporting the relation between margins and prices. The theoretical papers mentioned above provide some isolated examples for some individual assets. For instance, Garleanu and Pedersen (2011) use the spread between corporate bonds and credit default swaps, and the covered interest rate parity to empirically validate their model. Ashcraft, Garleanu, and Pedersen (2010), in turn, show that when the Fed offered margins for some securities during the last financial crisis², such securities had their required rate of returns decreased.

Although these are interesting empirical illustrations, we should look for more general evidences of the existence of a margin factor. If a margin factor exists, this should have economy-wide implications. This investigation is the goal of this paper.

First, in the time-series dimension, as we discuss, an aggregate margin factor should be able to forecast future excess returns of the market portfolio. We test such a prediction and find favorable empirical evidence. For example, during periods of financial distress, a 1% increase in the margin requirement for the market portfolio raises the expected excess return on the index in at least 1.8% per year. Additionally, a 1% increase in annual the cost of buying on margins raises the expected excess return in at least 2.7% per year. These effects are controlled for other standard risk factors

²This was done through the Term Auction Facility (TAF) and the Term Securities Lending Facility (TSLF). With the first program, the Fed offered collateralized loans to depository institutions at favorable margin requirements. With the second, the Fed offered Treasury collateral (low margin) to primary dealers in exchange for other high-margin collateral such as mortgage bonds and other investment grade securities.

such as price ratios (earnings-price, dividend-price, dividend yield), market volatility, inflation and the relative bill rate. Importantly, the impact of margins on future returns is increasing on the cost of buying on margins, and vice-versa. This is a crucial aspect of Garleanu and Pedersen (2011) model.

Second, with respect to the cross-section of returns, if Garleanu and Pedersen (2011) theory is correct, stocks with high exposures to the cost of buying on margin (controlled for other risk factors) should pay higher average returns. Our empirical findings are also favorable to this prediction. We construct portfolios on the basis of (constant and time-varying) exposures of the stocks to the cost of buying on margin, and compute their alphas. Under all specifications, the portfolio with higher exposed stocks has smaller alpha. For instance, considering the portfolios sorted on time-varying loadings, the annualized alphas from the model including the Fama-French factors and a momentum factor are equal to 11.3% (for the high-exposure portfolio) and to 3.9% (for the low-exposure portfolio).

The rest of the paper is organized as follows. Section 2 provides a simple theoretical model that motivates the empirical work. Section 3 presents the empirical analysis. Section 4 concludes.

3.2 The theoretical model

In this section we present a theoretical model, based on Garleanu and Pedersen (2011), to motivate our empirical work. We summarize their model and refer to their paper for a more detailed analysis, including how to solve for the general equilibrium.

The economy has two types of agents $n \in \{a, b\}$. Agent a is the risk-averse type and b is the brave one, with a smaller risk aversion, equal to one. Both agents have

CRRRA preferences and maximize

$$E_t \int_t^T \left(e^{-\rho(s-t)} \frac{C_s^{1-\gamma^n}}{1-\gamma^n} \right) ds. \quad (3.1)$$

There are several risky assets in the economy. The price of risky asset i follows a Geometric Brownian Motion process

$$dP_t^i = \mu_t^i P_t^i dt + P_t^i \sigma_t^i dw_t. \quad (3.2)$$

In addition to the risky assets there are two riskless money market assets, both in zero net supply. One represents borrowing and lending against collateral at the interest rate r_t^c and the other uncollateralized loans with interest rate r_t^u .

The first type is available to all agents in the economy. For example, when one investor takes a long position in a risky asset she can borrow in the collateralized loan market. To do so she must make some collateral available to her broker. The amount of required collateral is determined by the haircut applied by the broker. The haircut is the margin requirement, denoted by m_t^i , and determines how much of her own capital she must use to make the initial investment. Similarly, if she takes a short position, she must also deposit collateral as margin with her broker or at some exchange. In both cases, the margin is computed as a fraction of the total position: if the agent invests a fraction θ_t^i of their wealth W_t in the risk asset i , she must deposit $m_t^i |\theta_t^i| W_t$ as margin. Note again that she must deposit a positive margin whether she is long or short in the asset. Finally, the margin deposits are remunerated at r_t^c .

The uncollateralized loan market is a standard one. It is riskless as the collateralized loan. However, only type b agents can contract uncollateralized loans and therefore, as we show below, when this agent is capital constrained, the two interest rates are different.

Every instant, each consumer can chose how much to consume (C_t), the fraction of her wealth she wants to invest in the risky assets, and in the uncollateralized loan

market (η_t^u). Any residual wealth is invested in the collateralized loan market. The evolution of wealth is then given by

$$dW_t = \left[W_t \left(r_t^c + \eta_t^u (r_t^u - r_t^c) + \sum_i \theta_t^i (\mu_t^i - r_t^c) \right) - C_t \right] dt + W_t \sum_i \theta_t^i \sigma_t^i dw_t. \quad (3.3)$$

Consumers take as given all prices and maximize (3.1) subject to (3.3) and, because of the margins requirement,

$$\sum_i m_t^i |\theta_t^i| + \eta_t^u \leq 1. \quad (3.4)$$

The Hamilton-Jacobi-Bellman equation for the type b consumer is given by

$$\text{Max}_{\theta_t^i, \eta_t^u} \left\{ r_t^c + \eta_t^u (r_t^u - r_t^c) + \sum_i \theta_t^i (\mu_t^i - r_t^c) - \frac{1}{2} \sum_{i,j} \theta_t^i \theta_t^j \sigma_t^i \sigma_t^j \right\},$$

subject to (3.4).

The solution to this problem yields, in the case agent b is long in the risky asset i , two conditions:

$$r_t^u - r_t^c = \psi_t, \quad (3.5)$$

$$\mu_t^i - r_t^c = \gamma^b \beta_t^{C^b} + m_t^i \psi_t, \quad (3.6)$$

where ψ_t is the shadow price of capital (ie, the Lagrangian Multiplier associated with (3.4)), and $\beta_t^{C^b} \equiv \text{cov}_t \left(\frac{dC_t^b}{C_t^b}, \frac{dP_t^i}{P_t^i} \right)$.

A similar problem is solved by agents of type a , with the only difference that he cannot chose η_t^u . If we assume that his capital constraint is never binding, the solution to his portfolio choice problem is given by $\mu_t^i - r_t^c = \gamma^a \beta_t^{C^a}$. Then aggregating across consumers is straightforward and gives the main result from Garleanu and Pedersen (2011) that motivates our empirical work.

The risk premium of risky asset i , when only consumers of type b can be capital constrained and are long in this asset, is given by a margin-based premium in addition to the standard consumption-based premium,

$$\mu_t^i - r_t^c = \gamma_t \beta_t^C + x_t m_t^i \psi_t \quad (3.7)$$

where

$$\gamma_t^{-1} = \frac{1}{\gamma^a} \frac{C_t^a}{C_t} + \frac{1}{\gamma^b} \frac{C_t^b}{C_t} \quad (3.8)$$

and

$$x_t = \frac{C_t^b}{\gamma^b} \left(\frac{C_t^a}{\gamma^a} + \frac{C_t^b}{\gamma^b} \right)^{-1}. \quad (3.9)$$

Equation (3.7) is the main testable implication of the model. It states that the excess returns of any risky asset is composed of two terms. The first term is the standard risk premium in the CAPM literature: the product of the price of risk, which is given by an average of the risk aversion of the different agents in the economy, and the covariance between aggregate consumption and the return of the asset. The second term is the novelty. Because some investors might be capital constrained and cannot deposit additional margins, they require an additional premium to hold such an asset in equilibrium.

This extra premium is a combination of three factors. First, ψ_t is the shadow cost of buying on margin, and measures how binding the capital constraint is. By equation (3.5), it is given by the difference of two interest rates $r_t^u - r_t^c$. The second factor m_t^i , is the margin requirement itself. The last term gives the importance of the constrained investor in the economy. As emphasized by Garleanu and Pedersen (2011), even though the consumption share of the type b can be small, x_t can still be large because it takes into account the differences in risk aversion.

3.3 Testable implications of the model

The model presented above has economy-wide implications, for both the time-series and the cross-section of expected returns. These are investigated in this section.

3.3.1 Time-series testable implications

There are two direct consequences of equation (3.7) related to the time-series of the market portfolio return. First, (a) during periods of financial distress (when the margin premium is relevant), both the margin requirement on the market portfolio and the respective margin cost should positively forecast future returns. Second, (b) the effect of an increase in the margin cost should depend on the level of the margin and, at the same time, the effect of an increase in margin requirements should depend on the cost of buying on margin.

We can test implications (a) and (b) by estimating the regression

$$r_{t+h} - r_{t+h}^c = \delta_0 + \delta_1 m_t + \delta_2 \psi_t + \delta_3 x_t m_t \psi_t + z_t' \delta_4 + e_{t+h}, \quad (3.10)$$

where r_{t+h} and r_{t+h}^c are the h -month ahead risky (S&P 500) and collateralized risk-free returns respectively, e_{t+h} is an error term with zero conditional mean and z_t is a $k \times 1$ vector with other standard risk factors.

A main issue in the estimation of equation (3.10) is data availability. First, as Geanakoplos (2010) indicates, measures of aggregate margin are very hard to get historically. Second, it may not be immediately clear which variable should be used to represent ψ_t . Third, data on x_t , which measures the ratio of the aggregate consumption due to the brave investor (and not simply aggregate consumption), is also not readily available.

With respect to the first issue, the Chicago Mercantile Exchange provides data on the margin requirements for the S&P 500 futures. If the capital constrained agent can interchangeably trade spot and future contracts, and the spot and future markets are good substitutes, margin requirements in future and spot markets should be tightly, if not perfectly, related. Hence, under this assumption, we use the CME margin requirements to construct m_t . We compute the daily ratio between the initial margin requirements on S&P 500 futures for members of the CME (available from April 1982) and the value of the underlying S&P 500 index multiplied by the size of the contract. This is the usual way of computing margins. Then we use the end-of-month m_t .³

With respect to ψ_t , the shadow price of capital, equation (3.5) says that in equilibrium ψ_t has to be equal to the spread between the uncollateralized and the collateralized risk-free rates. In other words, it is a measure of how binding the capital constraint is. The well-known ted spread is given by the difference between the interest rates on interbank loans (Libor) and American treasury bills and, because of that, it is a widely observed indicator of credit conditions in financial markets. Hence, it is a natural choice to represent ψ_t . The ted spread is computed as the difference between the 3-month libor rate and the 3-month treasury bill. For the libor rate we use the Eurodollar 3-month deposit rate in the London market. Following the same convention as for margins, we use the end-of-month ted spread.

Regarding x_t , the problem of disaggregating consumption among different groups of individuals is not new in the asset pricing literature. Since Mankiw and Zeldes (1991), a number of papers have been trying to come up with measures for the consumption of stockholders as a way to address the equity premium puzzle. Because stockholders' consumption covariates more with returns, such studies are able to gener-

³Using the beginning-of-month series gives qualitatively the same results.

ate more reasonable risk aversion levels among other good results. Ait-Sahalia, Parker, and Yogo (2004), for example, employ data on the consumption of luxury goods as a proxy for stockholder's consumption. More recently, Malloy, Moskowitz, and VISSING-JØRGENSEN (2009) use microlevel household consumption data to approximate this series.

It seems reasonable to employ one of these series to construct a measure for x_t , and we use the data of Malloy, Moskowitz, and VISSING-JØRGENSEN (2009) which is publicly available. From their consumption growth rates, we compute x_t in accordance to equation (3.9). We impose $\gamma^B = 1$, $\gamma^A = 10$, and $x_0 = 27\%$, which are the values employed by Garleanu and Pedersen (2011) in their analysis of the model's predictions.⁴

However, as we discuss ahead, the presence of x_t in the regressions is immaterial for the results. This happens since x_t accounts for a very small part in the variation of the factor $x_t m_t \psi_t$.

Descriptive Statistics

Our final data set consists of monthly observations for m_t and ψ_t from April 1982 to July 2011, and for x_t from April 1982 to November 2004. The beginning of the sample (April 1982) is in accordance to the beginning of the CME margin requirements. Table 1 presents the descriptive statistics for m , ψ and x .

The sample correlation between m_t and ψ_t is only 14%. Notwithstanding, as Figure 1 illustrates, around periods of financial distress both series usually go up (although m_t has a longer memory, i.e., it moves slower).

The product $m_t \psi_t$ and x_t are presented in Figure 2. From the plot, it becomes

⁴We tested a number of alternative values for such parameters and the results suffer no qualitative change at all.

clear that the important role in the empirical exercises will be played by $m_t\psi_t$ given that x_t is relatively constant.

Time-series regressions

We want to estimate equation (3.10). However, our proxy for x_t is only available until 2004. Fortunately we can exclude x_t from our model with no harm, given that the contribution of x_t to the variation in $x_tm_t\psi_t$ is extremely small (as Figure 2 illustrates). To quantify this fact, we can compare the standard deviations of $\log(x_tm_t\psi_t)$ and $\log(m_t\psi_t)$.⁵ While the log of $x_tm_t\psi_t$ has standard error equal to 0.835, this is equal to 0.834 for the log of $m_t\psi_t$. To confirm the irrelevance of variable x , we estimated equation (3.10), restricted to 1982-2004, with and without x_t . Unreported results show that x is indeed immaterial as expected.

Given that, the model we estimate to test implications (a) and (b) mentioned above is

$$r_{t+h} - r_{t+h}^c = \delta_0 + \delta_1 m_t + \delta_2 \psi_t + \delta_3 m_t \psi_t + z_t' \delta_4 + e_{t+h}. \quad (3.11)$$

We include in z_t some prominent variables explored in the predictability literature, one at a time. These are the earnings-price ratio, the dividend-price ratio, the dividend yield, the market volatility, inflation and the relative bill rate. These variables are defined and computed as follows.

The earning price ration (e-p) is the log of earnings (12-month moving sum of earnings on the S&P 500 index) minus the log of prices (S&P 500 index). The dividend

⁵Comparing the standard deviations without taking logs would be misleading since x_t is always below 1 and this would depress the variance of $x_tm_t\psi_t$ per se. With additivity from logs this effect vanishes.

price ratio (d-p) is the difference between the log of dividends (12-month moving sums of dividends paid on the S&P 500 index) and the log of prices. The dividend yield (d-y) is the difference between the log of dividends and the log of 12-month lagged prices. The market volatility (vol) is the monthly average of squared daily returns on the S&P 500. Inflation (inf) is the CPI inflation. The relative bill rate (rrel) is difference between the 3-month treasury bill return and its 12-month moving average. Data on earnings, dividends and returns are from Robert Shiller's website. Inflation and t-bill returns come from the Federal Reserve Bank of St. Louis dataset.

Table 2 presents the estimation results of equation (3.11) for 12-, 18-, 24- and 48-month ahead excess returns respectively.⁶ The table is divided into 4 blocks, one for each horizon. Each block reports the coefficients of the margin requirements (δ_1), of the ted spread (δ_2), and of the product between the margin and the ted spread (δ_3), along with their standard errors, column by column. Moreover, each block is divided into seven rows. In the first row, no control is added to the regression. Then, from the second to the seventh row, the results are controlled for the indicated variables individually. The coefficients related to the control variables are not reported. The last two columns (7 and 8) of the table present the marginal effects of the ted spread and of the margin requirement on future returns, respectively, $\delta_2 + \delta_3 m$ and $\delta_1 + \delta_3 \psi$.

According to Table 2, the predictability results show up about the 24-month horizon. This can be justified by the behavior of $m_t \psi_t$, as illustrated in Figure 2. The series spikes around periods of financial distress and, once it spikes, it takes from 1.5 to 2 years to return to its low level. This characteristic, compatible to the idea of relative brief periods of binding capital constraints, is what produces higher returns about 24 months after a spike in $m_t \psi_t$ (prices decrease when $m_t \psi_t$ spikes, and return about 24

⁶Equation (3.11) was estimated using annualized returns in %. The margin and the ted spread (also annualized) were expressed in % as well.

months later). Note that the the predictability power gets weak at the 48-month horizon. This indicates that the 24-month horizon predictability is not an artificial result given by the well-known combination of overlapping returns with persistent regressors (if this was the case, the predictability power would be increasing with the horizon).

Columns 7 and 8 of Table 2 quantify the marginal effects when capital constraints bind.⁷ They report the partial derivatives of equation (3.11) with respect to the margin and the ted spread evaluated at $\psi = 2.5\%$ and $m = 10\%$. The average values for these variables are 0.7% and 4.7%, respectively, and the maximum values are 5.1% and 13.5%. Therefore, $\psi = 2.5\%$ and $m = 10\%$ represent periods when the capital constraint is restrictive.

The computations, using the 24-month horizon estimates, indicate that a 1% raise in the margin requirement (ted spread) should depress stock prices in 2.3% (6.9%) on average per year. These are the average marginal effects across specifications (across the rows in the third block). The lowest marginal effect of margin is 1.8% (when controlled for inf or rrel) and the lowest marginal effect of the ted spread is 2.7% (when controlled for d-p).

These empirical results are favorable to implications (a) and (b). First, as the marginal effect estimates indicate, both the margin requirement on the market portfolio and the respective margin cost do positively forecast future returns during periods of financial distress. Second, as the significance of the product $m_t\psi_t$ confirms, the effect of one variable does depend on the level of the other one.

In the next sub-section, we turn to the investigation of the cross-sectional impli-

⁷Periods of binding capital constraints are the ones we are interested in because of two related reasons. First, the theoretical model is about moments of binding capital constraints, i.e., when the margin premium is relevant. Second, as Figure 2 indicates, our empirical identification should be coming from a limited number of points in the sample, namely, the ones when the product between margin and ted spread spikes.

cations of the theoretical model.

3.3.2 Cross-sectional testable implications

The most direct way of testing the cross-sectional implications of equation (3.7) would be by comparing the relation between risk-adjusted returns and margin requirements across different assets. Garleanu and Pedersen (2011), for instance, use the spread between corporate bonds and credit default swaps, and the covered interest rate parity to do that.

Unfortunately, given the difficulty in obtaining data on margin requirements for individual securities, tests of this kind are restricted to isolated and individualized examples as the two above.

However, it is still possible to promote an interesting confrontation of equation (3.7) with data on the stock market, even with no data on individual margin requirements. We can do that by splitting the cross-sectional story under equation (3.7) into two complementary parts. First, the model predicts that stocks with higher exposure to ψ_t (controlled for other risk factors) should pay on average higher returns. Second, it says that a stock's exposure to ψ_t is determined by its margin requirement. Both parts are necessary conditions for the model to be valid. Together, they are sufficient. Given that information on individual stock margin requirement is not publicly available, we are not able to empirically address the second prediction. Nevertheless, we can test the first one.

Accordingly, in this sub-section, we investigate whether stocks with higher exposure to ψ_t (controlled for other risk factors) pay on average higher returns. As we will see, we find strong favorable evidence on this direction. Since this is only a necessary condition for the model to be valid, our results, for being favorable, do not provide

a conclusive empirical test for the model. However, the theoretical relation between the exposure to ψ_t and average returns, when controlled for other risk factors, is not a trivial one. Moreover, such a relation has never been empirically documented before, to the best of our knowledge. Given that, we see the following results as a relevant empirical evidence in favor of Garleanu and Pedersen (2011) model.

It is important to mention that using individual stock data to test the model in the cross-section only makes sense if margin requirements vary across stocks. By analyzing private data from a large hedge fund, Ang, Gorovyy, and van Inwegen (2011) report that this is indeed the case. According to their Table 1, margin requirements do vary a lot across securities, going from 5% to 50%.

Constructing portfolios using constant margin-betas

We call the exposure of an asset return to ψ_t by "margin-beta". We first assume a constant margin-beta, given by β_i . Under the model reasoning, this initial restriction makes sense if individual margin requirements do not vary much over time.

We construct portfolios formed on the basis of stocks' margin-betas. Controlling for other risk factors, in December of each year we estimate a pre-ranking β_i for every NYSE, AMEX and NASDAQ stock with share code 10 and 11 in the CRSP (Center for Research in Security Prices of the University of Chicago) database, using five years of prior monthly returns.⁸ That is, in each December, for each security, we estimate

$$r_{i,t}^e = \beta'_{F,i} F_t + \beta_i \psi_t + e_t, \quad (3.12)$$

⁸Stocks that do not have information for the last 5 years are not included in the portfolios for the following year. The average number of remaining stocks (permno) in each December is 3180 (from 2507 to 3461).

where $r_{i,t}^e$ is the excess return of security i and the vector F_t contains a constant, the 3 Fama-French factors and a momentum factor (all these factors are from Kenneth French web-site).

We then form ten equally weighted portfolios based on β_i and compute their returns for the next twelve months. We repeat this process for each year from 1987 to 2009. The result is monthly returns on ten portfolios sorted on margin-betas from January 1988 to December 2010.

Figure 3 reports the relation between the post-ranking margin-betas of the ten portfolios and their average returns.⁹ The post-ranking betas are obtained by estimating regression (3.12) over the whole sample period (January 1988 to December 2010).

The y-axis of Figure 3 presents the portfolios annualized average returns. As we can see, there is a positive relation between margin-betas and average returns.¹⁰ This is a first favorable empirical evidence. However, returns on the y-axis are not controlled for other risk-factors.

To investigate whether the margin-beta is priced in the presence of other risk factors, we compute the portfolios alphas for the ten portfolios. The CAPM alpha is computed with respect to risk factor related to the market excess return (MKT), the 3-factor alpha with respect to the Fama-French factors (MKT, SMB, HML) and the 4-factor alpha with respect to the Fama-French factors and the factor related to momentum (MOM). That is,

⁹The estimated margin-betas are negative, since returns and ted spread have a contemporaneous negative relation. We will report the results using the absolute value of the betas.

¹⁰The relation has a p-value equal to 0.012.

$$r_{i,t}^e = \alpha_{i,CAPM} + \beta_{i,MKT}MKT_t + e_{1,t}$$

$$r_{i,t}^e = \alpha_{i,3F} + \beta_{i,MKT}MKT_t + \beta_{i,SMB}SMB_t + \beta_{i,HML}HML_t + e_{2,t}$$

$$r_{i,t}^e = \alpha_{i,4F} + \beta_{i,MKT}MKT_t + \beta_{i,SMB}SMB_t + \beta_{i,HML}HML_t + \beta_{i,MOM}MOM_t + e_{3,t}$$

Table 3 presents the alphas and their t-statistics. We multiply the alphas by 12 to interpret them in terms of annualized returns. Portfolio number 1 has the stocks with low margin-betas and portfolio number 10 has the stocks with high margin-betas. So, if the margin-beta risk is priced, the premium for this risk should be positive, in that alphas should increase with the portfolio number.

The evidence in Table 3 favors the pricing of the constant margin-beta. All three alphas of the tenth portfolio are considerably higher than the ones of the first portfolio. Indeed, a "10 minus 1" spread, which goes long portfolio 10 and short portfolio 1 would have a CAPM alpha equal to 2.6%, a 3-factor alpha equal to 2.8% and a 4-factor alpha equal to 6.1% (these are simply the difference between the alphas from portfolio 10 and 1). Moreover, the 4-factor alpha of the "10 minus 1" spread is significant at 1% (the 3-factor alpha is significant at 10% and the CAPM alpha is not significant). We also test the hypothesis that all ten alphas are jointly equal to zero, using the test of Gibbons, Ross, and Shanken (1989). For all three models, the hypothesis is rejected at a 1% significance level.

Constructing portfolios using time-varying margin-betas

We now relax the assumption of a constant exposure to the term spread. To do that, we assume the margin-beta to be given by

$$\beta_{i,t} = \beta_{0,i} + \beta_{1,i}m_t, \quad (3.13)$$

where m_t is the margin requirement for the market portfolio used in the previous subsection.

This approach to incorporating time-variation in betas was first proposed by Shanken (1990) and has been frequently used (see, for instance, Pastor and Stambaugh (2001)). It is helpful whenever the researcher has a good idea on what may be causing the time-variation on the factor exposure. This seems to be the case here, given that a stock's exposure to ψ_t should be determined by its margin requirement. Based on that, equation (3.13) does possess some appeal ex ante. First, the constant will be capturing the stable component of the individual margin as before. Second, the margin requirement on the market portfolio will account for a common time-variation in individual margins given by some sort of aggregate tail risk. Note that we allow the loading on the aggregate margin ($\beta_{1,i}$) to vary across stocks.

In each December, for each security, we then estimate

$$r_{i,t}^e = \beta'_{F,i}F_t + (\beta_{0,i} + \beta_{1,i}m_t)\psi_t + e_t, \quad (3.14)$$

and form ten equally weighted portfolios based on the predicted margin-betas, that is,

$$\widehat{\beta}_{0,i} + \widehat{\beta}_{1,i}m_{Dec} \quad (3.15)$$

where m_{Dec} is the aggregate margin requirement in the respective December. As before, we then compute the portfolios' returns for the next twelve months and repeat this process for each year from 1987 to 2010. The result is monthly returns on other ten portfolios, now sorted on time-varying margin-betas.

By estimating regression (3.14) over the whole sample period we can then compute the post-ranking average time-varying margin-betas as

$$\frac{1}{T} \sum_{t=1}^T \left(\widehat{\beta}_{0,i} + \widehat{\beta}_{1,i} m_t \right).$$

Figure 4 presents a significant positive relation between the post-ranking average time-varying margin-betas of the portfolios and their average returns ($t = 5.74$).¹¹ Such a relation is stronger under time-varying than under constant betas.

The better fit of time-varying betas is confirmed by the analysis of the alphas. Table 4 presents strong results in favor of the theoretical model. The alphas of the three "10 minus 1" spreads are now even higher: the CAPM alpha is now 3.4%, the 3-factor alpha is 3.5% and the 4-factor alpha is 7.4%. They are all significant at 5% (the 4-factor alpha is significant at 1%). The test of Gibbons, Ross, and Shanken (1989) rejects the null hypothesis of all alphas equal to zero at a 1% significance level.

The fact that we obtain stronger results under the time-varying beta should be simply indicating that assuming constant margin requirements for individual stocks may be somewhat restrictive.

3.4 Conclusion

In this study we provide favorable evidence for the existence of an aggregate margin-related factor in the economy. As discussed in a recent literature, such a factor may have important theoretical consequences that are not limited to the understanding of asset prices. For instance, they may affect monetary policy efficiency during some periods.

¹¹As before, the betas are negative and we report the results using their absolute values.

According to our results, during periods of financial distress, both the margin requirement on the market portfolio and the respective margin cost positively forecast future returns. Moreover, the effect of an increase in the margin cost depend on the level of the margin and, at the same time, the effect of an increase in margin requirements should depend on the cost of buying on margin. These findings confirm the the time-series properties of the model by Garleanu and Pedersen (2011).

With respect to the cross-section of the returns, the theoretical model predicts that stocks with higher exposure to the ted spread (controlled for other risk factors) should pay on average higher returns. We test test this fact and, as before, find favorable empirical evidence.

3.5 Tables and Figures

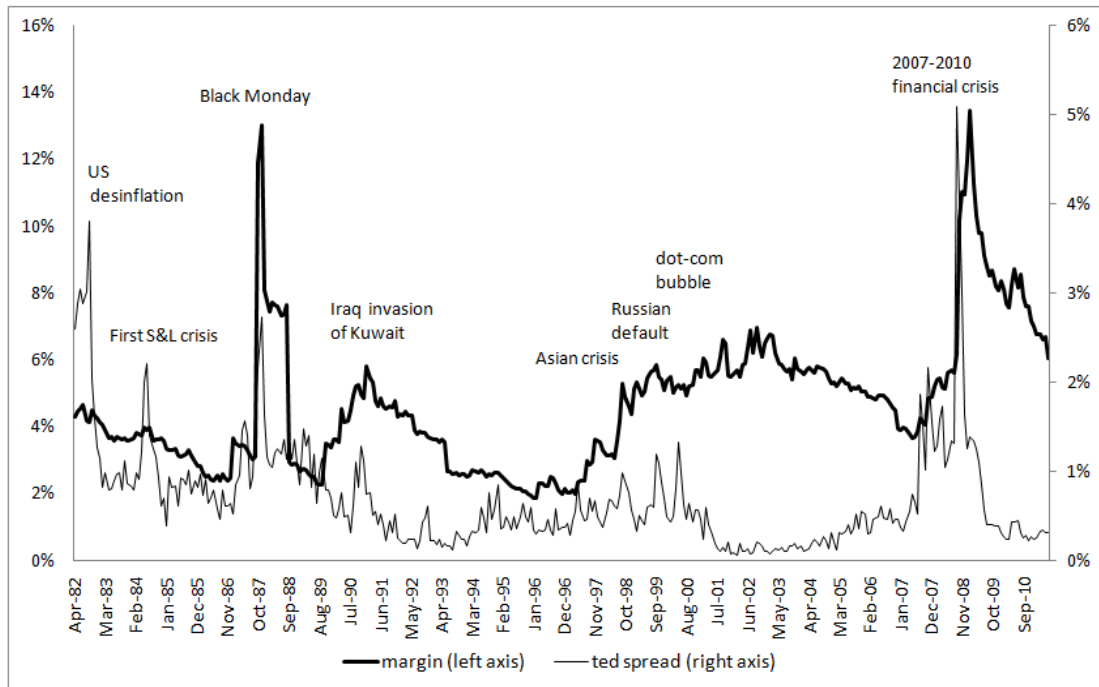


Figure 3.1: Figure 1. Margin requirement and ted spread.

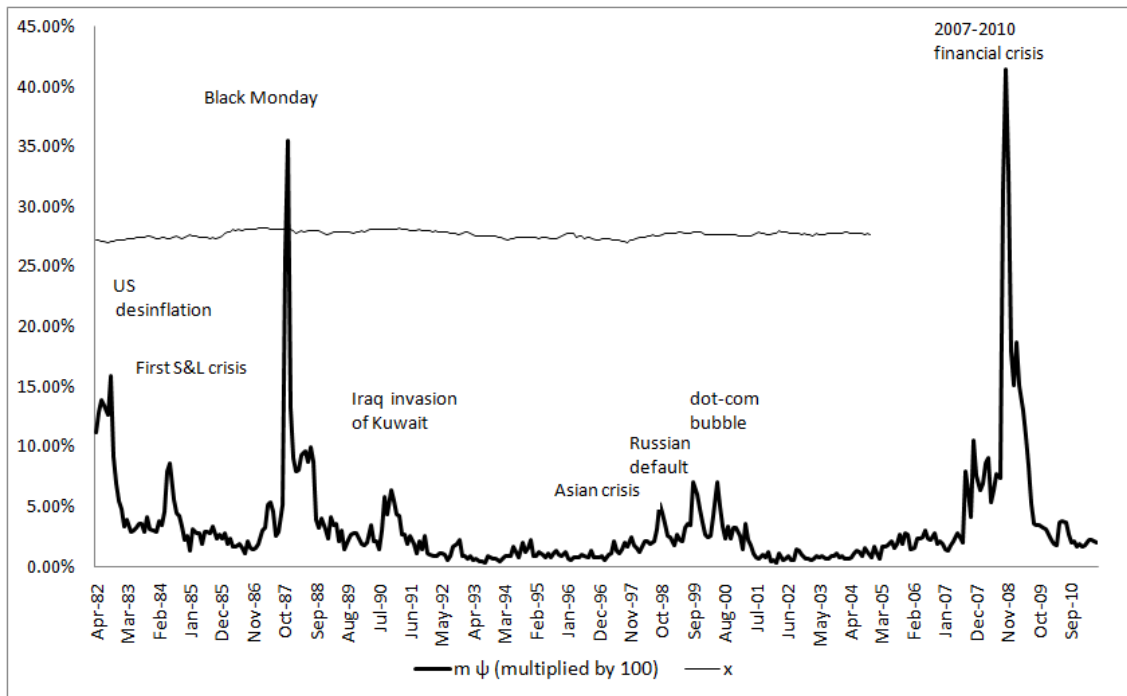


Figure 3.2: Figure 2. The margin factor (margin time the ted spread) and the risk-bearing capacity of the brave agent (x).

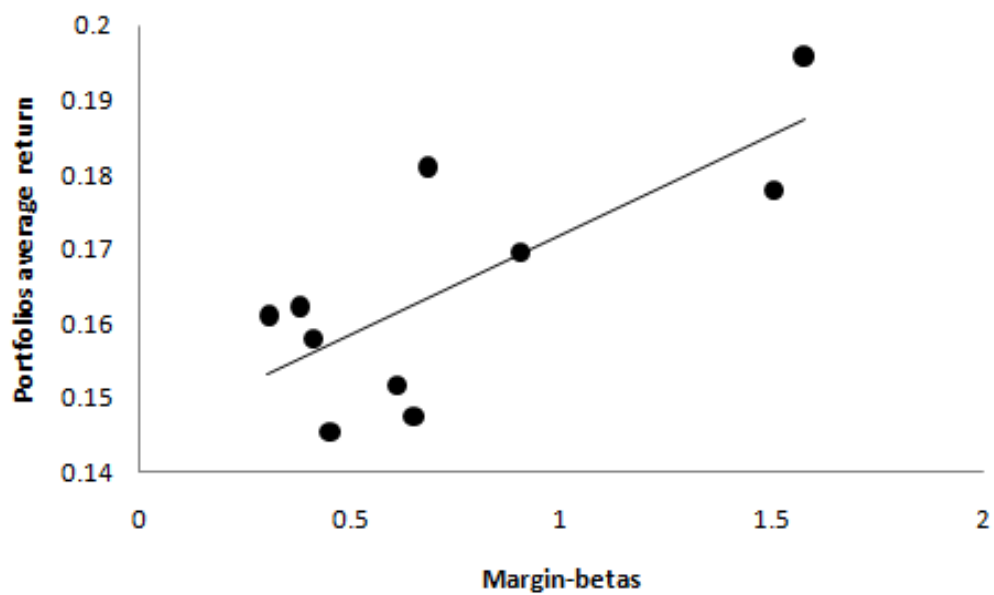


Figure 3.3: Figure 3. Constant margin-beta sorted portfolios (average returns x margin-betas)

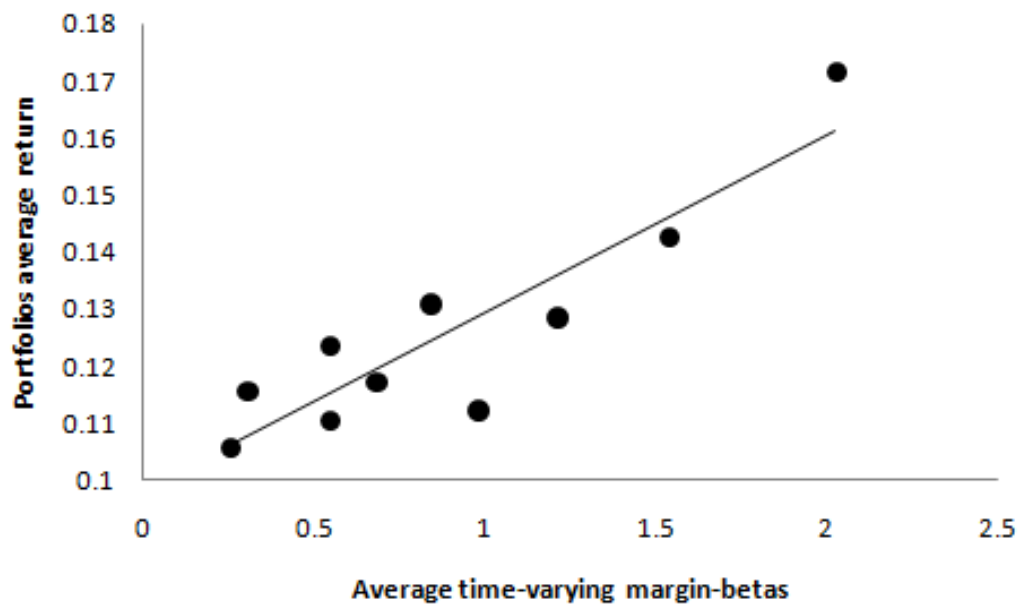


Figure 3.4: Figure 4. Time-varying margin-beta sorted portfolios (average returns x average margin-betas)

Table 3.1: Descriptive statistics

	mean	min	max	std. dev.	correl. m	correl. Ψ	correl. x
margin (m)	4.7%	1.9%	13.5%	2.0%	1		
ted spread (ψ)	0.7%	0.1%	5.1%	0.6%	14%	1	
consumption ratio (x)	27.7%	27.0%	28.3%	0.3%	35%	-15%	1

Table 3.2: Predictive regressions (equation 11)

		estimated parameters from equation (11)						marginal effects	
		δ_1	$\sigma(\delta_1)$	δ_2	$\sigma(\delta_2)$	δ_3	$\sigma(\delta_3)$	$\delta_1+\delta_3\psi$	$\delta_2+\delta_3m$
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
12-month ahead	no control	-1.529	(1.872)	-6.190	(10.23)	1.185	(1.137)		
	e-p	-0.248	(1.967)	-10.07	(10.25)	1.104	(1.173)		
	d-p	-0.643	(1.688)	-12.13	(9.786)	1.194	(1.108)		
	d-y	0.0350	(1.639)	-11.06	(10.19)	1.225	(1.165)		
	vol	-1.622	(1.863)	-7.964	(10.02)	1.652	(1.231)		
	inf	-1.345	(1.862)	-4.537	(9.553)	0.895	(1.069)		
	rrel	-1.362	(1.789)	-5.126	(9.910)	1.106	(1.124)		
18-month ahead	no control	-2.100	(1.938)	-9.112	(7.177)	1.622*	(0.952)	2.1%	7.1%
	e-p	-1.153	(1.932)	-12.18	(7.523)	1.579	(0.991)	2.8%	3.6%
	d-p	-1.134	(1.773)	-14.54**	(6.850)	1.574*	(0.917)	2.8%	1.2%
	d-y	-0.330	(1.848)	-13.07*	(7.208)	1.515	(0.966)		
	vol	-2.200	(1.925)	-10.86	(7.272)	2.081*	(1.113)	3.0%	10.0%
	inf	-2.030	(1.954)	-8.546	(7.052)	1.521	(0.955)		
	rrel	-1.972	(1.920)	-8.371	(7.111)	1.561*	(0.945)	1.9%	7.2%
24-month ahead	no control	-2.804	(1.952)	-9.500*	(5.365)	1.835**	(0.866)	1.8%	8.9%
	e-p	-1.927	(1.913)	-14.68**	(5.690)	1.978**	(0.898)	3.0%	5.1%
	d-p	-1.617	(1.964)	-13.93***	(5.110)	1.660*	(0.876)	2.5%	2.7%
	d-y	-0.855	(2.168)	-12.31**	(5.548)	1.574*	(0.937)	3.1%	3.4%
	vol	-2.845	(1.944)	-10.32*	(5.715)	2.052**	(1.014)	2.3%	10.2%
	inf	-2.819	(1.955)	-9.600*	(5.447)	1.853**	(0.890)	1.8%	8.9%
	rrel	-2.823	(1.992)	-9.604*	(5.329)	1.844**	(0.875)	1.8%	8.8%
48-month ahead	no control	-3.454**	(1.564)	-5.381	(4.907)	1.461*	(0.819)	0.2%	9.2%
	e-p	-2.642	(1.731)	-9.384	(6.191)	1.405	(0.901)		
	d-p	-1.869	(1.758)	-9.577**	(4.782)	1.054	(0.858)		
	d-y	-1.460	(1.992)	-7.298	(5.382)	0.880	(0.974)		
	vol	-3.446**	(1.547)	-5.486	(5.197)	1.488	(0.937)		
	inf	-3.465**	(1.576)	-5.538	(5.019)	1.475*	(0.834)	0.2%	9.2%
	rrel	-3.653**	(1.571)	-6.484	(4.432)	1.610**	(0.775)	0.4%	9.6%

Notes: Blocks 1 to 4 report results from monthly predictive regressions of S&P 500 excess returns over 12-, 18-, 24- and 48-month horizons, respectively, for the period between April 1982 to June 2011 (equation 11). Each block reports the coefficients and standard errors of the S&P 500 futures margin requirements (columns 1 and 2), of the ted spread (columns 3 and 4), and of the product between the margin and the ted spread (columns 5 and 6). Rows of each block report the estimates described above from regressions controlled for the following variables, respectively: earnings-price ratio (e-p), dividend-price ratio (d-p), dividend yield (d-y), monthly average of the daily squared returns of the S&P 500 (vol), CPI inflation (inf) and relative bill rate (rrel). Such variables are computed according to Goyal and Welch (2008) (rrel is in accordance to Lettau and Ludvigson 2001). Columns 7 and 8 report the marginal effects of a 1% increase in the margin (fixing the ted spread at 2.5%) and of a 1% increase in the ted spread (fixing the margin at 10%) on future returns. Standard errors are computed by Newey-West with lag length equal to the horizon. Significance levels are indicated as follows: * $p < .10$; ** $p < .05$; *** $p < .01$.

Table 3.3: Alphas on portfolios sorted on constant margin-betas

	Portfolios									
	1	2	3	4	5	6	7	8	9	10
CAPM alpha	4.5%	5.2%	5.4%	6.0%	4.6%	4.2%	4.6%	7.0%	6.0%	7.1%
	(1.25)	(2.30)	(2.63)	(3.19)	(2.53)	(2.01)	(2.17)	(2.78)	(1.94)	(1.54)
3-factor alpha	2.1%	2.5%	2.7%	3.4%	2.3%	1.4%	2.0%	4.3%	3.5%	5.0%
	(0.95)	(1.95)	(2.50)	(2.80)	(1.99)	(1.12)	(1.55)	(2.83)	(1.70)	(1.58)
4-factor alpha	4.1%	3.9%	4.0%	5.0%	3.6%	3.6%	4.3%	7.3%	7.2%	10.3%
	(1.51)	(2.68)	(3.18)	(4.58)	(3.28)	(2.88)	(3.83)	(4.69)	(3.26)	(2.84)

At each year-end between 1987 and 2009, eligible stocks are sorted into 10 portfolios according to constant margin-betas. The constant margin-betas are the given by the OLS coefficient of stocks returns on the ted spread, controlled for 4 other risk factors, namely, the 3 Fama-French factors and a momentum factor. The estimation and sorting procedure at each year-end uses only data available at that time. Eligible stocks are defined as ordinary common shares traded on the NYSE, AMEX, or NASDAQ with five years of monthly returns continuing through the current year-end. The portfolio returns for the 12 postranking months are linked across years to form one series of post-ranking returns for each decile. The table reports the decile portfolios' post-ranking alphas, in percent per year. The alphas are estimated as intercepts from the regressions of excess portfolio post-ranking returns on excess market returns (CAPM alpha), on the Fama-French factor returns (3-factor alpha), and on the Fama-French and momentum factor returns (4-factor alphas). The t-statistics are in parentheses.

Table 3.4: Alphas on portfolios sorted on time-varying margin-betas.

	Portfolios									
	1	2	3	4	5	6	7	8	9	10
CAPM alpha	4.6%	5.5%	5.2%	4.3%	4.8%	5.4%	4.5%	5.6%	6.6%	8.0%
	(1.28)	(2.35)	(2.49)	(2.30)	(2.70)	(2.82)	(2.07)	(2.28)	(2.12)	(1.77)
3-factor alpha	2.3%	2.7%	2.6%	1.7%	2.6%	2.9%	1.8%	2.9%	4.2%	5.8%
	(1.09)	(2.05)	(2.09)	(1.68)	(2.50)	(2.48)	(1.33)	(1.90)	(2.05)	(1.75)
4-factor alpha	3.9%	4.3%	4.2%	3.3%	3.9%	4.7%	4.3%	5.7%	7.7%	11.3%
	(1.71)	(3.27)	(3.33)	(3.40)	(3.95)	(3.93)	(3.06)	(3.59)	(3.31)	(2.78)

At each year-end between 1987 and 2009, eligible stocks are sorted into 10 portfolios according to predicted time-varying margin-betas, which are computed according to equation 14. The estimation and sorting procedure at each year-end uses only data available at that time. Eligible stocks are defined as ordinary common shares traded on the NYSE, AMEX, or NASDAQ with five years of monthly returns continuing through the current year-end. The portfolio returns for the 12 postranking months are linked across years to form one series of post-ranking returns for each decile. The table reports the decile portfolios' post-ranking alphas, in percent per year. The alphas are estimated as intercepts from the regressions of excess portfolio post-ranking returns on excess market returns (CAPM alpha), on the Fama-French factor returns (3-factor alpha), and on the Fama-French and momentum factor returns (4-factor alphas). The t-statistics are in parentheses.

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Appendix A

Chapter 1

A.1 Complete List of Equations

The equations below describe the dynamic equilibrium in the private sector, the interest rate rule, the government budget constraint and the balance sheet of government. Prices in real terms (with respect to the consumption basket) are denoted in small caps.

$$E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} \frac{R_t}{\Pi_{t+1}} \right] = 1 \quad (\text{A.1})$$

$$\lambda_t = \left(C_t - \tilde{L} \frac{L_t^{1+\psi}}{1+\psi} \right)^{-\sigma} \quad (\text{A.2})$$

$$L_t = \tilde{L}^{-1/\psi} w_t^{1/\psi} \quad (\text{A.3})$$

$$C_{H,t} = \gamma \frac{C_t}{p_{H,t}} \quad (\text{A.4})$$

$$C_{F,t} = (1 - \gamma) \frac{C_t}{s_t} \quad (\text{A.5})$$

$$L_t = \frac{\alpha}{(1 - \alpha)} \left(\frac{p_{w,t}}{w_t} \right)^{\frac{1}{1-\alpha}} K_{t-1} \quad (\text{A.6})$$

$$P_{K,t}K_{t+1} = P_t N_{w,t} + P_t D_{w,t} \quad (\text{A.7})$$

$$E_t \left[\mu_{w,t+1} \frac{1}{\Pi_{t+1}} (R_{K,t+1} - R_{b,t}) \right] = 0 \quad (\text{A.8})$$

$$N_{w,t} = \theta_w \left[\frac{R_{K,t} - R_{b,t-1}}{\Pi_t} p_{K,t-1} K_t + \frac{R_{b,t-1}}{\Pi_t} N_{w,t-1} \right] + \kappa_w p_{K,t} K_{t+1} \quad (\text{A.9})$$

$$\eta_{w,t} = E_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} \frac{R_{b,t}}{\Pi_{t+1}} \left((1 - \theta_w) + \theta_w \eta_{w,t+1} \right) \right\} \quad (\text{A.10})$$

$$\mu_{w,t} = \beta \frac{\lambda_t}{\lambda_{t-1}} \left((1 - \theta_w) + \theta_w \eta_{w,t} \right) \quad (\text{A.11})$$

$$p_{H,t} C_{H,t}^* = N_{e,t} + D_{e,t} + s_t D_{e,t}^* \quad (\text{A.12})$$

$$s_t P_{H,t}^* = p_{H,t} \psi_{e,t}^* R^* \quad (\text{A.13})$$

$$E_t \left[\mu_{e,t+1} \frac{s_{t+1}}{s_t} \psi_{e,t}^* R^* \right] \leq E_t \left[\mu_{e,t+1} \frac{1}{\Pi_{t+1}} R_{b,t} \right] \quad (\text{A.14})$$

$$N_{e,t} = \theta_e \left(s_t P_{H,t-1}^* C_{H,t-1}^* - s_t \psi_{e,t-1}^* R^* D_{e,t-1}^* - \frac{R_{b,t-1}}{\Pi_t} D_{e,t-1} \right) + \kappa_e p_{H,t} C_{H,t}^*. \quad (\text{A.15})$$

$$\eta_{e,t} = E_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} \frac{s_{t+1}}{s_t} \psi_{e,t}^* R^* \left((1 - \theta_e) + \theta_e \eta_{e,t+1} \right) \right\} \quad (\text{A.16})$$

$$\mu_{e,t} = \beta \frac{\lambda_t}{\lambda_{t-1}} \left((1 - \theta_e) + \theta_e \eta_{e,t} \right) \quad (\text{A.17})$$

$$F_t = \lambda_{w,t} Y_{H,t} p_{H,t}^\eta p_{w,t} + \alpha_p \beta E_t [\Pi_{t+1}^\eta F_{t+1}] \quad (\text{A.18})$$

$$G_t = \lambda_{w,t} Y_{H,t} p_{H,t}^\eta + \alpha_p \beta E_t [\Pi_{t+1}^{\eta-1} G_{t+1}] \quad (\text{A.19})$$

$$p_{H,t} = \left[(1 - \alpha_p) \left(\frac{F_t}{G_t} \right)^{1-\eta} + \alpha_p \left(\frac{p_{H,t-1}}{\Pi_t} \right)^{1-\eta} \right]^{\frac{1}{1-\eta}} \quad (\text{A.20})$$

$$\Delta_t = (1 - \alpha_p) \left(\frac{F_t}{G_t} \frac{1}{p_{H,t}} \right)^{-\eta} + \alpha_p \left(\frac{p_{H,t}}{\Pi_t p_{H,t-1}} \right)^\eta \Delta_{t-1} \quad (\text{A.21})$$

$$p_{K,t} = \left[\gamma_k (p_{H,t})^{1-\rho_k} + (1 - \gamma_k) (s_t)^{1-\rho_k} \right]^{\frac{1}{1-\rho_k}} \quad (\text{A.22})$$

$$K_{H,t+1} = \gamma_k K_{t+1} \left(\frac{p_{H,t}}{p_{K,t}} \right)^{-\rho_k} \quad (\text{A.23})$$

$$K_{F,t+1} = (1 - \gamma_k)K_{t+1} \left(\frac{s_t}{p_{K,t}} \right)^{-\rho_k} \quad (\text{A.24})$$

$$R_{b,t} = (1 + \Xi'_t)R_t \quad (\text{A.25})$$

$$\Xi_t = \tilde{\Xi} (D_{w,t} + D_{e,t})^\xi \quad (\text{A.26})$$

$$\psi_{e,t}^* = 1 + \tilde{\psi}_{e,t}^* \left(\frac{s_t D_{e,t}^*}{p_{H,t} C_{H,t}^*} \right)^{\eta_e} \quad (\text{A.27})$$

$$\left(\frac{L_t}{\alpha} \right)^\alpha \left(\frac{K_t}{1 - \alpha} \right)^{1-\alpha} = \Delta_t (C_{H,t} + K_{H,t+1} + C_{H,t}^* + \Xi_{H,t}) \quad (\text{A.28})$$

$$C_{H,t}^* = C^* (P_{H,t}^*)^{-v^*} \quad (\text{A.29})$$

$$P_{H,t-1}^* C_{H,t-1}^* - C_{F,t} - K_{F,t+1} = D_{e,t-1}^* \psi_{e,t-1}^* R^* - D_{e,t}^* + F A_t - R^* F A_{t-1} \quad (\text{A.30})$$

$$1 = p_{H,t}^\gamma s_t^{1-\gamma} \quad (\text{A.31})$$

$$\frac{R_{K,t}}{\Pi_t} = \frac{p_{w,t}}{p_{K,t-1}} \left(\frac{w_t}{p_{w,t}} \right)^{-\frac{\alpha}{1-\alpha}} \quad (\text{A.32})$$

$$\frac{R_t}{R} = (\Pi_t)^{\phi_\pi} \left(\frac{Y_t}{\bar{Y}} \right)^{\phi_y} \quad (\text{A.33})$$

$$T_t = D_{g,t} + s_t F A_t - B_{g,t} + \left(\frac{R_{t-1}}{\Pi_t} B_{g,t-1} - \frac{R_{g,t-1}}{\Pi_t} D_{g,t-1} - R_{t-1}^* s_t F A_{t-1} \right) \quad (\text{A.34})$$

$$D_{g,t} + s_t F A_t = B_{g,t} \quad (\text{A.35})$$

Appendix B

Chapter 2

B.1 Complete List of Equations

The model has 14 variables representing quantities ($C_t, C_{H,t}, C_{F,t}, C_{H,t}^*, Y_{H,t}, L_t, K_t, I_t, I_{n,t}, I_{H,t}, I_{F,t}, S_{K,t}, N_t, B_t^*$), 12 real prices and rates ($R_t, w_t, p_{w,t}, p_{H,t}, s_t, Q_t, R_{S,t}, R_{D,t}, R_{K,t}, R_{w,t}, \Psi_t^*, \Phi_t^*$), 3 nominal variables ($i_t, \Pi_{H,t}, \Pi_t$) and 8 auxiliary variables ($\lambda_t, \phi_t, \kappa_t, \eta_t, z_t, x_t, F_t, G_t$)

$$E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} R_t \right] = 1 \quad (\text{B.1})$$

$$C_{H,t} = \gamma \frac{C_t}{p_{H,t}} \quad (\text{B.2})$$

$$C_{F,t} = (1 - \gamma) \frac{C_t}{s_t} \quad (\text{B.3})$$

$$C_{H,t}^* = C_t^* (P_{H,t}^*)^{-v^*} \quad (\text{B.4})$$

$$Y_{H,t} = C_{H,t} + I_{H,t} + C_{H,t}^* \quad (\text{B.5})$$

$$w_t = \tilde{L} L_t^\psi \quad (\text{B.6})$$

$$S_{K,t} = Q_t K_t + \theta_w p_{w,t} Y_{H,t} \quad (\text{B.7})$$

$$K_t = (1 - \delta) K_{t-1} + I_t \quad (\text{B.8})$$

$$I_{n,t} = I_t - \delta K_{t-1} \quad (\text{B.9})$$

$$I_{H,t} = \gamma \frac{I_t}{p_{H,t}} \quad (\text{B.10})$$

$$I_{F,t} = (1 - \gamma) \frac{I_t}{s_t} \quad (\text{B.11})$$

$$S_{K,t} = \phi_t N_t \quad (\text{B.12})$$

$$N_t = \theta [(R_{S,t} - R_{D,t}) \phi_{t-1} + R_{D,t}] N_{t-1} + \xi S_{K,t} \quad (\text{B.13})$$

$$\Phi_t^* = (-B_t^*)^{\eta_\Psi} \quad (\text{B.14})$$

$$(1 - \theta_w (1 - R_{w,t}^{-1})) \alpha p_{w,t} Y_{H,t} = L_t w_t \quad (\text{B.15})$$

$$P_{H,t}^* C_{H,t}^* - C_{F,t} - I_{F,t} = B_t^* - \Psi_{t-1}^* B_{t-1}^* \quad (\text{B.16})$$

$$Y_{H,t} = A_t L_t^\alpha K_{t-1}^{1-\alpha} \quad (\text{B.17})$$

$$1 = p_{H,t}^\gamma s_t^{1-\gamma} \quad (\text{B.18})$$

$$Q_t = 1 + f() + f'() \frac{I_{n,t} + I_{ss}}{I_{n,t-1} + I_{ss}} - E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} f'() \left(\frac{I_{n,t+1} + I_{ss}}{I_{n,t} + I_{ss}} \right)^2 \right] \quad (\text{B.19})$$

$$R_{S,t} = \frac{Q_{t-1} K_{t-1} R_{k,t} + R_{w,t-1} \theta_w p_{w,t-1} Y_{H,t-1}}{S_{K,t-1}} \quad (\text{B.20})$$

$$R_{D,t} = \frac{s_t}{s_{t-1}} \Psi_{t-1}^* \phi_{t-1}^* + R_{t-1} (1 - \phi_{t-1}^*) \quad (\text{B.21})$$

$$R_{K,t} = \frac{(1 - \theta_w (1 - R_{w,t}^{-1})) (1 - \alpha) p_{w,t} Y_{H,t} + (Q_t - \delta) K_{t-1}}{Q_{t-1} K_{t-1}} \quad (\text{B.22})$$

$$E_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} [(1 - \theta) + \theta \eta_{t+1}] (R_{K,t+1} - R_{w,t}) \right\} = 0 \quad (\text{B.23})$$

$$E_t \left\{ \beta \frac{\lambda_{t+1}}{\lambda_t} [(1 - \theta) + \theta \eta_{t+1}] \left(R_t - \frac{s_{t+1}}{s_t} \Psi_t^* \right) \right\} = 0 \quad (\text{B.24})$$

$$\Psi_t^* = R_t^* \Phi_t^* \quad (\text{B.25})$$

$$(1 + i_t) = R_t E_t \Pi_{t+1} \quad (\text{B.26})$$

$$(1 + i_t) = (1 + i_t^n) (\Pi_{H,t})^{\phi_\pi} \left(\frac{Y_t}{Y_t^n} \right)^{\phi_y} \quad (\text{B.27})$$

$$\Pi_{H,t} = \frac{p_{h,t}}{p_{h,t-1}} \Pi_t \quad (\text{B.28})$$

$$1 = \left[(1 - \alpha_p) \left(\frac{F_t}{G_t} \right)^{1-\eta} + \alpha_p \left(\frac{1}{\Pi_{H,t}} \right)^{1-\eta} \right]^{\frac{1}{1-\eta}} \quad (\text{B.29})$$

$$\lambda_t = \left(C_t - \tilde{L} \frac{L_t^{1+\psi}}{1+\psi} \right)^{-\sigma} \quad (\text{B.30})$$

$$\phi_t = \frac{\eta_t}{\lambda - \kappa_t} \quad (\text{B.31})$$

$$\kappa_t = E_t \left\{ \beta (1 - \theta) \frac{\lambda_{t+1}}{\lambda_t} (R_{S,t+1} - R_{D,t+1}) + \theta \beta \Lambda_{t,t+1} x_{t+1} \kappa_{t+1} \right\} \quad (\text{B.32})$$

$$\eta_t = E_t \left\{ (1 - \theta) + \theta \beta \Lambda_{t,t+1} z_{t+1} \eta_{t+1} \right\} \quad (\text{B.33})$$

$$z_t = (R_{S,t} - R_{D,t}) \phi_{t-1} + R_{D,t} \quad (\text{B.34})$$

$$x_t = \frac{\phi_t}{\phi_{t-1}} z_t \quad (\text{B.35})$$

$$F_t = \lambda_t Y_{H,t} p_{w,t} + \alpha_p \beta E_t [\Pi_{H,t+1}^{\eta_h} F_{t+1}] \quad (\text{B.36})$$

$$G_t = \lambda_t Y_{H,t} p_{H,t} + \alpha_p \beta E_t [\Pi_{H,t+1}^{\eta_h - 1} G_{t+1}] \quad (\text{B.37})$$