Pontifícia Universidade Católica
do Rio de Janeiro

Guilherme Gomes Luz

Decomposing Banking Spreads: a Structural Approach

Dissertação de Mestrado

Masters dissertation presented to the Programa de Pós–graduação em Economia, do Departamento de Economia da PUC-Rio in partial fulfillment of the requirements for the degree of Mestre em Economia.

Advisor: Prof. Carlos Viana de Carvalho

Rio de Janeiro
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Abstract

Luz, Guilherme Gomes; Carvalho, Carlos Viana de (Advisor). **Decomposing Banking Spreads: a Structural Approach**. Rio de Janeiro, 2024. 62p. Dissertação de Mestrado – Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

We extend a dynamic general equilibrium model with financial frictions to quantify the relative importance of the elements that integrate the banking spread. Our model contemplates the main components highlighted in the literature: credit risk, banks' market power, taxes, and operational costs. An imperfectly competitive banking sector intermediates funds between depositors and borrowers. Banks face credit risk, as borrowers might become insolvent and default on their loans. We adjust the model parameters to align with the Brazilian economy, which has one of the highest spreads in the world. When calibrated, the model indicates that administrative costs and credit risk are the most substantial components of the spread. Among other counterfactuals, we show that if the Brazilian credit recovery rate were to improve to the US level, the spread would decrease by approximately 13% of its steady-state value.

Keywords

Banking spread; Financial frictions; Decomposition; Bank market power; Credit risk.

Resumo

Luz, Guilherme Gomes; Carvalho, Carlos Viana de. **Decompondo o Spread Bancário: uma Abordagem Estrutural**. Rio de Janeiro, 2024. 62p. Dissertação de Mestrado – Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

Estendemos um modelo de equilíbrio geral dinâmico com fricções financeiras para quantificar a importância relativa dos elementos que compõem o spread bancário. Nosso modelo contempla os principais componentes destacados na literatura: risco de crédito, poder de mercado dos bancos, impostos e custos operacionais. Um setor bancário imperfeitamente competitivo intermedia fundos entre depositantes e tomadores de empréstimos. Os bancos enfrentam risco de crédito, pois os tomadores de empréstimos podem se tornar insolventes e não pagar seus empréstimos. Ajustamos os parâmetros do modelo para alinhar com a economia brasileira, que possui um dos spreads mais altos do mundo. Quando calibrado, o modelo indica que os custos administrativos e o risco de crédito são os componentes mais substanciais do spread. Entre outros contrafactuais, mostramos que se a taxa de recuperação de crédito brasileira melhorasse para o nível dos EUA, o spread diminuiria em aproximadamente 13% do seu valor de equilíbrio.

Palavras-chave

Spread bancário; Fricções financeiras; Decomposição; Poder de mercado; Risco de crédito.

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List of Abreviations

AR – Autoregressive

Adm cost – Administrative cost

b.p. – basis points

BCB – Brazilian Central Bank

BGG – Bernanke, Gertler & Gilchrist (1999)

CDB – Certificate of Bank Deposit (*Certificado de Depósito Bancário*)

CES – Constant Elasticity of Substitution

CSLL – *Constribuição Social sobre Lucro Líquido*

DSGE – Dynamic Stochastic General Equilibrium

GDP – Gross Domestic Product

HH – Household

ICC – Cost of Credit Index (*Índice de Custo de Crédito*)

IC – Imperfect Competition

IOF – *Imposto sobre Operações Financeiras*

IR – *Imposto de Renda*

IRF – Impulse Response Function

IRPJ – *Imposto sobre Renda das Pessoas Jurídicas*

LGD – Loss Given Default

M&A – Mergers and Aquisitions

PIS/COFINS – *Program de Incentivo Social/Contribuição para o Financiamento de Seguridade Social*

p.p. – percentage points

TFP – Total Factor Productivity

UK – United Kingdom

US – United States

Models are there to be changed,
not to be admired

Guillermo Calvo

1
Introduction

Credit spreads, defined as the gap between lending and borrowing rates, tend to be higher in countries with less financial development. Extensive evidence supports a positive association between financial development and economic growth, with a strand of the literature suggesting a causal link from the former to the latter (see Levine, 2005 for a survey). Therefore, understanding why spreads are higher in certain countries is an important part of unraveling the mechanisms that connect finance and growth.

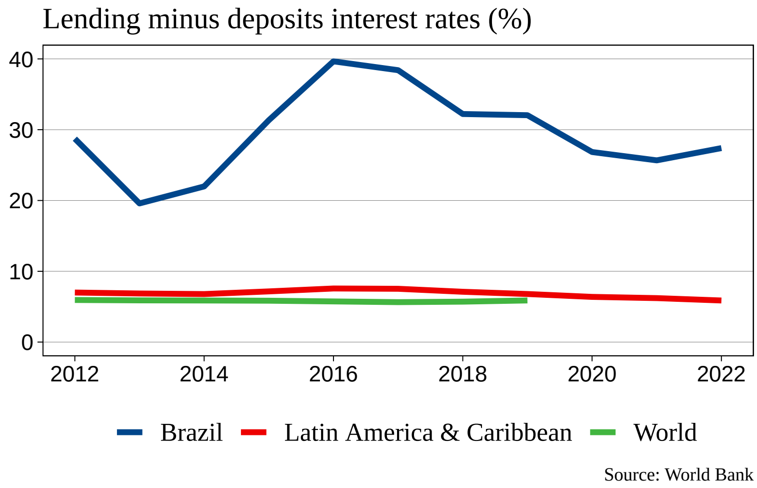
Credit spreads are a symptom of the intrinsic imperfections of credit markets. They are directly influenced by credit risk and imperfect competition in the banking sector. Hence, high levels of spread are frequently regarded as a matter of concern not only from a development perspective but also from a financial regulation standpoint. However, other factors also play a part in the composition of this gap, for instance, taxes and operational costs.

This paper aims to quantitatively assess the relative importance of the different factors that integrate credit spreads. We use a dynamic general equilibrium model with financial frictions, augmented by a stylized banking sector, to quantify each of the main components pointed out by the economic literature as the determinants of spreads. Our goal is to study how the conditions of financial intermediation in developing countries contribute to their high levels of spread. Using the model to decompose the spread in Brazil, we find that administrative costs and credit risk are the most substantial components.

Brazil is a particularly interesting country to study since its banking spreads are among the highest in the world. According to the World Bank, in 2019, the spreads in Brazil reached 32.21 p.p., well above the world median of 5.78 p.p. Even when compared to more similar countries (with similar levels of financial development), Brazilian spreads stand out - median spreads in Latin America and the Caribbean were 6.55 p.p. (Figure 1.1). Yet, no singular factor can account for this remarkable disparity between Brazil and the rest of the world.[1]

[1]One caveat of the direct comparison of credit spreads across countries is that it does not take into consideration the differences in the compositions of their credit portfolios. Developing countries such as Brazil, tend to have a larger portion of unsecured credit, which typically has a higher spread. For example, mortgages - which are the most common type of collateralized credit for households - represented 68% of US household credit in 2019, while in Brazil they represented only 32%.

Figure 1.1: Global banking spreads



Notes: Lending rates used consider all types of loans to the non-financial private sector by banks. Regional series represent the median spreads. World median series available up to 2019.

Most likely, many different factors contribute to Brazilian spreads being so high. When we look at the aspects that are generally thought of as the main drivers of spreads, for instance, default rates and banking sector concentration, Brazil is above average, but not a complete outlier. In 2019, the rate of non-performing loans in Brazil was on average 3.1%, which is roughly in line with other emerging countries, such as Mexico (2.1%) and South Africa (3.9%), according to the World Bank. This is not so far from the levels in the more financially developed nations (0.8% in the US or 1.1% in the UK), especially considering that some countries have default rates close to 10%, such as India and Russia.

Regarding banks' market power, one commonly used measure of concentration for this sector is the top 5 banks' asset share. World Bank data shows that concentration in the Brazilian market is significant, but not abnormal. In 2021, the 5-bank asset share in Brazil was 79.4% (which is below the world median), while in other emerging countries, such as Chile and South Africa it was 78.0% and 99.3%, respectively (see Appendix A). In particular, there are even developed countries with higher concentrations, for example, Canada (84.7%), Spain (85.0%) and Australia (91.2%), but these countries do not face such high spreads. The potential interaction between different factors compels us to analyze spreads using a model, in order to comprehend the mechanisms driving credit spreads.

Understanding what are the main components of the spread is important not only from an academic point of view, but also from a policy perspective. Reducing the cost of credit is one of the official goals of the Brazilian

Central Bank (BCB), and it has been at least since 1999 with the *Juros e Spread Bancário no Brasil* project. Among the research endeavors created with this goal in mind, the BCB has created an accounting methodology for decomposing the banking spreads. Their approach utilizes direct estimates of banks' administrative costs, tax payments, and provisions of loan losses based on balance sheet information from financial intermediaries, whereas our approach uses a structural general equilibrium model.

The key advantage of our approach is that the model establishes a connection between observable variables and the unobservable variables that are necessary for the decomposition. In the BCB's methodology, there is an implicit assumption that the banks' accounting costs are directly proportional to their associated contributions to the spread. However, one must consider the potential distortions that some costs might impose on the behavior of banks. The use of a model helps capture these aspects of agents' decisions that a pure accounting method does not, such as the effect of credit risk or taxes on interest rates charged by banks. Hence, our main contribution is to provide a decomposition of the banking spread in Brazil based on an alternative methodology that uses economic theory to establish the link between observable variables and the estimates of the components of the spread.

In the model, a stylized banking sector intermediates credit from borrowers to lenders. We build upon the standard Bernanke, Gertler & Gilchrist (1999) model of the financial accelerator (henceforth, BGG), in which loan contracts have limited enforcement, to capture the credit risk faced by banks. Default on debt is an endogenous choice by the borrower, which is essential to fully take into account the effect of the credit risk in the economy. Our main modification relative to the BGG model is allowing for imperfect competition in the banking sector. In addition, we include taxes and administrative costs for banks to originate loans, hence, contemplating the four main drivers of spreads as pointed out by the literature: credit risk, intermediaries' market power, taxes, and administrative costs. Moreover, we include in the model credit to both firms and households, as in Becard & Gauthier (2022).

While drawing on various contributions found in the existing literature, our paper distinguishes itself by uniquely combining two crucial elements essential for the examination of credit spreads: endogenous default and imperfect competition. Notably, the banking model proposed by Corbae & D'Erasmo (2021) incorporates these features; however, our model diverges in its treatment of market power. Unlike their utilization of a Stackelberg oligopoly model, we adopt the framework of monopolistic competition, wherein firms set prices rather than quantities - in our case, banks set interest rates rather than loan amounts.[2] In that sense, our approach is closer to Hafstead & Smith (2012).

The findings, as derived from our calibrated model, showcase that administrative costs constitute the most relevant component at 33% of the spread, followed by credit risk at 29%, taxes at 23%, and the remaining 15% are attributed to banks' market power. An exploration of credit risk's prominence reveals a high sensitivity of the spread with respect to the credit recovery rate. Our results underscore substantial potential gains from improvements in the regulatory framework for credit recovery. Counterfactual exercises reveal that if the Brazilian credit recovery rate was to improve to the US level, the banking spread would decrease by 13% of its steady-state value. Notably, this potential reduction of 163 b.p. surpasses the impact of improving banking competition, which stands at 158 b.p.

We explore the dynamic properties of the model by analyzing the response of the economy to credit shocks. The analysis demonstrates that the connection between loan and deposit rates is pivotal for understanding shock transmission. This connection lies in the management of banks' capital positions. In the presence of capital requirements and other capital adjustment frictions, the behavior of banks in loan and deposit markets will not be independent. Our model underscores the essential role of the deposit-loan linkage in propagating shocks, which has often been overlooked in the literature, that typically examines these channels in isolation.

The remainder of this paper is organized as follows. Firstly, the pertinent literature is reviewed in Chapter 2, conjecturing what are the most relevant determinants of spreads (to motivate the model). In Chapter 3, our proposed model is presented. Subsequently, we derive an analytical decomposition to provide intuition for the results. Chapter 5 explains the calibration procedure. The main results for the spread decomposition are presented in Chapter 6. Then, we discuss the dynamics related to credit shocks in Chapter 7. Lastly, Chapter 8 concludes.

[2] In terms of the underlying hypothesis about market structure, the choice of monopolistic competition in our model is more compatible with a differentiated product environment.

2
Literature Review

Our paper contributes to the literature on the determinants of credit spreads. Previous studies have taken two different approaches in the investigation of this topic. First, there is the reduced-form empirical literature on the determinants of spreads and, second, DSGE models with financial frictions.

On the empirical front, several studies have followed the work of Ho & Saunders (1981). They attribute spreads to "transaction uncertainty", that is, the uncertainty related to the bank's capital position due to asynchronous deposit supply and loan demand. In their empirical analysis, they use balance-sheet data from commercial banks and conclude that spreads are related to bank risk aversion, bank market power, and interest rate variance. Afanasieff, Lhacer & Nakane (2002) and Almeida & Divino (2015) have applied their methodology to Brazil. In the latter article, the authors argue that administrative costs are a key determinant of spreads. Although the empirical literature provides meaningful insights, these reduced-form regression analyses leave some questions unanswered. For instance, they cannot speak on counterfactual results from policy interventions.

Almeida & Divino (2015) also show some evidence that higher concentration in the banking sector is related to higher spreads. On a similar note, Joaquim, Doornik & Ornelase (2019) use M&A episodes as exogenous variation in the market structure to quantify the impact of an increase in credit market concentration on the spread and they find a positive effect. It is important to keep these findings in mind when constructing our model as we would like to include all of the most relevant determinants of spread to be able to assess their relative importance.

Understanding the relative contribution of each factor is one of the key advantages of a decomposition exercise. In the empirical literature on corporate bonds credit spreads, some decompositions that emphasize specific components have provided important insights into the relationships between credit spreads and business cycle fluctuations. Gilchrist & Zakrajšek (2012) decompose the credit spread in the US, isolating a measured default risk component. In doing so, they provide evidence that, although very important, this term alone is not capable of explaining corporate credit spreads, a well-known result coined "credit spread puzzle" (Huang & Huang, 2012; Bai, Goldstein & Yang, 2020). We diverge from this extensive literature in corporate finance by focusing on banking spreads, which are associated with bank-supplied loan contracts that are not traded in secondary markets, unlike corporate bonds. The focus on the banking sector reflects the relevance of bank-intermediated credit, especially, in developing countries. Moreover, our decomposition incorporates other factors beyond credit risk.

The strand of literature that employs DSGE models to investigate spreads, in which our paper is situated, also points to additional determinants. Souza-Sobrinho (2010) highlights the role of earmarked loans and reserve requirements, which were historically high in Brazil compared to other countries. However, since 2017, the Brazilian Central Bank has significantly reduced these requirements. The percentage of demand deposits that has to be kept in the Central Bank fell 24 p.p. (to 21% in 2019) and the percentage of savings accounts that has to be used in rural credit fell 14 p.p. (to 60%) (Brazilian Central Bank, 2019). Despite these changes, banking spreads remain elevated, indicating the presence of other factors that necessitate careful examination, as we undertake in this paper.

The work that is the closest to ours in terms of approach is Fujisima (2021). Using a structural model with limited enforcement and banks in monopolistic competition, the author does a steady-state analysis to decompose the spreads into four main factors: administrative cost, financial margin (related to banks' market power), taxes, and risk of default. These four factors are the same as those used in the BCB decomposition aforementioned.

Although Fujisima's model embodies all of the most relevant determinants of spreads, there is a limitation in what is arguably a key aspect of any model that aims to explain spreads: credit risk. In order to include default in the model, Fujisima resorts to "recycling firms" as a modeling device for the recovery of collateral by banks. When a household or a firm does not repay its debt, the bank seizes the collateral and sells it to the recycling firms at a discount. However, the payment enters the banks' problem as a lump-sum transfer, that is, the banks do not take into account the value of the seized assets when choosing what lending rate to charge. Our approach features a borrowing constraint that reflects the aspects of default risk. That constraint will be tighter when there is a higher probability of default or a smaller recovery rate because banks will take that into account when choosing what menu of debt contracts to supply.

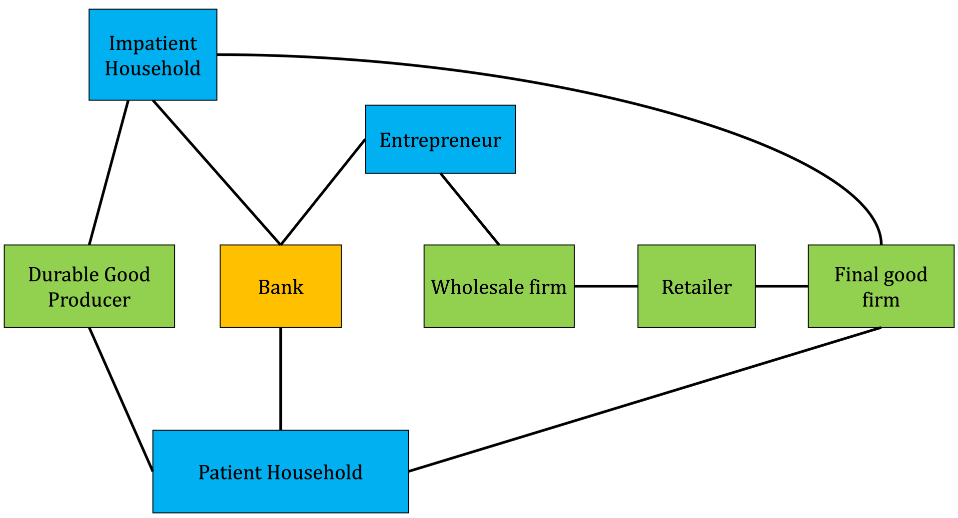
In addition to the steady state analysis, we contribute to the literature on credit market dynamics and their interaction with the macroeconomy by analyzing the propagation of shocks in our model economy. Our work engages mainly with the research of the impacts of credit shocks. We offer new insights into how credit markets respond to economic fluctuations, emphasizing the critical role of banks and their behavior. As in Justiniano, Primiceri & Tambalotti (2015) and Justiniano, Primiceri & Tambalotti (2019), we distinguish between demand and supply credit shocks and study their differences in the impact on the real economy. Moreover, our model builds on the findings of the vast body of literature on monetary policy transmission by combining endogenous default and imperfect competition. Bernanke & Gertler (1995) highlights the credit channel as a fundamental mechanism through which monetary policy effects are amplified by credit markets. Gerali et al. (2010), Wang et al. (2022) and Gomes (2024) add to this strand of literature investigating the role of imperfect competition in the banking sector in the transmission mechanisms.

3
Model

We present a DSGE model with financial frictions augmented with a stylized banking sector. The foundation of the model follows BGG, which is a New Keynesian model with limited enforcement of loan contracts (in a costly state verification framework). This friction gives rise to credit risk, as borrowers might become insolvent and default on their loans. Moreover, we add a banking sector along the lines of Gerali et al. (2010) in order to incorporate imperfect competition. Banks operate in the deposit and loan markets under monopolistic competition.

In our economy, there are four principal agents: patient households (or savers), impatient households, entrepreneurs, and banks. Patient households consume, provide labor, and save. Impatient households and entrepreneurs are our two types of borrowers. Entrepreneurs transform raw capital into effective capital, which can then be used in the production of goods. They can finance their purchase of raw capital using their own wealth or borrowing externally. Impatient households provide labor and consume durable and non-durable goods. Given their relatively higher impatience they will borrow from banks to finance their durable goods purchases. The financial intermediation between lenders and borrowers is done by the banking sector: banks take deposits from patient households and supply loans to impatient households and entrepreneurs (see Figure 3.1).

Figure 3.1: Diagram of the structure of the model



On the production side of the economy, there are capital producers, durable good producers, wholesale firms, retail firms, and a final good firm, which are included in order to incorporate additional friction, such as investment adjustment costs and nominal rigidities. Since this part is standard in New Keynesian models, we leave its description to Appendix B.

3.1 Patient Households

The representative patient household derives utility from leisure, a non-durable consumption good (C_t^P), and a durable consumption good (S_t^P). We assume a preference with exogenous habit formation on non-durable consumption.

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \left(\beta^P\right)^t \left\{ \log(C_t^P - hC_{t-1}^P) + \psi \log(S_t^P) - \zeta \frac{\left(L_t^P\right)^{1+\varphi}}{1+\varphi} \right\}$$

where β_P in the discount factor and L_t^P is the labor supply.

Given the assumption that $\beta^P > \beta^I$, patient households will always be savers. They will save in the form of bank deposits (D_t). Their budget constraint writes:

$$C_t^P + D_t + Q_t^s(S_t^P - S_{t-1}^P) \leq W_t^P L_t^P + \frac{(1 + r_{t-1}^d)}{\pi_t} D_{t-1} + T_t^P$$

The budget constraint states that the amount used in consumption and deposits is at most equal to the labor income plus the gross return on deposits from the previous period and lump-sum transfers T_t, which are dividends (paid by banks, entrepreneurs and retail firms). W_t denotes real wage, Q_t^s denotes the relative price of the durable good in terms of the non-durable good, and $(1 + r_{t-1}^d)$ is the gross nominal return on deposits (from period $t-1$ to period t).[1] $\pi_t \equiv P_t/P_{t-1}$ is the gross inflation rate, where P_t denotes the price level.

3.2 Impatient Households

An impatient household is composed of three types of members: workers, brokers, and financiers. Workers consume and provide labor, while financiers choose how much to borrow from banks to finance the purchase of durable goods. The two agents can transfer funds and there is perfect insurance for consumption within the household. The broker intermediates the purchase

[1]We adopt the convention of writing nominal interest rates in lower-case and real interest rates in upper-case.

of the durable goods by the financier - this is a modeling device used to include adjustment costs in the price of durable goods (which helps smooth the dynamics of this variable).

3.2.1 Workers

The impatient workers' preferences are similar to the patient households but with a different discount factor β^I. Workers do not own durable goods, so they rent it from financiers at the rate RR^s_t. They maximize their utility subject to the following budget constraint:

$$C^I_t + RR^s_t S^I_t \leq W^I_t L^I_t + \Xi_t$$

where Ξ_t is the transfer from financiers (which does not have to be positive).

3.2.2 Broker

The broker is the intermediator in the purchase of durable goods. He buys goods from the producer and sells them to the financier, subject to an adjustment cost. The broker's problem is:

$$\max_{S^I_t} \quad \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda^I_{0,t} \left\{ Q^h_t S^I_t - Q^h_t S^I_t \left[1 + Z^s \left(\frac{S^I_t}{S^I_{t-1}} \right) \right] \right\}$$

where $Z^s(x) = \frac{\kappa_s}{2}(x-1)^2$ represents the adjustment cost and $\Lambda^I_{0,t}$ is the stochastic discount factor of the impatient worker.

3.3 Borrowers

In this economy, impatient households (financiers) and entrepreneurs will borrow from banks. Since they have similar optimization problems, we describe them together.

There is a continuum $j \in [0,1]$ of borrowers of each type $o \in \{I, E\}$, where I denotes impatient financiers and E entrepreneurs. At every period, each borrower purchases asset $X_{j,t}$ using a combination of his own net worth and external financing (bank loans). Entrepreneurs purchase raw capital and convert it into effective capital services, while financiers purchase durable goods. The heterogeneity within each type of borrower lies in their net worth, N^o_{jt}, and in their idiosyncratic returns on capital. Below, we describe the timing of the borrowers' actions.

Timing. — In period t, borrower j obtains a loan B^o_{jt} from the banks. She uses the loan, in combination with her net worth, to purchase asset X_{jt} at price Q^o_t. Hence, $Q^x_t X_{jt} = N^o_{jt} + B^o_{jt}$.

At the beginning of period $t+1$, borrower j experiences an idiosyncratic shock $\omega^o_{t+1}(j)$ that converts the value of its assets $Q^x_t X_{jt}$ into $\omega^o_{t+1}(j) Q^x_t X_{jt}$. For entrepreneurs, this idiosyncratic shock represents the uncertainty in the transformation process of raw capital into effective capital, whereas for financiers, the shock represents random movements in durable goods prices. We assume that ω is independently and identically distributed across borrowers and across time. $F^o(.)$ denotes the distribution of these random variables, which we assume to be lognormal with unit-mean, following BGG. Next, borrowers rent out their assets at a rental rate of RR^x_{t+1}.

Capital is rented out to wholesale producers. After production, the remaining depreciated capital $(1-\delta^k)K_{jt}$ is sold back to capital producers at price Q^k_{t+1}. Therefore, we can write the return on capital for entrepreneur j as $\omega^E_{t+1}(j)(1+R^k_{t+1}) = \omega^E_{t+1}(j)\frac{RR^k_{t+1}+(1-\delta^k)Q_{t+1}}{Q_t}$. That is, each entrepreneur, regardless of net worth, has access to a stochastic, constant rate to scale technology, $\omega^E_{t+1}(j)(1+R^k_{t+1})$. In the case of financiers, we simply represent the return on durable goods, excluding rentals, as $(1+R^s_t) = Q^s_t/Q^s_{t-1}$.[2]

At this point, borrowers are supposed to repay their debt. However, there is limited enforcement of debt contracts. As a result, a borrower might choose to strategically default on its debt, depending on the draw of the idiosyncratic shock.

Financial friction. — There is an agency friction between banks and borrowers. This friction emerges because there is limited enforcement – borrowers might choose to default – and the idiosyncratic shock is privately observed by the borrowers *after* they choose the amount of assets for the next period. We assume the loans take the form of standard debt contracts, which is incentive compatible in that borrowers will choose to default only when their net worth becomes negative, minimizing banks' monitoring cost (in a costly state verification problem).[3]

[2]The return on durable goods is defined excluding rentals to reflect the assumptions that rental income cannot be seized by banks and that the idiosyncratic shock affects only the price of the durable good. This modeling choice, which is also present in Becard & Gauthier (2022), facilitates the solution of the model because the return on durable goods will not depend on the rental rate.

[3]Although the standard debt contract might not be the optimal contract in this environment, we consider an exogenously incomplete market approach by imposing that this is the only available financial product for lending. Carlstrom, Fuerst & Paustian (2016) show that the optimal contract in the BGG setting might involve a more complicated indexation. However, standard debt contracts are more realistic and are commonly used in the literature of financial frictions.

Under the standard debt contract, borrowers pledge their entire assets as collateral, therefore they become indifferent between repaying their debt or defaulting when the value of their assets $\omega^o_{t+1}(1 + R^x_{t+1})Q^x_t X_{t+1}$ is equal to the value of the debt $(1 + R^{b,o}_t)B_t$, where $R^{b,o}_t$ denotes the real loan rate. This defines an endogenous threshold $\bar{\omega}^o_{t+1}$ for the default decision. Hence, the cutoff rule is: if $\omega^o_{t+1}(j) < \bar{\omega}^o_{t+1}$, the borrower defaults; and if $\omega^o_{t+1}(j) > \bar{\omega}^o_{t+1}$, she repays the debt. Let $\bar{\omega}^o_{t+1}$ be the default threshold, then for $o \in \{E, I\}$,

$$\bar{\omega}^o_{t+1}(1 + R^x_{t+1})Q^x_t X_{t+1} \equiv (1 + R^{b,o}_t)B^o_t \tag{3-1}$$

We end the description of the borrowers' problems by explaining their objectives, which differ slightly.

3.3.1 Entrepreneurs

The objective of the entrepreneur is to maximize the pre-dividend expected net worth in period $t + 1$, given by expression (3-2), by choosing from a menu of standard debt contracts that are offered by the banks. As in Christiano, Motto & Rostagno (2014), we represent a standard debt contract by the ordered pair $(\bar{\omega}_{t+1}, \Theta_t)$, where $\Theta_t \equiv \frac{Q_t K_{t+1}}{N_t}$ is leverage.

$$\mathbb{E}_t \left[\int_{\bar{\omega}_{t+1}}^{\infty} \left[\omega(1 + R^k_{t+1})Q^k_t K_{t+1} - (1 + R^{b,E}_t)B^E_t \right] dF^E(\omega) \right] \tag{3-2}$$

Note that when taking the expectation of risky debt, the repayment value and the value of the assets when $\omega < \bar{\omega}_t$ are zero, since below the threshold the borrower will default and its assets will be seized.

Banks will offer only contracts that are compatible with their profit maximization. Hence, the available set of standard debt contracts, from which entrepreneurs can choose, is defined by the pairs $(\bar{\omega}_{t+1}, \Theta_t)$ that satisfy equation (3-5) (the bank's incentive compatibility constraint). We defer the explanation of this constraint to section 3.4.4, when we explain the bank's problem.

3.3.2 Financiers

The goal of the financiers is to maximize the expected present discounted value of future transfers to the impatient workers (similar to how a firm would maximize the discounted value of dividends to shareholders). The distinction between workers and financiers within the impatient households facilitates the solution of the borrowing problem, but ultimately, the utility of the impatient household is dictated by the workers.

Financiers will maximize their objective subject to three constraints: a budget constraint, a default cutoff rule as equation (3-1), and the bank's incentive compatibility constraint (to be explained in section 3.4.4). The budget constraint shows the expenditure on the left-hand side, and the available resources on the right-hand side. In order to make transfers to workers, purchase durable goods and repay the loans from the previous period, the financier can use proceeds from selling and renting durable goods, along with new external financing.

$$
\begin{aligned}
V_{j,t} = \max_{S^I_{j,t},\, B^I_{j,t}} \; & \left\{ \Xi_{j,t} + \mathbb{E}_t \left[\Lambda^I_{t,t+1} \max\{0, V_{j,t+1}\} \right] \right\} \\
\text{s.t.} \quad & \Xi_{j,t} + Q^s_t S^I_{j,t} + (1 + R^{b,I}_{t-1}) B^I_{j,t-1} \leq \omega^I_{j,t} (1 + R^s_t) Q^s_{t-1} S^I_{j,t-1} + RR^s_t S^I_{j,t} + B^I_{j,t} \\
& \bar{\omega}^I_{t+1} (1 + R^s_{t+1}) Q^s_t S^I_{t+1} = (1 + R^{b,I}_t) B^I_t \\
& \left(1 - F^I\left(\bar{\omega}^I_{t+1}\right)\right) \left[\left(\frac{\eta^I_b - 1}{\eta^I_b} \right) \left(1 + r^{b,I}_t\right) (1 - \tau^{rb}) + \tau^{rb} \right] + \frac{(1-\mu) E_t \Phi^I_{t+1}}{B^I_t} = \\
& = \left(1 + r^{wb}_t\right) + \tau^b
\end{aligned}
$$

3.4 Banking sector

Banks are intermediaries of the financial transactions between depositors and borrowers. They take deposits from patient households and supply loans to entrepreneurs and impatient households. There is a continuum $l \in [0,1]$ of banks that compete monopolistically on the deposits and the lending markets.

The monopolistic competition, in the Dixit-Stiglitz framework, is a modeling device to introduce bank market power in a tractable manner. In particular, all banks will lend to all borrowers, facilitating aggregation and allowing banks to diversify idiosyncratic risk. We assume that in order to save (borrow) one unit, lenders (borrowers) need a bundle of differentiated financial products with constant elasticity of substitution, CES – η_d for deposits and η^o_b for loans, $o \in \{I, E\}$. This CES aggregator could also be microfounded as the utility of the representative agent in an environment where each heterogeneous individual chooses a single bank and, then, chooses the amount of financial product that it will get from that bank.[4]

$$
D_t = \left[\int D_t(l)^{\frac{\eta_d - 1}{\eta_d}} dl \right]^{\frac{\eta_d}{\eta_d - 1}} \quad \text{and} \quad B^o_t = \left[\int B^o_t(l)^{\frac{\eta^o_b - 1}{\eta^o_b}} dl \right]^{\frac{\eta^o_b}{\eta^o_b - 1}}, \quad o \in \{I, E\}
$$

[4] This connection between discrete choice models and CES utility is shown in Anderson, De Palma & Thisse (1987)

Our banking sector follows closely that of Gerali et al. (2010), but we modify it so that the banks take into consideration the credit risk when choosing the loan rates. Each bank is composed of 3 branches: two retail branches (deposits branch and loan branch) and a bank holding company. The retail branches are responsible for the collection of deposits and the supply of loans, setting the interest rates in monopolistic competition. The holding company manages the capital position of the bank, connecting the two retail branches.

3.4.1 Loan and deposit demand

The retail branches operate under monopolistic competition. They are not price takers in deposit and loan markets, so they take into consideration the demand they face. We derive this demand from the cost minimization problem of households and entrepreneurs when choosing how to compose their bundle of financial products. The demand for bank l's financial products is given by

$$D_t(l) = \left(\frac{1+r_t^d(l)}{1+r_t^d}\right)^{\eta_d} D_t \tag{3-3}$$

$$\text{and} \quad B_t^o(l) = \left(\frac{1+r_t^{b,o}(l)}{1+r_t^{b,o}}\right)^{-\eta_b^o} B_t^o, \quad o \in \{I, E\} \tag{3-4}$$

where $r_t^d(l)$ and $r_t^{b,o}(l)$ are bank l's nominal net interest rates on deposits and loans, respectively.[5]

3.4.2 Bank holding company

The bank holding company manages the bank's capital position and acts as a wholesale bank, interacting with the two retail branches under perfect competition. It combines deposits $D_t(l)$ (from the deposit branch) and bank capital $K_t^b(l)$, on the liability side, to supply loans $B_t(l)$ (to the loan branch), on the asset side. The total amount of loans is the sum of the two different types of loans that the bank supplies $B_t(l) = B_t^E(l) + B_t^I(l)$. Also, the bank has a constant operational cost ξ of providing loans.

The main friction associated with the holding company is motivated by the literature on macro-prudential policies, which shows that capital requirements lead to higher spreads due to the restrictions imposed on bank leverage (e.g. Bichsel et al. (2022)). Following Gerali et al. (2010) once again, to

[5] r_t^d and $r_t^{b,o}$ are the aggregate rates, which are defined as $(1+r_t^d)^{-1} \equiv \left[\int ((1+r_t^d(l))^{-1})^{1-\eta_d} dl\right]^{\frac{1}{1-\eta_d}}$ and $1+r_t^{b,o} \equiv \left[\int (1+r_t^{b,o}(l))^{1-\eta_b^o} dl\right]^{\frac{1}{1-\eta_b^o}}$

capture these effects, we impose a quadratic cost on the deviation from banks' target capital-to-assets ratio parameterized by ν^b. An alternative approach would be to introduce costly equity issuance as in Appendix C. The dynamics produced are similar in both cases.

The holding company, thus, maximizes future cash flows, paying the capital deviation and the loan creation costs:

$$\max_{\{B_t(l),D_t(l)\}} \quad E_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \Bigg[(1+r_t^{wb})B_t(l) - B_{t+1}(l)\pi_{t+1} + D_{t+1}(l)\pi_{t+1} - (1+r_t^{wd})D_t(l) + \\ + K_{t+1}^b(l)\pi_{t+1} - K_t^b(l) - \frac{\kappa_{Kb}}{2}\left(\frac{K_t^b(l)}{B_t(l)} - \nu^b\right)^2 K_t^b(l) - \xi B_t(l) \Bigg],$$

subject to a balance sheet constraint

$$B_t(l) = D_t(l) + K_t^b(l)$$

where r_t^{wb} and r_t^{wd} are the wholesale rates of deposits and loans respectively. $\Lambda_{0,t}^P$ denotes the stochastic discount factor of the patient households. We assume that banks have access to unlimited finance at the policy rate r_t, implying $r_t^{wd} = r_t$ by no-arbitrage.[6]

3.4.3
Deposit branch

The deposit branch collects funds from households in monopolistic competition and channels these funds to the holding company, which remunerates them at r_t^{wd} $(= r_t)$. It maximizes discounted future cash flows subject to the deposit demand (equation 3-3), as it is not a price taker in this market.

$$\max_{r_t^d(l)} \quad \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \frac{P_0}{P_t} \left[(1+r_t)D_t(l) - (1+r_t^d(l))D_t(l) \right]$$

3.4.4
Loan branch

The loan branch takes wholesale loans from the holding company and lends to entrepreneurs and impatient households in monopolistic competition. Here, we depart from Gerali et al. (2010) in that the retail loans are subject to default risk.

[6]Alternative sources of financing could be, for example, interbank loans, whose rates follow very closely the risk-free rate

Revenues of the lending branch come from borrowers who repay their debt and from seized collateral from those who default. On the recovery of collateral, we borrow a modeling device from Hafstead & Smith (2012). We assume that there is a "recovery company" that collects all the collaterals and, then, pays the banks in proportion to their market share $B_t(l)/B_t$. Moreover, the recovery company can only observe the realized return on the assets of the entrepreneur by paying a monitoring cost (costly state verification). As a result, only a fraction $(1-\mu)$ of collaterals can be recovered. Denote $\mathbb{E}_t\Phi^b_{t+1}$ the total expected value of seized collaterals.

Therefore, the problem of the loan branch is

$$\max_{r_t^{b,E}(l), r_t^{b,I}(l)} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda^P_{0,t} \frac{P_0}{P_t} \Bigg\{ \overbrace{(1-F^E(\bar{\omega}^E_{t+1}))(1+r_t^{b,E}(l))B_t^E(l)}^{\text{Repaid debt}} + \overbrace{(1-\mu)\frac{B_t^E(l)}{B_t^E}\mathbb{E}_t\Phi^E_{t+1}}^{\text{Collateral recovery}}$$
$$+ (1-F^I(\bar{\omega}^I_{t+1}))(1+r_t^{b,I}(l))B_t^I(l) + (1-\mu)\frac{B_t^I(l)}{B_t^I}\mathbb{E}_t\Phi^I_{t+1}$$
$$- (1+r_t^{wb})B_t(l)\Bigg\},$$

subject to the loan demands (equation 3-4).

We use the fact that the linearity of the borrowers' objective function implies they will choose the same default cutoff $\bar{\omega}^o_{t+1}$ and leverage Θ_t in equilibrium (Christiano, Motto & Rostagno, 2014).[7] Hence, at each period, a measure $(1-F^E(\bar{\omega}^E_{t+1}))$ of entrepreneurs and $(1-F^I(\bar{\omega}^I_{t+1}))$ of impatient households repay their loans, and the value of seized collaterals is

$$\mathbb{E}_t\Phi^o_{t+1} = \pi_{t+1}\int_0^{\bar{\omega}^o_{t+1}} \omega(1+R^x_{t+1})Q^x_t X_{t+1} dF^o(\omega), \quad (o,x)\in\{(I,s),(E,k)\}$$

that is, the value of the assets of borrowers whose realization of the idiosyncratic shock was below $\bar{\omega}^o_{t+1}$.

The solution to the loan branch's problem is given by the first-order condition in equation (3-5). This condition establishes a spread for the loan rate $r_t^{b,o}$ above the wholesale rate r_t^{wb}, encompassing not only the compensation for losses resulting from default but also the market power of banks, with the term $(\eta^o_b - 1)/\eta^o_b$.

[7]Recall that entrepreneurs are heterogeneous in only two dimensions: their net worth and idiosyncratic shocks. Since net worth enters the objective function only as a factor of proportionality (and does not appear in the constraints), all entrepreneurs will choose the same $\bar{\omega}_{t+1}$. Becard & Gauthier (2022) prove an analogue result for the impatient household problem.

$$\left(1 - F^o\left(\bar{\omega}^o_{t+1}\right)\right)\left(\frac{\eta^o_b - 1}{\eta^o_b}\right)\left(1 + r^{b,o}_t\right) + \frac{(1-\mu)E_t\Phi^o_{t+1}}{B^o_t} = \left(1 + r^{wb}_t\right) \quad (3\text{-}5)$$

We can rewrite equation (3-5) in terms of $(\bar{\omega}^E_{t+1}, \Theta_t)$, instead of $(r^{b,o}_t, B^E_t)$, making more explicit its role in restraining the menu of debt contracts available to the entrepreneurs:

$$\left[\left(1 - F^E\left(\bar{\omega}^E_{t+1}\right)\right)\bar{\omega}^E_{t+1}\left(\frac{\eta^E_b - 1}{\eta^E_b}\right) + (1-\mu)G^E(\bar{\omega}^E_{t+1})\right](1+R^k_{t+1}) = \left(1 + R^{wb}_t\right)\left(\frac{\Theta_t - 1}{\Theta_t}\right)$$

where $G^E\left(\bar{\omega}_t\right) := \int_0^{\bar{\omega}_t} \omega dF^E\left(\omega\right)$. Banks will only offer loan contracts that satisfy this condition.

3.4.5 Bank profit

Finally, the bank profit is the sum of the cash flows of the three branches, which simplifies to

$$\begin{aligned} J_t =& (1 - F^I(\bar{\omega}^I_{t+1}))(1 + r^{b,I}_t(1-\tau^{rb}))B^I_t + (1-\mu)\mathbb{E}_t\Phi^I_{t+1} \\ &+ (1 - F^E(\bar{\omega}^E_{t+1}))(1 + r^{b,E}_t(1-\tau^{rb}))B^E_t + (1-\mu)\mathbb{E}_t\Phi^E_{t+1} \\ &- (1 + r^d_t)D_t - K^b_t - \kappa_t - \xi B_t \end{aligned}$$

The bank pays out a fraction Δ^b of profits in dividends to households and retains the rest, building capital. The banks' aggregate capital law of motion is

$$K^b_t = (1-\delta^b)K^b_{t-1} + (1-\Delta^b)J_{t-1}$$

3.5 Government

The government is composed of a fiscal and a monetary authority. The fiscal authority collects taxes to finance public expenditures G_t. We are mainly interested in the effect of taxes on the spread, so we include four different types of taxes that are related to financial intermediation. The fiscal authority keeps the budget balance in all periods:

$$G_t = \tau^{rb}\left[(1 - F^E(\bar{\omega}^E_t))r^{b,E}_{t-1}\frac{B^E_{t-1}}{\pi_t} + (1 - F^I(\bar{\omega}^I_t))r^{b,I}_{t-1}\frac{B^I_{t-1}}{\pi_t}\right] + \tau^b\frac{B_{t-1}}{\pi_t} + \frac{(r^d_{t-1}\tau^{rd})}{\pi_t}D_{t-1} + \tau J_{t-1}$$

The four taxes that we consider, from the Brazilian tax system, are tax on profits (CSLL and IRPJ), tax on loan revenue (PIS/Cofins), tax on loan amounts (IOF), and tax on return of deposits (IR). See Appendix D for a detailed explanation of how these taxes are levied.

The monetary authority follows a Taylor rule, as in Gerali et al. (2010):

$$(1+r_t) = (1+\bar{r})^{1-\rho_r}(1+r_{t-1})^{\rho_r}\left(\frac{\pi_t}{\bar{\pi}}\right)^{\phi_\pi(1-\rho_r)}\left(\frac{Y_t}{Y_{t-1}}\right)^{\phi_y(1-\rho_r)} e^{\epsilon_t^m}, \quad (3\text{-}6)$$

where $\bar{r}$ and $\bar{\pi}$ are the steady-state levels of policy rate and inflation, respectively. ϕ_π and ϕ_y are parameters that determine the responses of interest rates to inflation and output stabilization, respectively. ρ_r is an interest smoothing parameter and ϵ_t^m is the monetary policy shock.

3.6 Market clearing

In equilibrium, all markets clear (labor, deposits, loans, wholesale goods, final consumption goods, and durable goods). The market clearing condition for final consumption goods is

$$Y_t = C_t + I_t + G_t + \frac{\xi B_{t-1}}{\pi_t} + \underbrace{\frac{\mu\Phi_t^E}{\pi_t} + \frac{\mu\Phi_t^I}{\pi_t}}_{\text{monitoring cost}} + Adj_t$$

where $\mu\Phi_t^E + \mu\Phi_t^I$ is the aggregate monitoring cost and the term Adj_t includes all adjustment costs.

$$Adj_t = \underbrace{\frac{\kappa_{Kb}}{2}\left(\frac{K_t^b}{B_t} - \nu^b\right)^2 K_t^b}_{\text{Bank adj cost}} + \underbrace{\frac{\kappa_P}{2}\left(\pi_t - \pi_{t-1}^{\iota}\bar{\pi}^{1-\iota}\right)^2 Y_t}_{\text{Retailer adj cost}}$$

4
Analytical Decomposition

Having presented all the elements of the model, we can now analyze the components of the spread. We do so by computing the model's steady state numerically, but before going to the quantitative results we present some definitions and intuition in this chapter.

One useful decomposition separates the spread into three components associated with each branch of the banking sector. From the way we laid out the banking sector, the components of the retail branches contain a spread related to imperfect competition (both on the loan and deposit side). The component of administrative costs falls under the holding company's component, while taxes are disseminated across more than one component.

For $o \in \{I, E\}$,

$$\text{Banking Spread} \equiv \frac{(1+r^{b,o})}{(1+r^d)} = \underbrace{\frac{(1+r^{b,o})}{(1+r^{wb})}}_{\text{Loan branch}} \overbrace{\frac{(1+r^{wb})}{(1+r)}}^{\text{Holding company}} \underbrace{\frac{(1+r)}{(1+r^d)}}_{\text{Deposit branch}} \tag{4-1}$$

The deposit branch component (spread between the deposit rate and the risk-free rate) is determined by the elasticity of the deposit demand:

$$\frac{(1+r)}{(1+r^d)} = \frac{\eta_d + 1}{\eta_d}$$

For the loan branch, the monopolistic competition markup is not the only element. The interaction between the banks' market power and their required premium for the credit risk leads to a non-linear equation:

$$\frac{(1+r^{b,o})}{(1+r^{wb})} = \underbrace{\left(1 - \frac{(1-\mu)\Phi^o/B^o + (1-F^o(\bar{\omega}^o))\tau^{rb}}{1+r^{wb}}\right)}_{\substack{\text{Compensation for} \\ \text{low return on seized assets}}} \underbrace{\frac{1}{1-F^o(\bar{\omega}^o)}}_{\text{Delinquency}} \underbrace{\left(\frac{\eta_b^o}{\eta_b^o - 1}\right)}_{\text{Market power}} \underbrace{\frac{1}{1-\tau^{rb}}}_{\text{Tax}}$$

where the first parenthesis represents the required compensation for a return on seized assets that is lower than the loan branch's opportunity cost. Note that $(1-\mu)\Phi^o/B^o + (1-F^o(\bar{\omega}^o))\tau^{rb} < 1+r^{wb}$. The second term depends on the mass of borrowers that default in equilibrium. The larger the delinquency rate $F^o(\bar{\omega}^o)$, the higher the spread. Thirdly, we have a factor that decreases with the elasticity of the loan demand, that is, increases with bank market power. Lastly, the tax on loan revenue also contributes to this piece of the spread.

The holding company optimization condition imposes a wedge between the wholesale loan rate and the risk-free rate: $r^{wb} - r = \xi + \tau^b$. This wedge is due to administrative costs and the tax on loan amounts, both linear in the size of banks' assets. We can approximate the holding company spread as:

$$\frac{(1 + r^{wb})}{(1 + r)} \approx 1 + (\xi + \tau^b)$$

5 Calibration

We calibrate the model to ensure its steady state matches key statistics for the Brazilian economy. We consider the average of such statistics between 2013 and 2019. Time is in quarters.

We consider several sources of information to calibrate the parameters of the model. The procedure involves three distinct approaches: adopting literature-based values, utilizing direct data analogues, and performing internal calibration by matching moments. Refer to Table 5.1 for a concise overview of the procedure. The fourth block in Table 5.1 lists the parameters that affect only the model's dynamics without changing the results of our main exercise, the steady state decomposition. For these parameters, we follow the calibration in Carvalho et al. (2023).

Standard parameters related to preferences and production, as well as those affecting the model's dynamics rather than its steady state, are derived from the literature. Direct data analogues, such as Brazilian tax rates, are incorporated where applicable. The remaining parameters are disciplined by targeting moments of the Brazilian economy.

Literature-based values. — For preferences, we set the Frisch elasticity $1/\varphi$ to one and the relative preference for durable and non-durable goods to one, as commonly used in the literature. The habit formation parameter is set at 0.74, sourced from Castro et al. (2015). On the production side, the capital share is set to 0.448 and the elasticity of substitution between wholesale goods is calibrated to 6, implying a 20% markup in steady state. Also related to final goods prices, we set the parameters $\kappa_P = 50$ and $\iota = 0.158$ which denote the price adjustment cost *a la* Rotemberg and the inflation indexation respectively. The parameter ν_b is set to 0.16, following Ferreira & Nakane (2018).

For the impatient household discount factor β^I, we pick a value of 0.94, so that the impatience relative to the other type of household is similar to that of Iacoviello (2005), ensuring that the credit constraint binds at all times. The patient household discount factor, in turn, is chosen in the matching-moments block.

Direct data analogues. — Some parameters have data counterparts and are set accordingly. For instance, the bank dividend payout is based on the sample period average $\Delta^b = 0.4648$. All tax rates also have direct analogues, as each type of tax was introduced in the model according to the Brazilian tax system. τ is set at 45.00%, which is the tax rate levied on profits for the

Table 5.1: Calibration

Description	Parameter	Value	Source
1 - Literature			
Habit formation parameter	h	0.74	Castro et al (2011)
Capital share	α	0.448	Castro et al (2011)
Elasticity of substitution - final good	η	6	Carvalho et al (2023)
Inverse of Frisch elasticity	φ	1	Carvalho et al (2023)
Optimal capital-to-asset ratio (bank)	ν^b	0.16	Ferreira and Nakane (2018)
Discount factor - impatient	β^I	0.938	Iacoviello (2005)
Durable good preference	ψ	1	Carvalho et al (2023)
2 - Direct data analogue			
Dividend payout - bank	Δ^b	0.4648	Reuters
Monitoring cost	μ	0.8153	World Bank
Tax rate on bank profit	τ	45.00%	BCB
Tax rate on loan revenue	τ^{rb}	4.65%	BCB
Tax rate on entrepreneur loan	τ^b	0.47%	BCB
Tax rate on return of deposit	τ^{rd}	17.50%	BCB
Scale of administrative cost function	ξ	0.0099	BCB - Cosif
3 - Internal calibration			
Discount factor - patient	β^P	0.9824	-
Elasticity of substitution - deposit	η_d	537.7368	-
Elasticity of substitution - entrepreneur loan	η_b^E	627.1682	-
Elasticity of substitution - impatient loan	η_b^I	308.7006	-
Patient labor share	Ω	0.1955	-
Capital depreciation rate	δ^k	0.0672	-
Banks' capital depreciation rate	δ^b	0.0133	-
Variance of idiosyncratic shock - entrepreneur	σ^E	0.4963	-
Variance of idiosyncratic shock - impatient	σ^I	0.8736	-
Dividend payout - entrepreneur	Δ^e	0.0922	-
Labor disutility	ζ	2.8626	-
4 - Dynamics			
Investment adjustment cost	κ_i	2.53	Carvalho et al (2023)
Capital-to-asset adjustment cost	κ_{Kb}	22.96	Ferreira and Nakane (2018)
Interest smoothing parameter	ρ_r	0.79	Carvalho et al (2023)
Responsiveness to inflation in Taylor rule	ϕ_π	2.43	Carvalho et al (2023)
Responsiveness to output in Taylor rule	ϕ_y	0.16	Carvalho et al (2023)
Price adjustment cost - final good	κ_P	50	Carvalho et al (2023)
Steady state inflation weight - indexation	ι	0.158	Carvalho et al (2023)
AR(1) technology autocor. coeficient	ρ_a	0.91	Carvalho et al (2023)

banking sector (CSLL and IRPJ). Loan revenues are taxed at $\tau^{rb} = 4.65\%$ (PIS/Cofins). In addition, there is a tax on the total amount of loans supplied (IOF), which is composed of a fixed rate of 0.38% plus a daily rate that adds up to 1.50% annually. Hence, the quarterly tax rate is set at $\tau^b = 0.47\%$. Lastly, the tax levied on the return of deposits is the income tax. We set $\tau^d = 17.5\%$, which is the rate for investments with maturity between 1 and 2 years.

The monitoring cost parameter has taken different interpretations in the literature. We consider the interpretation of loss given default (LGD), that is, the proportion of the total loan value that the bank will not be able to recover through debt enforcement procedures in the case of a default by the borrower. According to the World Bank data, this would be 0.82 in Brazil.[1]

Our calibration strategy for the administrative cost parameter is closely linked to our modeling choice. We assumed that costs are linearly increasing in the size of assets, motivated by the empirical observation that the operating expenses to assets ratio is relatively stable across time and bank size in the US (around 3.3% yearly), as pointed out by Begenau & Stafford (2018). For Brazil, we find a slightly higher operating expenses ratio. Moreover, to mitigate the concern about how operating expenses are associated with different banking activities besides credit provision, we focus on banks that specialize in credit. Our definition for specialist banks is data-driven, based on a cluster analysis that uses the banks' sources of revenue as input (see Appendix E). The ratio of administrative cost to asset for these specialist banks is 3.97% yearly. Accordingly, we calibrate the parameter ξ based on this value.

Internal calibration. — The remaining parameters are calibrated by matching moments. The specific moments targeted in the internal calibration are outlined in detail in Table 5.2. We pick a single moment to discipline each parameter, and given our model's flexibility, we are capable of matching the moments exactly.

Table 5.2: Targets for the internal calibration

Parameter	Value	Target	Moment	Data	Model
β^P	0.9824	CDB	r^d	8.97%	8.97%
η_d	537.7368	Selic	r	9.78%	9.78%
η_b^E	627.1682	ICC - non-earmarked - firms	r^{bE}	21.97%	21.97%
η_b^I	308.7006	ICC - non-earmarked - households	r^{bI}	23.27%	23.27%
Ω	0.1955	Household debt/GDP	B^I/Y	13.49%	13.49%
δ^k	0.0672	I/GDP	I/Y	17.04%	17.04%
δ^b	0.0133	Bank capital-to-asset ratio	K^b/B	0.16	0.16
σ^E	0.4963	Delinquecy rate - firms	$F(\bar{\omega}^E)$	3.96%	3.96%
σ^I	0.8736	Delinquency rate - households	$F(\bar{\omega}^I)$	4.32%	4.32%
Δ^e	0.0922	Entrepreneur leverage	X	1.4	1.4
ζ	2.8626	Steady state hours worked	L	1	1

[1] Based on the "recovery rate" indicator of the Doing Business report by the World Bank. This indicator is related to secured credit provided by banks to limited liability companies and recovered through judicial reorganization, liquidation, or debt enforcement proceedings.

Our primary focus in terms of moments concerned the observable interest rates that relate directly to our decomposition. To match the nominal deposit rate of 8.97% per annum, which is the average *CDB* rate (Certificate of Bank Deposit), we set the patient household discount factor to 0.98.[2] The deposit elasticity η_d is adjusted so that the spread between the deposit rate and the central bank policy rate (SELIC) matches what we observe in the data.

The elasticities of the loan demands (η_b^I and η_b^E) are set to match the *ICC* (cost of credit index, calculated by the BCB), for each type of loan. For the loans to firms, we target the average cost of non-earmarked corporate credit; for the loans to households, we target the cost of non-earmarked credit for vehicle acquisition. Our choice for a more specific category of loans on the household side was made in light of the large heterogeneity in the financial instruments used for personal credit. The cost of credit and delinquency rate varies greatly across different types of credit, such as payroll loans, uncollateralized credit, and collateralized credit. In this paper, we focus on the last one, which is usually related to financing the purchase of durable goods. Vehicle acquisition financing represents around 90% of goods financing by households.[3]

The parameters associated with credit risk, namely, the variance of idiosyncratic shocks faced by borrowers, are calibrated to match delinquency rates. Impatient households have a higher delinquency rate of 4.32% per year compared to entrepreneurs at 3.96%, leading to a slightly higher variance in their shocks.

Moreover, we calibrate the relative size of the financial sector using some additional moments such as entrepreneurial leverage, the ratio of debt to GDP, investment to GDP, and banks' capital to assets.

[2]The CDB is a fixed-income security issued by banks. It is the main source of funding for most banks in Brazil.

[3]Although mortgages represent a larger portion of total household credit, they fall under earmarked credit and have regulatory restrictions on their interest rates in Brazil. Therefore, mortgage rates would not be appropriate for the calibration.

6
Quantitative Results

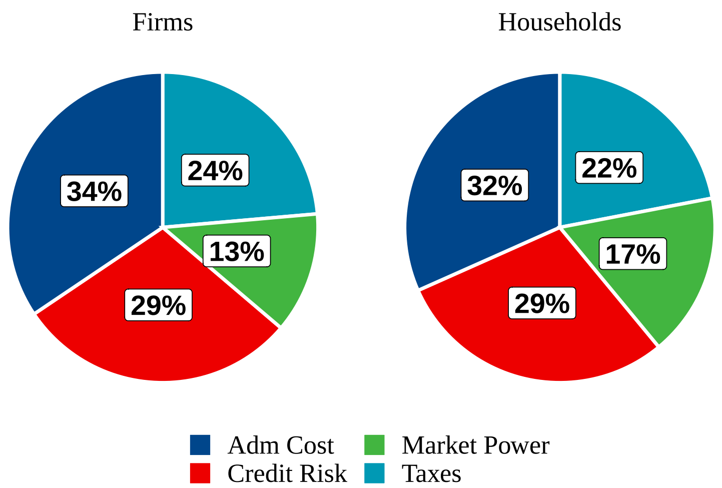
We assess the size of the components of the spread with two approaches. First, we shut down each element *ceteris paribus*, creating a decomposition of the observed banking spread. Second, we evaluate the size of the spread in counterfactual scenarios where each component is turned off. In this second exercise, other variables are allowed to change endogenously in response to the absence of each spread component.

6.1
Decomposition of the spread

For the main quantitative decomposition, we eliminate each component of the banking spread sequentially. First, we set the three elasticities associated with bank market power in the two loan segments (η_b^I and η_b^E) and the deposit market (η_d) to an arbitrarily high value, which gives us the spread under perfect competition. Second, we remove the administrative costs by setting $\xi = 0$. Third, we set all tax rates to zero, leaving only the credit risk component.

Our results indicate that administrative costs are the most relevant component, accounting for 33% of the aggregate spread (calculated as a weighted average of the spreads for firms and household loans). Credit risk is the second largest component representing 29% of the spread, followed by taxes at 23%. The remaining 15% are attributed to banks' market power.

Figure 6.1: Banking spread decomposition



The difference in the size of the spread on loans for firms and households is explained by a difference in the market power of banks in each segment. While the market power component on loans to entrepreneurs represents 13% of the banking spread, the same component represents 17% on loans for impatient households. The other components have slight differences even though we assume a similar structure on the banking side (Figure 6.1). For instance, administrative expenses have the same impact on both spreads in terms of percentage points. However, since the spread on household loans is larger, that component represents a smaller share of 32% (smaller by 2 p.p.).

We also perform a more detailed decomposition based on the analytical results. Table 6.1 presents the interest rates for both firms and households in the calibrated model. Moreover, between the lines where the interest rates are displayed, it shows each component that contributes to that specific part of the spread, in percentage points. Note that the components in the table are multiplicative as in equation (4-1) of the analytical decomposition.

This detailed breakdown reveals differences in the market power of banks in each market they operate. The market power in deposits generates a spread of 0.74%, which contributes towards both the firm and the household spread. However, in the loan market, the banks' margin represents a spread of 1.31% in the household segment but only 0.64% in the firms segment. Thus, the bank market power factor in firm loans is smaller than that of deposits.

Regarding taxes, we see the two main taxes that impact the spread directly: taxes on loan revenue and loan amount. The latter is the largest component of spread, representing 1.83%. This is an important fact that we explore in the next section with a counterfactual exercise to measure the impact of economic policies that use this tax to stimulate credit.

Table 6.1: Banking spread detailed factorization

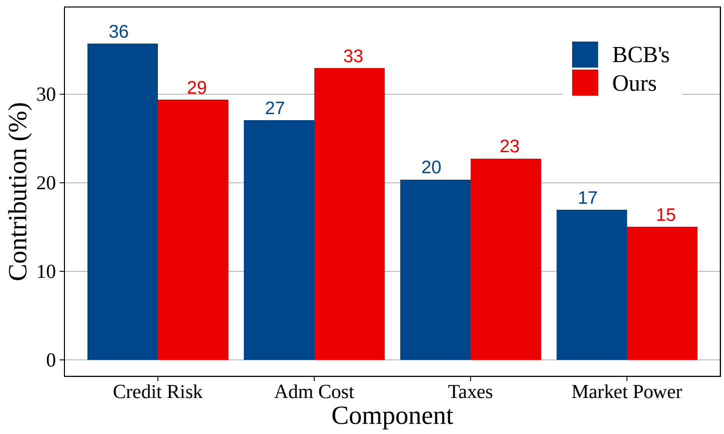
		Firms		**Households**	
		Rates	**Spread**	**Rates**	**Spread**
r^b		21.9679		23.2730	
	market power		0.6422		1.3142
	tax (PIS/Cofins)		0.8768		0.8946
	credit risk		3.3956		3.7886
r^{wb}		16.1781		0.161781	
	tax (IOF)		1.8315		1.8315
	adm cost		3.9252		3.9252
r		9.7795		9.7795	
	market power		0.7459		0.7459
r^d		8.9666		8.9666	
Total			**11.9314**		**13.1291**

Note: All number are in annualized percentage points. The column Rates shows the value of each interest rate in the calibrated model. All rates are observable, expect for r^{wb}, and match the data exactly. The spread components are multiplicative.

In comparing our results with those from the BCB's current methodology, our estimates attribute a larger weight to administrative expenses and a smaller weight to credit risk (Figure 6.2). As previously mentioned, the BCB's methodology uses balance sheet information from financial intermediaries. For credit risk analysis, it relies on banks' provisions for losses due to default, which might not be fully passed through to borrowers considering the possibility of recovering collateral for those loans, albeit paying a high cost.

Although our market power component is in line with the BCB's estimates, we find less heterogeneity in the two sectors of lending. Brazilian Central Bank (2018) points to a difference of almost 17 p.p. between the financial margin of household and firm spreads, while our estimates show a difference of 4 p.p. This discrepancy might result from our choice to focus on collateralized loans instead of other types of household loans, such as credit cards, for which banks' market power might be higher. In contrast, the BCB considers all types of non-earmarked loans in its 2018 report.

Figure 6.2: Spread decomposition - comparison with BCB's results



There are also important differences between our results and those of Fujisima (2021). As previously explained, one of the limitations of Fujisima's approach pertained to the collateral recovery process. His model overlooks the impact of collateral recovery on bank behavior and credit risk assessment because banks do not take into account the value of seized assets in their lending decisions. Consequently, Fujisima finds a smaller credit risk component. By internalizing the value of collateral in banks' decisions, our model gives a credit risk component of 29%, compared to 24% in Fujisima's work. In addition, his estimate of the administrative cost component is lower than ours and closer to that of the BCB, which he uses as a target moment. Despite having smaller estimates for the two most substantial components of our analysis, Fujisima also finds that market power is the smallest of the four components.

6.2 Counterfactuals

In this section, we sequentially eliminate each friction from the model and analyze not only the impact on the spread but also on other key economic variables, such as credit supply and output. Table 6.2 summarizes the results.

While it is expected that eliminating a component reduces the spread, this reduction may be cushioned by changes in other variables in equilibrium, differently from the previous decomposition exercise. For instance, the reduction in the spread that would result from eliminating deposit market power could be offset by an increase in the default rate that leads to an increase in the spread between the wholesale rate and the loan rate. This means that the percentage reductions we find in these exercises are smaller than the total size of the component we remove and need not add up to 100%.

In line with our earlier decomposition, eliminating administrative costs yields the biggest reduction of spread (3.51 p.p. annually, or a 28.6% reduction relative to the baseline for entrepreneurs). However, the effects on GDP, consumption, and investment are just as large when we eliminate taxes (1.7%, 2%, and 4% increase respectively). Notably, the increase in total credit is slightly larger in the scenario without taxes.

In comparing the counterfactual scenario of no taxes and that of no loan market power, it is worth noting that the reduction in the household spread is the same, even though our decomposition had shown taxes to represent a larger share of those spreads. In our decomposition, taxes accounted for 22%, while market power accounted for only 17% of the household spread. However, removing the market power does not change banks' risk-taking behavior as much as removing taxes does, keeping default rates relatively closer to the baseline and allowing for a sizable reduction in the spread of 10.7%.

Removing deposit market power reduces the wedge between the deposit rate and the policy rate, leading to a lower steady state policy rate. Since the deposit rate is determined by the representative patient household's preference, which remains the same in the counterfactual, it is the policy rate that goes down in the absence of the deposit spread.

We further investigate why credit risk stands out as one of the largest components by analyzing the sensitivity of the banking spread relative to the different parameters associated with this specific factor. Notably, we find that the spread is very sensitive to the loss given default parameter μ, as Figure a depicts. Moreover, this parameter has an even larger impact on the volume of loans. Figure b shows how the volume of household loans changes depending on μ. In light of this observation, the next section estimates the potential gains

Table 6.2: Counterfactual scenarios

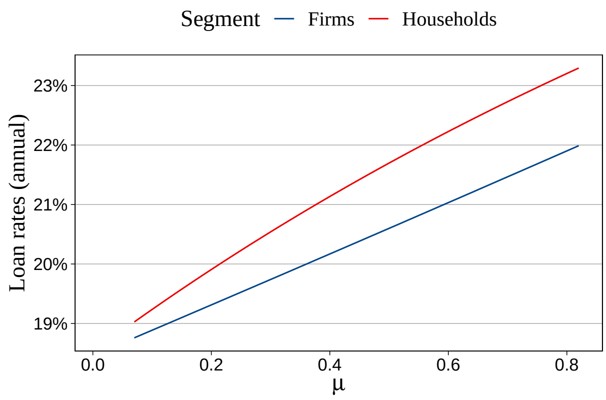
						Percentage change relative to baseline			
	Baseline	No deposit market power	No adm cost	No taxes	No loan market power	No deposit market power	No adm cost	No taxes	No loan market power
Entrepreneurs spread*	11.93	11.25	8.42	10.15	11.37	-5.5%	-28.6%	-14.4%	-4.6%
Impatient spread*	13.13	12.62	10.54	11.66	11.67	-3.7%	-19%	-10.7%	-10.7%
Deposit rate*	8.97	8.97	8.97	7.36	8.97	0%	0%	-17.5%	0%
Policy rate*	9.78	8.97	9.78	8.16	9.78	-8%	0%	-16.1%	0%
Wholesale loan rate*	16.19	15.34	11.81	12.43	16.19	-5%	-26%	-22.2%	0%
Entrepreneurs loan rate*	21.97	21.23	18.14	18.25	21.35	-3.1%	-16.4%	-15.9%	-2.6%
Impatient loan rate*	23.27	22.72	20.45	19.87	21.68	-2.2%	-11.3%	-13.7%	-6.4%
GDP	2.13	2.14	2.17	2.17	2.13	0.3%	1.7%	1.7%	0.2%
C	1.71	1.71	1.74	1.75	1.71	0.3%	2%	2.3%	0.2%
L	1.00	1.00	1.00	1.00	1.00	0%	-0.1%	-0.1%	0%
Investment	0.36	0.37	0.38	0.38	0.36	0.7%	4%	4.1%	0.6%
Total credit	1.83	1.87	2.02	2.03	1.85	1.9%	10.1%	11%	1.3%
Entrepreneur default*	3.95	4.13	4.89	5.20	4.10	4.5%	23.7%	31.6%	3.7%
Impatient default*	4.32	4.67	6.19	5.91	4.32	8%	43.2%	36.7%	-0.1%
Bank profit	0.01	0.01	0.01	0.01	0.01	-24.9%	10%	2.8%	-24.5%

* In percentage points (annual)

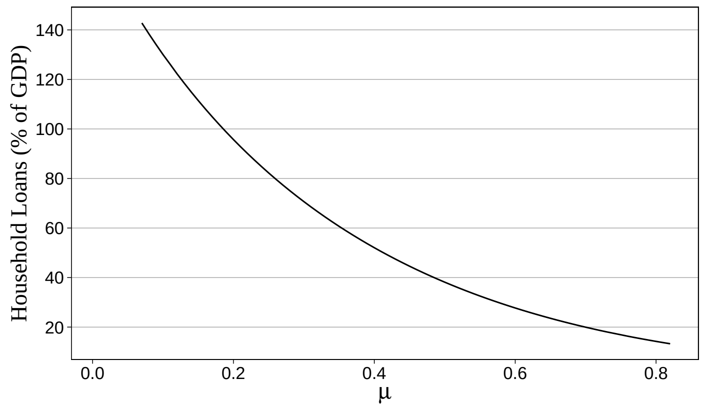
from policies aimed at reducing the loss given default.

Figure 6.3: Sensitivity analysis - loss given default parameter μ

(a) Loan rates



(b) Loan volume



6.2.1 Economic policies

We analyze two specific policy interventions that have been implemented in Brazil. The intended goal of these policies was to stimulate credit. First, we analyze the potential gains from policies that reduce the loss given default by improving debt enforcement mechanisms and collateral recovery processes. Second, we quantify the effect of setting to zero the tax rate levied on loan amount (IOF), which was revealed as an important component of the spread in the previous sections.

Loss given default. — In a counterfactual exercise, we show that aligning the loss given default in Brazil with the level observed in the United States would result in a 13% reduction in the spread. More precisely, changing μ from 82% to 28%, would reduce the annualized spread by an absolute value of 163 b.p.[1] This is a sizable reduction, especially when contrasted with the decline of 158 b.p. that would derive from removing all market power from banks. This suggests a potential avenue for policy intervention, indicating that enhancing the regulatory framework for credit recovery in Brazil could be instrumental in reducing the cost of external financing.

While significant changes have occurred in the regulation governing the repossession and resale of collateral, our results underscore that there are still considerable potential gains from further enhancements in the credit recovery process. For instance, Assunção, Benmelech & Silva (2013) studies the effect of a credit reform that facilitated the reselling process of seized collateral. They show that the reform led to a reduction in spreads while increasing the default rate. Our model duly captures this effect on the default rate since improving the credit recovery rate alleviates the borrowing constraint imposed by banks on entrepreneurs (as expressed by equation 3-5). This results in higher leverage and an elevated default threshold, signifying that banks are willing to take on more risk due to the prospect of recovering a larger portion of collateral in the event of default. Even so, the reduction of spreads is expressive.

Zero loan tax. — We evaluate the impact of eliminating the tax on loan amounts (IOF), which has been implemented in Brazil temporarily on a few occasions. We have already shown that taxes are an important factor in the spread decomposition, and our counterfactual table shows the impact it can have on credit supply. It appears that policymakers already had this intuition. In recent years, the IOF tax has been set to zero with the stated purpose of stimulating credit supply and stabilizing output. During the COVID-19 pandemic, the tax rate on credit operations was set to zero between April and November of 2020. After that, in 2022, a tax exemption was once again implemented, but this time targeting small-size enterprises. We perform a counterfactual exercise to quantify the effects of this type of policy.

Setting the IOF tax to zero leads to a relative decline in the spread of 11.6%, or 145 b.p. in absolute terms (entrepreneur spread reduces by 13.5% while household spread by 9.1%). This already accounts for the increase in default rates, which raise 11.1% for entrepreneurs and 20% for households. Total credit supply increases 4.7%, leading to an increase of 1.8% in investment by alleviating entrepreneurs' credit constraints. The impact on GDP is 0.8%. Therefore, the IOF tax reduction can, in fact, stimulate credit and even increase GDP.

[1]The typical calibration range for this parameter for the US economy, according to Carlstrom & Fuerst (1997), spans between 20% and 36%.

7
Credit shocks

This chapter analyzes the dynamic properties of our model, highlighting its unique contributions and enhancements. We emphasize the crucial role of the connection between deposits and loans in the transmission of shocks. This linkage is essential for capturing the movements of banking spreads.

We investigate the dynamics related to credit shocks. We consider on demand shock and one supply shock. In Appendix F, we also discuss the transmission of two traditional macroeconomic shocks, namely productivity and monetary shocks.

7.1
Credit demand shock

For the demand shock, we use a similar approach from Justiniano, Primiceri & Tambalotti (2015). They implement a credit shock via a taste shock that increases demand for the good used as collateral in the economy. In their case, the focus is the housing boom around the Great Recession, while in our model the collateral used by impatient households is the durable good. By introducing a shock in durable goods preference ψ, we can generate an increase in durable good prices that will propagate to the rest of the economy. Since the shock emerges from the borrower side and acts through the demand for durable goods, we call it a demand shock.

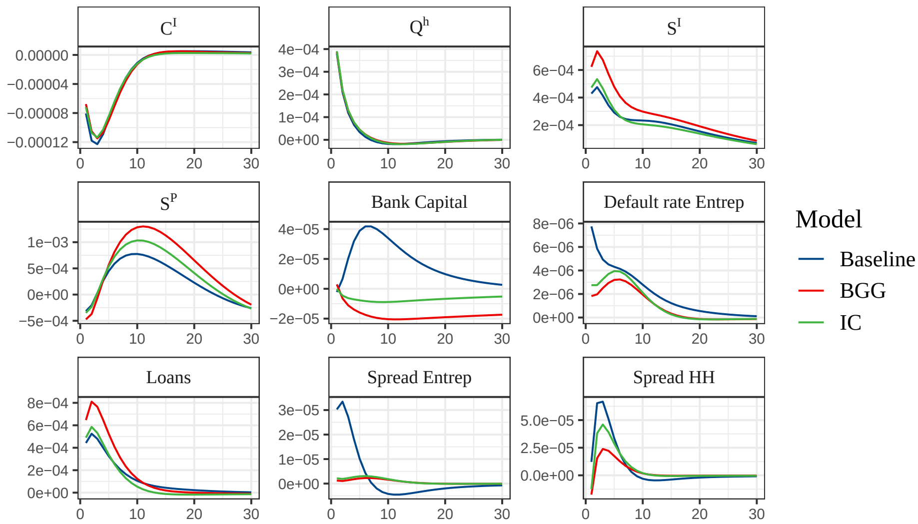
The credit demand shock increases the relative preference of households for durable goods. As a result, impatient households reduce consumption of non-durables and take up more loans to increase their durable consumption. The patient household initially sells some of its durable goods in response to the increase in prices, but as soon as investment in durable production picks up they also increase their consumption of durable goods.

Since the demand for non-durable goods becomes weaker, price level falls, and the deflation turns real risk-free interest rates positive. The monetary authority responds by lowering nominal rates.

The structure of the banking sector (or the regulations) will determine the magnitude of the propagation of the shock. In Figure 7.1, the red line represents the standard financial accelerator model with a perfectly competitive bank sector (BGG); the green line represents the model with imperfect competition (IC); and the blue line is the baseline model, with imperfect competition and capital requirements. In any case, the higher real interest rate discourages investment leading to a decline in capital and capital prices. In the BGG model, this effect is small and does not lead to a relevant increase in default rates. Banks are able to match the higher demand for household credit by decreasing their capital-to-asset ratio. On the other hand, in the baseline model, to provide impatient households with more loans, the banks need to build capital, as they pay a higher cost of funds when they deviate from the optimal ratio. The higher cost of funds is reflected in a higher wholesale spread which is passed through to both households and entrepreneurs.

Figure 7.1 shows that a key difference between the two versions of the model is an increase in the entrepreneurial spread when the capital requirement is in place. The increase in the spread will weaken the demand for capital as credit becomes more expensive for entrepreneurs. As a result, the price of capital will drop by a larger amount and the financial accelerator will act: the price of capital falls, then net worth falls, which tightens the borrowing constraint and reduces credit to entrepreneurs further. For impatient households, the increase in the loan rates is also higher in the baseline model, which dampens the rise of durable goods consumption.

Figure 7.1: IRF for a credit demand shock

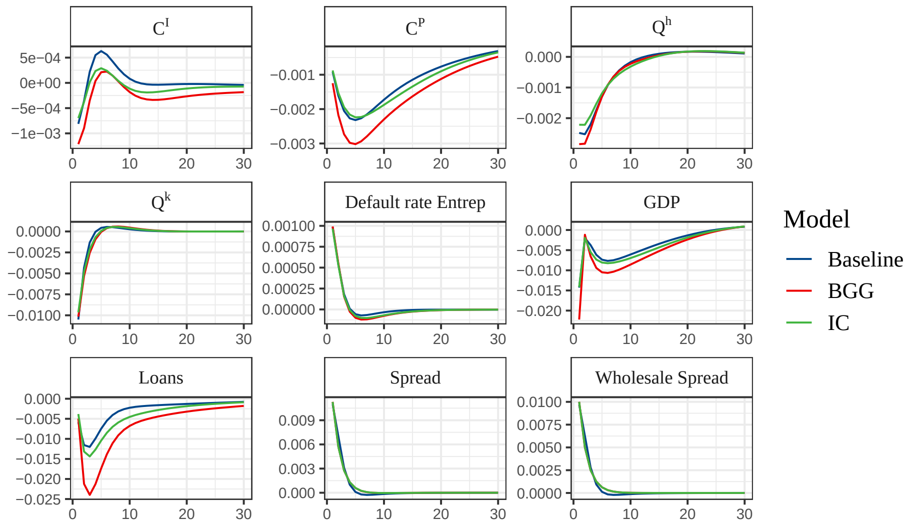


7.2 Credit supply shock

Our credit supply shock is defined as an increase in the marginal cost of banks. In the context of our model, this is implemented by increasing ξ, the administrative cost parameter. Unlike the other shocks previously discussed, this shock originates within the banking sector.

As illustrated in Figure 7.2, higher administrative costs, reflected in the higher wholesale spread, are passed through to both impatient households and entrepreneurs. As a result, there is a decline in loan volumes. The reduction in credit weakens the demand for capital (investment drops) and, consequently, drives down the price of capital. Net worth drops prompting more entrepreneurs to default on their debts. A similar mechanism affects impatient household loans and the price of durable goods.

Figure 7.2: IRF for a credit supply shock



On the household side, in addition to the declining durable goods prices, the decrease in capital lowers the marginal productivity of labor, leading to a decrease in wages. Thus, patient households reduce their non-durable consumption and their deposits.

The effects produced by the credit supply shock are consistent with those observed in Justiniano, Primiceri & Tambalotti (2019). The authors argue that credit supply shocks align more closely with the empirical facts about the credit cycle around the Great Recession. These facts include rising collateral prices, increasing loan amounts, and declining loan rates. Although the nature of the credit supply shocks in question is different - given that ours affects the banks' costs directly instead of their lending constraints - our model is able to generate these comovements as well.

8
Conclusion

In this paper, we employ a dynamic general equilibrium model with financial frictions, augmented by a stylized banking sector, to study how the conditions of financial intermediation contribute to high levels of spread. We quantify the relative importance of the elements that integrate the banking spread in Brazil. We find that administrative costs and credit risk are the most substantial components. Administrative costs constitute the most relevant component at 33%, followed by credit risk at 29%, taxes at 23%, and the remaining 15% are attributed to banks' market power.

An exploration of credit risk's prominence reveals a high sensitivity of the spread with respect to the credit recovery rate. In a counterfactual exercise, we show that if the Brazilian credit recovery rate were to improve to the US level, the spread would decrease by approximately 13%. We conclude that there are substantial potential gains from improvements in the regulatory framework for credit recovery.

Regarding the tax component, we find that tax exemption policies can indeed have a positive effect on credit supply. Specifically, zeroing the tax on loan amounts (IOF), which has an expressive contribution to the overall banking spread, can produce an increase of 4.7% on total credit.

The financial margin of banks is the smallest component of the spread, despite the apparently high concentration of the banking sector. In comparison to other countries, Brazil's banking sector is not particularly high. Its concentration in terms of the top 5 banks' asset share is below the world median. Nevertheless, we quantify the market power component indirectly, which is a limitation that could be addressed provided the availability of more detailed data on loan markets (in Appendix G, we propose a method for the direct estimation of market power). Yet, given the estimated size of the other components, it is reasonable to argue that market power is not the main element of the spread.

9
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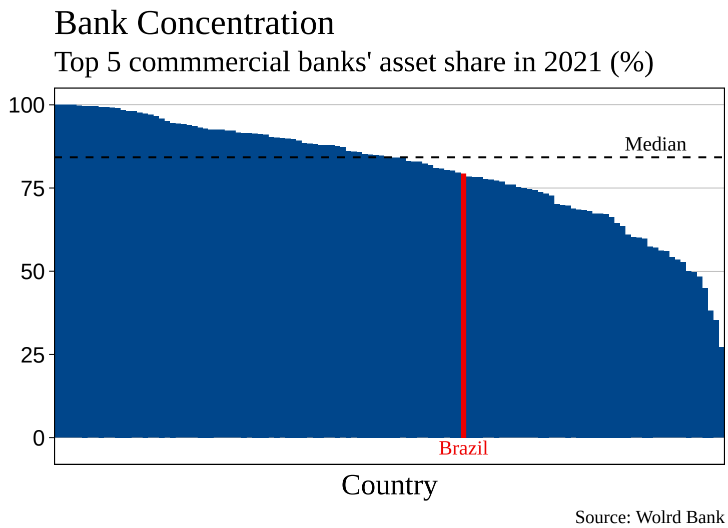
A

Bank Concentration



B
Production sector

The production chain is composed of wholesale firms, retail firms and a final good producer. The wholesale producers use capital and labor to produce wholesale goods, which they sell to retailers. Then, we introduce nominal stickiness using a retail sector that buys wholesale goods, differentiates them at no cost, and sells them to a final good producer, whose technology is a CES aggregator.

B.1
Final good producer

Final goods are produced by aggregating a basket of retail goods indexed by m.

$$Y_t = \left[\int_0^1 Y_t(m)^{\frac{\eta-1}{\eta}} dm\right]^{\frac{\eta}{\eta-1}}$$

Cost minimization implies[1]

$$Y_t(m) = \left(\frac{P_t(m)}{P_t}\right)^{-\eta} Y_t \tag{B-1}$$

B.2
Retailer

Retailers buys wholesale goods at price P_t^W and sell them to the final good producer. They choose a price $P_t(m)$ to maximize profit subject to equation (B-1).

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_t^P \left[\left(P_t(m) - P_t^W\right) Y_t(m) - \frac{\kappa_P}{2}\left(\frac{P_t(m)}{P_{t-1}(m)} - \pi_{t-1}^{\iota}\bar{\pi}^{1-\iota}\right)^2 P_t Y_t\right]$$

where we introduce nominal rigidity through a quadratic cost on the adjustment of price.

B.3
Wholesale producer

Wholesale goods are produced with a constant returns to scale technology that employs capital and labor. The wholesale producer's problem is

[1] $P_t = \left[\int_0^1 P_t(m)^{1-\eta} dm\right]^{\frac{1}{1-\eta}}$

$$\max_{K_t, L_t^P, L_t^I} \frac{P_t^W}{P_t} A_t K_t^{\alpha} ((L_t^P)^{\Omega} (L_t^I)^{1-\Omega})^{1-\alpha} - RR_t^k K_t - W_t^P L_t^P - W_t^I L_t^I$$

where A_t is the total factor productivity (TFP), whose log follows an autoregressive process, $\log A_t = \rho_a \log A_{t-1} + \epsilon_t^a$.

B.4 Capital producer

The representative capital producer buys investment goods and existing undepreciated capital $(1-\delta^k)K_t$ from entrepreneurs, and combines them to create capital for the next period, K_{t+1}. The transformation of investment goods into capital is subject to an adjustment cost $Z^i\left(I_t/I_{t-1}\right)$. The producer chooses investment to maximize its profit, discounting the future in the same way as the household it belongs to.

$$\begin{aligned} \max_{I_t} \quad & \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \left[Q_t^k \left(K_{t+1} - (1-\delta^k) K_t \right) - I_t \right] \\ \text{s.t.} \quad & K_{t+1} = (1-\delta^k) K_t + \left[1 - Z^i \left(\frac{I_t}{I_{t-1}} \right) \right] I_t \end{aligned} \tag{B-2}$$

We assume the adjustment cost function is $Z^i(\cdot) = 0$ and $(Z^i)'(\cdot) = 0$ in steady state, following Christiano et al (2005). In particular, we use $Z^i(x) = \frac{\kappa_I}{2}(x-1)^2$, so that $(Z^i)'(x) = \kappa_I(x-1)$.

B.5 Durable good producer

The durable goods producer behaves in a similar way to the capital producer. He buys investment goods I_t^s and existing undepreciated durable goods $(1-\delta^s)S_t$, and combines them to create more durable goods for the next period, S_{t+1}

$$\begin{aligned} \max_{I_t^s} \quad & \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \left[Q_t^s \left(S_{t+1} - (1-\delta^s) S_t \right) - I_t^s \right] \\ \text{s.t.} \quad & S_{t+1} = (1-\delta^s) S_t + \left[1 - Z^i \left(\frac{I_t^s}{I_{t-1}^s} \right) \right] I_t^s \end{aligned} \tag{B-3}$$

C
Holding Company

In this section of the appendix, we outline an alternative modeling approach for the bank holding company. Instead of having a target for the capital-to-asset ratio as in Gerali et al. (2010), we assume banks can vary their leverage. However, they rely on equity issuance or dividend payout to change their capital position and deviations from a target level of dividend payout are costly. This approach is similar to dividend adjustment costs seen in Jermann & Quadrini (2012) and Begenau (2020).

Let d_t be dividends paid by banks (chosen by the holding company). A negative value of d_t represents equity issuance. Banks' goal is to maximize expected discounted future dividends to their shareholders (households). The budget constraint states that the bank's net worth in the following period is:

$$N_{t+1}^b = (1 + r_t^{wb})B_t - (1 + r_t^{wd})D_t + J_t - d_t - \frac{\kappa_d}{2}(d_t - \bar{d})^2 - \xi B_t$$

where $\frac{\kappa_d}{2}(d_t - \bar{d})^2$ is the quadratic cost paid for a deviation from the target level of dividend payout $\bar{d}$. The constraint will always hold at equality, otherwise, the bank could increase dividend payment d_t.

The bank also faces two important restrictions: a balance sheet restriction and a capital requirement restriction along the lines of Basel III, given by

$$N_t^b \geq \chi B_t$$

Hence, the holding company's problem would be

$$\begin{aligned}
\max_{d_t, B_t, D_t, N_t^b} \quad & \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \Lambda_{0,t}^P d_t \right] \\
\text{s.t.} \quad & N_{t+1}^b = (1 + r_t^{wb})B_t - (1 + r_t^{wd})D_t + J_t - d_t - \frac{\kappa_d}{2}(d_t - \bar{d})^2 - \xi B_t \\
& B_t = N_t^b + D_t \\
& N_t^b \geq \chi B_t
\end{aligned}$$

D
Taxes

The presence of taxes will change the following equations in the model setup.

- Income taxes (IR) are levied on deposit returns, so the household's budget constraint becomes:

$$C_t^P + D_t + Q_t^s(S_t^P - S_{t-1}^P) \leq W_t^P L_t^P + \frac{(1 + r_{t-1}^d(1 - \tau^{rd}))}{\pi_t} D_{t-1} + T_t^P$$

- Tax on loan amounts (IOF) is charged on the bank holding company. This is added similar to a cost in the sum of discounted cash-flows:

$$\begin{aligned} E_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \frac{P_0}{P_t} \Bigg[& (1 + r_t^{wb}) B_t(l) - B_{t+1}(l)\pi_{t+1} + D_{t+1}(l)\pi_{t+1} - (1 + r_t^{wd}) D_t(l) \\ & + K_{t+1}^b(l)\pi_{t+1} - K_t^b(l) - \frac{\kappa_{Kb}}{2} \left(\frac{K_t^b(l)}{B_t(l)} - \nu^b \right)^2 K_t^b(l) \\ & - \xi B_t(l)^\gamma - \tau^b B_t(l) \Bigg] \end{aligned}$$

- Taxes on profits appear in the banks' capital law of motion:

$$K_t^b = (1 - \delta^b) K_{t-1}^b + (1 - \Delta^b)(1 - \tau) J_{t-1}$$

- Tax on loan revenue (PIS/Cofins) is paid by the loan branch, whose maximization problem becomes:

$$\begin{aligned} \max_{r_t^{b,E}(l), r_t^{b,I}(l)} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \frac{P_0}{P_t} \Bigg\{ & (1 - F^E(\bar{\omega}_{t+1}^E))(1 + r_t^{b,E}(l)(1 - \tau^{rb})) B_t^E(l) + (1 - \mu) \frac{B_t^E(l)}{B_t^E} \mathbb{E}_t \Phi_{t+1}^E \\ & + (1 - F^I(\bar{\omega}_{t+1}^I))(1 + r_t^{b,I}(l)(1 - \tau^{rb})) B_t^I(l) + (1 - \mu) \frac{B_t^I(l)}{B_t^I} \mathbb{E}_t \Phi_{t+1}^I \\ & - (1 + r_t^{wb}) B_t(l) \Bigg\} \end{aligned}$$

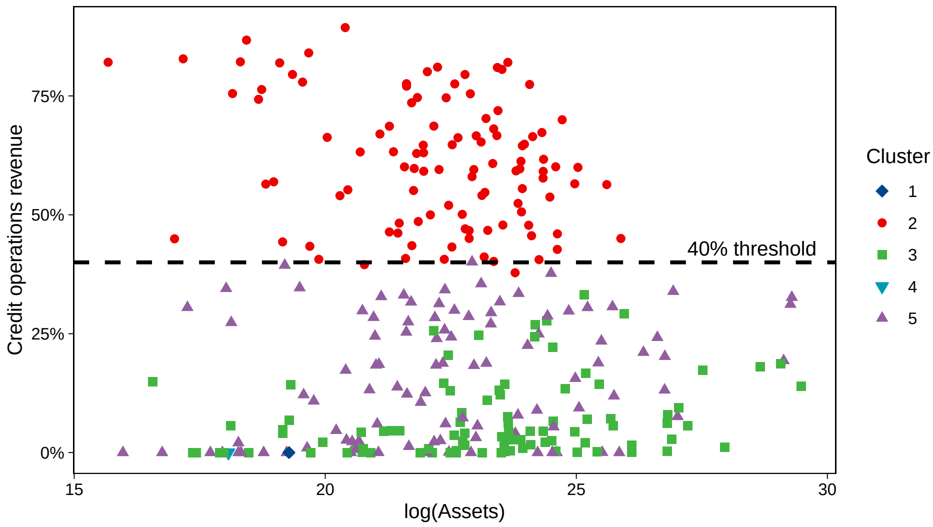
E
Administrative costs

The parameter representing the size of administrative costs in the model is ξ. Since administrative costs are assumed to be a linear function of assets (loans), the empirical counterpart of ξ is the ratio between administrative costs and assets. This statistic can be readily obtained from bank balance sheet data. However, one challenge is isolating the portion of administrative costs specifically associated with credit provision, as opposed to other banking activities.

To address this, we start by focusing on the banks whose main activity is credit provision. To avoid arbitrariness in this classification, we use cluster analysis, which provides a data-driven classification of banks. Our clusters are based on the vector space of revenue proportion from various categories defined by the BCB's accounting system for financial institutions (COSIF). In other words, each dimension represents the proportion of bank revenues from one specific category, such as revenues from credit operations or derivatives operations.

One distinctive cluster that emerges is that of banks with a high proportion of revenue from credit operations. Interestingly, this group can be almost perfectly classified by a threshold of credit revenues above 40% of total revenues (see Figure E.1). Using this cutoff, we can correctly classify 104 out of the 106 banks in the specialist group, with only one misclassification. Note that since our classification is based on revenue proportions, each cluster encompasses banks of varying sizes.

Figure E.1: Cluster analysis of banks revenues



Notes: Credit operations revenue in percentage of total revenue. Cluster number 2 is defined as the banks that specialize in credit

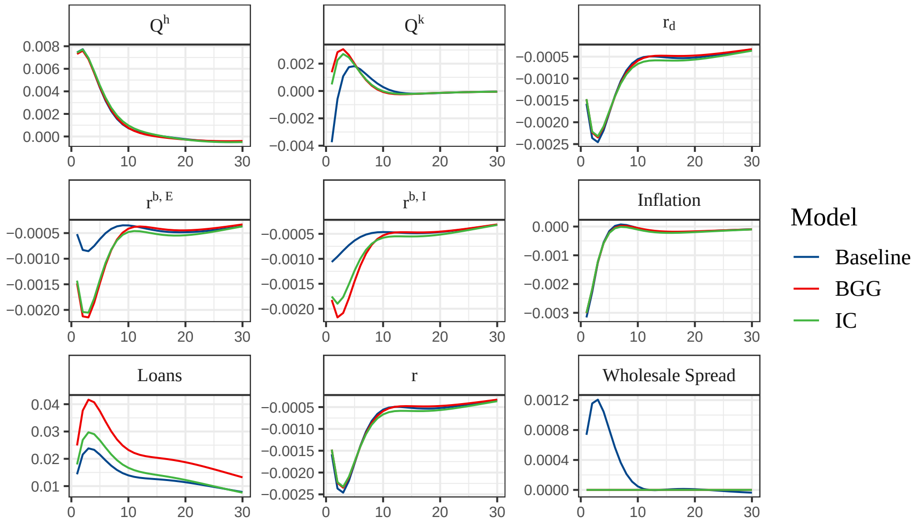
The administrative cost to asset ratio for these specialist banks is on average 3.97%. This ratio is stable across time and bank size, consistent with the findings from Begenau & Stafford (2018) for the US - in the case of Brazil, this holds for the group of banks that specialize in credit, but not for all banks.

F
Dynamics

F.1
Productivity shock

We assume the log of total factor productivity (TFP) A_t follows an autoregressive process, $\log A_t = \rho_a \log A_{t-1} + \epsilon_t^a$, where ϵ_t^a represents a productivity shock. Figure F.1 shows the impulse response functions for this shock.

Figure F.1: IRF for a productivity shock



An increase in TFP will lead to a decline in deposit rates. When TFP increases, output rises creating a deflationary pressure that increases real interest rates. The monetary authority reacts by reducing the nominal policy rate. The deposit rate follows the policy rate in this downturn.

The banking sector plays a central role in the transmission of the shock. In Figure F.1, the red line represents the standard financial accelerator model with a perfectly competitive bank sector (BGG). The green line represents the model with imperfect competition (IC), and the blue line is the baseline model, with imperfect competition and capital requirements. In the BGG model, we see a fall in loan rates that leads to an increase in loan demand. This creates an upward pressure in capital and durable goods prices increasing the value of collateral and, consequently, net worth. This alleviates the borrowing constraint which leads to more credit in the standard financial accelerator cycle. In the baseline model, however, the capital requirements create a connection between the deposit and loan rate that changes the propagation mechanism.

In the baseline model, the deposit rate falls, but the loan rates do not, at least not in the same magnitude. To meet the higher loan demand, the bank will have to build more capital to comply with capital requirements. This will increase the cost of funds of banks initially, as indicated by a higher wholesale spread. Thus, loan rates will not go down as much as they do in the BGG model. By bringing down the deposit rates more than loan rates, the banks manage to increase the spread and, consequently, their profits. The retained earnings help build bank capital.

This connection between the loan and deposit rates is a key feature of our model, distinguishing it from much of the existing literature, which often treats the loan and deposit channels separately. Central to this mechanism is the banks' capital position, which depends on banks' profits. Hence, given the positive correlation between credit losses and banks' profits, featuring time-varying default rates is essential for capturing this channel. For instance, in comparison to Gerali et al. (2010), whose model lacks equilibrium default, our model shows that after a productivity shock, banks' capital rises instead of falling, as banks aim to increase their lending capacity.

F.2
Monetary shock

The monetary policy shock has been studied extensively in the context of DSGE models with financial frictions. Our analysis here highlights the channels at work in our model in the transmission of this shock in light of the existing literature.

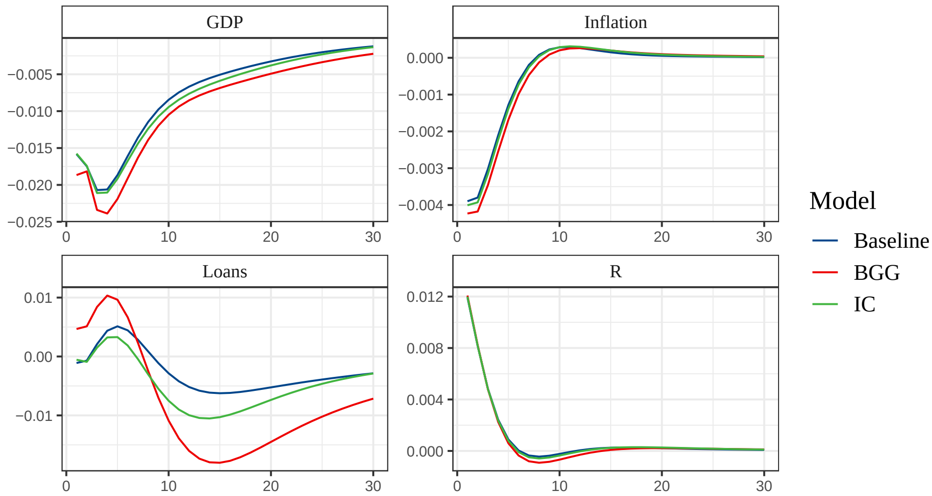
Regarding the credit channel of monetary policy transmission, Bernanke & Gertler (1995) describes two different mechanisms: the balance sheet channel and the bank lending channel. Both are present in our model.

According to the balance sheet channel, a contractionary monetary policy shock leads to a decline in asset prices. As a consequence, the value of collateral and net worth drops, which leads to higher interest rates on loans. In our model, the fall in collateral value generates a spike in default rates and the fall in net worth tightens the borrowing constraint (borrowers' access to credit will be restricted to more expensive contracts). Hence, the amount of credit in the economy declines.

The bank lending channel works through the cost of financing of banks. The rise of the policy rate leads to a higher deposit rate, increasing the cost of funding for banks. Since it is costly to substitute the source of funding, this restricts the banks' lending capacity, resulting in a drop in loan supply. This cost of substituting deposits with other sources of funding is represented in our model by a quadratic cost of deviation from the optimal capital-to-assets ratio.

In addition to these two classic channels, our model features imperfect competition in the banking sector, but this is not relevant to the monetary policy shock. Other studies have also found imperfect competition to have a limited role in the transmission of monetary policy, such as Gerali et al. (2010). Although they state that the banking sector attenuates the transmission of monetary shocks, the main cause is the adjustment cost of banking rates, which we do not have in our model.

Figure F.2: IRF for a monetary shock



G
Market Power Estimation

In our decomposition of the spread, we leave the market power component as a residual, that is, we calibrate all the parameters of the other three components and then adjust the market power parameters to match the observed level of spread. Alternatively, we could estimate the loan demand elasticity to interest rates, which pinpoints the market power of banks. This would allow us to disentangle the markup associated with imperfect competition from other spread components. In this section, we propose an estimation method that was not implemented in the main exercise due to data availability restrictions.

Market power can be defined as a firm's ability to influence the prices of its inputs and/or outputs. This ability is related to the elasticity of the demand faced by the firm - if demand is perfectly elastic, then the firm possesses no market power. Accordingly, we refer to the market power of the banks as their ability to influence the interest rates of deposits and loans.

In our model, banks' market power is summarized by two key elasticities: that of demand for deposits η_d and that of demand for loans η_b. On the deposits side, the parameter η_d represents the sole source of the wedge between the deposit rate r_t^d and the risk-free rate r_t. Hence, we can discipline this parameter by targeting the moments of these variables in the calibration procedure. On the other hand, η_b represents one of many components of the wedge between the risk-free rate r_t and the loan rate r_t^b. Therefore, we need a different approach. We could estimate this parameter by employing methods used in the Industrial Organization literature (Berry (1994), Nakane, Alencar & Kanczuk (2006), Dick (2008)).

We propose estimating the elasticity of the demand for loans from equation (3-4). Taking the natural log of the ratio of demands of a given pair of banks (l, k) yields:

$$\ln B_t(l) - \ln B_t(k) = -\eta_b \left[\ln\left(1 + r_t^b(l)\right) - \ln\left(1 + r_t^b(k)\right)\right] + \epsilon_{lk} \tag{G-1}$$

We could identify the relevant elasticity by employing cost shifters as instrumental variables. In the literature, cost shifters are commonly used to address the problem of price endogeneity. In principle, we could use banks' labor costs and loan loss provisions as instruments. The underlying assumption is that changes in these variables impact quantity demanded only through their effect on prices, generating exogenous variation that is orthogonal to the unobserved demand shock ϵ_{lk}.

To be consistent with the emphasis on collateralized lending in our theoretical framework, we could define the market for loans as the Brazilian national market for non-earmarked loans during this estimation procedure.

The complete calibration procedure would utilize a dual approach in the spirit of Wang et al. (2022) to match the key characteristics of Brazil's economy. First, we would directly estimate the parameters of bank market power, employing the demand estimation techniques described to obtain the elasticity of loan demand to interest rates. Second, we would calibrate the remaining parameters, based on moments of macroeconomics variables, as well as standard values from the literature, as was done in the main exercise. The advantage of this approach is that the estimation in the first step allows us to separate the market power component from the rest, in spite of having a limited number of informative moments to target in the calibration.

Data requirements

For the estimation of the parameters related to bank market power, we need a panel of financial institutions in Brazil, that contains information on the values and the interest rates of the loans. This panel can be constructed from different databases maintained by the BCB. Information pertaining to the credit portfolio of banks is obtained from a mandatory survey in accordance with financial regulations. Concurrently, data on the average interest rates charged by each institution is sourced from the central bank's credit registry (SCR). By combining these datasets, we can obtain quarterly data on quantities and average rates at the level of financial institutions. We have collected this data and created such a panel. However, as explained before, we also need an instrumental variable to obtain an unbiased estimate. This is where data availability becomes an issue, because the bank-level data on labor costs and loan loss provisions, which are plausible instrumental variables, is not made publicly available by the BCB. The balance sheet data released by the institution is aggregated at a level that is higher than the ideal for this type of estimation. Nevertheless, we have outlined the estimation method for future research or other applications in which data is available.