Pontifícia Universidade Católica do Rio de Janeiro

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Decomposing Banking Spreads of Multiple Types of Credit: a Structural Model 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

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Abstract

Perez Rojo, Flavio Fernando; Viana de Carvalho, Carlos (Advisor). **Decomposing Banking Spreads of Multiple Types of Credit: a Structural Model Approach**. Rio de Janeiro, 2026, 63p. Dissertação de Mestrado - Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

We propose a DSGE model with multiple types of credit and two financial frictions to address two objectives. First, we decompose Brazilian banking spreads into four components: administrative costs, financial margins, taxes, and default risk. Second, we examine the effects of technology and monetary policy shocks on these spreads. The model features an imperfectly competitive banking sector that lends to heterogeneous households and to an entrepreneur subject to default risk, following Bernanke et al. (1999). Within this framework, each type of credit is characterized by different levels of impatience, costs, default rates, and market power. The model also incorporates a tax structure and financial costs consistent with the Brazilian economy. Then, we calibrate the model to match key determinants of banking spreads in Brazil. The main results are as follows: (i) the spread decomposition reported by the Central Bank of Brazil is closely replicated; (ii) reductions in costs and loan taxes -policies implemented in Brazil- lower all spreads; (iii) productivity and monetary policy shocks generate responses consistent with the financial frictions literature; and (iv) these results are robust when long-term credit is considered.

Keywords

Financial Frictions; DSGE; Banking Spreads; Decomposition; Credit Risk; Types of Credit; Heterogeneity.

Resumo

Perez Rojo, Flavio Fernando; Viana de Carvalho, Carlos (Advisor). **Decompondo os spreads bancários de múltiplos tipos de crédito: uma abordagem de modelo estrutural**. Rio de Janeiro, 2026, 63p. Dissertação de Mestrado - Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

Propomos um modelo DSGE com múltiplos tipos de crédito e duas fricções financeiras para abordar dois objetivos. Primeiro, decompomos os spreads bancários brasileiros em quatro componentes: custos administrativos, margens financeiras, impostos e risco de inadimplência. Segundo, examinamos os efeitos de choques tecnológicos e de política monetária sobre esses spreads. O modelo apresenta um setor bancário imperfeitamente competitivo que concede crédito a famílias heterogêneas e a um empreendedor sujeito a risco de inadimplência, seguindo Bernanke et al. (1999). Nesse contexto, cada tipo de crédito é caracterizado por diferentes níveis de impaciência, custos de monitoramento, taxas de inadimplência e poder de mercado. O modelo também incorpora uma estrutura tributária e custos financeiros consistentes com a economia brasileira. Em seguida, calibramos o modelo para reproduzir os principais determinantes dos spreads bancários no Brasil. Os principais resultados são os seguintes: (i) a decomposição dos spreads reportada pelo Banco Central do Brasil é reproduzida de forma próxima; (ii) reduções nos custos de monitoramento e nos impostos sobre empréstimos - políticas implementadas no Brasil - reduzem todos os spreads; (iii) choques de produtividade e de política monetária geram respostas consistentes com a literatura de fricções financeiras; e (iv) esses resultados são robustos quando o crédito de longo prazo é considerado.

Palabras-chave

Fricções Financeiras; DSGE; Spreads Bancários; Decomposição; Risco de Crédito; Tipos de Crédito; Heterogeneidade.

Contents

List of Tables

List of Figures

List of Abbreviations

AR(1) - Autoregressive of Order 1
BCB - Banco Central do Brasil
BGG - Bernanke, Gertler, and Gilchrist
CC - Credit Card
CDB - Certificado de Depósito Bancário
CES - Constant Elasticity of Substitution
COFINS - Contribuição para o Financiamento da Seguridade Social
CSLL - Contribuição Social sobre o Lucro Líquido
DSGE - Dynamic Stochastic General Equilibrium
EOS - Elasticity of Substitution
FOC - First Order Condition
GDP - Gross Domestic Product
ICC - Índice de Custo de Crédito
ICCO - Incentive Compatibility Constraint
IOF - Imposto sobre Operações Financeiras
IR - Imposto de Renda
IRF - Impulse Response Function
IRPJ - Imposto de Renda das Pessoas Jurídicas
NPD - Non Payroll-Deducted
PD - Payroll-Deducted
PIS - Programa de Integração Social
SELIC - Sistema Especial de Liquidação e de Custódia
TFP - Total Factor Productivity
US - United States of America
VF - Vehicle Financing

1 Introduction

Banking spreads typically reveal imperfections in credit markets, and the Brazilian economy stands out in this regard. Specifically, the World Bank (2020) reports that, in 2019, the spreads in Brazil reached 32.21 p.p., compared with a global median of 5.78 p.p. These spreads are directly influenced by several factors, including credit risk, imperfect competition in the banking sector, taxes, and operational costs.

The combination of multiple factors may help explain the Brazilian case. While default rates and banking sector concentration are, respectively, above and below the global average, neither is extreme. For instance, the World Bank (2020) reports that, in 2019, the nonperforming loan ratio in Brazil averaged 3.1%, a level relatively close to that of more financially developed economies (0.8% in the United States and 1.1% in the United Kingdom). Moreover, using the asset share of the five largest banks as a proxy for market power, the World Bank estimates that, in 2021, this measure reached 79.4% in Brazil - below the world median. At the same time, some developed countries exhibit higher levels of concentration without correspondingly high banking spreads, such as Canada (84.7%) and Australia (91.2%).

Reducing banking spreads has been a key objective of the of the Central Bank of Brazil (BCB) since 1999, with the launch of the *Juros e Spread Bancário no Brasil* project. In addition, the BCB has sought to lower default rates and foster greater competition in credit markets as complementary objectives. Within this framework, the BCB developed the *Índice de Custo de Crédito (ICC)* spread decomposition, a methodology that decomposes banking spreads into administrative costs, tax payments, financial margins, and provisions for loan losses using accounting information. For example, the Central Bank of Brazil (2019) reports the following ICC components: administrative costs (27%), financial margin (17%), tax (20%) and default (36%).

However, the BCB methodology does not differentiate these components across types of credit. There is a substantial heterogeneity among credit categories, as market power, collateral requirements, and other characteristics vary. Accordingly, this dissertation computes the four main components of banking spread, following the ICC methodology, for several types of credit in Brazil using a DSGE model with financial frictions. The model features a patient household (a high-discount-factor agents) that supplies savings, and multiple impatient households (low-discount-factor agents) and entrepreneurs that demand credit. Heterogeneity among impatient households arises from different levels of impatience, costs, default rates, and market power.

The analysis considers four types of credits of household credit: non payroll-deducted loans, payroll-deducted loans, vehicle financing loans, and credit cards. Impatient households and entrepreneurs pledge collateral subject to idiosyncratic shocks, which might lead to default. Financial intermediation between savers and borrowers Bernanke et al. (1999) (hereafter, BGG), where loan contracts are subject to limited enforcement and default arises endogenously. In addition, banks face administrative cost of extending credit, reserve requirements, and taxes.

The main results are as follows. First, the model is calibrated to match key statistics of the Brazilian economy. Second, the spread decomposition is obtained by sequentially shutting down each component - administrative costs, taxes, market power, and credit risk. For firms and vehicle credits, administrative components are the dominant component and generate the largest reduction in spread. In contrast, for non payroll-deducted loans, payroll-deducted loans and credit cards, market power is the primary and leads to the greatest decline in spreads. Third, the ICC components estimated by the Central Bank of Brazil (2018) are closely matched by the model-based decomposition when weighted by the share of each type of credit. Fourth, we evaluate two credit stimulus policies implemented in Brazil -reductions in costs and the elimination of taxes on loans - and find that both lead to declines in all spreads. Fifth, we analyze two standard macroeconomic shocks, namely productivity and monetary shocks. The corresponding impulse response functions are consistent with the financial frictions literature. Finally, these results are robust when long-term credit is considered.

The remainder of this dissertation is organized as follows. Section 2 reviews the relevant literature. Section 3 presents the structural model. Section 4 discusses the main results. Secion 5 includes business cycle frictions. Section 6 concludes.

2 Literature Review

This dissertation contributes to the literature on the determinants of banking spreads for Brazil. Although most DSGE models incorporate financial frictions to study these determinants, they typically consider a single type of credit. Therefore, the main contribution of this dissertation is to include multiple types of credit.

Initially, most of the literature adopted an empirical approach to analyze the determinants of banking spreads. One of the most widely referenced papers is Ho and Saunders (1981), who use panel data from banks to argue that banking spreads are driven by risk aversion, market power and interest rate volatility. For Brazil, Almeida and Divino (2015) follow Ho and Saunders (1981) and find that the main drivers of banking spreads are the administrative costs and banking sector concentration. In a similar vein, Joaquim et al. (2019) use banks merges and acquisitions as exogenous shocks to estimate the effect of credit market concentration on banking spreads. They find that an increase in concentration raises spreads but cuts reduces credit supply.

Considering the structural approach, most papers use DSGE models with financial frictions. Under stylized banking requirements that act similarly to non-lump-sum taxes, Souza-Sobrinho (2010) assesses the impact of credit and reserve requirements on banking spreads. In the steady state, the author finds out that earmarked credit is the main determinant of non-earmarked credit spreads. Similarly, Fujisima (2021) proposes a model that includes loans to households and entrepreneurs, which may default according to a simple cut-off rule, a banking sector in monopolistic competition subject to administrative costs, and a tax structure consistent with the ICC spread decomposition. Using the steady-state to decompose the spreads into the four ICC components, the author shows that reductions in household and entrepreneur spreads are larger when increasing banking competition and reducing administrative costs, respectively.

Luz (2024) argues that the credit risk modeling in Fujisima (2021) is questionable and therefore proposes a borrowing constraint consistent with Bernanke et al. (1999). In the latter framework, loan contracts feature limited enforcement, where default on debt is an endogenous decision by the borrower. Under steady-state analysis, Luz (2024) finds that administrative costs (33%) and credit risk (29%) are the main drivers of banking spreads.

However, the literature has primarily focused on a single type of credit for all agents, whereas in reality multiple forms of financing coexist, implying credit heterogeneity. This dissertation therefore aims to model the simultaneous heterogeneity of multiple types of credit as a direct extension to Luz (2024). To attain this objective, the literature discusses three approaches. First, Campbell (1978) considers two types of credit (fixed- and variable-rate loans), where borrowing agents choose the share of the total credit allocated to fixed rates, with the remainder at variable rates. Second, Greenwood et al. (2023) introduce two types of credit (credit lines and term loans) and two types of borrowers, where each borrower has access to only one type of credit. In addition, credit lines carry a fixed spread over the risk-free interest rate, while term loans are priced at the market-clearing rate. Third, Elsas et al. (2004) propose a framework with two types of banks, each offering different types of credits at distinct interest rates.

In this dissertation, the approach considers multiple households, each which access to a single type of credit. For instance, impatient household 3 may borrow through vehicle financing, while impatient household 5 is calibrated to use credit card debt. The use of BGG, as in Luz (2024), allows the model to incorporate different types of collaterals through varying recovering values and market competitiveness through changing EOS. However, this modeling strategy has several limitations that could be addressed by future literature.

First, assuming that households cannot choose among credit types may be overly restrictive; however, it can be interpreted as capturing the dominance of a particular credit type. In practice, many households lack access to all forms of credit and, when they do have access, tend to use the cheapest option available. Second, the model does not aggregate across heterogeneous households to match national statistics. This simplification is intentional, as aggregation over different interest and default rates would require microdata and a more detailed methodological framework. Third, following a shock, the model effectively rules out substitution between credit types, since interest and default rates respond differently across them. This likely affects primarily the magnitude of aggregate variables, although it remains a limitation for future research to address.

3 The Model

The model, which is mainly based on Luz (2024), is a DSGE framework with financial frictions that incorporates both costly state verification mechanism, as in BGG, and monopolistic competition in the banking sector, as in Gerali et al. (2010). Consequently, banks are subject not only to credit risk but also to administrative costs, reserve requirements and a tax structure consistent with the ICC framework.

There are three infinitely-lived agents: a patient household, impatient households (which differ in impatience, costs, default rates, and market power), and entrepreneurs. First, all households consume and supply labor, while entrepreneurs transform raw capital into effective capital, which serves as an input in goods production. Second, impatient households and entrepreneurs are less patient than the patient household; therefore, the former are always borrowers, while the latter is saver. Third, banks intermediate loans and deposits under the two previously defined financial frictions. Recall that the approach considers multiple impatient households, each of which has access to a single type of credit. Figure 1 summarizes the main connections in the model.

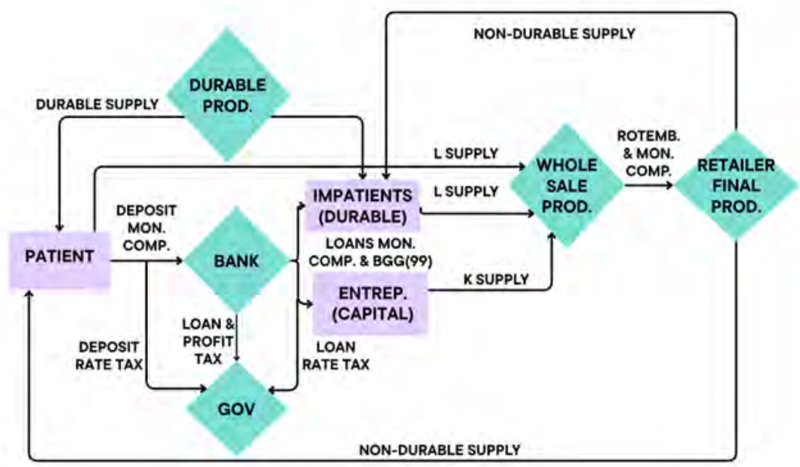

Figure 1: Model

3.1 Patient Household

Given the relative price of durable goods in terms of non-durable goods Q^s_t, the real wage W^P_t, transfers T^P_t (dividends paid by banks, entrepreneurs, retail firms, and capital and durable goods firms), and the gross nominal deposit rate net of taxes $1 + r^d_t(1 - \tau^{rd})$, this household solves

$$\max_{\{C^P_t, S^P_t, L^P_t, D_t\}} \mathbb{E}_0 \sum_{t=0}^{\infty} (\beta^P)^t \left\{ log(C^P_t) + \psi log(S^P_t) - \zeta \frac{(L^P_t)^{1+\varphi}}{1+\varphi} \right\}$$

subject to

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

3.2 Impatient Household

Is is composed of a worker (consumes and works) and a financier (who chooses loans). The rationale for considering these two roles is to ensure that the financier's problem is linear in net worth, which facilitates aggregation. It is assumed that the worker and financiers can transfer funds between each other and that there is perfect consumption insurance within the household.

3.2.1 Worker

His preferences are similar to those of the patient household, with the following differences: (i) he has a lower discount factor, $\beta^I < \beta^P$; (ii) he does not save; and (iii) he rents durable goods from financier i at the rate RR_t^{Si}. Thus, he solves

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

subject to

$$C_t^{Ii} + RR_t^{si} S_t^{Ii} \leq W_t^{Ii} L_t^{Ii} + \Xi_t^i$$

where Ξ_t^i correspond to the transfers from financiers i. Recall that each impatient household differs in impatience, costs, default rates, and market power (through elasticitity of substitution, EOS here onwards).

3.3 Borrowers

Financiers and entrepreneurs borrow from banks, assuming a mass of one of each type $j \in [0,1]$ and $o \in \{Ii, E\}$. At every period, each borrower purchases assets using their own net worth and bank loans: entrepreneurs buy raw capital and transform it into effective capital, while financiers purchase durable goods. Heterogeneity within each type of borrower arises from net worth and idiosyncratic shock.

The timing of events in the borrower's life is as follows. At the end of period t, borrower j obtains a loan $B_{j,t}^o$ and combines it with its net worth $N_{j,t}^o$ to purchase assets $Z_{j,t}$ at price Q_t^z. Hence, $Q_t^z Z_{j,t} = N_{j,t}^o + B_{j,t}^o$. At the beginning of period $t+1$, borrower j is hit by an i.i.d. idiosyncratic shock $\omega_{j,t+1}^o$, whose distribution $F(\cdot)$ is log-normal with unit mean, which scales the value of its assets into $\omega_{j,t+1}^o Z_{j,t}$. Next, borrowers get a return R_{t+1}^zon their assets. On the one hand, capital is rented to wholesale producers at rate RR_{t+1}^k, and the undepreciated capital stock $(1 - \delta^k)$ is sold to capital producers at price Q^k_{t+1}. Thus, the return on capital for entrepreneur j is given by

$$1 + R^k_{t+1} = \frac{RR^k_{t+1} + (1-\delta^k)Q^k_{t+1}}{Q^k_t}$$

On the other hand, the return on durable goods for the financiers is

$$1 + R^s_{t+1} = \frac{Q^s_{t+1}}{Q^s_t}$$

assuming that rental income cannot be seized by banks and that the idiosyncratic shock affects only the price of the durable good.

Afterwards, borrowers repay their debt. We assume costly state verification, where $\omega^o_{j,t+1}$ is privately observed and the bank can observe it only by paying a cost μ^o. Loans are standard debt contracts in which borrowers' assets are pledged as collateral; in case of default, the bank monitors the borrower and recovers the asset net of costs. This implies an endogenous cutoff $\bar{\omega}^o_{j,t+1}$, which determines the default decision. The threshold is defined by the point at which the value of assets equals the value of debt:

$$\bar{\omega}^o_{j,t+1}(1 + R^z_{t+1})Q^z_t Z_{j,t} \equiv (1 + R^{b,o}_{j,t+1})B^o_{j,t} \tag{1}$$

where $R^{b,o}_{j,t+1}$ is the real loan rate.

3.3.1 Entrepreneurs

They maximize expected pre-dividend net worth in period $t+1$ subject to a participation constraint. However, the problem can be rewritten in terms of the pair $(\bar{\omega}^E_{j,t+1}, X_{j,t})$, where $X_{j,t} \equiv \frac{Q_t K_{j,t+1}}{N^E_{j,t}}$ denotes leverage,

$$\begin{aligned} &max \mathbb{E}_t \left[\int_{\bar{\omega}^E_{j,t+1}}^{\infty} \left[\omega^E_{j,t+1}(1 + R^k_{t+1})Q^k_t K_{j,t+1} - (1 + R^{b,E}_{j,t})B^E_{j,t} \right] dF(\omega^E_{j,t+1}) \right] \\ &\approx max \mathbb{E}_t \left[1 - \Gamma_t(\omega^E_{j,t+1}) \right] (1 + R^k_{t+1}) X_{j,t} N^E_{j,t} \end{aligned} \tag{2}$$

subject to contracts that are compatible with bank's profit maximization: bank's ICCO (5).

3.3.2 Financiers

They maximize the expected present discounted value of future transfers to impatient workers, subject to a budget constraint, a default cutoff rule, and the bank's ICCO. To finance dividend transfers, durable goods purchases, and repayment of past loans, they rely on revenues from selling and renting durable goods, as well as new borrowing,

$$V^i_{j,t} = \max_{\{S^{Ii}_{j,t}, B^{Ii}_{j,t}\}} \Xi^i_{j,t} + \mathbb{E}_t \left[\Lambda^{Ii}_{t,t+1} max\{0, V^i_{j,t+1}\}\right]$$
$$s.t. \Xi^i_{j,t} + Q^s_t S^{Ii}_{j,t} + (1 + R^{b,Ii}_t) B^{Ii}_{j,t-1} \leq \omega^{Ii}_{j,t}(1 + R^s_t) Q^s_{t-1} S^{Ii}_{j,t-1} + RR^{si}_t S^{Ii}_{j,t} + B^{Ii}_{j,t}$$
$$\bar{\omega}^{Ii}_{j,t+1}(1 + R^s_{t+1}) Q^s_t S^{Ii}_{j,t} = (1 + R^{b,Ii}_{t+1}) B^{Ii}_{j,t}$$
(5)

3.4 Banking sector

Banks intermediate deposits from the patient household and extend loans to entrepreneurs and financiers. To include bank market power in a tractable way, we adopt a Dixit-Stiglitz framework. We assume a unit mass of banks ($l \in [0, 1]$) that compete monopolistically in both deposit and lending markets. Moreover, saving (borrowing) one unit requires a composite bundle of differentiated financial products,

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

where η_d and η^o_b are the EOS for deposits and loans, respectively. Each bank consists of three branches: two retail branches (which collect the deposits and extend loans, setting interest rates under monopolistic competition) and a bank holding company (which manages the bank's capital position and links the two retail branches).

3.4.1 Deposit and loan demands

The retail branches operate under monopolistic competition; accordingly, the demands they face are derived from the cost-minimization problem of financiers and entrepreneurs when choosing how to compose their basket of financial products,

$$D_t(l) = \left(\frac{1 + r^d_t(l)}{1 + r^d_t}\right)^{\eta_d} D_t \tag{3}$$
$$B^o_t(l) = \left(\frac{1 + r^{b,o}_t(l)}{1 + r^{b,o}_t}\right)^{-\eta^o_b} B^o_t, o \in \{Ii, E\} \tag{4}$$

where $r^d_t(l)$ and $r^{b,o}_t(l)$ denote bank l's nominal interest rates on deposits and loans, respectively. Moreover, we define the following aggregate rates
$1 + r^d_t \equiv \left[\int [1 + r^d_t(l)]^{1+\eta_d} dl\right]^{\frac{1}{1+\eta_d}}$ and $1 + r^{b,o}_t \equiv \left[\int [1 + r^{b,o}_t(l)]^{1-\eta^o_b} dl\right]^{\frac{1}{1-\eta^o_b}}$.

3.4.2 Bank holding company

It manages the bank's capital position by combining deposits $D_t(l)$ and bank capital $K_t^b(l)$ to supply loans $B_t(l)$, where $B_t(l) = B_t^E(l) + \sum_{i=1}^N B_t^{Ii}(l)$, subject to a constant operational cost ξ on loans. To capture the effect of capital requirements on lending spreads, we follow Gerali et al. (2010) and introduce a quadratic cost for deviations from the target capital-to-assets ratio ν^b. Consequently, the holding company of bank l solves the following problem:

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

where r_t^{wb} and r_t^{wd} are the wholesale rates of loans and deposits, respectively. We assume that banks have access to unlimited finance at the policy rate r_t, implying that $r_t^{wd} = r_t$.

3.4.3 Deposit branch

It collects funds from the patient household under monopolistic competition and channels them to the holding company. The problem is thus defined as follows:

$$\begin{aligned}
\max_{\{r_t^d(l)\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \frac{P_0}{P_t} & \Big[(1+r_t)D_t(l) - (1+r_t^d(l))D_t(l) \Big] \\
s.t. D_t(l) &= \left(\frac{1+r_t^d(l)}{1+r_t^d} \right)^{\eta_d} D_t
\end{aligned}$$

3.4.4 Loan branch

It obtains funds from the holding company and lends to entrepreneurs and impatient households under monopolistic competition. Revenues derive from borrowers who repay their debt and from seized collateral in the event of default. Regarding collateral recovery, we follow Hafstead and Smith (2012) by introducing a "recovery company" that collects all collateral and compensates the banks in proportion to their market share $\frac{B_t(l)}{B_t}$. Moreover, due to costs, only a fraction $(1-\mu^o)$ of collateral can be recovered. Accordingly, the problem is to choose $\{r_t^{b,E}(l), r_t^{b,Ii}(l)\}$ to maximize

$$max\mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \frac{P_0}{P_t} \left[(1-F(\bar{\omega}_{t+1}^E))(1+r_t^{b,E}(l)(1-\tau^{rb}))B_t^E(l) + (1-\mu^E)\frac{B_t^E(l)}{B_t^E}\mathbb{E}_t\Phi_{t+1}^E + ... \right.$$
$$\left. ... + \sum_{i=1}^{N} \left[(1-F(\bar{\omega}_{t+1}^{Ii}))(1+r_t^{b,Ii}(l)(1-\tau^{rb}))B_t^{Ii}(l) + (1-\mu^{Ii})\frac{B_t^{Ii}(l)}{B_t^{Ii}}\mathbb{E}_t\Phi_{t+1}^{Ii} \right] - (1+r_t^{wb})B_t(l) \right]$$
$$s.t. B_t^o(l) = \left(\frac{1+r_t^{b,o}(l)}{1+r_t^{b,o}} \right)^{-\eta_b^o} B_t^o, o \in \{Ii, E\}$$

where $\mathbb{E}_t\Phi_{t+1}^o = \pi_{t+1} \int_0^{\bar{\omega}_{t+1}^o} \omega_{t+1}^o (1+R_{t+1}^z) Q_t^z Z_{t+1} dF^o(\omega_{t+1}^o)$ denotes the total expected value of seized collateral. The solution to the loan branch's problem is characterized by the first-order condition, which corresponds to the bank's ICCO, as shown below:

$$(1-F(\bar{\omega}_{t+1}^o)) \left[\left(1-\frac{1}{\eta_b^o}\right)(1+r_t^{b,o}(1-\tau^{rb})) + \tau^{rb} \right] + \frac{(1-\mu^o)E_t\Phi_{t+1}^o}{B_t^o} = (1+r_t^{wb}) \quad (5)$$

3.4.5 Bank profit

It is the sum of the cash flows of the three branches

$$J_t = \sum_{i=1}^{N} \left[(1-F(\bar{\omega}_{t+1}^{Ii}))(1+r_t^{b,Ii}(1-\tau^{rb}))B_t^{Ii} + (1-\mu^{Ii})\mathbb{E}_t\Phi_{t+1}^{Ii} \right] + ...$$
$$... + (1-F(\bar{\omega}_{t+1}^E))(1+r_t^{b,E}(1-\tau^{rb}))B_t^E + (1-\mu^E)\mathbb{E}_t\Phi_{t+1}^E + ...$$
$$... - (1+r_t^d)D_t - K_t^b - \kappa_t - \xi B_t - \tau^b B_t$$

The bank pays a share Δ^b of profits to the patient household and retains the rest, building capital. Thus, the banks' aggregate capital evolves as follows

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

3.5 Production Sector

This sector consists of a capital producer, a durable goods producer, a wholesale producer (which uses capital and labor and sells to retailers), retail firms (which differentiate wholesale goods at no cost), and a final goods producer (which buys from retail firms).

3.5.1 Final good producer

It aggregates the goods produced by retailers using a CES basket:

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

where m is a variety and η is the elasticity of substitution between varieties. Cost minimization then implies:

$$Y_t(m) = \left(\frac{P_t(m)}{P_t}\right)^{-\eta} Y_t \tag{6}$$

where the price index is given by $P_t = \left[\int_0^1 P_t(m)^{1-\eta} dm\right]^{\frac{1}{1-\eta}}$.

3.5.2 Retail firms

Firm m purchases wholesale goods at price P_t^W, differentiates them at no cost, and sells them to the final good producer. It sets price $P_t(m)$ to maximize profit:

$$\max_{\{P_t(m)\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \frac{P_0}{P_t} \left[P_t(m) - P_t^W\right] Y_t(m)$$

subject to (6):

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

Moreover, profits are transferred to patient households.

3.5.3 Wholesale producer

It employs capital and labor to produce wholesale goods according to:

$$\max_{\{K_t, L_t^P, L_t^{Ii}\}} Q_t^w Y_t - RR_t^k K_t - W_t^P L_t^P - \sum_{i=1}^{N} W_t^{Ii} L_t^{Ii}$$
$$s.t. Y_t = A_t K_t^\alpha \left((L_t^P)^\Omega (L_t^I)^{1-\Omega}\right)^{1-\alpha}$$
$$L_t^I = \prod_{i=1}^{N} (L_t^{Ii})^{\varsigma_i}, \varsigma_N = 1 - \sum_{i=1}^{N-1}$$

where A_t denotes the total factor productivity (TFP), which evolves according to $logA_t = \rho_a logA_{t-1} + \epsilon_t^a$ and $Q_t^w \equiv \frac{P_t^w}{P_t}$.

3.5.4 Capital producer

It buys investment goods and undepreciated capital $(1-\delta^k)K_t$ from entrepreneurs and combines them to produce next-period capital K_{t+1}. The producer chooses investment to maximize profits:

$$\max_{\{I_t\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \left[Q_t^k \left(K_{t+1} - (1-\delta^k)K_t\right) - I_t\right]$$

subject to

$$s.t.K_{t+1} = (1-\delta^k)K_t + I_t \tag{7}$$

Profits are transferred to patient households.

3.5.5 Durable good producer

For simplicity, housing is in fixed supply and does not depreciate. The total housing stock is given by:

$$S_t = S_t^P + \sum_{i=1}^{N} S_t^{Ii} \tag{8}$$

Profits are transferred to patient households

3.6 Government

The fiscal authority balances revenues and public expenditures G_t in every period:

$$G_t = \tau^{rb}\left[(1-F(\bar{\omega}_t^E))r_{t-1}^{b,E}\frac{B_{t-1}^E}{\pi_t} + \sum_{i=1}^{N}\left[(1-F(\bar{\omega}_t^{Ii}))r_{t-1}^{b,Ii}\frac{B_{t-1}^{Ii}}{\pi_t}\right]\right] + ...$$
$$... + \tau^b\frac{B_{t-1}}{\pi_t} + \frac{(r_{t-1}^d\tau^{rd})}{\pi_t}D_{t-1} + \tau J_{t-1}$$

3.7 Market Clearing

In equilibrium, all markets clear and the following conditions holds:

$$C_t = C_t^P + \sum_{i=1}^{N} C_t^{Ii}$$

A further market-clearing condition for final consumption goods is given by:

$$Y_t = C_t + I_t + G_t + \frac{\xi B_{t-1}}{\pi_t} + \sum_{i=1}^{N}\frac{\mu^{Ii}\Phi_t^{Ii}}{\pi_t} + \frac{\mu^E\Phi_t^E}{\pi_t} + \kappa_t$$

where $\frac{\xi B_{t-1}}{\pi_t}$ represents operational costs, $\sum_{i=1}^{N}\frac{\mu^{Ii}\Phi_t^{Ii}}{\pi_t} + \frac{\mu^E\Phi_t^E}{\pi_t}$ correspond to costs, and κ_t denotes bank's adjustment costs.

3.8 Analytical Decomposition of the Spread

We can analytically decompose all the components of the spread by splitting it into three parts associated with each branch of the banking sector as follows:

$$spread^j \equiv \frac{1+r^{b,o}}{1+r^d} = \underbrace{\frac{1+r^{b,j}}{1+r^{wb}}}_{\text{loan branch}} \underbrace{\frac{1+r^{wb}}{1+r}}_{\text{holding company}} \underbrace{\frac{1+r}{1+r^d}}_{\text{deposit branch}} ,o \in \{Ii, E\} \tag{9}$$

First, for the loan branch, we use equilibrium equation (A22):

$$\frac{1+r^{b,o}}{1+r^{wb}} = \underbrace{\left(1 - \frac{(1-\mu^o)\Phi^o/B^o + (1-F(\bar{\omega}^o))\tau^{rb}}{1+r^{wb}}\right)}_{\text{compensation for low return on assets}} \underbrace{\frac{1}{1-F(\bar{\omega}^o)}}_{\text{delinquency rate}} \underbrace{\frac{\eta_b^o}{\eta_b^o - 1}}_{\text{market power}} \underbrace{\frac{1}{1-\tau^{rb}}}_{\text{tax}}$$

where the first term captures the compensation for low return on seized assets; the second reflects the share of defaulting borrowers; the third term decreases with higher loan demand elasticity; and the fourth term incorporates the effect of taxes.

Second, for the holding company, using the equilibrium equation (A20), the wedge arises from administrative costs and taxes and can be approximated as:

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

Finally, the deposit branch is determined by the elasticity of deposit demand using equilibrium condition (A25):

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

4 Steady State Quantitative Analysis

For the quantitative results, we consider $N = 4$ impatient households that would mimic four credit categories: non payroll-deducted loans (NPD), payroll-deducted loans (PD), vehicle financing loans (VF), and credit card loans (CC). These credits types are selected as they represent the main lending segments of the economy. Throughout the paper, we use the notation $\{NPD, PD, VF, CC\}$ to refer to these respective credit categories. First, we calibrate the model to match key stylized facts of the Brazilian economy. Next, we compare the steady-state decomposition implied by the model with that obtained under the ICC accounting methodology.

4.1 Calibration

We consider three approaches to calibrate the model and Table 1 summarizes all results. The description of the data is detailed in Appendix A2[1].

1. Literature	Parameter	Value	Source	Moment	Data	Model
Capital share	α	44.8%	Castro et al. (2015)			
EOS - final good	η	6	Carvalho et al. (2023)			
Inverse of Frisch elasticity	φ	1	Carvalho et al. (2023)			
Optimal capital-to-asset-ratio	ν^b	16%	Ferreira and Nakane (2018)			
Capital-to-asset adjustment	κ_{Kb}	22.96	Ferreira and Nakane (2018)			
Discount factor - NPD	β^{NPD}	0.8359	Appendix 2			
Discount factor - PD	β^{PD}	0.9422	Appendix 2			
Discount factor - VF	β^{VF}	0.9481	Appendix 2			
Discount factor - CC	β^{CC}	0.9118	Appendix 2			
Durable good preference	ψ	1.25	Carvalho et al. (2023)			
Patient labor share	Ω	19.55%	Luz (2024)			
Scale of administrative function	ξ	0.99%	Luz (2024)			
2. Direct data analogue	**Parameter**	**Value**	**Source**			
Dividend payout - bank	Δ^b	46.48%	Reuters			
EOS - firm loan	η_b^E	3407.544	Step 1			
EOS - NPD loan	η_b^{NPD}	8.681	Step 1			
EOS - PD loan	η_b^{PD}	74.492	Step 1			
EOS - VF loan	η_b^{VF}	458.531	Step 1			
EOS - CC loans	η_b^{CC}	28.198	Step 1			
Labor share - NPD household	ς_{NPD}	14.53%	Credit share NPD			
Labor share - PD household	ς_{PD}	37.03%	Credit share PD			
Labor share - VF household	ς_{VF}	24.75%	Credit share VF			
Labor share - CC household	ς_{CC}	23.70%	Credit share CC			
Tax rate on bank profit	τ	40%	CSLL/IRPJ			
Tan rate on loan revenue	τ^{rb}	4.65%	PIS/Cofins			
Tax rate on impatient and entrepreneur loan	τ^b	0.47%	IOF			
Tax rate on return of deposit	τ^{rd}	17.5%	IR			
3. Internal calibration	**Parameter**	**Value**	**Target**	**Moment**	**Data**	**Model**
Discount factor - patient	β^P	0.991	CDB	r^d	1.09%	1.09%
EOS - deposit	η_d	78.36	Selic	r	2.38%	2.38%
Monitoring cost - firm loan	μ^E	55.99%	ICC - firms	$r^{b,E}$	4.72%	4.96%
Monitoring cost - NPD loan	μ^{NPD}	81.79%	ICC - NPD	$r^{b,NPD}$	19.51%	19.51%
Monitoring cost - PD loan	μ^{PD}	81.80%	ICC - PD	$r^{b,PD}$	6.02%	6.02%
Monitoring cost - VF loan	μ^{VF}	81.80%	ICC - VF	$r^{b,VF}$	5.37%	5.37%
Monitoring cost - CC loan	μ^{CC}	81.79%	ICC - CC	$r^{b,CC}$	9.56%	9.56%
Capital depreciation rate	δ^k	1.064%	I/GDP	I/Y	4.46%	4.46%
Banks' capital depreciation rate	δ^b	5.840%	Bank capital-to-asset ratio	K^b/B	16%	16%
Variance of ω^E	σ^E	0.495	Delinquency rate - firms	$F(\bar{\omega}^E)$	0.97%	0.97%
Variance of ω^{NPD}	σ^{NPD}	0.247	Delinquency rate - NPD	$F(\bar{\omega}^{NPD})$	1.91%	1.91%
Variance of ω^{PD}	σ^{PD}	0.644	Delinquency rate - PD	$F(\bar{\omega}^{PD})$	0.61%	0.61%
Variance of ω^{VF}	σ^{VF}	1.574	Delinquency rate - VF	$F(\bar{\omega}^{VF})$	1.15%	1.15%
Variance of ω^{CC}	σ^{CC}	0.636	Delinquency rate - CC	$F(\bar{\omega}^{CC})$	1.76%	1.76%
Dividend payout - entrepreneur	Δ^e	9.05%	Entrepreneur leverage	X	1.4	1.4
Labor disutility	ζ	0.818	Steady state hours worked	L	1	1

Table 1: Calibration

[1] We use data up to 2019 to avoid the impact of the COVID-19 pandemic on interest rates, particularly the sharp rate cuts that followed.

Literature. - In this approach, we follow standard values from the literature. We set the inverse Frisch elasticity φ to 1 and the durable goods preference parameter ψ to 1.25, as in Carvalho et al. (2023). Moreover, the impatient household's discount factors β^{Ii} are set so that the credit constraint binds at all times, following Iacoviello (2005). Specifically, we set $\beta^{Ii}(1 + R^{b,Ii}) = 0.999$ (see Appendix A2 for more details). In addition, the capital share α is set to 0.448, as in Castro et al. (2015), and the EOS between final goods η is calibrated at 6, as in Carvalho et al. (2023). The optimal capital-to-asset ratio ν^b and the capital-to-asset adjustment cost κ_{K^b} are set to 0.16 and 22.96, respectively, following Ferreira and Nakane (2018). For the administrative cost ξ, we set 0.99%, following Luz (2024), who documents that the operating expenses-to-assets ratio is relatively stable over time and bank sizes, similar to the U.S. Finally, for Ω we follow Luz (2024).

Direct sample analogues. - This block is calibrated using data counterparts. The bank dividend pay-out Δ^b is set to 0.4648, matching the observed dividend payout of publicly traded financial institutions. In addition, the loan market elasticities η_b^E, η_b^{NPD},η_b^{PD},η_b^{VF}, η_b^{CC} are obtained from a first-step calibration in which the costs are fixed using the World Bank's loss-given-default indicator (0.818), in order to match the specific *Indice de Custo de Credito* (ICC). The labor shares $\varsigma_{NPD}, \varsigma_{PD}, \varsigma_{VF}, \varsigma_{CC}$ uses the ratio of particular secure credit to total credits.

Taxes are set as follows. First, the tax rate on bank profits τ is fixed at 40%, consistent with the combined burden of *Contribuição Social Sobre Lucro Líquido* (CSLL) and *Imposto de Renda das Pessoas Jurídicas* (IRPJ). Second, the tax rate on loan revenue τ^{rb} is calibrated at 4.65%, matching the rates of the *Programa de Integração Social* (PIS) and *Contribuição para Financiamento da Seguridade Social* (COFINS). Third, the tax rate on loans to impatient and entrepreneurs τ^b is set to 0.4622%, reflecting the sum of the fixed rate and the daily rate of *Imposto sobre Operaçoes Financeiras* (IOF) on credit operations. Finally, the tax rate on deposit returns τ^{rd} is set to 17.5%, corresponding to the *Imposto de Renda* (IR), applied to financial investments with maturities between 1 and 2 years.

Internal calibration. - For these parameters, we use moment matching. The patient household's discount factor β^P is set to 0.991 to match the nominal rate on CDB/RDB instruments. Moreover, the deposit market elasticity η_d is calibrated at 78.36 to match the spread between the deposit rate and the SELIC rate.

The dividend payoff parameter Δ^e is set to be consistent with entrepreneurs' leverage. Furthermore, the capital depreciation rates δ^k and δ^b are calibrated to match the investment-to-GDP and bank's target capital-to-asset ratios, respectively. In addition, the costs are set to match the corresponding ICC measures. Regarding the variance of idiosyncratic shocks $(\sigma^E, \sigma^{NPD}, \sigma^{PD}, \sigma^{VF}, \sigma^{CC})$, these are calibrated to capture observed heterogeneity in delinquency rates across firms and households. Finally, the labor disutility parameter ζ is chosen so that the steady-state hours worked is 1.

4.2 ICC Accounting Spread Decomposition

In this exercise, we sequentially shut down each component of the spread. First, to obtain the steady-state spread under perfect competition, we set all loan elasticities (η_b^o) and the deposit elasticity (η_d) to arbitrary high values. Second, the perfect-competition spread without taxes is obtained by setting $\{\tau, \tau^b, \tau^{rd}, \tau^{rb}\} = 0$. Third, the perfect-competition spread without administrative cost and taxes is obtained by additionally setting $\xi = 0$, leaving only the credit risk component.

Figure 2 presents the spread decomposition based on the four components of ICC[2]. Our findings for firms and vehicle financing credits are consistent with Luz (2024), indicating that administrative costs are the most important component. Moreover, credit risk ranks second in importance, followed by taxes and bank market power.

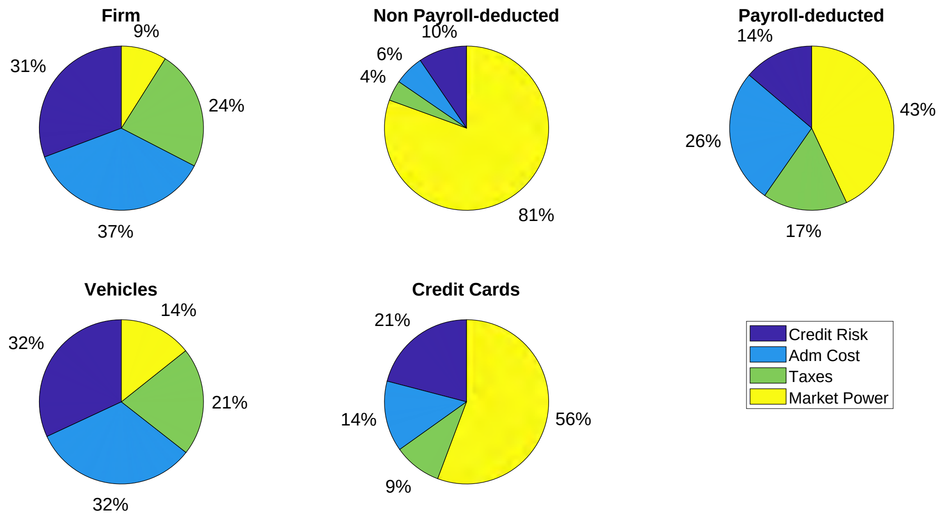

Figure 2: Banking Spread Decomposition

In this paper, we also consider other types of credits, such as non payroll-deducted loans, payroll-deducted loans and credit card loans. Differences in the spread decomposition across these products, relative to vehicle financing, are primarily driven by variations in bank market power and delinquency rates. On the one hand, as the EOS increases, the contribution of market power to the spread declines. For example, since $\eta_b^{VF} = 458.531$, market power accounts for only a small share of the spread (14%) in the case of vehicle financing loans, whereas $\eta_b^{CC} = 28.198$ implies that this component explains a much larger share for credit card loans. On the other hand, higher delinquency rates increases the spread. For instance, the difference between vehicle financing loans and payroll-deducted loans is largely explained by their respective delinquency rates, $F(\bar{\omega}^{VF}) = 1.15\%$ and $F(\bar{\omega}^{PD}) = 0.61\%$.

[2]Appendix A5 shows that our results are robust to alternative orderings. Moreover, Appendix A6 shows that under long-run credits, all results are robust.

It is important to explain why, despite a high EOS, market power still contributes significantly to the spread (e.g., around 9% for firms, which account for nearly 80% of total credit and profits). This can be understood through the bank's ICCO (A23) as applied to firm credit. The relevant condition implies a negative relationship between the EOS η_b^e and the return on capital R^K. Intuitively, a higher elasticity compresses markups, reducing the the return on capital. In turn, a lower return on capital leads to a higher equilibrium capital stock, which increases the value of the firm's collateral. As collateral value raises, banks expand lending toward firms with stronger balance sheets, sustaining a relatively large contribution from this segment despite the high elasticity. Under perfect competition, elasticities increase further, reinforcing this mechanism. In this case, the return on capital declines (by approximately 5%), which raises the aggregate capital stock (by about 9%) and, consequently, the value of seized collateral (also around 9%). This expansion in collateral supports higher lending to firms (around 9%) and leads to a reduction in lending rates (approximately 10%). Together, these effects help explain why firm credit still accounts for about 12% of the spread.

Table 2 presents a detailed decomposition based on the baseline model's interest rates and the multiplicative spread components defined in equation (9). The results indicate that market power has the largest impact for non payroll-deducted loans and the smallest for firm loans. Moreover, the compensation for low returns on assets is relatively similar across credit categories, which may reflect risk diversification at the bank level. Finally, taxes are the main driver of the loan-branch spread in most segments, with the exception of non payroll-deducted loans, where market power is the dominant component.

		Firm	NPD	PD	VF	CC
r^b		4.96	19.52	6.02	5.37	9.56
	compensation	0.952	0.952	0.954	0.954	0.953
	delinquency	1.010	1.020	1.006	1.012	1.018
	market power	1.000	1.130	1.014	1.003	1.037
	tax	1.049	1.049	1.049	1.049	1.049
r^{wb}		2.89	2.89	2.89	2.89	2.89
	holding company	1.015	1.015	1.015	1.015	1.015
r		1.43	1.43	1.43	1.43	1.43
	market power	1.013	1.013	1.013	1.013	1.013
r^d		1.22	1.22	1.22	1.22	1.22
Total		3.60%	18.22%	4.88%	4.27%	8.41%

Table 2: Banking Spread Detailed Factorization

The Central Bank of Brazil (2018) estimates the following ICC components: administrative costs (27%), financial margin (17%), taxes (20%), and default (36%). When we compute the spread decomposition using weights based on each credit category's share in total lending, we obtain: administrative costs (30%), financial margin (26%), taxes (20%) and default (25%). Taxes and financial margins remain broadly similar across both approaches, while administrative costs are higher and default is lower in our framework. Luz (2024) argues that this difference arises from the Central Bank's credit risk methodology, which relies on banks' provisions for expected default losses. However, such provisions may not be fully passed on to borrowers, as part of the losses can be mitigated through collateral recovery, albeit at a significant cost.

In our estimation, we find substantial heterogeneity across the six types of lending. However, in two cases we overestimate the figures reported by Banco Central do Brasil (2018), which documents a 17 p.p. difference between the financial margins of household and firm credit spreads. Specifically, for non payroll-deducted loans and credit card loans, our estimates imply differences relative to firm credit of approximately 13.5 p.p. and 3.8 p.p., respectively. Nevertheless, this result could be mitigated by incorporating additional credit categories for which the discrepancy is more pronounced.

4.3 Counterfactuals

In this section, we sequentially eliminate each friction and analyze its effects on a range of variables. Although removing a given component mechanically reduces the spread, endogenous adjustments in other variables may offset this effect; as a result, the percentage changes we obtain can be smaller than the direct contribution of the eliminated component. In all exercises, we hold constant several parameters at their baseline values: δ^k, δ^b, Δ^e, σ^e, σ^{Ii}, ζ. Table 3 reports the results.

	Baseline (1)	$\eta^d \to \infty$ (2)	$\xi = 0$ (3)	No taxes (4)	$\eta^o \to \infty$ (5)	(2)/(1) %	(3)/(1) %	(4)/(1) %	(5)/(1) %
Firm spread	2,69%	2,52%	1,87%	2,27%	2,67%	-6,25%	-30,52%	-15,54%	-0,89%
NPD spread	16,93%	16,72%	15,91%	16,25%	3,45%	-1,24%	-6,04%	-3,98%	-79,64%
PD spread	3,73%	3,55%	2,88%	3,22%	2,33%	-4,64%	-22,58%	-13,54%	-37,38%
VF spread	3,07%	2,96%	2,54%	2,74%	2,85%	-3,66%	-17,46%	-10,71%	-7,32%
CC spread	7,19%	7,03%	6,42%	6,68%	3,38%	-2,20%	-10,73%	-7,03%	-52,96%
Deposit rate	1,22%	1,22%	1,22%	1,01%	1,22%	0,00%	0,00%	-17,50%	0,00%
Policy rate	1,43%	1,22%	1,43%	1,21%	1,43%	-14,18%	0,00%	-15,05%	0,00%
Wholesale loan rate	2,89%	2,68%	1,90%	2,20%	2,89%	-7,01%	-34,29%	-23,72%	0,00%
GDP	3,59	3,61	3,69	3,66	3,49	0,61%	2,79%	1,94%	-2,75%
C	3,12	3,14	3,26	3,30	3,06	0,54%	4,44%	5,56%	-2,23%
Investment	0,16	0,16	0,17	0,17	0,16	1,44%	7,17%	5,56%	-2,64%
Total credit	9,16	9,40	10,40	10,18	10,15	2,69%	13,52%	11,17%	10,82%
Firm default	0,97%	1,02%	1,20%	1,23%	0,98%	4,86%	24,04%	26,84%	0,68%
NPD default	1,91%	1,94%	2,07%	2,02%	1,85%	1,63%	8,05%	5,48%	-3,39%
PD default	0,61%	0,66%	0,84%	0,77%	0,61%	7,26%	36,39%	24,89%	-0,34%
VF default	1,15%	1,25%	1,68%	1,51%	1,15%	9,20%	46,44%	31,69%	-0,06%
CC default	1,76%	1,82%	2,08%	1,98%	1,74%	3,67%	18,32%	12,52%	-0,95%
Bank profit	0,16	0,14	0,18	0,18	0,04	-9,71%	10,92%	10,56%	-74,76%

Table 3: Counterfactuals

For firm credit, as well as vehicle financing loans, the removal of administrative costs generates the largest reduction in spreads. For example, the loan spread for firms declines by 30.52%. In contrast, for the remaining household credit categories, perfect competition in the loan market is the main driver of the reduction in spreads. For instance, the banking spread on non payroll-deducted loans decreases by 79.64%.

Despite these differences in the primary drivers of spread reduction, eliminating administrative costs leads to the largest increase in total credit (13.52%), reflecting the fact that firms account for the largest share of lending (52%). Moreover, when deposit market power is removed, macroeconomic aggregates such as GDP, consumption, and investment remain close to the baseline model.

Under the no-tax scenario, both the deposit rate and the policy rate experience their largest declines (-17.50% and -15.05%, respectively). This result follows directly from equations (A1) and (A25). Specifically, given patient households' preferences, a reduction in taxes lowers the required return on deposits, which in turn reduces the policy rate (given the fixed wedge) and leads to higher output and consumption. Regarding the elimination of deposit market power, this change equalizes the deposit and policy rates, thereby reducing the steady-state policy rate. In this case, the level of the policy rate is primarily determined by patient households' intertemporal preferences.

4.4 Economic policies

We analyze two credit stimulus policy interventions implemented in Brazil: (i) a reduction in μ, and (ii) setting $\tau^b = 0$. The results for this section are reported in Appendix A5.

4.4.1 Loss given default

Changing the loss given default to U.S. levels ($\mu = 28\%$) leads to a decline in all spreads. For example, the spreads for firms and payroll-deducted fall by 11.54% and 37.57%, respectively. The result is driven by an increase in total credit, which raises the value of seized collateral through bigger cutoff thresholds. Since default rates remain unchanged, all spreads decrease.

4.4.2 Zero loan tax

We next consider the impact of eliminating the IOF tax (τ^b), a policy that has been implemented in Brazil in episodes such as the COVID-19 pandemic and in 2022. In this case, all spreads decline (the firm spread decreases by 14.50%, while the payroll-deducted spread falls by 10.75%). At the same time, default rates, and total credit increase. This policy expansion raises total lending, which increases the value of seized collateral and cutoff thresholds. In the absence of a compensating effect through higher default-related components in the spread, all spreads decline. Moreover, the policy improves macroeconomic outcomes, with GDP, consumption, and investment increasing by 1.30%, 2.02%, and 3.28%, respectively.

5 Dynamics

This section focuses on the dynamic properties of our model related to two standard macroeconomic shocks: productivity and monetary policy shocks. First, we introduce additional frictions into the model. Second, we describe the effect of these two shocks.

5.1 Modifications

The modifications are as follows. First, we introduce exogenous habit formation in the patient household

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

subject to

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

and in the impatient workers

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

subject to

$$C_t^{Ii} + RR_t^{si} S_t^{Ii} \leq W_t^{Ii} L_t^{Ii} + \Xi_t^i$$

Second, the retailer's problem incorporates price adjustment costs that depend on a weighted combination of past and steady-state inflation, thereby introducing price stickiness in a Rotemberg-style framework:

$$\max_{\{P_t(m)\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \frac{P_0}{P_t} \left[(P_t(m) - P_t^W) Y_t(m) - \frac{\kappa_P}{2} \left(\frac{P_t(m)}{P_{t-1}(m)} - \pi_{t-1}^{\iota} \bar{\pi}^{1-\iota} \right)^2 P_t Y_t \right]$$

subject to

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

where κ_P is the price adjustment cost parameter and ι is the steady-state inflation weight. Third, the capital producer faces an adjustment cost in investment given by $Z^i(x) = \frac{\kappa_I}{2}(x-1)^2$

$$\max_{\{I_t\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \left[Q_t^k \left(K_{t+1} - (1-\delta^k) K_t \right) - I_t \right]$$

subject to

$$K_{t+1} = (1-\delta^k)K_t + \left[1 - Z^i\left(\frac{I_t}{I_{t-1}}\right)\right] I_t$$

Fourth, we introduce a central bank that follows a Taylor rule

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

where $\bar{r}$ and $\bar{\pi}$ are the steady-state levels of the interest rate and inflation, respectively; ϕ_π and ϕ_y are the response coefficients to inflation and output; ρ_r captures interest rate smoothing; and ϵ_t^m is the monetary policy shock. Finally, we consider the following market-clearing condition for final consumption goods:

$$Y_t = C_t + I_t + G_t + \frac{\xi B_{t-1}}{\pi_t} + \sum_{i=1}^{N}\frac{\mu^{Ii}\Phi_t^{Ii}}{\pi_t} + \frac{\mu^E\Phi_t^E}{\pi_t} + \frac{\kappa_P}{2}\left(\pi_t - \pi_{t-1}^{\iota}\bar{\pi}^{1-\iota}\right)^2 Y_t + \kappa_t$$

where $\frac{\kappa_P}{2}\left(\pi_t - \pi_{t-1}^{\iota}\bar{\pi}^{1-\iota}\right)^2 Y_t$ are the retailer's adjustment cost. The relevant parameters are specified in Table 4.

Description	Parameter	Value	Source
Habit formation	h	0.74	Castro et al. (2023)
Investment adjustment	κ_i	2.53	Carvalho et al. (2023)
Interest smoothing parameter	ρ_r	0.79	Carvalho et al. (2023)
Inflation rate weight in Taylor rule	ϕ_π	2.43	Carvalho et al. (2023)
Output weight in Taylor rule	ϕ_y	0.16	Carvalho et al. (2023)
Price adjustment - final good	κ_P	50	Carvalho et al. (2023)
Steady state inflation weight	ι	0.158	Carvalho et al. (2023)
AR(1) technology coefficient	ρ_a	0.91	Carvalho et al. (2023)

Table 4: Dynamics: Calibration

5.2 Impulse Response Functions (IRFs)

5.2.1 Productivity shocks

We assume thatA_t follows an AR(1) process, as specified in equation (A47). Figure 3 reports the IRFs to this shock.

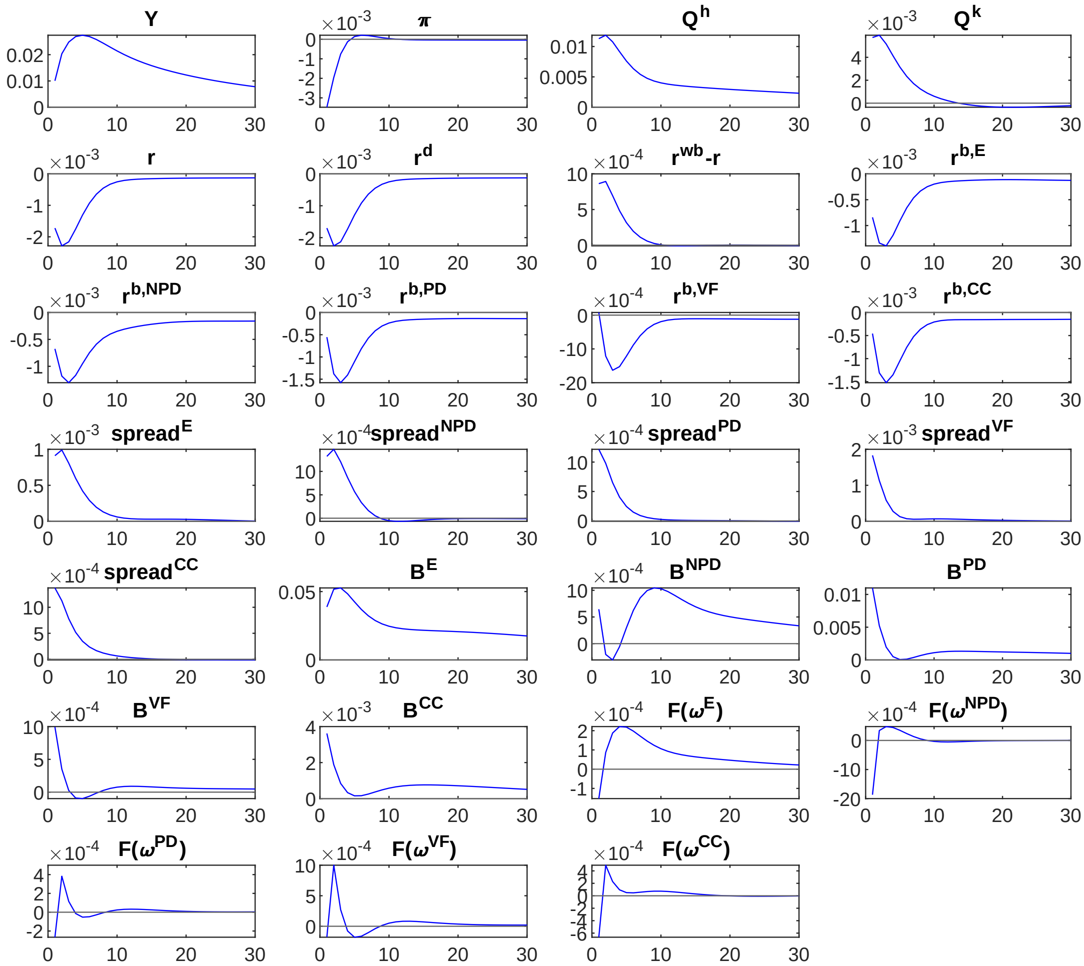

Figure 3: IRFs for a 1% Productivity Shock

The increase in TFP raises output while reducing inflation. As a result, the central bank lowers the nominal policy rate, and due to the fixed wedge between the policy rate and the deposit rate, the latter also declines. In addition, all loan rates fall by less than the deposit rate, which stimulates loan demand. Consequently, the prices of capital and durable goods increase, raising both collateral values and borrowers' net worth. At the same time, to meet higher loan demand, banks must expand their capital positions to satisfy capital requirements, which increases their funding costs through the wholesale spread. Since the deposit rate falls more than all loan rates, banks increase their spreads and profits, which are also used to accumulate bank capital. Note that this dynamic is independent of the specific credit category considered in the model, and our results are consistent with Luz (2024).

5.2.2 Monetary policy shocks

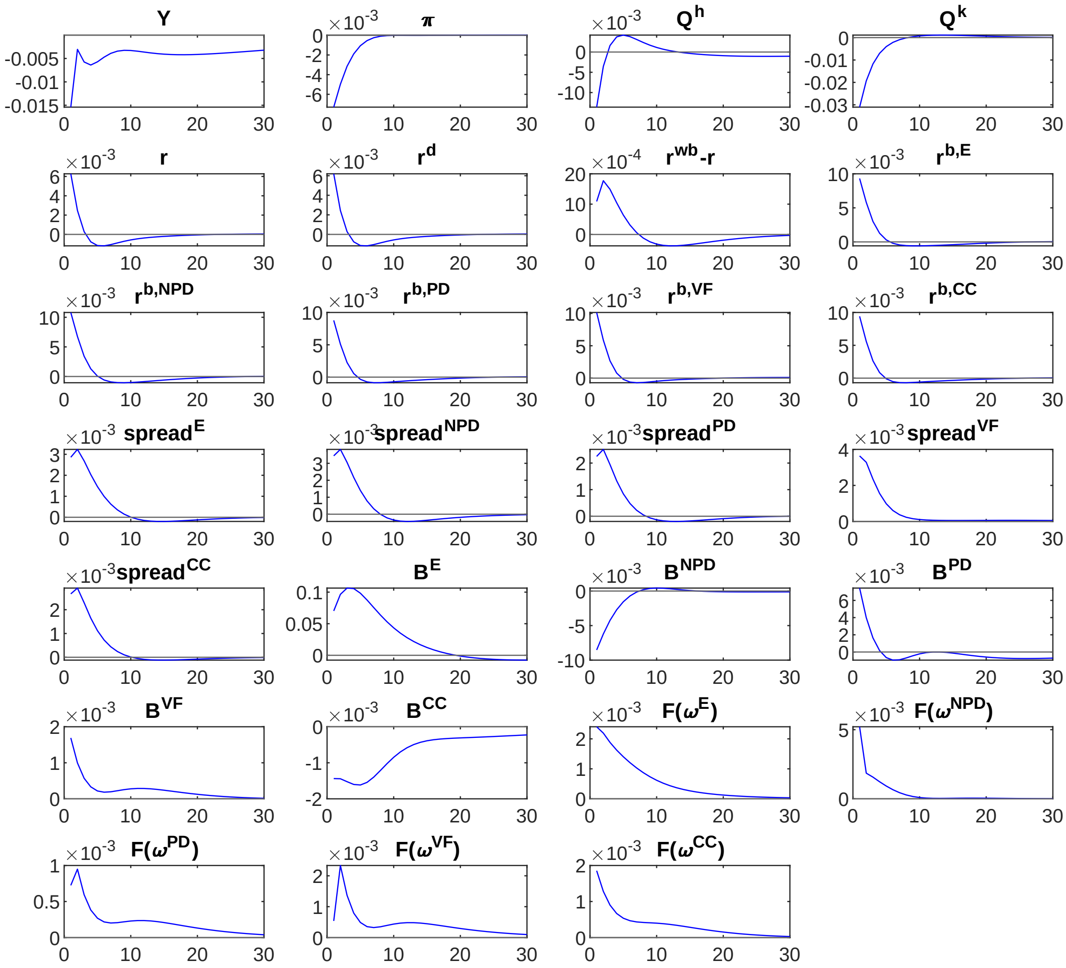

Figure 4: IRFs for a 1% Monetary Policy Shock

In our model, we can analyze two distinct mechanisms of the credit channel of monetary policy transmission: the balance sheet channel and the bank lending channel. According to Bernanke and Gertler (1995), the balance sheet channel implies that a contractionary monetary policy shock reduces asset prices, which is reflected in lower capital and durable goods price. This generates two effects. On the one hand, the value of collateral declines and the adjustment in the default cutoff improves default rates; on the other hand, net worth decreases, tightening borrowing constraints. As a result, all loan interest rates increase. Regarding the bank lending channel, a higher policy rate initially increases the deposit rate and, consequently, banks' cost of funding.

5.2.3 Monetary policy shocks under different costs

Figure 5 depicts the response of key variables to monetary policy shocks under two different monitoring cost regimes (81.8% and 28%) for all agents. First, the model exhibits a financial accelerator mechanism, as the transmission to output and inflation is stronger under lower monitoring costs. Second, loan rates and loan spreads respond stronger under high monitoring costs, closely tracking the path of the nominal policy rate. Finally, loan quantities exhibit larger responses under low monitoring costs, which may be explained by the financial accelerator operating through endogenous default rates.

Our results suggest that the transmission of monetary policy shocks is stronger for credit segments with higher steady-state interest rates and default rates. In particular, for non payroll-deducted and credit card loans, the increase in spreads and default rates is larger than that observed for firms. This pattern also persists when monitoring costs are reduced.

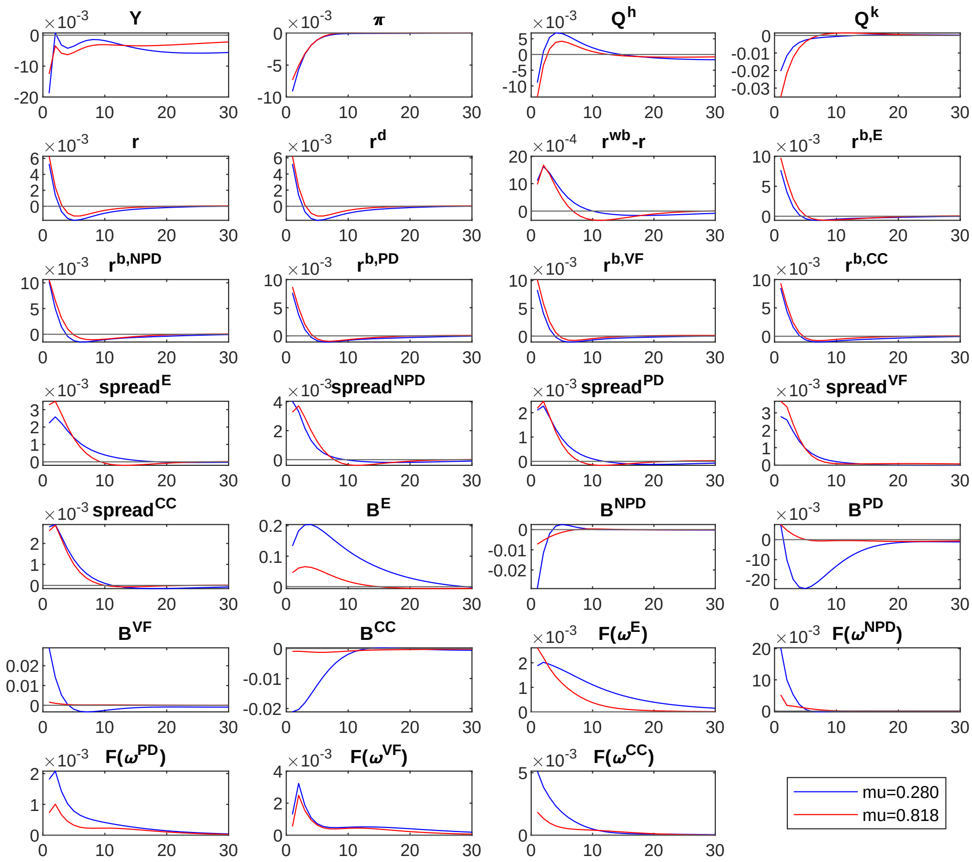

Figure 5: Different Costs: IRFs for a 1% Monetary Policy Shock

6 Conclusion

We extend a DSGE model with financial frictions to decompose the banking spread. In the model, a banking sector with imperfect competition lends to both households and entrepreneurs, who may default. The framework incorporates heterogeneity across households arising from differences in impatience, costs, default rates, and market power.

We calibrate the model to match banking spread components observed in Brazil. The results indicate that credit spreads for firms and two types of households are primarily driven by administrative costs, whereas for the remaining household segments market power is the main determinant. Moreover, the ICC components estimated by the Central Bank of Brazil are closely replicated by our framework.

In addition, we evaluate policy experiments involving reductions in costs and loan taxes - both of which have been implemented in Brazil - and find that all spreads decline. Finally, under productivity and monetary policy shocks, the model generates responses consistent with the standard financial frictions literature.

The limitations of this article, which could be addressed in future research, are as follows. First, costs should ideally be estimated using microdata. Although this is a challenging task, as it requires adapting the World Bank methodology, we believe the gains would be substantial not only for this study but also for the broader credit literature. Second, heterogeneity among firms could be further incorporated. While this paper considers multiple types of household credit, extending the framework to include heterogeneous firms would allow for a more detailed decomposition of the largest share of firm lending.

References

[1] Almeida, F. D., and Divino, J. A. (2015). "Determinants of the banking spread in the Brazilian economy: The role of micro and macroeconomic factors." International Review of Economics & Finance 40, 29-39.

[2] Assunção, J. J., Benmelech, E., and Silva, F. S. S. (2014). "Repossession and the Democratization of Credit." The Review of Financial Studies 27(9), 2661-2689.

[3] Banco Central do Brasil (2018). "Relatório de economia bancária." Banco Central do Brasil.

[4] Banco Central do Brasil (2019). "Relatório de economia bancária." Banco Central do Brasil.

[5] Bernanke, B. S., and Gertler, M. (1995). "Inside the black box: The credit channel of monetary policy transmission." Journal of Economic Perspectives 9(4), 27-48.

[6] Bernanke, B. S., Gertler, M., and Gilchrist, S. (1999). "The financial accelerator in a quantitative business cycle framework." Handbook of Macroeconomics 1(C), 1341-1393.

[7] Campbell, T. S. (1978). "A Model of the Market for Lines of Credit." The Journal of Finance 33(1), 231-244.

[8] Carvalho, C., Pasca, N., Souza, L., and Zilberman, E. (2023). "Macroeconomic effects of credit deepening in Latin America." Journal of Money, Credit and Banking 55(7), 1817-1855.

[9] De Castro, M. R., Gouvea, S. N., Minella, A., Santos, R., and Souza-Sobrinho, N. F. (2015). "SAMBA: Stochastic analytical model with a Bayesian approach." Brazilian Review of Econometrics 35(2), 103-170.

[10] Elsas, R., Heinemann, F., and Tyrell, M. (2004). "Multiple but asymmetric bank financing: The case of relationship lending." CESifo Working Paper No. 1251.

[11] Ferrante, F. (2019). "Risky lending, bank leverage and unconventional monetary policy." Journal of Monetary Economics 101, 100-127.

[12] Ferreira, L. N., and Nakane, M. I. (2018). "Macroprudential policy in a dsge model: anchoring the countercyclical capital buffer." Economics Bulletin 38, 2345-2352.

[13] Fujisima, O. (2021) "Banking Spread Decomposition through a Structural Macroeconomic Model." Dissertação (Mestrado) - PUC-Rio.

[14] Gerali, A., Neri, S., Sessa, L., and Signoretti, F. M. (2010). "Credit and Banking in a DSGE Model of the Euro Area." Journal of Money, Credit and Banking 42, 107-141.

[15] Greenwood, D. L., Krainer, J., and Pascal, P. (2023). "The Credit Line Channel." Working Paper 2020-26, Federal Reserve Bank of San Francisco.

[16] Ho, T. S., and Saunders, A. (1981). "The determinants of bank interest margins: theory and empirical evidence." Journal of Financial and Quantitative analysis 16(4), 581-600.

[17] Joaquim, G., van Doornik, B. F. N., and Ornelas, J. R. H. (2019). "Bank competition, cost of credit and economic activity: evidence from Brazil." Banco Central do Brasil.

[18] Luz, G. (2024) "Decomposing Banking Spreads: a Structural Model Approach." Dissertação (Mestrado) - PUC-Rio.

[19] Souza-Sobrinho, N. F. (2010). "Macroeconomics of bank interest spreads: Evidence from Brazil." Annals of Finance 6, 1-32.

[20] Woodford, M. (2001). "Fiscal Requirements for Price Stability." Journal of Money, Credit and Banking 33(3), 669-728.

[21] World Bank (2020). "Doing business brazil - economy profile of brazil." World Bank Group.

A1 Equilibrium Equations

Patient Household

FOC:

$$\frac{1}{C_t^P - hC_{t-1}^P} = E_t \left[\beta_P \frac{1 + r_t^d (1 - \tau_{r_d})}{\pi_{t+1}} \frac{1}{C_{t+1}^P - hC_t^P} \right] \tag{A1}$$

$$\frac{W_t^P}{C_t^P - hC_{t-1}^P} = \zeta \left(L_t^P \right)^{\varphi} \tag{A2}$$

$$\Lambda_{t,t+1}^P \equiv \beta^P \frac{C_t^P - hC_{t-1}^P}{C_{t+1}^P - hC_t^P} \tag{A3}$$

$$0 = \frac{\psi}{S_t^P} - \frac{Q_t^s}{C_t^P - hC_{t-1}^P} + \beta^P E_t \left[\frac{Q_{t+1}^s}{C_{t+1}^P - hC_t^P} \right] \tag{A4}$$

Budget constraint:

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

Impatient Household

Worker FOC:

$$\Lambda_{t,t+1}^{Ii} \equiv \beta^{Ii} \frac{C_t^{Ii} - hC_{t-1}^{Ii}}{C_{t+1}^{Ii} - hC_t^{Ii}} \tag{A5}$$

$$\frac{\psi}{S_t^{Ii}} = \frac{RR_t^{si}}{C_t^{Ii} - hC_{t-1}^{Ii}} \tag{A6}$$

$$\frac{W_t^{Ii}}{C_t^{Ii} - hC_{t-1}^{Ii}} = \zeta \left(L_t^{Ii} \right)^{\varphi} \tag{A7}$$

Borrower FOC:

$$0 = RR_t^{si} S_t^{Ii} + B_t^{Ii} - Q_t^s S_t^{Ii} + E_t \left[\Lambda_{t,t+1}^{Ii} \left\{ (1 + R_{t+1}^s) Q_t^s S_t^{Ii} - (1 + R_{t+1}^{b,Ii}) B_t^{Ii} \right\} \right] \tag{A8}$$

$$\begin{aligned} 1 = E_t \Bigg[& \Lambda_{t,t+1}^{Ii} (1 + R_t^{wb}) - (1 - \mu^{Ii}) G'(\cdot)(1 + R_t^{b,Ii}) \\ & + \frac{F'(\cdot)\bar{\omega}_{t+1}^{Ii}}{1 - F(\cdot)} \left[(1 + R_t^{wb}) - (1 - \mu^{Ii}) G(\cdot)(1 + R_{t+1}^s) Q_t^s \frac{S_{j,t}^{Ii}}{B_{j,t}^{Ii}} \right] - (1 - F(\cdot)) \frac{\tau^{rb}}{\pi_{t+1}} \Bigg] \end{aligned} \tag{A9}$$

$$\bar{\omega}_{t+1}^{Ii} (1 + R_{t+1}^s) Q_t^s S_t^{Ii} = \left(1 + R_{t+1}^{b,Ii} \right) B_t^{Ii} \tag{A10}$$

Aggregate budget constraint:

$$C_t^{Ii} + Q_t^s S_t^{Ii} = W_t^{Ii} L_t^{Ii} + B_t^{Ii} + (1 - \Gamma(\cdot))\,(1 + R_t^s)\, Q_{t-1}^s S_{t-1}^{Ii} \tag{A11}$$

Housing return:

$$1 + R_t^s = \frac{Q_t^s}{Q_{t-1}^s} \tag{A12}$$

Entrepreneur

Default cut-off:

$$\bar{\omega}_{t+1}^E (1 + R_{t+1}^k) Q_t^k K_{t+1}^E = \left(1 + R_{t+1}^{b,E}\right) B_t^E \tag{A13}$$

FOC:

$$E_t \left[\frac{\Gamma'(\cdot)(1 + R_{t+1}^k)}{X_t} - \Psi \left[(1 + R_{t+1}^k) \left[(1 - \tau^{rb}) \frac{\eta_b^E - 1}{\eta_b^E} \left(1 - F(\cdot) - F'(\cdot) \bar{\omega}_{t+1}^E \right) + (1 - \mu^E) G'(\cdot) \right] - \left(1 - \frac{1}{X_t} \right) \frac{\tau^{rb}}{\pi_{t+1}} F'(\cdot) \right] \right] = 0 \tag{A14}$$

$$\frac{(1 - \Gamma(\cdot))\,(1 + R_{t+1}^k)}{1 + R_t^{wb} - (1 - F(\cdot)) \frac{\tau^{rb}}{\pi_{t+1}}} = \Psi$$

$$\frac{1}{X_t} = 1 - \frac{1 + R_{t+1}^k}{1 + R_t^{wb} - (1 - F(\cdot)) \frac{\tau^{rb}}{\pi_{t+1}}} \left[(1 - F(\cdot)) \bar{\omega}_{t+1}^E (1 - \tau^{rb}) \frac{\eta_b^E - 1}{\eta_b^E} + (1 - \mu^E) G(\cdot) \right]$$

Aggregate net worth:

$$(1 + \Delta^E) N_t = (1 - \Gamma(\cdot))\,(1 + R_t^k) Q_{t-1}^k K_t \tag{A15}$$

$$N_t = Q_t^k K_{t+1} - B_t^E \tag{A16}$$

$$X_t \equiv \frac{Q_t^k K_{t+1}}{N_t} \tag{A17}$$

Capital return:

$$1 + R_t^k = \frac{RR_t^k + (1 - \delta^k) Q_t^k}{Q_{t-1}^k} \tag{A18}$$

Bank

Banking holding company

Bank law of motion:

$$K_t^b = (1 - \delta^b) K_{t-1}^b + (1 - \Delta^b)(1 - \tau) J_{t-1} \tag{A19}$$

FOC:

$$r_t^{wb} - r_t = -\kappa_{K^b}\left(\frac{K_t^b}{B_t} - \nu^b\right)\left(\frac{K_t^b}{B_t}\right)^2 + \xi + \tau^b \tag{A20}$$

$$B_t = D_t + K_t^b \tag{A21}$$

Loan branch

FOC:

$$(1 - F(\cdot))\left[\frac{\eta_b^o - 1}{\eta_b^o}(1 + r_t^{b,o})(1 - \tau^{rb}) + \tau^{rb}\right] + \frac{(1 - \mu^o)\mathbb{E}_t\Phi_{t+1}^o}{B_t^o} = 1 + r_t^{wb} \tag{A22}$$

$$\left[(1 - F(\cdot))\bar{\omega}_{t+1}^o\left(\frac{\eta_b^o - 1}{\eta_b^o}\right)(1 - \tau^{rb}) + (1 - \mu^o)G(\cdot)\right]\frac{(1 + R_{t+1}^h)}{\left(\frac{X_t - 1}{X_t}\right)} = \left(1 + R_t^{wb} - (1 - F(\cdot))\frac{\tau^{rb}}{\pi_{t+1}}\right) \tag{A23}$$

$$B_t = B_t^E + \sum_{i=1}^{N} B_t^{Ii} \tag{A24}$$

Deposit branch

$$1 + r_t = \frac{\eta_d + 1}{\eta_d}(1 + r_t^d) \tag{A25}$$

Bank profit

$$\begin{aligned} J_t = \sum_{i=1}^{N}\Big[&(1 - F(\bar{\omega}_{t+1}^{Ii}))(1 + r_t^{b,Ii}(1 - \tau^{rb}))B_t^{Ii} + (1 - \mu^{Ii})\mathbb{E}_t\Phi_{t+1}^{Ii}\Big] + ... \\ &... + (1 - F(\bar{\omega}_{t+1}^E))(1 + r_t^{b,E}(1 - \tau^{rb}))B_t^E + (1 - \mu^E)\mathbb{E}_t\Phi_{t+1}^E + ... \\ &... - (1 + r_t^d)D_t - K_t^b - \kappa_t - \xi B_t - \tau^b B_t \end{aligned} \tag{A26}$$

Adjustment costs:

$$\kappa_t = \frac{\kappa_{K^b}}{2}\left(\frac{K_t^b}{B_t} - \nu^b\right)^2 K_t^b \tag{A27}$$

Value of seized collateral

$$\mathbb{E}_t\Phi_{t+1}^E = \pi_{t+1}(1 + R_{t+1}^k)Q_t^k K_{t+1}G(\cdot) \tag{A28}$$

$$\mathbb{E}_t\Phi_{t+1}^{Ii} = \pi_{t+1}(1 + R_{t+1}^s)Q_t^s S_t G(\cdot) \tag{A29}$$

Production

Retailer

$$1-\eta+Q^w_t\eta-\kappa_P(\pi_t-\pi^{\iota}_{t-1}\bar{\pi}^{1-\iota})\pi_t+E_t\left[\frac{\Lambda^P_{t,t+1}}{\pi_{t+1}}\kappa_P\left(\pi_{t+1}-\pi^{\iota}_t\bar{\pi}^{1-\iota}\right)\pi^2_{t+1}\frac{Y_{t+1}}{Y_t}\right]=0 \tag{A30}$$

Wholesale producer

$$Y_t = A_tK^{\alpha}_t(L_t)^{1-\alpha} \tag{A31}$$

$$RR^k_t = \alpha Q^W_t Y_t/K_t \tag{A32}$$

$$W^P_t = (1-\alpha)\Omega Q^W_t Y_t/L^P_t \tag{A33}$$

$$W^{Ii}_t = (1-\alpha)(1-\Omega)\varsigma_i Q^W_t Y_t/L^{Ii}_t \tag{A34}$$

$$L_t = (L^P_t)^{\Omega}(L^I_t)^{1-\Omega} \tag{A35}$$

$$L^I_t = \prod_{i=1}^{N}(L^{Ii}_t)^{\varsigma_i}, \varsigma_N = 1-\sum_{i=1}^{N-1}\varsigma_i \tag{A36}$$

Capital producer

$$K_{t+1} = (1-\delta^k)K_t+\left[1-S\left(\frac{I_t}{I_{t-1}}\right)\right]I_t \tag{A37}$$

$$1 = Q^k_t\left[1-S\left(\frac{I_t}{I_{t-1}}\right)-S'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}}\right]+E_t\left[\Lambda^P_{t,t+1}Q^k_{t+1}S'\left(\frac{I_{t+1}}{I_t}\right)\left(\frac{I_{t+1}}{I_t}\right)^2\right] \tag{A38}$$

$$S(x) = \frac{\kappa_I}{2}(x-1)^2$$

Government

Treasury:

$$\begin{aligned}G_t = \tau^{rb}&\left[(1-F(\cdot))r^{b,E}_{t-1}\frac{B^E_{t-1}}{\pi_t}+\sum_{i=1}^{N}\left[(1-F(\cdot))r^{b,Ii}_{t-1}\frac{B^{Ii}_{t-1}}{\pi_t}\right]\right]+...\\ &...+\tau^b\frac{B_{t-1}}{\pi_t}+\frac{r^d_{t-1}\tau^{rd}}{\pi_t}D_{t-1}+\tau J_{t-1}\end{aligned} \tag{A39}$$

Central bank:

$$(1+r_t) = (1+\bar{r})^{1-\rho_r}(1+r_{t-1})^{\rho_r}\left(\frac{\pi_t}{\bar{\pi}}\right)^{\phi_\pi(1-\rho_r)}\left(\frac{Y_t}{Y_{t-1}}\right)^{\phi_y(1-\rho_r)} e^{\epsilon_t^m} \tag{A40}$$

Closing the model

Market clearing

Transfers:

$$T_t^P = \Delta^b J_t + \Delta^e N_t$$

Markets clear:

$$Y_t = C_t + I_t + G_t + \frac{\xi B_{t-1}}{\pi_t} + \sum_{i=1}^{N} \mu^{Ii}\Phi_t^{Ii} + \mu^E \Phi_t^E + \frac{\kappa_P}{2}\left(\pi_t - \pi_{t-1}^{\iota}\bar{\pi}^{1-\iota}\right)^2 Y_t + \kappa_t \tag{A41}$$

$$C_t = C_t^P + \sum_{i=1}^{N} C_t^{Ii} \tag{A42}$$

$$S_t = S_t^P + \sum_{i=1}^{N} S_t^{Ii} \tag{A43}$$

Real rates

$$\pi_t = P_t / P_{t-1}$$

$$1 + R_{t-1}^{wb} = \frac{1 + r_{t-1}^{wb}}{\pi_t} \tag{A44}$$

$$1 + R_{t-1}^{b,Ii} = \frac{1 + r_{t-1}^{b,Ii}}{\pi_t} \tag{A45}$$

$$1 + R_{t-1}^{b,E} = \frac{1 + r_{t-1}^{b,E}}{\pi_t} \tag{A46}$$

Exogenous process

$$logA_t = \rho_a logA_{t-1} + \epsilon_t^a \tag{A47}$$

A2 Proof

The objective of this section is to demonstrate that, in the model's steady state, impatient household financiers (hereafter, financiers) always operate at the borrowing limit imposed by their credit constraint. The proof combines two key elements: an analytical argument based on the linearity of the financier's optimization problem and a parametric condition that is numerically verified using the model's calibrated values. Note that this proof will be valid for all financiers. We will proceed as follows:

- Lema 1: The financier's optimization problem is linear in $B^{Ii}_{j,t}$ for a given $S^{Ii}_{j,t}$ with a net marginal payoff (current plus future) equal to $\frac{1-\beta^{Ii}(1+R^{b,Ii}_t)}{S^{Ii}_{j,t-1}}$
- Key condition: For the model's calibrated parameter values, $\beta^{Ii}(1+R^{b,Ii}) < 1$ in the steady state. Consequently, the marginal payoff is strictly positive, implying that the financier always chooses B^{Ii} at the maximum level permitted by the ICCO.
- Lema 2: Since the financier always maximizes B^I, the borrowing limit imposed by the ICC coincides exactly with the default cutoff, which therefore holds with equality.

Lema 1

The normalized dividend, $\xi^i_{j,t} \equiv \Xi^i_{j,t}/S^{Ii}_{j,t-1}$, is linear in $(S^{Ii}_{j,t}, B^{Ii}_{j,t})$ for a given $S^{Ii}_{j,t-1}$:

$$\xi^i_{j,t} = \omega^{Ii}_{j,t}(1+R^s_t)Q^s_{t-1} - \frac{(1+R^{b,Ii}_{t-1})B^{Ii}_{j,t-1}}{S^I_{j,t-1}} + \frac{RR^s_t - Q^s_t}{S^{Ii}_{j,t-1}}S^{Ii}_{j,t} + \frac{B^{Ii}_{j,t}}{S^{Ii}_{j,t-1}}$$

The net effect (current plus discounted future) of an increase in $B^{Ii}_{j,t}$ on the normalized value $v^i_{j,t} \equiv V^i_{j,t}/S^{Ii}_{j,t-1}$ is

$$\frac{\partial v^i_{j,t}}{\partial B^{Ii}_{j,t}} = \frac{1-\beta^{Ii}(1+R^{b,Ii}_t)}{S^{Ii}_{j,t-1}}$$

Proof. Solving the budget constraint for $\Xi^i_{j,t}$ and dividing by $S^I_{j,t-1} > 0$ yields

$$\xi^i_{j,t} = \omega^{Ii}_{j,t}(1+R^s_t)Q^s_{t-1} - \frac{(1+R^{b,Ii}_{t-1})B^{Ii}_{j,t-1}}{S^{Ii}_{j,t-1}} + \frac{RR^s_t - Q^s_t}{S^{Ii}_{j,t-1}}S^{Ii}_{j,t} + \frac{B^{Ii}_{j,t}}{S^{Ii}_{j,t-1}}$$

The coefficients on $S^{Ii}_{j,t}$ and $B^{Ii}_{j,t}$ depend only on variables that are predetermined at time t, so linearity follows immediately. The contemporaneous effect of increasing $B^{Ii}_{j,t}$ on $\xi^i_{j,t}$ is $\frac{\partial \xi^i_{j,t}}{\partial B^{Ii}_{j,t}} = \frac{1}{S^{Ii}_{j,t-1}}$. The future effect arises because $B^{Ii}_{j,t}$ enters $\xi^i_{j,t+1}$ as $B^{Ii}_{j,t-1}$, with coefficient $-\frac{1+R^{b,Ii}_t}{S^{Ii}_{j,t}} = -\frac{1+R^{b,Ii}_t}{S^{Ii}_{j,t-1}}\frac{1}{g^{Ii}_{j,t}}$. Since the normalized value $v^i_{j,t+1}$ must be multiplied by $g^{Ii}_{j,t}$

to be expressed in units of $S^{Ii}_{j,t-1}$, the discounted future effect on $v^i_{j,t}$ is $-\frac{\beta^{Ii}(1+R^{b,Ii}_t)}{S^I_{j,t-1}}$. Combining the current and future effects yields

$$\frac{\partial v^i_{j,t}}{\partial B^{Ii}_{j,t}} = \frac{1-\beta^{Ii}(1+R^{b,Ii}_t)}{S^{Ii}_{j,t-1}}$$

This establishes the result.

Key condition

The main proposition requires that $\beta^{Ii}(1+R^{b,I1}) < 1$ in the steady state. This condition has a straightforward economic interpretation: the present cost of repaying one unit of debt tomorrow is smaller than the current benefit of receiving that unit today.

For the model's calibrated parameter values, the steady-state borrowing rate faced by financiers satisfies $\beta^{Ii}(1+R^{b,Ii}) < 1$, a condition that is verified numerically. This assumption is analogous to that in Iacoviello (2005), where uncertainty is assumed to be sufficiently small for the borrowing constraint to remain binding at all times. In both cases, the condition imposes a restriction on the model's parameters that ensures impatient agents operate at the limit of the credit market.

Lema 2

Under the condition $\beta^{Ii}(1+R^{b,I1}) < 1$, which is satisfied for the model's calibrated parameter values, financiers always choose B^{Ii} at its maximum feasible level for a given S^{Ii}. Consequently, the default cutoff condition holds with equality:

$$\bar{\omega}^{Ii}(1+R^s)Q^sS^{Ii} = (1+R^{b,Ii})B^{Ii}$$

with $\bar{\omega}^{Ii} > 0$.

Proof. Under the key condition, $\frac{\partial v^i}{\partial B^{Ii}} = \frac{1-\beta^{Ii}(1+R^{b,Ii})}{S^{Ii}} > 0$, the financier's value is strictly increasing in B^{Ii}. Therefore, for a given S^{Ii}, the financier always seeks to increase B^{Ii} up to the maximum level permitted by the bank's ICCO. Moreover, for a given S^{Ii} and threshold $\bar{\omega}^{Ii}$, the maximum level of B^{Ii} consistent with the ICCO is determined by the default cutoff condition

$$B^{Ii} = \frac{\bar{\omega}^{Ii}(1+R^s)Q^sS^{Ii}}{1+R^{b,Ii}}$$

Since the financier always chooses this maximum level, the default cutoff condition must hold with equality. Finally, it just remains to proof that $\bar{\omega}^{Ii} > 0$. Suppose, for contradiction, that $\bar{\omega}^{Ii} = 0$. Then, by the default cutoff condition, $B^{Ii} = 0$. However, when $B^I = 0$, the financier has a strict incentive to increase borrowing, yielding a contradiction. Therefore, $\bar{\omega}^{Ii} > 0$, which in turn implies $F(\bar{\omega}^{Ii}) > 0$ and a strictly positive probability of default.

A3 Data

1. CDB rate. Periodicity: Monthly; Range: 2011-2019; Source: BCB. Data code: 28585.
2. IPCA. Periodicity: Monthly; Range: 2011-2019; Source: BCB. Data code: 433.
3. SELIC. Periodicity: Monthly; Range: 2011-2019; Source: BCB. Data code: 4189.
4. Investment rate. Periodicity: Yearly; Range: 2011-2019. Source: IBGE.
5. Household debt. Periodicity: Monthly; Range: 2011-2019; Source: BCB. Data code: 20541.
6. GDP. Periodicity: Monthly; Range: 2011-2019; Source: BCB. Data code: 4380.
7. Loans - Non-earmarked - Households - Credit card total. Periodicity: Monthly; Range: 2013-2019; Source: BCB. Data code: 20590.
8. Loans - Non-earmarked - Households - Non Payroll-deducted personal loans. Periodicity: Monthly; Range: 2013-2019; Source: BCB. Data code: 20574.
9. Loans - Non-earmarked - Households - Payroll-deducted personal loans. Periodicity: Monthly; Range: 2013-2019; Source: BCB. Data code: 20579.
10. Loans - Non-earmarked - Households - Vehicles financing. Periodicity: Monthly; Range: 2013-2019; Source: BCB. Data code: 20581.
11. ICC - Non-earmarked - Non-financial corporations. Periodicity: Monthly; Range: 2013-2019; Source: BCB. Data code: 25355.
12. ICC - Non-earmarked - Households - Credit card total. Periodicity: Monthly; Range: 2013-2019; Source: BCB. Data code: 27686.
13. ICC - Non-earmarked - Households - Non payroll-deducted personal loans. Periodicity: Monthly; Range: 2013-2019; Source: BCB. Data code: 27673.
14. ICC - Non-earmarked - Households - Payroll-deducted personal loans. Periodicity: Monthly; Range: 2013-2019; Source: BCB. Data code: 27678.
15. Delinquency Rate - Non-earmarked - Non-financial corporations. Periodicity: Monthly; Range: 2011-2019; Source: BCB. Data code: 21086.
16. Delinquency Rate - Non-earmarked - Households - Credit Card total. Periodicity: Monthly; Range: 2011-2019; Source: BCB. Data code: 21129.
17. Delinquency Rate - Non-earmarked - Households - Non Payroll-deducted personal loans. Periodicity: Monthly; Range: 2011-2019; Source: BCB. Data code: 21114.

18. Delinquency Rate - Non-earmarked - Households - Payroll-deducted personal loans. Periodicity: Monthly; Range: 2011-2019; Source: BCB. Data code: 21119.

19. Delinquency Rate - Non-earmarked - Households - Vehicles financing. Periodicity: Monthly; Range: 2011-2019; Source: BCB. Data code: 21121.

A4 Alternative Spread Decompositions

This section shows decompositions considering alternative orders, alternative number of impatient credits and an alternative method. Figure A1 shows the results when eliminating the components in the following order: market power, administrative costs, and taxes.

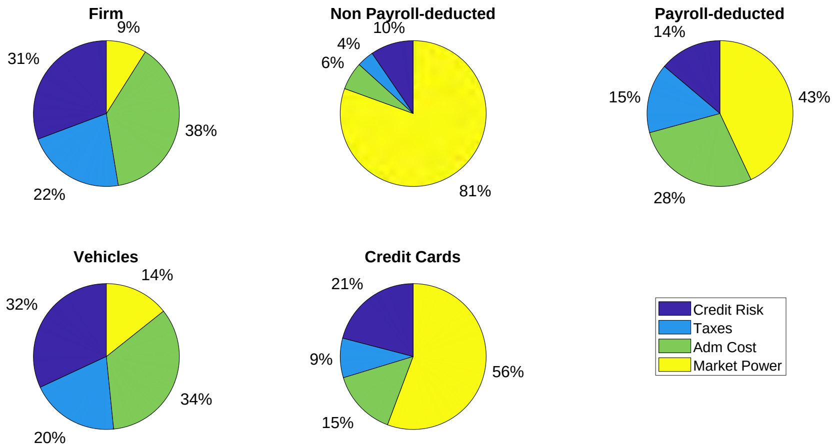

Figure A1: Alternative Order 1

Figure A2 shows the results when eliminating the components in the following order: administrative costs, market power, and taxes.

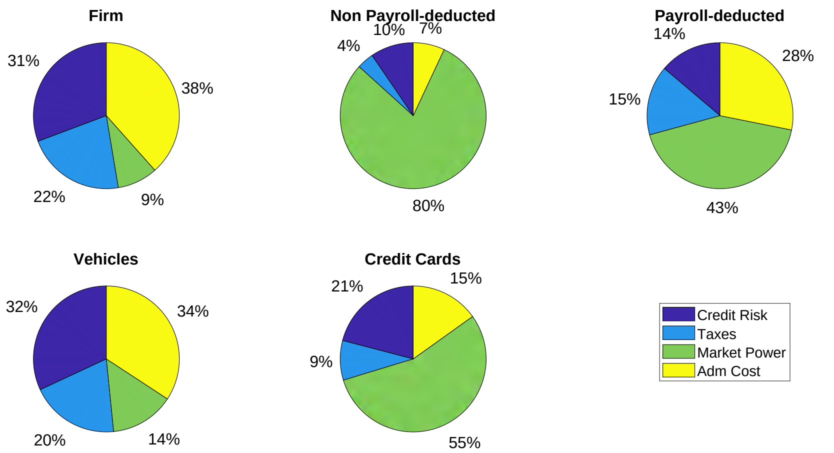

Figure A2: Alternative Order 2

Figure A3 shows the results when eliminating the components in the following order: administrative costs, taxes, and market power.

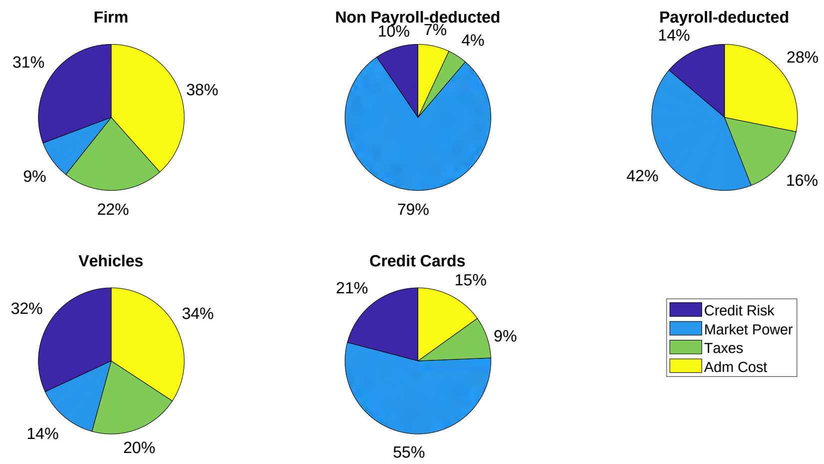

Figure A3: Alternative Order 3

Figure A4 shows the results when eliminating the components in the following order: taxes, market power, and administrative costs.

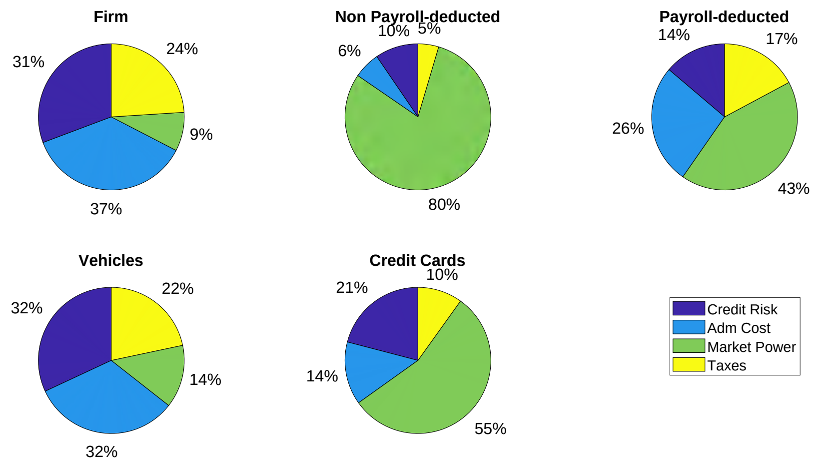

Figure A4: Alternative Order 4

Figure A5 shows the results when eliminating the components in the following order: taxes, administrative costs, and market power.

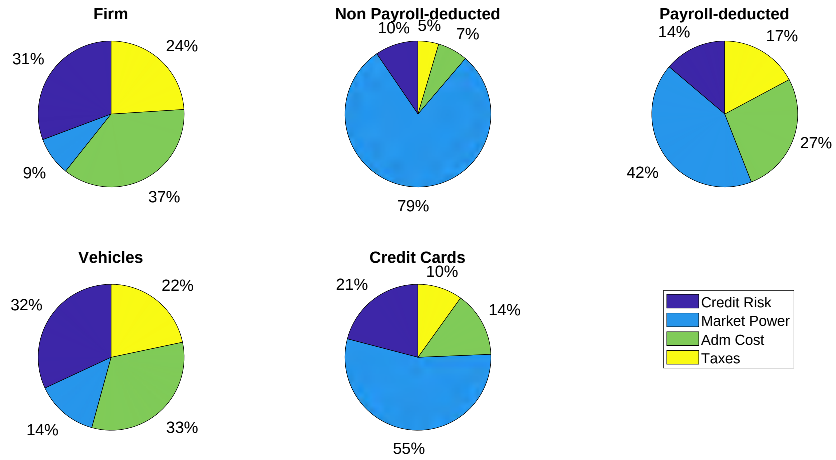

Figure A5: Alternative Order 5

A5 Other Counterfactuals

	Baseline (1)	US monitoring cost (2)	No loan tax (3)	(2)/(1) %	(3)/(1) %
Firm spread	2,69%	2,38%	2,30%	-11,54%	-14,50%
NPD spread	16,93%	2,73%	16,44%	-83,86%	-2,87%
PD spread	3,73%	2,33%	3,33%	-37,57%	-10,75%
VF spread	3,07%	2,55%	2,81%	-16,88%	-8,43%
CC spread	7,19%	2,73%	6,82%	-62,01%	-5,11%
Deposit rate	1,22%	1,22%	1,22%	0,00%	0,00%
Policy rate	1,43%	1,43%	1,43%	0,00%	0,00%
Wholesale loan rate	2,89%	2,89%	2,42%	0,00%	-16,28%
GDP	3,59	5,01	3,64	39,60%	1,30%
C	3,12	4,10	3,19	31,21%	2,02%
Investment	0,16	0,22	0,17	39,60%	3,28%
Total credit	9,16	29,02	9,73	216,86%	6,21%
Firm default	0,97%	0,97%	1,08%	0,00%	11,33%
NPD default	1,91%	1,91%	1,99%	0,00%	3,79%
PD default	0,61%	0,61%	0,72%	0,00%	17,00%
VF default	1,15%	1,15%	1,39%	0,00%	21,61%
CC default	1,76%	1,76%	1,91%	0,00%	8,59%
Bank profit	0,16	0,20	0,17	22,70%	5,00%

Table A1: Other Counterfactuals

A6 Model with Duration

We extend the previous model by assuming that loans to financiers and entrepreneurs are subject to a coupon c_o and a principal repayment λ_o for $o \in \{E, Ii\}$. We focus only on the elements that differ from the one-period loan structure. The main references are Ferrante (2019) and Woodford (2001).

Borrowers

The timing of events in the borrower's life is as follows. At the end of period t, borrower j obtains a loan $B^o_{j,t}$ valued as $Q^{B,o}_t$ and combines it with its net worth $N^o_{j,t}$ to purchase assets $Z_{j,t}$ at price Q^z_t. Hence, $Q^z_t Z_{j,t} = N^o_{j,t} + Q^o_t B^o_{j,t}$. At the beginning of period $t+1$, borrower j is hit by an i.i.d. idiosyncratic shock $\omega^o_{j,t+1}$, whose distribution $F(\cdot)$ is log-normal with unit mean, which scales the value of its assets into $\omega^o_{j,t+1} Z_{j,t}$. Next, borrowers get a return R^z_{t+1}on their assets. On the one hand, capital is rented to wholesale producers at rate RR^k_{t+1}, and the undepreciated capital stock $(1-\delta^k)$ is sold to capital producers at price Q^k_{t+1}. Thus, the return on capital for entrepreneur j is given by

$$1 + R^k_{t+1} = \frac{RR^k_{t+1} + (1-\delta^k)Q^k_{t+1}}{Q^k_t}$$

On the other hand, the return on durable goods for the financiers is

$$1 + R^s_{t+1} = \frac{Q^s_{t+1}}{Q^s_t}$$

assuming that rental income cannot be seized by banks and that the idiosyncratic shock affects only the price of the durable good.

Afterwards, borrowers repay their debt. We assume costly state verification, where $\omega^o_{j,t+1}$ is privately observed and the bank can observe it only by paying a cost μ^o. Loans are standard debt contracts in which borrowers' assets are pledged as collateral; in case of default, the bank monitors the borrower and recovers the asset net of costs. This implies an endogenous cutoff $\bar{\omega}^o_{j,t+1}$, which determines the default decision. The threshold is defined by the point at which the value of assets equals the value of debt:

$$\bar{\omega}^o_{j,t+1}(1 + R^z_{t+1})Q^z_t Z_{j,t} \equiv (1 + R^{b,o}_{j,t+1})Q^{B,o}_t B^o_{j,t}$$

where $R^{b,o}_{j,t+1}$ is the real loan rate.

Mortgages are long-term securities that promise to pay, in every period, a coupon c_o and a fraction λ_o of the principal (implying ab expected duration of λ_o^{-1}). Consequently, all agents face the following pricing condition:

$$1 + R^{b,o}_{j,t+1} = \frac{1}{\pi_{t+1}} \frac{c_o + \lambda_o + (1-\lambda_o) Q^{B,o}_{t+1}}{Q^{B,o}_t}$$

Financiers

They maximize the expected present discounted value of future transfers to impatient workers, subject to a budget constraint, a default cutoff rule, and the bank's ICCO. To finance dividend transfers, durable goods purchases, and repayment of past loans, they rely on revenues from selling and renting durable goods, as well as new borrowing,

$$\begin{aligned}
V^i_{j,t} = & \max_{\{S^{Ii}_{j,t}, B^{Ii}_{j,t}\}} \Xi^i_{j,t} + \mathbb{E}_t \left[\Lambda^{Ii}_{t,t+1} max\{0, V^i_{j,t+1}\} \right] \\
s.t. & \Xi^i_{j,t} + Q^s_t S^{Ii}_{j,t} + (1 + R^{b,Ii}_t) Q^{B,I1}_{t-1} B^{Ii}_{j,t-1} \leq \omega^{Ii}_{j,t} (1 + R^s_t) Q^s_{t-1} S^{Ii}_{j,t-1} + RR^{si}_t S^{Ii}_{j,t} + Q^{B,I1}_t B^{Ii}_{j,t} \\
& \bar{\omega}^{Ii}_{j,t+1} (1 + R^s_{t+1}) Q^s_t S^{Ii}_{j,t} = (1 + R^{b,Ii}_{t+1}) Q^{B,I1}_t B^{Ii}_{j,t} \\
& (A49)
\end{aligned}$$

Entrepreneurs

They maximize expected pre-dividend net worth in period $t+1$ subject to a participation constraint. However, the problem can be rewritten in terms of the pair $(\bar{\omega}^E_{j,t+1}, X_{j,t})$, where $X_{j,t} \equiv \frac{Q_t K_{j,t+1}}{N^E_{j,t}}$ denotes leverage,

$$\begin{aligned}
& max \mathbb{E}_t \left[\int_{\bar{\omega}^E_{j,t+1}}^{\infty} \left[\omega^E_{j,t+1} (1 + R^k_{t+1}) Q^k_t K_{j,t+1} - (1 + R^{b,E}_{j,t}) Q^{B,E}_t B^E_{j,t} \right] dF(\omega^E_{j,t+1}) \right] \quad \text{(A48)} \\
\approx & max \mathbb{E}_t \left[1 - \Gamma_t(\omega^E_{j,t+1}) \right] (1 + R^k_{t+1}) X_{j,t} N^E_{j,t}
\end{aligned}$$

subject to contracts that are compatible with bank's profit maximization: bank's ICCO (A49).

Banking sector

Bank holding company

It manages the bank's capital position by combining deposits $D_t(l)$ and bank capital $K^b_t(l)$ to supply loans $B_t(l)$, where $B_t(l) = Q^{B,E}_t B^E_t(l) + \sum_{j=1}^{N} Q^{B,Ij}_t B^{Ij}_t(l)$, subject to a constant operational cost ξ on loans. To capture the effect of capital requirements on lending spreads, we follow Gerali et al. (2010) and introduce a quadratic cost for deviations from the target capital-to-assets ratio ν^b. Consequently, the holding company of bank l solves the following problem:

$$\max_{\{B_t(l),D_t(l)\}} E_0 \sum_{t=0}^{\infty} \Lambda^P_{0,t} \frac{P_0}{P_t} \Big[(1+r^{wb}_t)B_t(l) - (1+r^{wd}_t)D_t(l) - K^b_t(l) - B_{t+1}(l)\pi_{t+1} + ...$$
$$... + D_{t+1}(l)\pi_{t+1} + K^b_{t+1}(l)\pi_{t+1} - \kappa_t - \xi B_t(l) - \tau^b B_t(l) \Big]$$
$$s.t. B_t(l) = D_t(l) + K^b_t(l)$$
$$\kappa_t = \frac{\kappa_{K^b}}{2} \left(\frac{K^b_t(l)}{B_t(l)} - \nu^b \right)^2 K^b_t(l)$$

where r^{wb}_t and r^{wd}_t are the wholesale rates of loans and deposits, respectively. We assume that banks have access to unlimited finance at the policy rate r_t, implying that $r^{wd}_t = r_t$.

Loan branch

It obtains funds from the holding company and lends to entrepreneurs and impatient households under monopolistic competition. Revenues derive from borrowers who repay their debt and from seized collateral in the event of default. Regarding collateral recovery, we follow Hafstead and Smith (2012) by introducing a "recovery company" that collects all collateral and compensates the banks in proportion to their market share $\frac{B_t(l)}{B_t}$. Moreover, due to costs, only a fraction $(1-\mu^o)$ of collateral can be recovered. Accordingly, the problem is to choose $\{r^{b,E}_t(l), r^{b,Ii}_t(l)\}$ to maximize

$$max \mathbb{E}_0 \sum_{t=0}^{\infty} \Lambda^P_{0,t} \frac{P_0}{P_t} \Bigg[(1-F(\bar{\omega}^E_{t+1}))(1+r^{b,E}_t(l)(1-\tau^{rb}))Q^{B,E}_t B^E_t(l) + (1-\mu^E)\frac{B^E_t(l)}{B^E_t}\mathbb{E}_t\Phi^E_{t+1} + ...$$
$$... + \sum_{i=1}^{N} \left[(1-F(\bar{\omega}^{Ii}_{t+1}))(1+r^{b,Ii}_t(l)(1-\tau^{rb}))Q^{B,Ii}_t B^{Ii}_t(l) + (1-\mu^{Ii})\frac{B^{Ii}_t(l)}{B^{Ii}_t}\mathbb{E}_t\Phi^{Ii}_{t+1} \right] - (1+r^{wb}_t)B_t(l) \Bigg]$$
$$s.t. B^o_t(l) = \left(\frac{1+r^{b,o}_t(l)}{1+r^{b,o}_t} \right)^{-\eta^o_b} B^o_t, o \in \{Ii, E\}$$

where $\mathbb{E}_t\Phi^o_{t+1} = \pi_{t+1} \int_0^{\bar{\omega}^o_{t+1}} \omega^o_{t+1}(1+R^z_{t+1})Q^z_t Z_{t+1} dF^o(\omega^o_{t+1})$ denotes the total expected value of seized collateral. The solution to the loan branch's problem is characterized by the first-order condition, which corresponds to the bank's ICCO, as shown below:

$$(1-F(\bar{\omega}^o_{t+1})) \left[\left(1 - \frac{1}{\eta^o_b}\right)(1+r^{b,o}_t(1-\tau^{rb})) + \tau^{rb} \right] + \frac{(1-\mu^o)E_t\Phi^o_{t+1}}{Q^{B,o}_t B^o_t} = (1+r^{wb}_t) \tag{A49}$$

where $\mathbb{E}_t\Phi^o_{t+1} = \pi_{t+1}(1+R^z_{t+1})Q^z_t Z_t \int_0^{\bar{\omega}^o_{t+1}} \omega^o_{t+1} dF(\omega^o_{t+1})$ is the total expected value of seized collaterals.

Bank profit

It is the sum of the cash flows of the three branches

$$
\begin{aligned}
J_t = \sum_{i=1}^{N} &\left[(1 - F(\bar{\omega}_{t+1}^{Ii}))(1 + r_t^{b,Ii}(1 - \tau^{rb}))Q_t^{B,Ii} B_t^{Ii} + (1 - \mu^{Ii})\mathbb{E}_t \Phi_{t+1}^{Ii}\right] + ... \\
&... + (1 - F(\bar{\omega}_{t+1}^{E}))(1 + r_t^{b,E}(1 - \tau^{rb}))Q_t^{E} B_t^{E} + (1 - \mu^{E})\mathbb{E}_t \Phi_{t+1}^{E} + ... \\
&... - (1 + r_t^d) D_t - K_t^b - \kappa_t - \xi B_t - \tau^b B_t
\end{aligned}
$$

Government

The fiscal authority balances revenues and public expenditures G_t in every period:

$$
\begin{aligned}
G_t = \tau^{rb} &\left[(1 - F(\bar{\omega}_t^{E}))r_{t-1}^{b,E} Q_{t-1}^{B,E} \frac{B_{t-1}^{E}}{\pi_t} + \sum_{i=1}^{N}\left[(1 - F(\bar{\omega}_t^{Ii}))r_{t-1}^{b,Ii} Q_{t-1}^{B,Ii} \frac{B_{t-1}^{Ii}}{\pi_t}\right]\right] + ... \\
&... + \tau^b \frac{B_{t-1}}{\pi_t} + \frac{(r_{t-1}^d \tau^{rd})}{\pi_t} D_{t-1} + \tau J_{t-1}
\end{aligned}
$$

Results

Spread Decomposition

For the following results we considered the same number of credits and $\lambda_o = 0.05$, which implies 5 year-long credits.

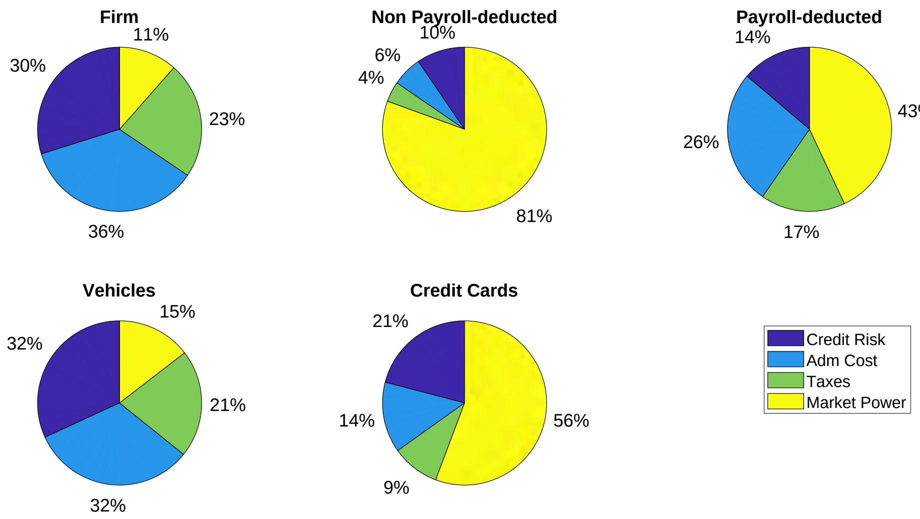

Figure A6: Duration: Banking Spread Decomposition

Figure A6 presents the spread decomposition based on the four ICC components. Overall, the results under long-term credit contracts are broadly consistent with those obtained under short-term contracts. First, for firm and vehicle financing credits, administrative costs remain the main driver of the spread, while for the remaining credit categories, market power is the dominant component.

Second, when computing the spread decomposition weighted by each credit category's share in total lending, we obtain the following breakdown: administrative costs (32%), financial margin (21%), taxes (21%), and default (26%). Compared with the Central Bank of Brazil (2018) estimates - administrative costs (27%), financial margin (17%), taxes (20%), and default (36%) - taxes and financial margins are very similar, whereas administrative costs are higher and default is lower in our framework.

Productivity shocks

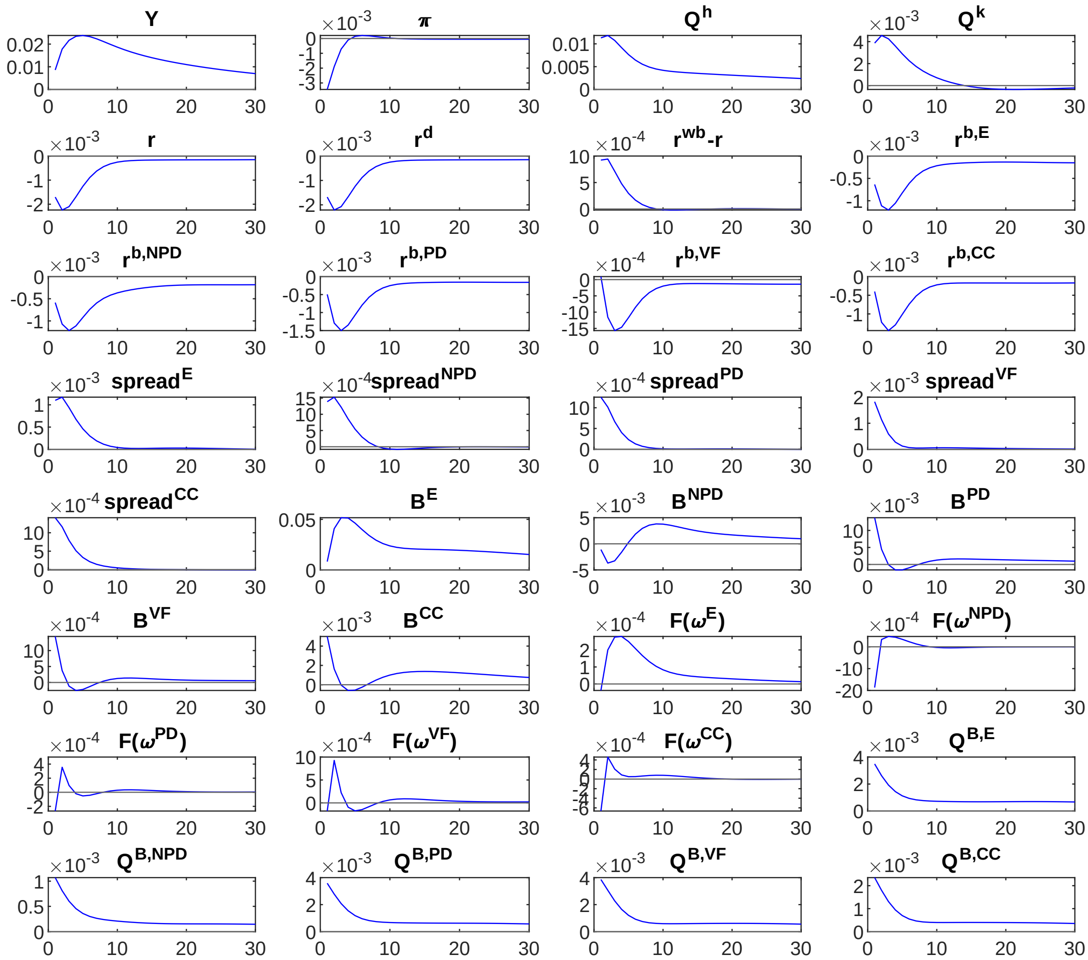

Figure A7: Duration: IRFs for a 1% Productivity Shock

Figure A7 depicts the response of key variables to a productivity shock. In general, the results obtained under long-term loans are consistent with those observed under short-term loans. First, output increases while inflation declines, prompting the central bank to reduce the nominal policy rate, which in turn lowers the deposit rate. Second, all loan rates decrease by less than the deposit rate, leading to higher loan demand and wider spreads. Third, the prices of capital and durable goods increase. Finally, all loan prices $Q^{B,o}$ rise due to lower loan interest rates and inflation.

Monetary policy shocks

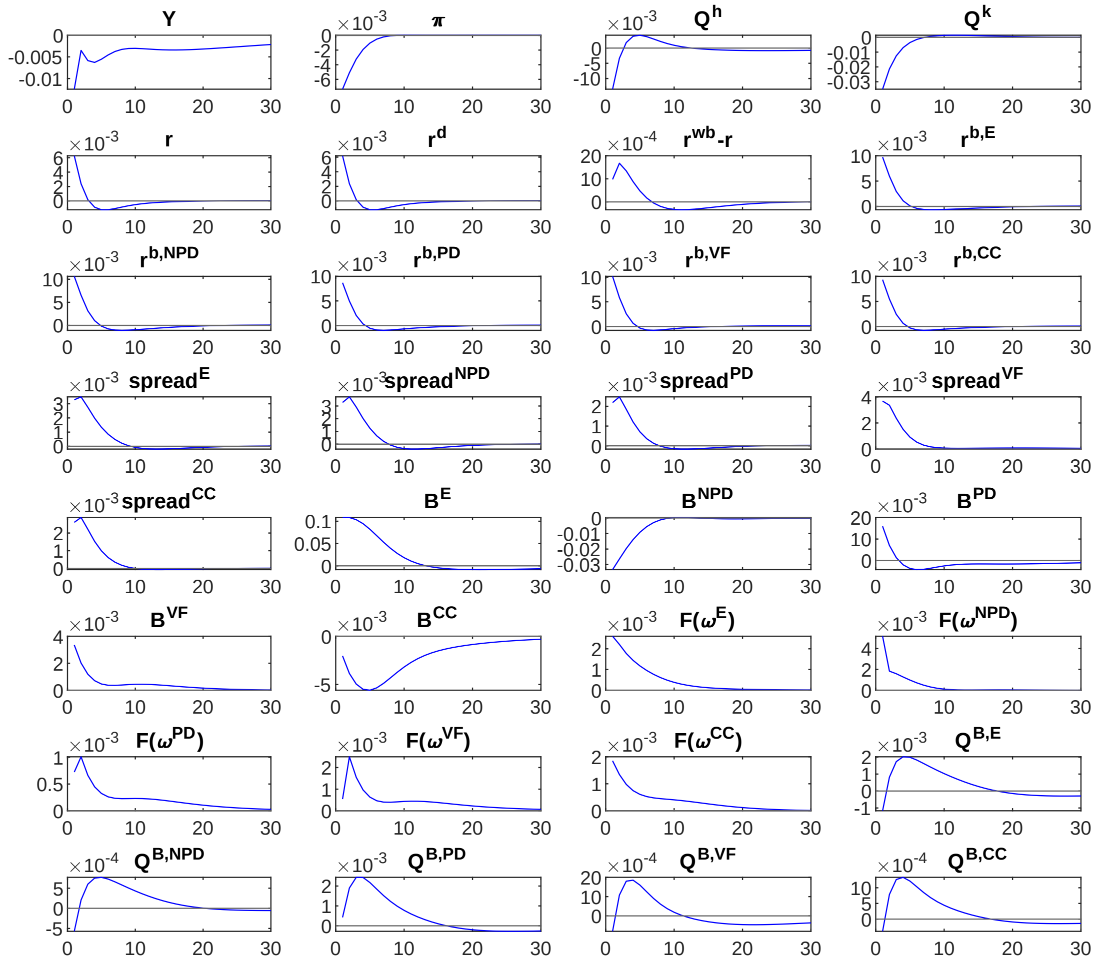

Figure A8: Duration: IRFs for a 1% Monetary Policy Shock

Figure A8 plots the reaction of the main variables to a monetary policy shock. All the results observed under short-run loans remain the same. First, considering the balance sheet channel, the contractionary monetary policy shock cuts asset prices, which is displayed in lower capital and durable goods price in the short and long-run, respectively. Consequently, all default rates and, thereby, loan interest rates increase. Second, regarding the bank lending channel, the higher policy rate increases the deposit rate, but both diminish to boost the economy. Finally, all loans' prices $Q^{B,o}$ increase given that lower inflation dominates the rise in all loans' interest rate.

A7 Model with Duration: Equilibrium Equations

Patient Household

FOC:

$$\frac{1}{C_t^P - hC_{t-1}^P} = E_t\left[\beta_P \frac{1+r_t^d(1-\tau_{r_d})}{\pi_{t+1}} \frac{1}{C_{t+1}^P - hC_t^P}\right] \tag{A50}$$

$$\frac{W_t^P}{C_t^P - hC_{t-1}^P} = \zeta\left(L_t^P\right)^{\varphi} \tag{A51}$$

$$\Lambda_{t,t+1}^P \equiv \beta^P \frac{C_t^P - hC_{t-1}^P}{C_{t+1}^P - hC_t^P} \tag{A52}$$

$$0 = \frac{\psi}{S_t^P} - \frac{Q_t^s}{C_t^P - hC_{t-1}^P} + \beta^P E_t\left[\frac{Q_{t+1}^s}{C_{t+1}^P - hC_t^P}\right] \tag{A53}$$

Impatient Household

Worker FOC:

$$\Lambda_{t,t+1}^{Ii} \equiv \beta^{Ii} \frac{C_t^{Ii} - hC_{t-1}^{Ii}}{C_{t+1}^{Ii} - hC_t^{Ii}} \tag{A54}$$

$$\frac{\psi}{S_t^{Ii}} = \frac{RR_t^{si}}{C_t^{Ii} - hC_{t-1}^{Ii}} \tag{A55}$$

$$\frac{W_t^{Ii}}{C_t^{Ii} - hC_{t-1}^{Ii}} = \zeta\left(L_t^{Ii}\right)^{\varphi} \tag{A56}$$

Borrower FOC:

$$0 = RR_t^{si}S_t^{Ii} + Q_t^{B,Ii}B_t^{Ii} - Q_t^s S_t^{Ii} + E_t\left[\Lambda_{t,t+1}^{Ii}\left\{(1+R_{t+1}^s)Q_t^s S_t^{Ii} - (1+R_{t+1}^{b,Ii})Q_t^{B,Ii}B_t^{Ii}\right\}\right] \tag{A57}$$

$$\begin{aligned} 1 = E_t \Bigg[& \Lambda_{t,t+1}^{Ii}(1+R_t^{wb}) - (1-\mu^{Ii})G'(\cdot)(1+R_t^{b,Ii}) \\ & + \frac{F'(\cdot)\bar{\omega}_{t+1}^{Ii}}{1-F(\cdot)}\left[(1+R_t^{wb}) - (1-\mu^{Ii})G(\cdot)(1+R_{t+1}^s)Q_t^s \frac{S_{j,t}^{Ii}}{Q_t^{B,Ii}B_{j,t}^{Ii}}\right] - (1-F(\cdot))\frac{\tau^{rb}}{\pi_{t+1}}\Bigg] \end{aligned} \tag{A58}$$

$$\bar{\omega}_{t+1}^{Ii}(1+R_{t+1}^s)Q_t^s S_t^{Ii} = \left(1+R_{t+1}^{b,Ii}\right)Q_t^{B,Ii}B_t^{Ii} \tag{A59}$$

Aggregate budget constraint:

$$C_t^{Ii} + Q_t^s S_t^{Ii} = W_t^{Ii}L_t^{Ii} + Q_t^{B,Ii}B_t^{Ii} + (1-\Gamma(\cdot))\left(1+R_t^s\right)Q_{t-1}^s S_{t-1}^{Ii} \tag{A60}$$

Asset pricing condition

$$1 + R_t^{b,Ii} = \frac{1}{\pi_{t+1}} \frac{c_{Ii} + \lambda_{Ii} + (1 - \lambda_{Ii}) Q_t^{B,Ii}}{Q_{t-1}^{B,Ii}}$$

Housing return:

$$1 + R_t^s = \frac{Q_t^s}{Q_{t-1}^s} \tag{A61}$$

Entrepreneur

Default cut-off:

$$\bar{\omega}_{t+1}^E (1 + R_{t+1}^k) Q_t^k K_{t+1}^E = \left(1 + R_{t+1}^{b,E}\right) Q_t^{B,E} B_t^E \tag{A62}$$

FOC:

$$E_t \left[\frac{\Gamma'(\cdot)(1 + R_{t+1}^k)}{X_t} - \Psi \left[(1 + R_{t+1}^k) \left[(1 - \tau^{rb}) \frac{\eta_b^E - 1}{\eta_b^E} \left(1 - F(\cdot) - F'(\cdot)\bar{\omega}_{t+1}^E\right) + (1 - \mu^E) G'(\cdot) \right] - \left(1 - \frac{1}{X_t}\right) \frac{\tau^{rb}}{\pi_{t+1}} F'(\cdot) \right] \right] = 0 \tag{A63}$$

$$\frac{(1 - \Gamma(\cdot))\,(1 + R_{t+1}^k)}{1 + R_t^{wb} - (1 - F(\cdot)) \frac{\tau^{rb}}{\pi_{t+1}}} = \Psi$$

$$\frac{1}{X_t} = 1 - \frac{1 + R_{t+1}^k}{1 + R_t^{wb} - (1 - F(\cdot)) \frac{\tau^{rb}}{\pi_{t+1}}} \left[(1 - F(\cdot)) \bar{\omega}_{t+1}^E (1 - \tau^{rb}) \frac{\eta_b^E - 1}{\eta_b^E} + (1 - \mu^E) G(\cdot) \right]$$

Aggregate net worth:

$$(1 + \Delta^E) N_t = (1 - \Gamma(\cdot))\,(1 + R_t^k) Q_{t-1}^k K_t \tag{A64}$$

$$N_t = Q_t^k K_{t+1} - Q_t^{B,E} B_t^E \tag{A65}$$

$$X_t \equiv \frac{Q_t^k K_{t+1}}{N_t} \tag{A66}$$

Capital return:

$$1 + R_t^k = \frac{RR_t^k + (1 - \delta^k) Q_t^k}{Q_{t-1}^k} \tag{A67}$$

Asset pricing condition

$$1 + R_t^{b,E} = \frac{1}{\pi_{t+1}} \frac{c_E + \lambda_E + (1 - \lambda_E) Q_t^{B,E}}{Q_{t-1}^{B,E}}$$

Bank

Banking holding company

Bank law of motion:

$$K_t^b = (1-\delta^b)K_{t-1}^b + (1-\Delta^b)(1-\tau)J_{t-1} \tag{A68}$$

FOC:

$$r_t^{wb} - r_t = -\kappa_{K^b}\left(\frac{K_t^b}{B_t} - \nu^b\right)\left(\frac{K_t^b}{B_t}\right)^2 + \xi + \tau^b \tag{A69}$$

$$B_t = D_t + K_t^b \tag{A70}$$

Loan branch

FOC:

$$(1-F(\cdot))\left[\frac{\eta_b^o - 1}{\eta_b^o}(1+r_t^{b,o})(1-\tau^{rb}) + \tau^{rb}\right] + \frac{(1-\mu^o)\mathbb{E}_t\Phi_{t+1}^o}{B_t^o Q_t^{B,o}} = 1 + r_t^{wb} \tag{A71}$$

$$\left[(1-F(\cdot))\bar{\omega}_{t+1}^o\left(\frac{\eta_b^o-1}{\eta_b^o}\right)(1-\tau^{rb}) + (1-\mu^o)G(\cdot)\right]\frac{(1+R_{t+1}^h)}{\left(\frac{X_t-1}{X_t}\right)} = \left(1 + R_t^{wb} - (1-F(\cdot))\frac{\tau^{rb}}{\pi_{t+1}}\right) \tag{A72}$$

$$B_t = Q_t^{B,E}B_t^E + \sum_{j=1}^{N} Q_t^{B,Ij}B_t^{Ij} \tag{A73}$$

Deposit branch

$$1 + r_t = \frac{\eta_d + 1}{\eta_d}(1 + r_t^d) \tag{A74}$$

Bank profit

$$\begin{aligned} J_t = &\sum_{i=1}^{N}\left[(1-F(\bar{\omega}_{t+1}^{Ii}))(1+r_t^{b,Ii}(1-\tau^{rb}))Q_t^{B,Ii}B_t^{Ii} + (1-\mu^{Ii})\mathbb{E}_t\Phi_{t+1}^{Ii}\right] + \ldots \\ &\ldots + (1-F(\bar{\omega}_{t+1}^E))(1+r_t^{b,E}(1-\tau^{rb}))Q_t^{B,E}B_t^E + (1-\mu^E)\mathbb{E}_t\Phi_{t+1}^E + \ldots \\ &\ldots - (1+r_t^d)D_t - K_t^b - \kappa_t - \xi B_t - \tau^b B_t \end{aligned} \tag{A75}$$

Adjustment costs:

$$\kappa_t = \frac{\kappa_{K^b}}{2}\left(\frac{K_t^b}{B_t} - \nu^b\right)^2 K_t^b \tag{A76}$$

Value of seized collateral

$$\mathbb{E}_t\Phi_{t+1}^E = \pi_{t+1}(1+R_{t+1}^k)Q_t^k K_{t+1} G(\cdot) \tag{A77}$$

$$\mathbb{E}_t\Phi_{t+1}^{Ii} = \pi_{t+1}(1+R_{t+1}^s)Q_t^s S_t G(\cdot) \tag{A78}$$

Production

Retailer

$$1-\eta+Q_t^w\eta-\kappa_P(\pi_t-\pi_{t-1}^{\iota}\bar{\pi}^{1-\iota})\pi_t+E_t\left[\frac{\Lambda_{t,t+1}^P}{\pi_{t+1}}\kappa_P\left(\pi_{t+1}-\pi_t^{\iota}\bar{\pi}^{1-\iota}\right)\pi_{t+1}^2\frac{Y_{t+1}}{Y_t}\right]=0 \tag{A79}$$

Wholesale producer

$$Y_t = A_t K_t^{\alpha}(L_t)^{1-\alpha} \tag{A80}$$

$$RR_t^k = \alpha Q_t^W Y_t/K_t \tag{A81}$$

$$W_t^P = (1-\alpha)\Omega Q_t^W Y_t/L_t^P \tag{A82}$$

$$W_t^{Ii} = (1-\alpha)(1-\Omega)\varsigma_i Q_t^W Y_t/L_t^{Ii} \tag{A83}$$

$$L_t = (L_t^P)^{\Omega}(L_t^I)^{1-\Omega} \tag{A84}$$

$$L_t^I = \prod_{i=1}^{N}(L_t^{Ii})^{\varsigma_i}, \varsigma_N = 1-\sum_{i=1}^{N-1}\varsigma_i \tag{A85}$$

Capital producer

$$K_{t+1} = (1-\delta^k)K_t + \left[1-S\left(\frac{I_t}{I_{t-1}}\right)\right]I_t \tag{A86}$$

$$1 = Q_t^k\left[1-S\left(\frac{I_t}{I_{t-1}}\right)-S'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}}\right]+E_t\left[\Lambda_{t,t+1}^P Q_{t+1}^k S'\left(\frac{I_{t+1}}{I_t}\right)\left(\frac{I_{t+1}}{I_t}\right)^2\right] \tag{A87}$$

$$S(x) = \frac{\kappa_I}{2}(x-1)^2$$

Government

Treasury:

$$G_t = \tau^{rb}\left[(1-F(\cdot))r^{b,E}_{t-1}\frac{B^E_{t-1}Q^{B,E}_{t-1}}{\pi_t} + \sum_{i=1}^{N}\left[(1-F(\cdot))r^{b,Ii}_{t-1}\frac{B^{Ii}_{t-1}Q^{B,Ii}_{t-1}}{\pi_t}\right]\right] + ...$$
$$... + \tau^b\frac{B_{t-1}}{\pi_t} + \frac{r^d_{t-1}\tau^{rd}}{\pi_t}D_{t-1} + \tau J_{t-1} \tag{A88}$$

Central bank:

$$(1+r_t) = (1+\bar{r})^{1-\rho_r}(1+r_{t-1})^{\rho_r}\left(\frac{\pi_t}{\bar{\pi}}\right)^{\phi_\pi(1-\rho_r)}\left(\frac{Y_t}{Y_{t-1}}\right)^{\phi_y(1-\rho_r)} e^{\epsilon^m_t} \tag{A89}$$

Closing the model

Market clearing

Markets clear:

$$Y_t = C_t + I_t + G_t + \frac{\xi B_{t-1}}{\pi_t} + \sum_{i=1}^{N}\mu^{Ii}\Phi^{Ii}_t + \mu^E\Phi^E_t + \frac{\kappa_P}{2}\left(\pi_t - \pi^{\iota}_{t-1}\bar{\pi}^{1-\iota}\right)^2 Y_t + \kappa_t \tag{A90}$$

$$C_t = C^P_t + \sum_{i=1}^{N} C^{Ii}_t \tag{A91}$$

$$S_t = S^P_t + \sum_{i=1}^{N} S^{Ii}_t \tag{A92}$$

Real rates

$$\pi_t = P_t/P_{t-1}$$

$$1 + R^{wb}_{t-1} = \frac{1 + r^{wb}_{t-1}}{\pi_t} \tag{A93}$$

$$1 + R^{b,Ii}_{t-1} = \frac{1 + r^{b,Ii}_{t-1}}{\pi_t} \tag{A94}$$

$$1 + R^{b,E}_{t-1} = \frac{1 + r^{b,E}_{t-1}}{\pi_t} \tag{A95}$$

Exogenous process

$$logA_t = \rho_a logA_{t-1} + \epsilon^a_t \tag{A96}$$