Pontifícia Universidade Católica
do Rio de Janeiro

Pedro Martins Pessoa

Financial institutions, growth, and inequality: A quantitative exploration of financial development in Brazil

Dissertação de Mestrado

Dissertation presented to the Programa de Pós–graduação em Economia of PUC-Rio in partial fulfillment of the requirements for the degree of Mestre em Economia.

Advisor: Prof. Juliano Junqueira Assunção

Rio de Janeiro
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Abstract

Martins Pessoa, Pedro; Assunção, Juliano (Advisor). **Financial institutions, growth, and inequality: A quantitative exploration of financial development in Brazil**. Rio de Janeiro, 2017. 39p. Dissertação de Mestrado – Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

Financial depth surged in Brazil during the mid-2000s, largely as a result from institutional reforms. At the same time, the country experienced strong economic growth with decreasing income inequality. The objective of this work is to gain perspective on the effects of this financial development on growth and distribution at the national level. We do this through the lens of a dynamic model with financial frictions, in which agents who differ in their wealth and abilities as workers and entrepreneurs make occupational and productive choices under credit constraints. We calibrate the model to replicate the financial deepening observed in Brazil from 2003 to 2012. Our main results indicate that GDP per capita increases by 15 percent and TFP by 2 percent. Workers benefit indirectly as wages rise by 14 percent in equilibrium. Yet, income inequality slightly increases.

Keywords

Financial frictions; Credit deepening; Economic growth; Inequality.

Resumo

Martins Pessoa, Pedro; Assunção, Juliano. **Instituições financeiras, crescimento e desigualdade: Análise quantitativa do desenvolvimento financeiro no Brasil**. Rio de Janeiro, 2017. 39p. Dissertação de Mestrado – Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

Intermediação financeira se intensificou fortemente no Brasil entre 2002 e 2013. Este período também foi marcado por forte crescimento econômico com queda na desigualdade de renda. O objetivo deste trabalho é investigar o efeito do desenvolvimento financeiro observado no Brasil sobre crescimento econômico e desigualdade usando um modelo dinâmico de escolha ocupacional com fricções financeiras. No modelo, agentes com riqueza e habilidades distintas tomam decisões de trabalhar ou empreender, mas são sujeitos a restrições de crédito que distorcem a alocação de fatores. Nossos resultados indicam um aumento de 15% no PIB per capita e de 2% na PTF, e um leve aumento na desigualdade de renda. Há um forte efeito de equilíbrio geral sobre o salário, que aumenta em 14%.

Palavras-chave

Fricções financeiras; Racionamento de crédito; Crescimento econômico; Desigualdade.

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1
Introduction

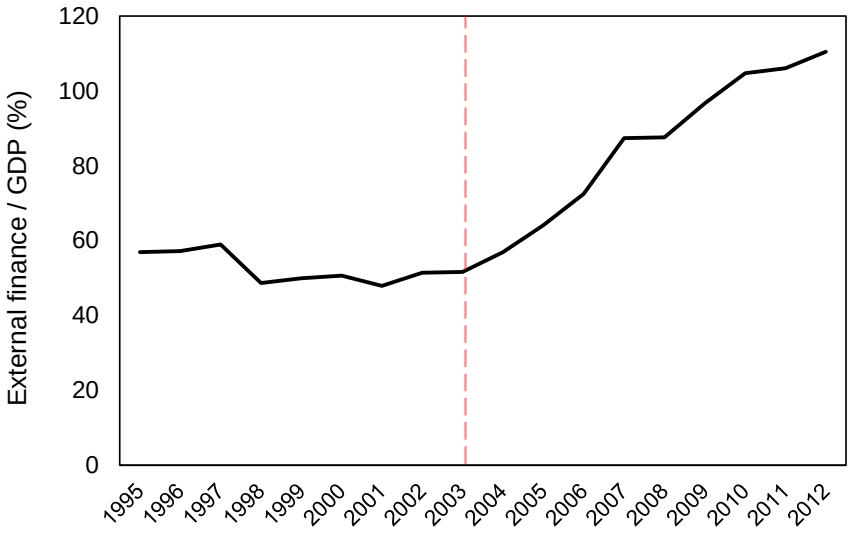
Brazil experienced a sizable financial deepening during the decade spanning the period of 2003 to 2012. Domestic credit to the private sector surged from 28 to 63 percent of GDP during this interval, and total equity market capitalization increased more than sevenfold from 2003 through 2011 [Mello and Garcia (1)].

This was largely the result of institutional reforms that expanded the supply of financial services by reducing financial frictions and improving market efficiency. Ponticelli and Alencar (2) show that firms in municipalities with swift judicial enforcement greatly benefited from a new bankruptcy law approved in 2005 that improved legal protection for creditors. Coelho, Mello, and Funchal (3) show that a law passed in 2003 allowing banks to offer personal loans with automatic repayment through payroll deduction substantially increased the volume of personal credit by facilitating use of future income as collateral. Assunção, Benmelech, and Silva (4) substantiate the relevance of collateral constraints showing that a law from 2004 that enhanced banks' capacity to sell repossessed cars used as collateral for auto loans led to larger loans with higher leverage, and democratized access to the auto credit market.

The timing in which financial deepening occurred also suggests that it reflects improvements in market efficiency, rather than just a temporary boom. After a long period of macroeconomic instability frustrating the advance of financial intermediation, external finance took off in 2003 following a series of reforms aimed at recomposing credit markets. Figure 1 plots external finance as a share of GDP from 1995 to 2012. We measure external finance adding domestic private credit, outstanding private debt securities, and stock market capitalization from the World Bank's Financial Development Database, as in Buera, Kaboski, and Shin (5). The share of external finance to GDP in Brazil more than doubled from 2003 to 2012, rising from 52 to 110 percent.

The objective of this work is to gain perspective on the aggregate effects of recent reforms that reduced financial frictions in Brazil on economic development and inequality. To quantify these impacts, we reduce financial frictions in a dynamic model with credit constraints so that it reproduces the financial deepening observed in Brazil from 2002 to 2013.

Figure 1.1: Financial deepening in Brazil



Note: data from the World Bank's Financial Development Database. External finance is defined as in (5) as the sum of domestic private credit, outstanding private debt securities, and stock market capitalization. The dashed line highlights the start of financial deepening. *Domestic credit to private* sector refers to financial resources provided to the private sector, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment. For some countries these claims include credit to public enterprises. *Stock market capitalization* refers to the total value of all listed shares in stock market. *Outstanding private debt securities* refers to the total amount of domestic private debt securities outstanding issued in domestic markets.

The model is the same as in Buera and Shin (6) and Buera, Kaboski, and Shin (7). It features heterogeneous agents with different wealth and ability as workers and entrepreneurs. They make choices regarding occupation and production under credit constraints that arise because financial intermediaries, which lend capital, demand collateral to prevent defaults. Hence, financial frictions prevent productive entrepreneurs from opening firms if their wealth is insufficient to overcome capital constraints and operate in a profitable scale. They also prevent some active entrepreneurs from obtaining capital to expand their scale of operation. In this way, this model provides a structure to empirically access the idea put forward in Banerjee and Newman (8) and Lloyd-Ellis and Bernhardt (9) that financial frictions have consequences for both aggregate output and inequality.

The degree of financial frictions is calibrated to data on external finance to GDP, depicted in figure 1. We model the reforms as a one-time shock to the parameter governing financial frictions and let the economy reach a new steady state. We perform two exercises in both partial and general equilibrium: (i) loosen credit constraints to replicate the increase in external finance to GDP observed between 2003 and 2012, and (ii) eliminate credit constraints

altogether.

In the first exercise, reducing financial frictions increases output per worker by a total of 15 percent, TFP by 2 percent, and capital-to-output by 14 percent. This indicates that financial reforms could explain up to one-half of total growth in GDP per capita between 2003 and 2012 (31 percent). We also find that the financial deepening has similar effects in open and closed economies. Although workers do not borrow in the model, they also benefit indirectly from a rise of 14 percent in wages. Improving capital markets slightly reduces wealth inequality, but it aggravates income inequality.

These results contribute to understand the macroeconomic effects of recent financial deepening in Brazil. Previous studies focusing on the role of personal credit through consumption find that the credit deepening during the years 2000s had weak effects on aggregate output, with the exception of Mendes and Assunção (10), which explores the gradual expansion of payroll lending using an IV strategy and finds that it increases borrowing and causes growth in GDP, wages, and business profits.

Our work is very close to Silva (11). We use the same theoretical framework, but he includes a separate constraint for personal credit to workers that is used to smooth consumption across time. He simulates the credit deepening in Brazil from 2001 to 2011 by increasing credit to firms from 10 to 15 percent of GDP and personal credit to workers from 5 to 15 percent of GDP. The result is a timid rise in output of 2 percent between 2001 and 2011, accounting for 8 percent of growth in GDP per capita in the period.

Carvalho et al. (12) also concludes that the credit deepening fails to explain recent economic growth. Their model differs from ours because they use representative agents, shutting down the interplay between credit constraints and misallocation. Similarly to Silva (11), the bulk of credit deepening is modeled as personal loans for consumption.

Our work differs in two important ways. First, we focus exclusively on the channel of expanding external finance to entrepreneurs, and we take into account the expansion in capital markets. Second, we examine the distributional consequences of the financial deepening in Brazil, which has not been done to the best of our knowledge.

From out second exercise, we find that removing financial frictions altogether raises output by 59 percent, and TFP by 9.1 percent, and significantly reduces both wealth and income inequality. These results are similar in size to findings in partial equilibrium from Allub and Erosa (13) regarding the relevance of financial frictions in the Brazilian economy. Antunes, Cavalcanti, and Villamil (14) calibrate a model to match the U.S. economy and finds that

reducing their measure of contract enforcement to the Brazilian level reduces output per capita by roughly 50 percent in partial equilibrium, but only by 6 percent in general equilibrium.

This work relates to a large body of empirical evidence on the relationship between financial and economic development [Levine (15)] and the importance of factor misallocation in developing countries [Banerjee and Duflo (16), Hsieh and Klenow (17)]. More specifically, our paper adds to a vast empirical literature quantifying the interplay between financial frictions, entrepreneurship, and economic development. Our paper is similar in spirit to Giné and Townsend (18) and Jeong and Townsend (19, 20), that pioneered this kind of analysis estimating theoretical models with data on Thailand's growth experience to quantify the impacts of financial liberalization on economic development and distribution. Buera, Kaboski, and Shin (5) and Buera and Shin (6) show that financial frictions can explain large variations in output per worker and TFP across countries. Moll (21) demonstrates that including forward-looking savings is important since self-financing can abate the effects of misallocation on the lung run [see Buera, Kaboski, and Shin (22) for a comprehensive review].

Finally, this paper relates to the literature on growth in Latin America and Brazil. Latin American countries, in general, and Brazil, specifically, has failed to catch-up to developed countries, in terms of output per capita, while other countries at similar stages of development have been successful. Output per worker declined by 0.6 percent from 1980 to 2009 in Brazil, and increased by only 0.1 percent in Latin America during the same period – less than any group of countries other than Sub-Saharan Africa [Veloso, Ferreira, and Pessoa (23)]. Exercises in comparative growth accounting find that it is explained by low TFP, which is nearly 50 percent lower than in the United States [Cole et al. (24), Ferreira, Pessoa, and Veloso (25)]. Starting in 2003, however, Brazil experienced strong growth in output per worker and TFP. We contribute to this literature by examining the role of institutional reforms reducing financial frictions in an expanded growth model with endogenous TFP in explaining the recent success.

The remainder of this work is as follows. Chapter 2 briefly describes the institutional background, Chapter 3 introduces the theoretical framework, Chapter 4 discusses the calibration and the results from our quantitative analysis, and Chapter 5 concludes.

2
Institutional Background

The prolonged period of hyperinflation in Brazil had consequences for the structure of the banking system, since revenues were highly dependent to inflationary income. This caused banks to focus their activity in raising deposits, rather than providing credit. As a result, private capital markets remained irrelevant as mechanisms for long-term financing, and financial intermediation is largely dependent on the public sector.

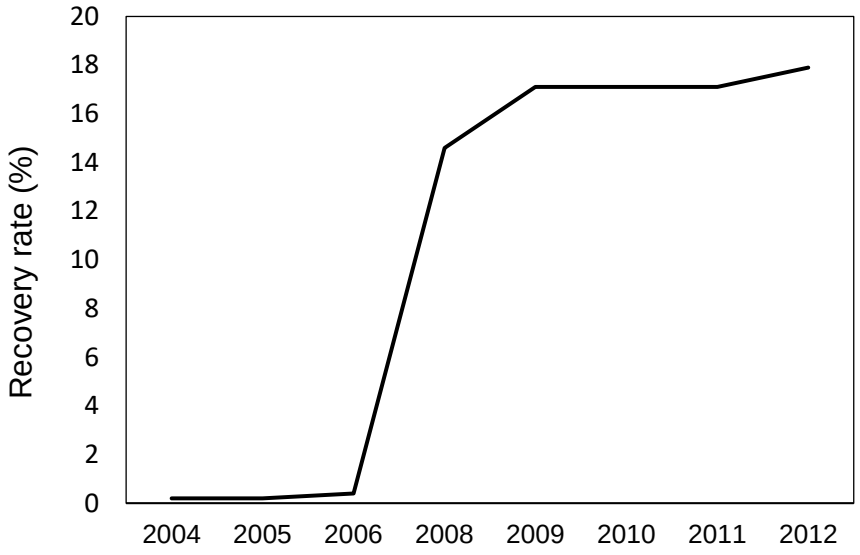
Since the end of hyperinflation in 1994 and the subsequent macroeconomic stability that followed, the Brazilian financial system experienced important advances. In particular, several institutional reforms amounted to a major supply shift during the mid-2000s. In this chapter, we describe three of the most important improvements reduced financial frictions and improved market efficiency: the new bankruptcy law, payroll lending, and fiduciary law.

Bankruptcy law (2) – the new bankruptcy law enacted in 2005 improved the legal protection of creditors in an attempt to facilitate firm's access to external finance. To do this, the new law aimed at increasing the overall value recovered from insolvent firms that entered into bankruptcy, and to increase the recovery rate of secured creditors, such as banks providing loans guaranteed by collateral. The new law changed the order in which claims are paid when a firm is liquidated, giving higher priority to secured creditors at the expense of workers and the tax authority. In addition, it promoted the market for insolvent firms by removing successor liability, which required tax and labor liabilities to be transfered to the buyer of insolvent firms sold as an operating business.

Figure 2 shows the increase in the expected recovery rate of secured creditors in Brazil just after passing the new bankruptcy law, using data from the World Bank's Doing Business Database from 2004 to 2012. During this period, the expected recovery rate of secured creditors increased from 0.4 to 18 cents on the dollar.

Ponticelli and Alves (2) show that the introduction of the new law had stroger benefits in municipalities with swift judicial enforcement, causing a higher increase in loans to manufacturing firms and firm investment.

Figure 2.1: Recovery rates, 2004–2012



Note: data from the World Bank's Doing Business Database. The recovery rate is recorded as cents on the dollar recovered by secured creditors through judicial reorganization, liquidation or debt enforcement proceedings in the country's largest city (São Paulo).

Payroll lending (3) — In December 2003, the payroll lending law allowed banks to offer personal loans with automatic repayment deducted directly from borrowers' payroll checks. It reduced the probability of default – the delinquency rate on personal loans oscillated around 9 percentage points until mid-2006 – and essentially turned future income into collateral.

Payroll lending already existed since 1990, but covered exclusively public sector employees or retirees. The new law allowed commercial banks to underwrite payroll loans to private-sector employees and to beneficiaries from the Brazilian federal pension system (Instituto Nacional do Seguro Social, INSS). As INSS had to approve financial institutions before they started underwriting loans to retirees, the law only became effective in April 2004.

Payroll lending reduced delinquency rates on personal loans, which decreases the marginal cost of loan underwriting for chartered institutions, and concessions of new payroll loans increased dramatically, both in absolute terms and relative to personal loans, which increased nearly tenfold between 2000 and 2011.

Fiduciary law (4) – Under fiduciary alienation, an asset remains under the property of the lender until the loan is paid in full, whereas the control of the asset remains with the borrower. In case of default, the creditor can repossess the asset after proving nonpayment. The new fiduciary law approved in 2004 improved the efficiency of the market for auto loans by

reducing the time between repossession and resale of cars used as collateral for auto loans. Before it was enacted, banks had to wait for a long time until earning authorization to resell repossessed vehicles in court, while cars' value depreciated quickly. As a result, the auto loan market had a remarkable expansion comparable to that of personal loans.

Credit deepening and capital markets

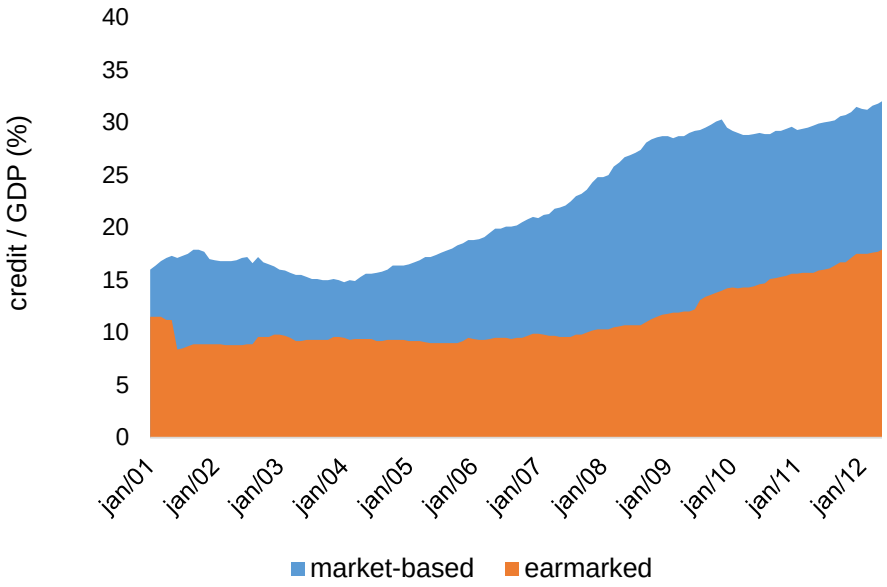
In 2000, total credit to GDP amounted to 27 percent of GDP. Among them, only about 58 percent was market-based. The remaining was earmarked, which means that it has a destination (e.g. rural credit,) and interest rate determined by government regulation. Starting in 2004, credit over GDP deepened, driven mainly by a threefold increase in marked-based personal credit, as shown in figure 2.

This credit deepening led by consumer credit motivated recent research to examine its macroeconomic effects through a demand mechanism driven by boosted consumption (12, 11). This work will take a different approach and focus exclusively on the channel between output and access to external finance driven by the reduction of financial frictions.

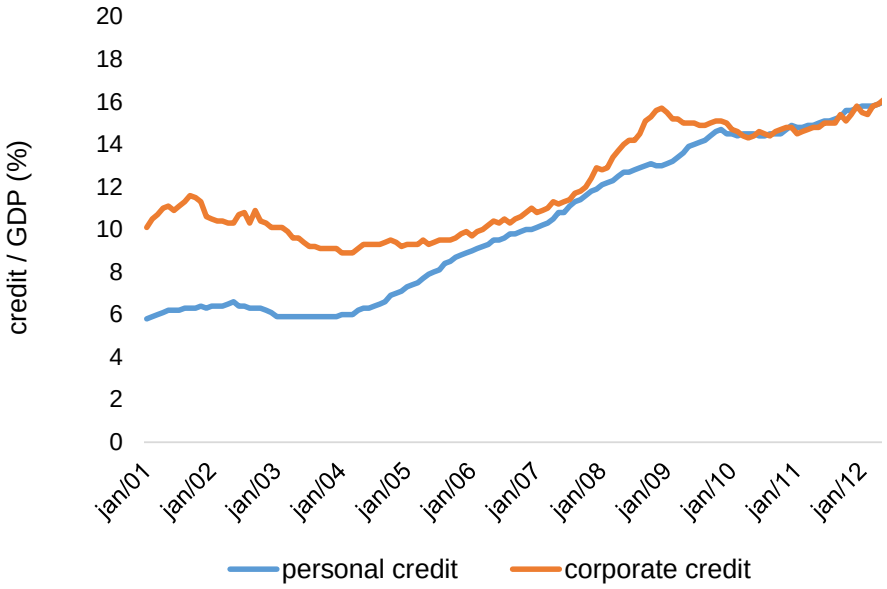
Institutional improvements also advanced private capital markets for long-term financing over the perdiod between 2003 and 2012. In particular, Mello and Garcia (1) document a sevenfold increase in total market capitalization from 2003 after the establishment of BOVESPA NOVO MERCADO in 2000, a listing segment with rules in line with international standards for corporate governance. In order to better capture the expansion in external finance, we measure it as the sum of domestic private credit, outstanding private debt securities, and stock market capitalization from the World Bank's Financial Development Database, as in Buera, Kaboski, and Shin (5) (see figure 1).

Figure 2.2: Credit deepening, 2001–2012

(A) Total credit: market-based vs. earmarked



(B) Market-based credit: personal vs. corporate



Note: data from the Brazilian Central Bank. Market-based credit refers to financing and loans in which rates and destination are freely negotiated between financial institutions and borrowers.

3
Theoretical Framework

Environment – The economy is populated by a continuum of infinitely-lived agents of measure one. They are heterogeneous with respect to their wealth, denoted as a, and their productivity, represented by a vector of abilities (z, x), where z denotes their ability as entrepreneurs and x denotes their ability as workers.

The entrepreneurial and labor productivity follow independent Markov processes. From one period to the next, individuals with entrepreneurial ability z retain it with probability γ, and draw a new ability z' with probability $1-\gamma$ from a discretized version of a Pareto distribution with density $\mu(z') = \eta z'^{-(\eta+1)}$. Their ability as workers can take two values, $x \in \{x_l, x_h\}$, and they remain the same from one period to the next with probability π.

The timing of the model is as follows. Individuals know their own wealth and abilities, and make dynamic decisions regarding occupation and investment to maximize expected lifetime utility. In each period, agents begin choosing either to be an entrepreneur or to work for a wage. Then, entrepreneurs choose the amount of capital and labor to hire. Finally, agents decide how much of their earnings to consume or save.

Technology – Entrepreneurs with ability z pay a fixed cost κ to produce y units of a final good using capital (k) and labor (l) according to

$$y = zf(z,k,l) = zk^{\alpha}l^{\theta};\ \alpha+\theta<1 \tag{3-1}$$

where α and θ are the elasticities of output with respect to capital and labor, respectively, and we assume diminishing returns to scale. There is only one product in the economy, so both wealth a and capital k are measured in terms of output y. This individual-specific technology implies that more talented entrepreneurs choose to operate larger firms, but this will not be always possible due to the existence of financial frictions.

Credit markets – Financial intermediaries pool savings, paying the interest rate r, and lend capital to entrepreneurs. We assume that they operate in a competitive market and make zero profits, which implies a rental price for capital of $R = r + \delta$, where δ is the rate of capital depreciation. Entrepreneurs deposit their assets as collateral and borrow k units of capital in order to

produce, but credit is limited by a quantity constraint. Capital rental markets operate only within a period and, consequently, wealth must be nonnegative in all periods.

Credit constraints emerge as the result of a problem of limited liability, as in Buera, Kaboski, and Shin (5). We assume that entrepreneurs can default on their credit contracts after production takes place. In the case of default, the entrepreneur keeps a fraction $1-\phi$ of the undepreciated capital and the output net of labor costs ($zk^{\alpha}l^{\theta}-wl$), but loses the collateral deposited with the financial intermediary (a). In the following period, defaulters regain access to financial markets. The individual-specific credit constraint, denoted as $\overline{k}(a,z;\phi)$, is the largest value of k satisfying the following incentive-compatibility condition:

$$\begin{aligned}\max_{l}[zk^{\alpha}l^{\theta}-wl]-Rk-(1+r)\kappa+(1+r)a \\ \geq(1-\phi)\{\max_{l}[zk^{\alpha}l^{\theta}-wl]+(1-\delta)k\}\end{aligned}$$

The credit constraint $\overline{k}(a,z;\phi)$ is increasing in a, z, and ϕ. The parameter $\phi\in[0,1]$ indexes the quality of financial institutions, ranging from no credit markets ($\phi=0$) to perfect credit markets ($\phi=1$).

The index ϕ has a natural interpretation as the strength of legal institutions facilitating the enforcement of credit contracts. This is at the core of recent financial reforms discussed in Chapter 2 – namely the fiduciary and bankruptcy laws, and payroll lending. A similar alternative to this specification would be a simpler collateral constraint independent of z and linear in wealth, $\overline{k}=\lambda a$ (26, 8, 6, 11). Under this alternative, financial frictions would have stronger impacts on more productive firms and aggregate outcomes than in our specification. Such a constraint might be adequate if z was unobservable or if financial intermediaries could not pursue income sources of the borrower in the event of default. In practice, financial intermediaries try to assess the ability to generate future cash flows, and the increased capacity to use them as collateral through the payroll lending technology plays an important part in the Brazilian financial deepening.

Individual's problem – Agents make forward-looking decisions using a common discount rate β and risk-aversion σ. The following expected utility function represents the preferences over a consumption sequence, c. The expectation is over the realizations of z and x.

$$U(c) = E\left[\sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}}{1-\sigma}\right] \tag{3-2}$$

Individuals maximize (3-2) by choosing sequences of consumption (c), wealth (a'), occupation (e), and production inputs (k, l), subject to a sequence of budget and credit constraints. Given the equilibrium interest rate r_t and wage per efficiency unit of labor w_t, the problem of an individual with wealth a and productivity vector (z, x) at time t is described by the following Bellman equation:

$$v_t(a, z, x) = \max_{c,a',k,l\geq 0, e\in\{0,1\}} \frac{c^{1-\sigma}}{1-\sigma} + \beta E_{z',x'}[v_{t+1}(a', z', x')|z, x] \tag{3-3}$$

$$\textbf{s.t. } c + a' \leq e[zk^{\alpha}l^{\theta} - w_t l - (r+\delta)k - (1+r)\kappa] + (1-e)xw_t + (1+r)a \tag{3-4}$$

$$\textbf{and s.t. } k + (1+r)\kappa \leq \overline{k}(a, z; \phi) \tag{3-5}$$

Agents with ability (z, x) and wealth a choose to be entrepreneurs if and only if profits $\pi(z, a; w, r)$ are larger than the wage, xw. This occupational choice is represented by a policy function in which agents (z, x) decide to be entrepreneurs when their wealth a exceeds the threshold $\underline{a}(z, x)$ solving the break-even equation $\pi(z, \underline{a}(z, x); w, r) = w$. Under perfect credit markets, the occupation choice will depend solely on the comparative advantage of being an entrepreneur, z/x, and firms use the optimal amount of factors $(k^u(z), l^u(z))$. Financial frictions will distort occupation decisions compared to a situation with perfect credit markets: for a given set of abilities, people depend on initial wealth to overcome credit constraint and run their firms on a profitable scale.[1]

Stationary competitive equilibrium

We denote the mass of types z and x by $\mu(z)$ and $\omega(x)$, respectively, the cdf for the joint distribution of wealth and abilities by $G(a, z, x)$, and the associated cdf for wealth given abilities (z, x) by $G(a|z, x)$.

[1]Figure A.2–4 in Appendix A illustrate this. They are maps (for the quantitative exercises described in the next chapter) partitioning agents' occupation into workers, entrepreneurs, and constrained entrepreneurs. Figure A.4 is the equilibrium with perfect credit markets: occupations are independent of wealth, and only the best entrepreneurs open firms and operate them at the optimal scale. Figures A.2–3 show the distortions of financial frictions: some productive would-be-entrepreneurs are working for a wage, and many entrepreneurs are capital-constrained.

A stationary competitive equilibrium consists of the invariant distribution of wealth and abilities $G(a, z, x)$, policy functions $\{e(a, z, x), l(a, z, x), k(a, z, x), c(a, z, x), a'(a, z, x)\}$, rental limits $\overline{k}(a, z; \phi)$, and prices $\{w, r, R\}$, that satisfy the following conditions:

1. Given $\overline{k}(a, z; \phi)$, w, and r, $\{o(a, z, x), l(a, z, x), k(a, z, x), c(a, z, x), a'(a, z, x)\}$ solve the individual's problem in (3-3);

2. Financial intermediaries make zero profit: $R = r + \delta$;

3. Rental limits $\overline{k}(a, z; \phi)$ are the highest amount of capital satisfying both the incentive compatibility condition and $\overline{k}(a, z, ; \phi) \leq k^u(z)$;

4. Capital rental, labor, and goods markets clear;

$$\sum_{z \in Z} \mu(z) \sum_{x \in \{x_l, x_h\}} \omega(x) \left[\int_{\underline{a}(z,x)}^{\infty} k(a, z, x) G(da|z, x) - \int_0^{\infty} a G(da|z, x) \right] = 0$$

$$\sum_{z \in Z} \mu(z) \sum_{x \in \{x_l, x_h\}} \omega(x) \left[\int_{\underline{a}(z,x)}^{\infty} l(a, z, x) G(da|z, x) - \int_0^{\underline{a}(z,x)} x G(da|z, x) \right] = 0$$

5. The joint distribution of individual state variables $G(a, z, x)$ is stationary.

4
Quantitative Analysis

We calibrate the model so that, in steady state, it approximates the Brazilian economy prior to the mid-2000s financial reforms. The degree of financial frictions is calibrated to data on external finance to GDP. The following quantitative analysis holds fixed all technological parameters and the underlying endowment of abilities in the economy through time in order to isolate the direct impact of financial frictions on economic development and inequality.

The quantitative analysis is a comparison between two steady-states: starting from the baseline economy in steady state, we model the reforms as a one-time shock to the parameter governing financial frictions, ϕ, and let the economy reach a new steady state. We perform two exercises in both partial and general equilibrium: (i) loosen credit constraints to replicate the increase in external finance to GDP observed between 2003 and 2012, and (ii) eliminate credit constraints altogether.

4.1
Calibration

We begin specifying values for eleven parameters: technology parameters (α, θ, κ), the depreciation rate (δ), preference parameters (β, σ), five parameters describing the endowment of abilities – (γ, η) for entrepreneurial productivity and (π, x_l, x_h) for labor productivity – and the enforceability of contracts parameter governing the degree of financial frictions (ϕ).

We set the coefficient of risk aversion to the standard value from similar exercises in the macro-development literature, $\sigma = 1.5$ (5, 6, 7, 13). We used the rate of capital depreciation $\delta = 0.035$ as usual in growth models calibrated to the Brazilian economy (11, 27, 28), and $\alpha/(\alpha + \theta) = 0.4$ corresponding to the share of returns to capital of 40 percent.

The remaining parameters are jointly calibrated so that specific statistics simulated in the model match their corresponding values observed in the Brazilian economy prior to the financial reforms. Table 4.1 summarizes the calibration of these targeted parameters.

The discount rate is set to $\beta = 0.9$ to be compatible with an interest rate of 2 percent per year, which is approximately the average real interest rate for

Table 4.1: Calibration

	Data	Model	Parameter
Employment in 10% largest firms	0.74	0.74	$\eta = 4.65$
Establishment exit rate	0.129	0.129	$\gamma = 0.86$
Fraction of entrepreneurs	0.08	0.08	$\alpha + \theta = 0.792$
Average employees per establishment	14	12	$\kappa = 0.1$
Real annual interest rate	0.02	0.02	$\beta = 0.9$
External finance / GDP	0.52	0.52	$\phi = 0.23$

savings accounts from 1999 to 2003.

In order to pin down the Markov productivity processes, we use information from RAIS, an annual administrative panel dataset collected by the Ministry of Labor containing the universe of formal establishments and employees in Brazil.[1] The tail parameter of the entrepreneurial productivity distribution determines the dispersion of ability across individual. We set $\eta = 4.65$ to match the proportion of employees working in the largest 10 percent of establishments in 2003, which amounted to 74 percent. The persistence of individual entrepreneurial ability is set to $\gamma = 0.86$, so that the exit rate of establishments is equal to the exit probability for the average firm of 12.9 percent estimated in Ulyssea (29). We set the parameters from the symmetric Markov chain governing the evolution of worker productivity ($\pi = 0.9, x_l = 0.4, x_h = 1.6$) to approximate the autocorrelation and standard deviation of wages.

Because $(1 - \alpha - \theta)$ determines the share of rents accruing to the entrepreneur, we calibrate the returns to scale $\alpha + \theta = 0.792$ to match the fraction of entrepreneurs in the economy of 8 percent. We define entrepreneurs as individuals who report owning a business with at least one employee in PNAD, a representative national household survey. We choose the fixed cost $\kappa = 0.1$ to match the average employment size of establishments in 2003 of 14 employees.

Finally, the enforceability of contracts $\phi = 0.225$ is chosen so that the ratio of external finance to GDP in the model is 52 percent, as in the Brazilian economy in 2003. In 2012, the ratio of external finance to GDP had increased to 110 percent ($\phi = 0.404$). Following (5, 7), we define external finance as the sum of private credit by banks, outstanding domestic private credit, outstanding private debt securities, and stock market capitalization[2] as a fraction of GDP,

[1] An observation in the RAIS (Relação Anual de Informações Sociais) dataset is a formal contract between an employee and a firm. For each individual, we keep only the highest income contract in order to avoid double-counting. We also exclude employees contracted for less than twenty hours per week or reporting no income from our sample.

[2] Following Buera et al. (5), we multiply the reported stock market capitalization by 0.33, the average book-to-market ratio in the data, since the market value of equity overstates

from the World Bank's Financial Development Database.

4.2 Economic growth

Table 4.2 shows our results for output, aggregate TFP, and capital-to-output ratios.[3] Column 1 is the baseline economy, prior to financial reforms ($\phi = 0.225$). Column 2 is the economy after reforms that replicate the financial deepening ($\phi = 0.404$), which is the focus of our analysis. Column 3 is the benchmark economy with perfect credit markets ($\phi = 1$). All statistics correspond to the steady-state equilibrium of the model.

Table 4.2: Impacts on economic growth

	Before (1)	After (2)	Benchmark (3)
External finance / Y	0.52	1.09	2.74
Output (Y)	1	1.15	1.59
TFP	1	1.024	1.091
Capital / Output	2.14	2.48	3.45
Interest rate	0.02	0.026	0.055

Note: column (1) is the baseline economy ($\phi = 0.225$); column (2) replicates the observed financial deepening ($\phi = 0.404$); column (3) is the benchmark economy with perfect credit markets ($\phi = 1$). *Output* and *TFP* are measured as a fraction of the baseline value.

Reducing financial frictions have a substantial impact on output. The financial deepening observed in Brazil can boost output by up to 15 percent, which amounts to roughly one-half of total growth in GDP per capita from 2002 to 2012 (31 percent). Assuming that the economy reaches the new steady state after nine years, the model predicts an annualized growth of 1.5 percent from 2003 to 2012 caused by reducing credit constraints alone.

This follows an increase of 16 percent in the capital-to-output ratio, and of 2.4 percent in TFP (or 0.26 per year). Ferreira and Veloso (25) estimates that TFP growth from 2003 to 2009 in Brazil was 1.5 percent per year, and thus this result suggests that financial deepening could explain 17 percent of TFP growth during this period of growth acceleration.

Removing financial frictions altogether raises output by 59 percent, and TFP by 9.1 percent. This is a stark exercise that demands a fivefold rise in external finance to GDP, but it suggests that gains from financial reforms

the book value, which is conceptually closer to the financed capital in the model.

[3]TFP is defined as $Y(K^{\alpha}L^{1-\alpha})^{-1}$, where $\alpha = 0.4$, Y is the aggregate output, K is the aggregate capital, and L is the size of the labor force, which is normalized to 1.

are far from exhausted. These results are similar in size to findings in partial equilibrium from Allub and Erosa (13) regarding the relevance of financial frictions in the Brazilian economy. They eliminate financial frictions starting from a baseline economy calibrated to match the average ratio of private credit to GDP in Brazil during the period from 2003 to 2010, and conclude that output and TFP increase by 48 and 9 percent, respectively.

Discussion

Partial equilibrium – Antunes, Cavalcanti, and Villamil (14) puts forward that the relevance of financial frictions to economic development may depend a great deal on whether interest rates are set exogenously or adjust endogenously. They find that calibrating a model to match the U.S. economy and reducing their index of contract enforcement to the Brazilian level reduces output per capita by roughly 50 percent in partial equilibrium, but only by 6 percent in general equilibrium.

We recalculated the previous exercises in partial equilibrium in order to examine if our results would be magnified in an open economy. In partial equilibrium, the increased demand for capital following a credit deepening is not compensated by additional savings induced by rising interest rates. Therefore, it tends to augment the capital-to-output ratio and taper off TFP growth.

Table 4.3 shows that reducing frictions to simulate the financial deepening in partial equilibrium leaves the impact on output unchanged. TFP growth, however, is reduced by half. Eliminating all frictions in partial equilibrium intensify the impact on output considerably. Now, financial frictions reduce output by 50 percent in comparison to the benchmark with perfect markets, which is twice the effect in general equilibrium.

External finance – These results are in contrast to previous studies documenting that credit deepening had weak aggregate effects on economic development in Brazil (11, 12). In particular, we use the same theoretical framework as Silva (11), yet come to different conclusions. He simulates the credit deepening in Brazil from 2001 to 2011 by increasing credit to firms from 10 to 15 percent of GDP and personal credit to workers from 5 to 15 percent of GDP using two independent credit constraints. Personal credit is only used to smooth consumption, and thus the only way it affects growth is by increasing the interest rate. Hence, external finance rises only from 10 to 15 percent (50 percent) in his exercise (compared to a change from 52 to 110 in ours). The result is a timid rise in output of 2 percent between 2001 and 2011, accounting

Table 4.3: Impacts on economic growth – Partial equilibrium

	Before (1)	After (2)	Benchmark (3)
External finance / Y	0.52	1.09	5.17
Output (Y)	1	1.15	2.02
TFP	1	1.013	1.026
Capital / Output	2.14	2.55	5.76
Interest rate	0.02	0.02	0.02

Note: column (1) is the baseline economy ($\phi = 0.225$); column (2) replicates the observed financial deepening ($\phi = 0.395$); column (3) is the benchmark economy with perfect credit markets ($\phi = 1$). *Output* and *TFP* are measured as a fraction of the baseline value.

for 8 percent of growth in GDP per capita in the period.

In order to assess the sensibility in our results to the definition of external finance, we also simulated the financial deepening in partial equilibrium substituting the ratio of domestic credit to GDP from the World Bank for the ratio of firm credit to GDP from the Brazilian Central Bank, used in Silva (11). Domestic credit includes both market-based and earmarked credit, and both corporate and personal credit.

Therefore, we measure external finance adding market-based credit to firms, outstanding private debt securities, and stock market capitalization, which increases from 34 to 65 percent of GDP between 2003 and 2012. Our results decrease substantially compared to our main specification, but we still find an increase of 8 percent in output, which amounts to roughly 20 percent of total growth in GDP per capita from 2003 to 2012.

Table 4.4: Impacts on economic growth – Firm credit

	Before (1)	After (2)
External finance / Y	0.33	0.63
Output (Y)	1	1.083
TFP	1	1.022
Capital / Output	2.09	2.22
Interest rate	0.02	0.02
Wage	1	1.075

Occupation and misallocation

Now, we return to our main results in general equilibrium to document the endogenous changes in prices and the subsequent factor reallocation that are behind the effects of financial deepening on economic development from the previous section.

Financial frictions repress TFP in two ways: misallocating entrepreneurial talent, as poor individuals with high entrepreneurial ability cannot afford to operate a firm in a profitable scale, and misallocating capital among firms, as poor entrepreneurs cannot afford to reach the optimal scale. We show changes in these two dimensions in table 4.5.

Figures A.2–4, in Appendix A, illustrate these two effects. They partition the equilibrium occupational choices into workers (blue), constrained entrepreneurs (green), and unconstrained entrepreneurs (yellow). The vertical axis increases with wealth and the horizontal axis increases with entrepreneurial ability.

Compared to the benchmark steady state (A.4), credit constraints prevent some agents with high entrepreneurial ability from becoming entrepreneurs and bind firms' scale of operation, especially for productive firms. As a consequence, financial frictions depress wages and interest rates, so the blue area shrink to the left: individuals who did not profit from operating firms under the efficient allocation, now choose to become entrepreneurs, reducing the average ability.

It is important to note that the types in the lower-left part of the map are more frequent in the population (see figure A.1), so even small changes in this region are important. For example, unconstrained firms (yellow) only amount to 5 percent of businesses (0.4 percent of the population) in the baseline economy.

In table 4.5, we show the fraction of entrepreneurs, average ability, firm size, and factor prices in order to quantify those effects.In column 2, we find that financial deepening raises the interest rate from 2 to 2.6 percent. Wages rise by 14 percent, which is roughly one-third of the increase in hourly wages observed from 2003 to 2012[4] – this implies that, although employees do not borrow in the model, they will significantly benefit from the credit deepening indirectly through wages.

As a consequence of the changes in occupational choices that we have described, financial deepening reduces the pool of entrepreneurs by 0.7 per-

[4]Data from PNAD (Pesquisa Nacional por Amostra de Domicílios), a national representative household survey. Hourly wages are income from the primary occupation of employees aged between 18 and 60 who reported working for at least 20 hours per week.

Table 4.5: Impacts on occupation and misallocation

	Before (1)	After (2)	Benchmark (3)
Entrepreneurs (%)	8	7.3	5
Interest rate	0.02	0.026	0.055
Wage	1	1.14	1.55
Average ability			
Entrepreneurs ($\bar{z}$)	1	1.04	1.19
Workers ($\bar{x}$)	1	0.999	0.995
Firm size			
Capital (*avg.*)	12	17	48
s.d.	87	119	162
Labor (*avg.*)	12	13	19
s.d.	69	70	65
Returns to capital (*avg.*)	0.23	0.18	0.09
s.d.	0.19	0.11	0

Note: column (1) is the baseline economy ($\phi = 0.225$); column (2) replicates the observed financial deepening ($\phi = 0.404$); column (3) is the benchmark economy with perfect credit markets ($\phi = 1$). *Wage* and *average ability* are measured as a fraction of the baseline value. Wage is per efficiency unit. The income workers receive is $0.4wage$ for low-skilled employees, and $1.6wage$ for high-skilled employees.

centage points, and the ability of the average entrepreneur rises. Those who remain active are on average more productive and operate larger firms. Regarding the factor reallocation among firms, we see a reduction in the dispersion of marginal returns to capital in the economy, reflecting an improvement in how financial intermediaries allocate capital. The standard deviation of the marginal returns to capital decreases from 0.23 to 0.18.

There is also a negative effect on the skill composition of active workers. The proportion of low-skilled employees increased because marginal entrepreneurs are more likely to have low labor productivity, as even very unproductive entrepreneurs are better off opening a firm than receiving the lower wage. Since $\mu(z)$ is decreasing in z, the prevalence of low-skilled workers increases with financial deepening. However, this effect seems to be unimportant in our application.

In order to make sense of the relative importance of each margin of misallocation for output growth following the financial deepening, we held fixed the occupational structure as in the pre-reform economy and allowed firms to borrow under the new financial environment. This exercise is just an approximation to the true relative effect of the misallocation of

capital and entrepreneurial ability, because we are not keeping the amount of capital fixed. Shutting down the occupational shifts weaken the impact from financial deepening on output by one-half, indicating that the reallocation of capital within entrepreneurs and the reallocation of entrepreneurial talent had equivalent roles in raising GDP per capita.

4.4 Income and wealth inequality

The effects of lifting financial frictions are heterogeneous across types of individuals. We find that the largest benefits from financial deepening accrue to poor, very talented entrepreneurs, who significantly expand their scale after alleviating capital constraints. On the other hand, the largest losses accrue to rich, very talented entrepreneurs, who operate firms in large scale incur in additional factor costs.

Table 4.6 shows the consequences of reducing financial frictions on inequality. We calculated income inequality excluding returns from assets, $(1 + r)a$, in order to make it comparable to data from PNAD, since it fails to capture earnings from financial assets. Our results show that the wealth distribution becomes more equal in both exercises, as entrepreneurs need to accumulate less wealth in order to overcome collateral constraints.

Eliminating financial frictions altogether (column 3) largely reduces income inequality measured using the GINI coefficient. Recall that in this situation, wealth has no influence on income, since decisions regarding occupation and production will depend solely on ability. In this sense, it informs the degree of income inequality in the economy when we remove inequality of opportunity and reward ability efficiently.

However, the opposite happens for the financial deepening in column 2 – it significantly increase income inequality. During the period spanning from 2003 to 2012, income inequality in Brazil fell sharply from 0.58 to 0.525. Our results suggest that without financial deepening, this decline would have been even stronger. The rise in income inequality is explained by gains in the top quintile. Together with previous results indicating that the dispersion of firm sizes increased and benefits were concentrated on productive firms, it suggests a strong trade-off between inequality and output growth.

Table 4.6: Impacts on inequality

	Before (1)	After (2)	Benchmark (3)
GINI coefficient			
Income	0.509	0.530	0.471
Wealth	0.885	0.881	0.854
Income share by quintile			
Fifth	0.523	0.545	0.488
Fourth	0.216	0.205	0.232
Third	0.153	0.148	0.165
Second	0.054	0.051	0.058
First	0.053	0.051	0.058
Wealth share by quintile			
Fifth	0.892	0.887	0.868
Fourth	0.060	0.062	0.070
Third	0.036	0.038	0.043
Second	0.012	0.013	0.019
First	0.000	0.000	0.001

Note: column (1) is the baseline economy ($\phi = 0.225$); column (2) replicates the observed financial deepening ($\phi = 0.404$); column (3) is the benchmark economy with perfect credit markets ($\phi = 1$). We compute income excluding returns from financial assets, $(1 + r)a$,

5
Conclusion

This study uses a dynamic model with heterogeneous agents and credit constraints to examine the aggregate effects of recent institutional reforms that improved financial intermediation in Brazil during the mid-2000s. The degree of financial frictions is calibrated to data on external finance to GDP, and we perform two exercises in both partial and general equilibrium: (i) loosen credit constraints to replicate the increase in external finance to GDP observed between 2003 and 2012, and (ii) eliminate credit constraints altogether.

Reducing financial frictions had a substantial impact on output. The financial deepening observed in Brazil can boost output by up to 15 percent, which amounts to roughly one-half of total growth in GDP per capita from 2002 to 2012 (31 percent). We show that this effect is similar in open and closed economies. In general equilibrium, this follows an increase of 16 percent in the capital-to-output ratio, and 2.4 percent in TFP. Assuming that the economy reaches a new steady state after nine years, our results suggest that financial deepening could explain 17 percent of TFP growth during the period of growth acceleration in Brazil.

From out second exercise, we find that removing financial frictions altogether raises output by 59 percent and TFP by 9.1 percent, and significantly reduces both wealth and income inequality. These results are similar in size to findings in partial equilibrium from Allub and Erosa (13) regarding the relevance of financial frictions in the Brazilian economy.

The effects of lifting financial frictions are heterogeneous across types of individuals. We find that workers are significantly benefit from the credit deepening in equilibrium through a rise of 14 percent in wages. The largest benefits from financial deepening accrue to poor, very talented entrepreneurs, who significantly expand their scale after alleviating capital constraints. On the other hand, the largest losses accrue to rich, very talented entrepreneurs, who operate firms in large scale and incur in additional factor costs. While we find that removing financial frictions altogether would decrease income inequality, a financial deepening emulating the Brazilian experience increases income inequality.

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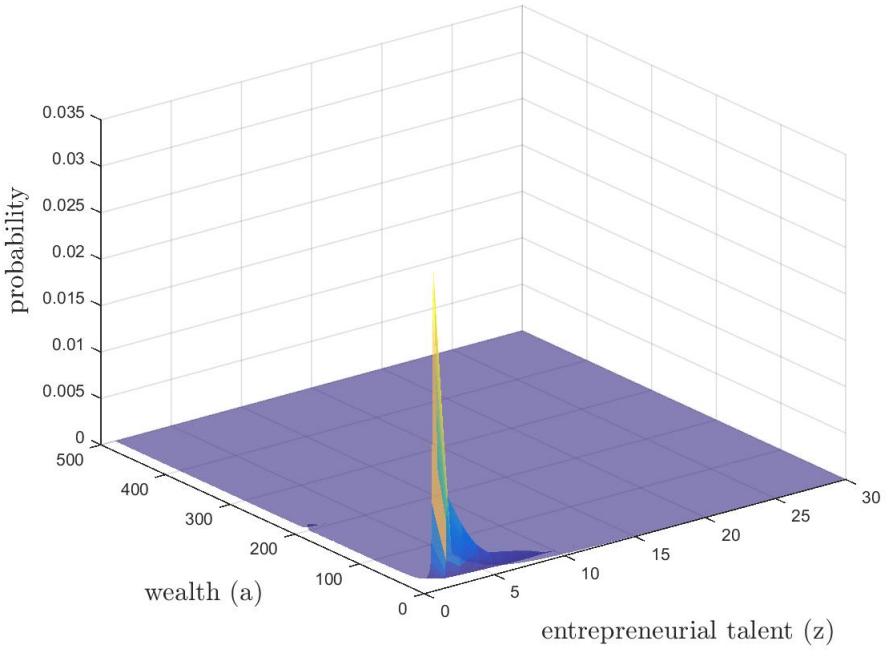
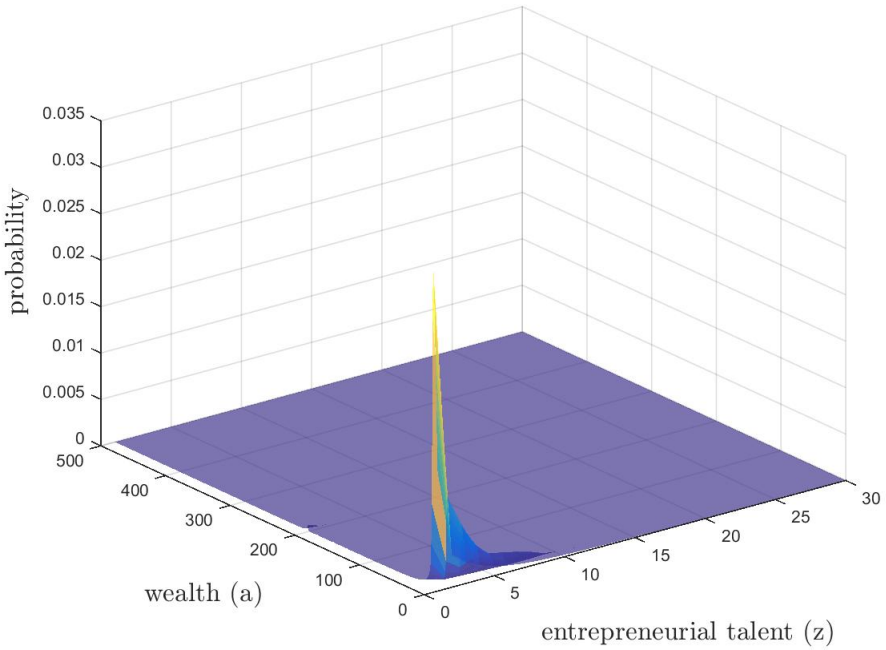
A
Figures

Figure A.1: Distribution of types (a, z) in the economy

(a) Baseline steady-state



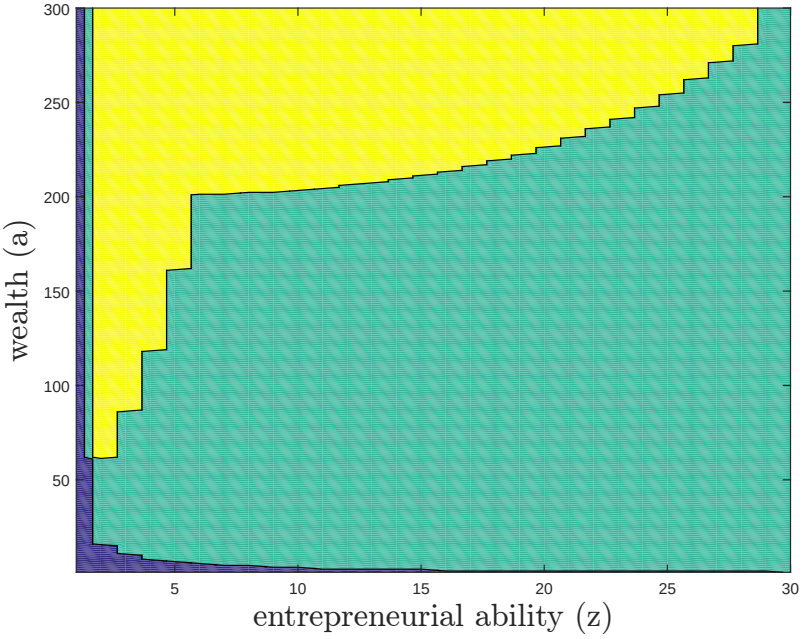
(b) New steady-state



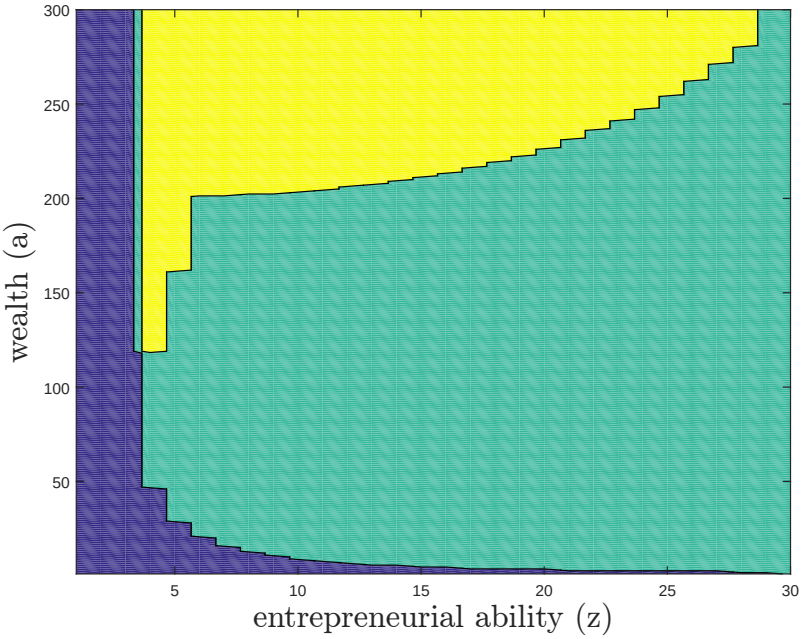
Notes: Probability distribution of individual types in the steady state economy for agents with high labor productivity.

Figure A.2: Baseline occupation map

(a) Low-skilled workers



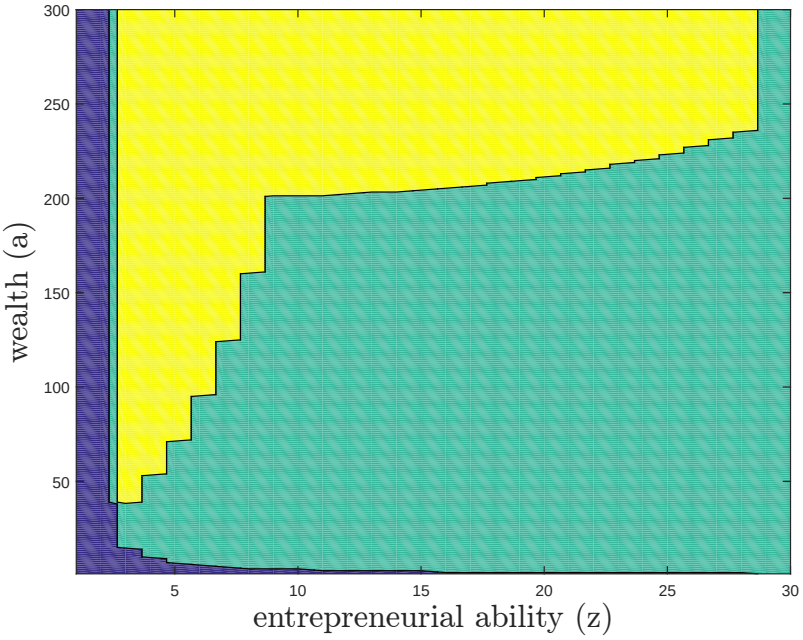
(b) High-skilled workers



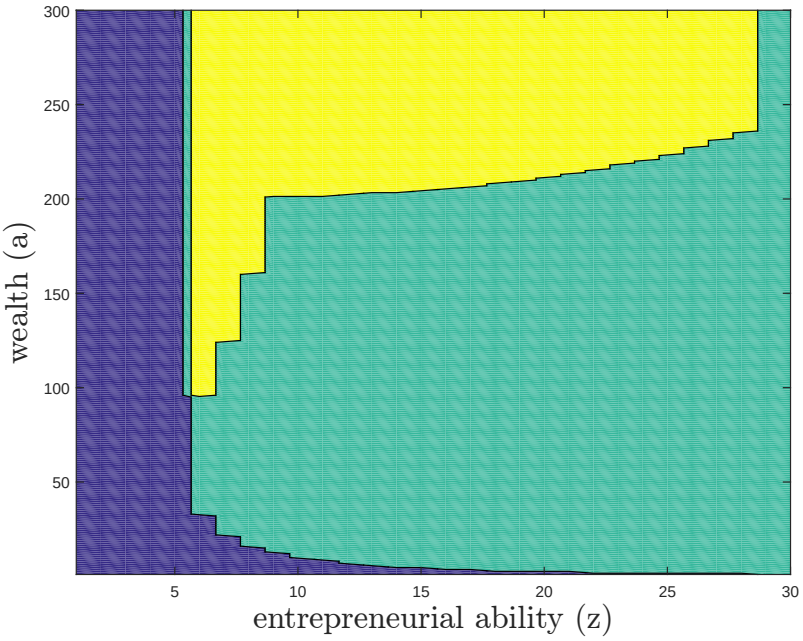
Notes: This occupation map partitions individuals into workers (blue), constrained entrepreneurs (green), and unconstrained entrepreneurs (yellow) according to their occupation decisions on the initial steady state. Panel (a) and (b) show, respectively, the initial occupation map for workers with low and high ability. It shows that for a given wealth, more talented entrepreneurs tend to be constrained, despite the fact that credit limits $\overline{k}(a, z; \phi)$ are increasing in z, because the unconstrained level of capital $k^u(z)$ is also larger for productive entrepreneurs.

Figure A.3: New occupation map

(a) Low-skilled workers



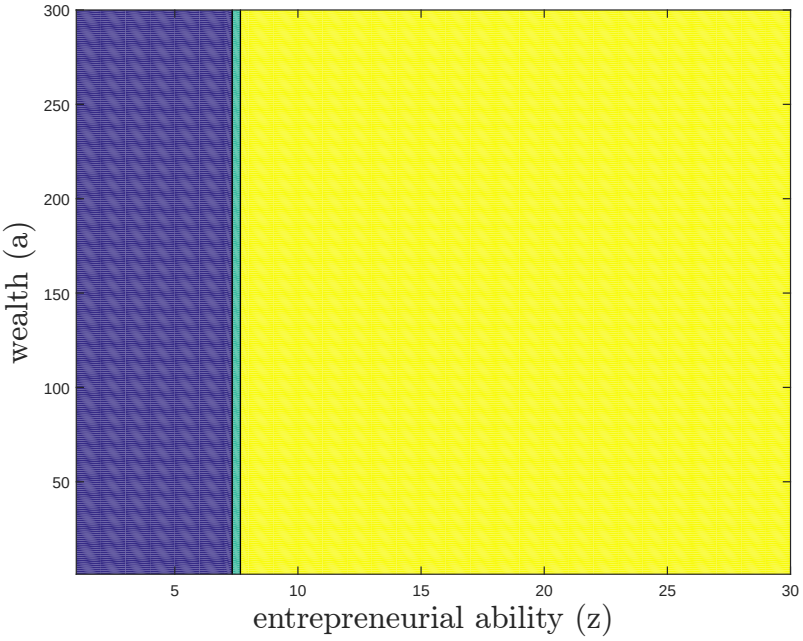
(b) High-skilled workers



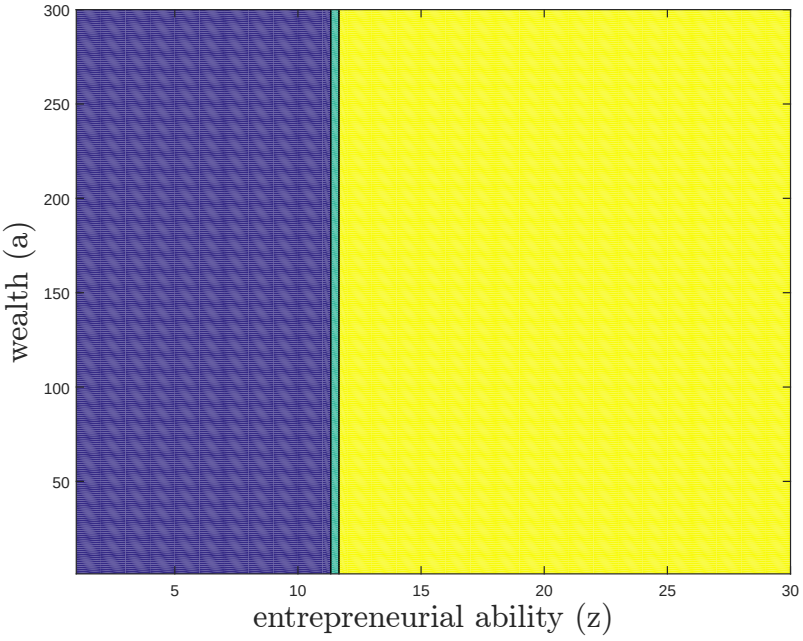
Notes: This occupation map partitions individuals into workers (blue), constrained entrepreneurs (green), and unconstrained entrepreneurs (yellow) according to their occupation decisions on the new steady state after financial reforms take place. Panel (a) and (b) show, respectively, the map for workers with low and high ability.

Figure A.4: Benchmark occupation map (no frictions)

(a) Low-skilled workers



(b) High-skilled workers



Notes: This occupation map partitions individuals into workers (blue) and entrepreneurs (yellow) according to their occupation decisions on the steady state without financial frictions. Panel (a) and (b) show, respectively, the map for workers with low and high ability. In the benchmark without financial frictions, occupational choices and firm size are independent from initial wealth.